Sovereign Wealth Funds and Optimal Foreign Reserves*

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Abstract

In this paper, we study the relationship between sovereign wealth funds (SWFs) and the accumulation of foreign reserves. We develop a small open economy model in which households and firms borrow from banks that face collateral constraints and rely on external financing. The central bank optimally accumulates reserves based on the type of SWF–stabilization or savings–implemented by the government. When the SWF serves a stabilization function, foreign reserves and the SWF become imperfect substitutes in times of financial distress. As a result, the central bank accumulates fewer reserves when the SWF helps stabilize the economy. We provide cross-country evidence supporting the model's implications, emphasizing the crucial role of central banks' independence. Among the different stabilization policies considered, SWF-driven liquidity provisions to banks welfare-dominates direct transfers to households.

Keywords: Sovereign Wealth Fund, Foreign Reserves, Stabilization Policy
JEL Codes: E58, E63, F31, F41

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1 Introduction

In this paper, we address the question of how does the presence and specific objectives of a sovereign wealth fund (SWF), in an economy where the central bank decisions are independent of those of a central government, influences the optimal accumulation of foreign reserves. Furthermore, we explore the institutional arrangement of a SWF that better benefits the economy. This is, we analyze the mechanisms through which specific interactions between the SWF and the central bank reserves accumulation policy yield higher welfare. As a result, our analysis contributes to providing direct policy implications for foreign reserves management and the role of a SWF in the economy.

To motivate our work, Figure 1a shows the total value of foreign reserves in the world, and the total value of assets under management of SWFs. While the worldwide stock of foreign reserves increased 547% between 2000 and 2024, the stock of assets managed by SWFs increased by about 933% during the same period. By the end of 2024, countries worldwide were managing more assets under SWFs than through central banks in the form of foreign reserves.

While the literature has studied the strong build-up of foreign reserves since the 2000s by central banks around the world (Aizenman and Lee 2007; Bianchi and Lorenzoni 2022), less attention has been paid to the accumulation of assets by SWFs and, more importantly, its relationship with foreign reserves. Figure 1b shows the evolution of reserves and SWFs' assets relative to 2000. From the figure it is worth noticing that the official hoarding of foreign reserves slowed down following the global financial crisis, while the accumulation of assets under management of SWFs kept increasing. On average, are SWFs substitutes to foreign reserves? How do they interact with each other? What are the policy implications of this interaction? We answer these questions in our work.

In turn, despite the fact that SWFs are not officially considered as foreign reserves when

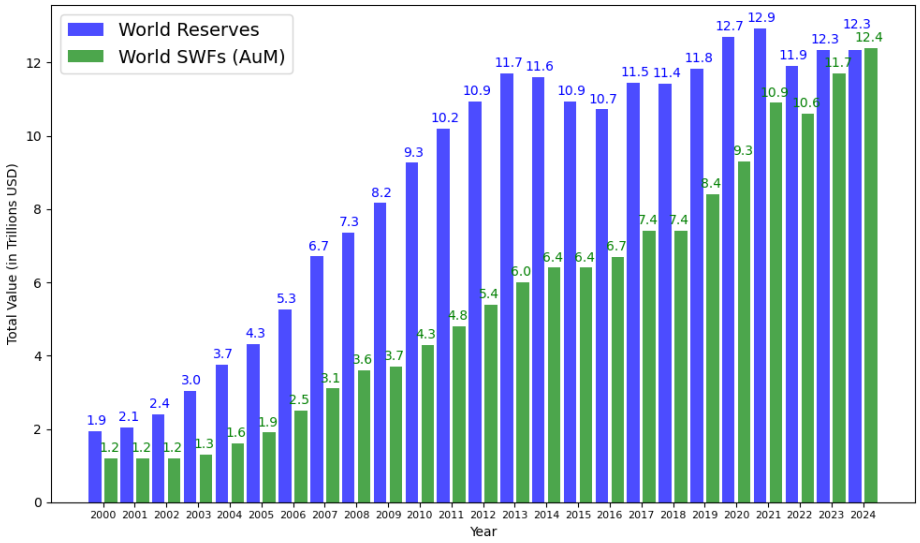
they are not in control of the central bank, they could have similar objectives under economic distress, such as a stabilization purpose. On the one hand, SFWs that have a savings long-term usage simply transfer resources to support structural goals such as pensions or infrastructure. On the other hand, stabilization SWFs may act during a crisis to support the economy. Specifically, this type of funds could be considered as a tool to deploy counter-cyclical fiscal policy in times of distress.[1] Therefore, considering that one crucial motive to accumulate foreign reserves is to insure the economy against a financial crisis (Jeanne and Rancière 2011; Calvo et al. 2013; Céspedes and Chang 2024), SWFs could be either substitutes or complements to foreign reserves, depending on their purpose.

We develop a two-sector (tradable and non-tradable) three-period small open economy model with financial frictions, building upon the framework of Céspedes and Chang (2024). The economy is inhabited by households, firms, banks, a central bank, and the government. The central bank accumulates reserves to mitigate the adverse effects of binding financial constraints, whereas the government accumulates assets through a SWF, which may serve different policy objectives. Crucially, the central bank is independent from the government in its decisions, choosing the optimal level of foreign reserves taking the government's actions as given.

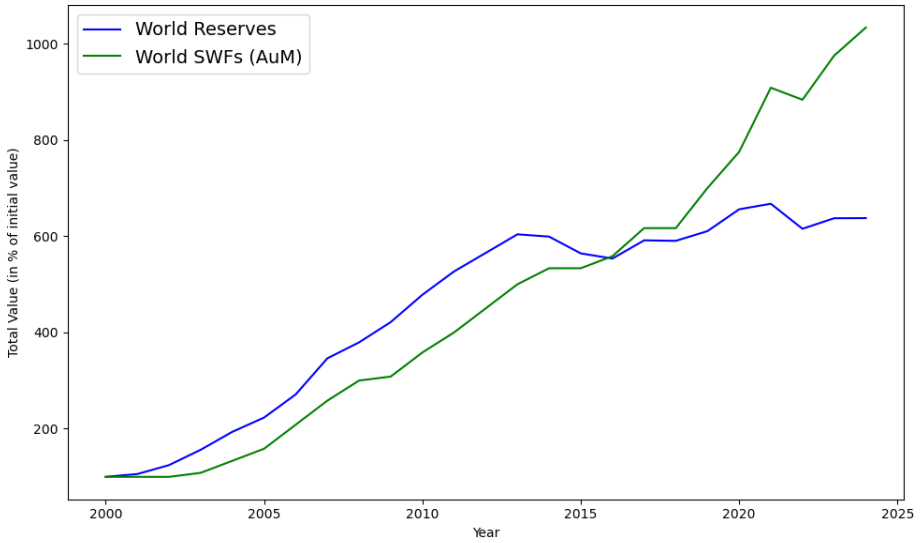
In this economy, banks borrow from abroad at a risk-free interest rate. Households and firms borrow from domestic banks to, respectively, consume and invest in capital to produce in the future. Banks have a balance sheet collateral constraint, which is subject to financial shocks that can make the constraint bind (i.e., a financial crisis). The central banks borrows by issuing long-term bonds abroad to buy reserves and intervene in the case of a crisis. This represents a cost to households that is paid for with taxes. Yet, it also has the potential benefit that, in the case of a crisis, the central bank may provide liquidity to banks, relaxing the constraint and stimulating the provision of credit in the economy.

[1] The IMF (2010) defines the the role of a SWF as: "...to finance future potential deficits...and, to smooth fiscal spending, or to finance regular extraordinary public debt amortization..."

Figure 1: Sovereign Wealth Funds and Foreign Reserves - Worldwide



(a) SWF and Foreign Reserves (USD trillions)



(b) Evolution of Foreign Reserves Relative to 2000

Note: The upper panel shows the global stock of foreign reserves and the total stock of assets under management by SWFs in USD trillions. The lower panel shows their evolution relative to their level in 2000. Sources: Own calculations based on López (2023), www.globalswf.com, and the IMF's COFER database.

A crucial aspect of our model is the government. We add it by defining a government that spends exogenous quantities funded with taxes. The government may be one of four different types: 1) No SWF. 2) SWF: Savings. This is, a SWF that does not intervene in case of a crisis, and gives a transfer to households in the final period. 3) SWF: Stabilization - Tax

Burden. A SWF that stabilizes the economy by providing direct transfers to households. 4) SWF: Stabilization - Banks Net Worth. A SWF that stabilizes the economy by providing liquidity to banks. Under plausible parametrizations, our model yields lower accumulation of reserves in regimes 3 and 4 than in regimes 1 and 2. These are, the regimes where there is a stabilization SWF yield a lower optimal lever of foreign reserves than a world with either no SWF or a savings SWF.

The main mechanism behind these results is that the tax burden of the household is a decreasing function of the SWF when it can stabilize the economy. Lower taxation leads households to borrow less, which in turn relaxes the collateral constraint. The central bank still stabilizes through foreign reserves but, given the lower probability of financial crisis due to the stabilizing SWF, it accumulates lower foreign reserves compared to a scenario without a stabilizing SWF. In this case, the SWF and foreign reserves are imperfect substitutes. To our knowledge, we are the first to provide theoretical framework that allows for the derivation of an independent central bank's optimal reserves policy in the presence of different types of SWFs. This the first main contribution of this paper.

We use our model to analyze if the type stabilization matters matters for the economy beyond reserves accumulation. We find that the policy that dominates in terms of welfare is a stabilizing SWF that injects liquidity to banks during a crisis. This creates ex-ante lower probability of crisis and stimulates further the provision of credit to both households and firms during the crisis. This is better than merely transferring resources to households, which does not directly affect the provision of credit to firms. These direct policy implications derived from the model are the second main contribution of our work.

Finally, we complement our theoretical work with cross-country evidence that points out in the direction of the model's predictions. For this purpose, we use a comprehensive novel dataset on the extensive margin of SWFs and their type, across countries and time, developed by Acosta-Henao, Martínez, and Rondón-Moreno (2025). The data cover 114 SWFs in 86

countries between 1970 and 2022. Crucially, the dataset provides a classification for each of the SWFs in the data according to their *de jure* description, such that it can be either a stabilization SWF or not.[2] We complement these data with relevant macroeconomic variables that the literature identifies as key in explaining the accumulation of foreign reserves. Among these variables, the central bank independence index–taken from Garriga (2024)–stands out. Since a crucial assumption in our model is the independence of the central bank from the government, we test empirically whether this characteristic of central banks is a relevant mechanism behind the empirical relationship between SWFs and foreign reserves, as in the model.

We estimate panel fixed effects specifications and show that, on average, countries with SWFs have less foreign reserves than countries without them. Furthermore, we show that this difference stems from stabilization SWF. Thus, having a stabilization SWF is the mechanism behind a lower accumulation of foreign reserves. This result supports the models' implication for the optimal accumulation of reserves, where having a stabilization SWF regime leads to lower reserves than an economy without it.

However, as we show in our estimates, this lower accumulation of reserves occurs for more independent central banks. The more independent a central bank is, the less foreign reserves it accumulates in the presence of a stabilization SWF, compared to countries with less independent central banks. This result underscores the crucial role of assuming an independent central bank in the model.

The empirical results provide suggestive cross-country evidence of the model's implications, without posing any causal claim. However, they shed light on what features are arguably the most relevant in determining a relationship between the presence of a SWF and the accumulation of foreign reserves. These are, the institutional arrangements of the SWF and the Central Bank. It is the type of fund what matters to determine the accumula-

[2]Non-stabilization SWF could have savings purposes to be transferred to households in the long term, strategic purposes, or other.

tion of foreign reserves rather than the mere presence of it, as well as degree of independence of the central bank. Providing this empirical evidence in support of the model's implications, is the third and last main contribution of our work.

Related literature. The question of why countries accumulate foreign reserves goes back, at least, to Heller (1966) who views reserves as an instrument to cover current account adjustments. Following the financial crises in emerging markets at the end of the nineties, foreign reserves where viewed as an appropriate self-insurance mechanism against the volatility of capital flows (Feldstein, 1999).

From a theoretical perspective, Jeanne and Rancière (2011) estimate the optimal level of reserves to insure an economy against financial dry-ups in international markets while Calvo et al. (2013) do the same in a statistical model. More recently, people have introduced foreign reserves into sovereign default models to study optimal reserves holdings and management when governments can default on their debt (Alfaro and Kanczuk 2009; Bianchi et al. 2018; Barbosa-Alves et al. 2024), while others have highlighted the role of reserves as a potential macroprudential instrument (Bianchi and Lorenzoni, 2022).

Our paper builds on Céspedes and Chang (2024), where reserves can be used to alleviate financial frictions. We explicitly introduce fiscal policy to this framework, to study what is the optimal response of a central bank in the presence of different types of SWF policies. We show that the way a government uses its SWF matters. Thus, it is not only about the size of the SWF, but also about the potential uses of these resources amid a financial crisis that affects the central bank's optimal level of reserves.

On the empirical front, several papers argue that countries build up their stock of reserves due to precautionary motives. Aizenman and Lee (2007) find that countries with greater capital mobility indices tend to have greater levels of reserves. Obstfeld et al. (2010) find a positive relationship between broad money and the level of reserves, which they interpret as evidence of the desire of central banks to protect domestic banks from *internal drains* by

having sufficient reserves.[3] Similarly, Ghosh et al. (2017) present evidence that the motives behind reserves accumulation have shifted from current account concerns in the eighties to capital and financial account risks in the 2000s. Closer to our paper, for a sample of twenty two countries, Aizenman and Glick (2009) show that foreign reserves holdings fall over time following the creation of a SWF. That is, if SWF have any impact on reserves, it is only observable in the long-term.

In response to the growing size of SWFs after the global financial crisis, a growing body of literature focusing on the structural characteristics of these funds has emerged (Gintschel and Scherer 2008; Megginson et al. 2013; Bortolotti et al. 2015; López 2023). There has been also great interest in understanding the macro-fiscal and macro-financial linkages of SWFs. For instance, Griffith-Jones and Antonio Ocampo (2012) explore the role of these funds in explaining the broader accumulation of foreign reserves in developing countries during the commodities boom of the late 2000s.

Our paper contributes to this empirical literature by showing that the relationship between SWFs and a central bank's foreign reserves does not depend on the presence of a SWF, but on the type of SWF that is established. Furthermore, this finding is explained by the degree of central bank independence, such that the inverse relationship between having a stabilizing SWF and accumulating reserves holds for countries with independent central banks. We find, consistent with the view that reserves are accumulate for precautionary motives, that central banks hold less amounts of reserves when the SWF also has stabilization objectives.

The rest of the paper is organized as follows: The second section describes the model. The third section analyzes the optimal level of reserves for different SWF regimes and their welfare implications. The fourth section provides cross-country empirical evidence supporting the main results of the model. The fifth section concludes.

[3] An internal drain is defined as an event where domestic residents withdraw their resources from the economy and buy assets abroad (capital outflows).

2 Model

In this section, we examine the central bank's optimal level of foreign reserves following the introduction of a Sovereign Wealth Fund (SWF). We develop a theoretical framework in which, given an SWF and its type—stabilization or savings—the central bank endogenously accumulates foreign reserves and intervenes during financial crises. This framework provides a theoretical foundation for analyzing the optimal reserve accumulation in the presence of an SWF and across its different types. Additionally, it serves as a valuable tool for assessing how an SWF should be best utilized for stabilization purposes, comparing the welfare implications of different stabilization policies.

Our model builds on the three-period small open economy model of Céspedes and Chang (2024), in which households and firms borrow from banks that, in turn, obtain funding from international markets to finance consumption and production. External borrowing by banks is subject to a collateral constraint, which also defines the borrowing capacity of domestic agents. When this constraint binds, domestic agents are unable to secure sufficient external funding, forcing them to reduce investment and consumption in equilibrium. We refer to this last scenario as a financial crisis in the economy.

As in Céspedes and Chang (2024), foreign reserves in our model function as a welfare-improving instrument by serving as a liquidity support policy, which helps relax collateral constraints and facilitates higher levels of consumption and investment. In this framework, the central bank determines the optimal level of reserves by balancing these positive effects against the cost of reserve accumulation.

We extend this framework by introducing fiscal policy into the model. The government finances transfers and public expenditure using its initial endowment and by collecting lump-sum taxes from households. This endowment, which can be interpreted as windfall income from past commodity exports, enables the establishment of a Sovereign Wealth Fund (SWF)

with a specific policy objective.

The SWF policy determines the type of fund—either stabilization or savings. On the one hand, if designed for stabilization, the fund can be used during financial crises to either provide liquidity to banks or direct transfers to households. On the other hand, if the SWF is defined as a savings fund, its sole purpose is the intergenerational transfer of wealth, ensuring the distribution of its resources over the very long term.

Importantly, this analysis does not model an optimizing central government. Instead, it examines how the central bank's demand for foreign reserves responds to predetermined SWF policies. This framework relies on two key assumptions. First, foreign reserves and fiscal policy are determined by separate institutions—the central bank and the government. Second, the central bank operates independently, selecting its optimal level of foreign reserves while treating fiscal policy as exogenously given in each scenario. Conversely, fiscal policy follows an exogenous path, unaffected by the central bank's decisions. Thus, in the terminology of the monetary policy literature, foreign reserves are "passive", while fiscal policy is "active".

2.1 Environment

Our model considers a three period ($t = 0, 1, 2$) small open economy, featuring tradable and non-tradable goods and borrowing from international markets. The economy consists of five agents: households, firms, banks, the central bank, and the government. Our model embeds the model of Céspedes and Chang (2024), such that in the special case where there is no government—hence no SWF—our model collapses to theirs, eliminating the role of fiscal policy.

2.1.1 Households

Households consume only tradable goods at the initial period ($t = 0$) and at the final period ($t = 2$), with preferences given by $U(C_0) + \beta E(C_2)$ where C_t denotes consumption of tradables in period t, $U(\cdot)$ is a CRRA function, and $E(\cdot)$ is the expectations operator.

Households own banks and firms, of which last period's profits are household's sole sources of income, denoted by Π_b and Π_f, respectively. Thus, households borrow tradables L_0^H from domestic banks at a gross interest rate R_0 to finance both consumption and lump-sum taxes (τ_0) at $t = 0$.

$$L_0^H = C_0 + \tau_0$$

At $t = 1$, households borrow L_1^H at a gross rate of R_1, again, from domestic banks to pay their initial debt and finance any taxes that are collected by the government in this period.

$$L_1^H = R_0 L_0^H + \tau_1$$

Importantly for our analysis, note that a part of L_1^H is determined by what households need to pay the government via taxes in both $t = 0$ and $t = 1$. Thus, we define households tax burden at $t = 1$ with τ_b, given by $\tau_b \equiv R_0\tau_0 + \tau_1$. We allow for τ_b to be negative, in which case the government provides a net transfer of resources to households.

In the final period, households receive Π_f and Π_b, pay off their debts and remaining taxes, and consume whatever they have left. Therefore, household's budget constraint in the final period is given by

$$R_1 L_1^H + \tau_2 + C_2 = \Pi_f + \Pi_b$$

When choosing how much to consume at $t = 0$, households take as given interest rates as well as profits. Moreover, there are no frictions at $t = 0$, making R_0 equal to the international interest rate, R_0^*. However, this is not the case at $t = 1$. Since domestic banks are subject

to collateral constraints, it is possible for the domestic gross rate, R_1, to be greater than the international gross rate, R_1^*, at $t = 1$. Hence, households make decisions at $t = 0$ based on their expected cost of rolling over their debt at $t = 1$. By denoting this expectation as $E(R_1)$, households optimal initial consumption is determined by the following Euler Equation

$$U'(C_0^*) = \beta R_0^* E(R_1) \tag{1}$$

At this point, it is worth highlighting that households' decision is not directly affected by fiscal policy since we are assuming lump-sum taxes. Thus, regardless of τ_b, households will borrow from domestic banks enough to pay τ_b and consume C_0^*.

However, in equilibrium, fiscal policy may crowd out household consumption. As shown below, under certain conditions, a larger τ_b may imply the collateral constraint of domestic banks binds in some states of the economy, leading to an value of $E(R_1)$ greater than R_1^*. In this case, households are underborrowing and consuming at inefficiently low levels.

2.1.2 Firms

Domestic firms produce Y_2 quantities of tradable goods at $t = 2$ using capital, K_2, they bought at $t = 1$ at a unit price of Q_1. To acquire this capital, firms borrow $L_1^f = Q_1 K_2$ from domestic banks. Thus, firms' profits are given by

$$\Pi_f = Y_2 - R_1 Q_1 K_2$$

where the output is a decreasing returns to scale function of the form $Y_2 = ZK_2^\alpha$ with $0 < \alpha \leq 1$, and R_1 is the loan's financial cost.

A competitive firm, as a price taker, buys capital until its marginal product is equal to its marginal cost. In this case, the marginal cost of capital is equal to the product of its price times the gross domestic interest rate of the loan. Therefore, the optimal demand for

capital is given by

$$K_2^d = \left(\frac{\alpha Z}{R_1 Q_1} \right)^{\frac{1}{1-\alpha}} \tag{2}$$

Capital, in turn, is produced in period 1 using tradables and non-tradables, denoted by I_W and I_H. More specifically, the production of capital follows a Cobb-Douglas aggregator of the form $K_2 = \frac{1}{\gamma^\gamma (1-\gamma)^{1-\gamma}} I_H^\gamma I_W^{1-\gamma}$, implying that the price of capital in terms of tradables is equal to

$$Q_1 = X_1^\gamma$$

where X_1 is real exchange rate of this model, and that the optimal demand for tradables and non-tradables is, respectively, equal to

$$I_W = (1-\gamma) Q_1 K_2 \quad \& \quad I_H = \gamma (Q_1 / X_1) K_2 \tag{3}$$

2.1.3 Banks

Domestic banks act as intermediaries between the economy and international markets. All loans between banks and private domestic and foreign agents have a maturity of one period. At $t = 0$, banks lend an amount L_0 of tradables to households, at the domestic interest rate R_0, which they finance by borrowing D_0 from international markets at the world rate R_0^*. Thus, the initial period budget constraint is given by

$$L_0 = D_0$$

At the beginning of $t = 1$, banks collect $R_0 L_0$ from households, borrow again from international markets D_1 at interest rate R_1^*, and receive an endowment comprised of tradables (T), and non-tradables (N). Then, banks use these resources to pay back debt acquired in the initial period ($R_0^* D_0$), and finance an amount L_1 of new loans to households and domestic

firms. Banks budget constraint at $t = 1$ is equal to

$$L_1 + R_0^* D_0 = R_0 L_0 + T + X_1 N + D_1$$

In the last period, banks recoup $R_1 L_1$ from domestic agents and transfer profits to households. Thus, profits, which we denote by Π_b, are given by

$$\Pi_b = R_1 L_1 - R_1^* D_1$$

2.1.4 Collateral Constraint

Contracts between domestic banks and foreign investors are subject to an incentive compatible constraint (ICC). Specifically, we assume that bank profits should be greater or equal to a fraction θ of banks final period income. That is,

$$\Pi_b \geq \theta R_1 L_1 \qquad (ICC)$$

This type of constraint emerges naturally in environments where incentives between the lender–in this case the foreign lender–and the borrower–the domestic bank–are not aligned. Therefore, in any incentive compatible contract the lender needs to guarantee that the borrower obtains a minimum fraction of profits such that optimal behavior by the latter is aligned with the objective function of the former.[4]

The ICC in the final period defines a collateral constraint for domestic borrowing at $t = 1$. To see this, replace banks $t = 1$ budget constraint and the definition of Π_b in the ICC, and after some reorganization we obtain Equation 4. This equation underscores that this economy's external private borrowing at $t = 1$ is limited by the share of endowment that is *credibly pledgeable* to foreigners.

[4]See Holmström and Tirole (2011) for a greater discussion.

$$D_1 \leq \frac{R_1(1-\theta)}{R_1^* - R_1(1-\theta)} (T + X_1 N) \tag{4}$$

We assume that fraction θ is a *random variable* whose realization occurs at the start of $t = 1$, and determines the fraction of the domestic interest rate that is pledgeable to international markets, $R_1(1-\theta)$.[5]

2.1.5 Government

We model a government that needs to finance an *exogenous* expenditure path $\{G_0, G_1, G_2\}$. To do so, the government receives an initial endowment of tradables, denoted by A, and has the ability to tax households in every period.

The government's fiscal policy is characterized by a sequence of taxes in each period (τ_t for $t = 0, 1, 2$) and the policy choice of how much to save between periods 0 and 1 (s_0), and periods 1 and 2 (s_1). We denote a fiscal policy as set Γ that contains elements $\{\tau_0, \tau_1, \tau_2, s_0, s_1\}$.

Although we do not model an optimizing government, we only evaluate sets Γ that satisfy the government intertemporal budget constraints (Equation 5). This equation shows that feasible Γ's are those where the present value of taxes to households plus the initial endowment is equal to the present value of net government expenditures where the latter includes a transfer to the central bank due to the cost of accumulating reserves ($\tau^* F$).

$$A + \tau_0 + \frac{\tau_1}{R_0^*} + \frac{\tau_2}{R_0^* R_1^*} = G_0 + \frac{G_1}{R_0^*} + \frac{G_2}{R_0^* R_1^*} + \tau^* F \tag{5}$$

[5]Random variable θ is the only source of uncertainty in the model for which we assume that it can take n values, denoted by θ_s, $s = 1, ..., n$, between $\theta_L = \theta_1 > 0$ and $\theta_H = \theta_n < 1$, plus each θ_s with probability $\pi_s > 0$ where $\sum_{i=1}^{n} \pi_s = 1$.

2.1.6 Central Bank

We model a central bank that has access to long-term debt at $t = 0$ and can act as a lender of last resort at $t = 1$. Its only policy instrument is to provide liquidity in tradable goods to domestic banks when the economy remains in a crisis after all agents, including the government, have implemented their actions. However, to provide tradables at $t = 1$, it needs to preemptively accumulate them in the initial period.[6]

Specifically, we assume that the central bank can borrow a quantity F of tradables at $t = 0$ from international markets by issuing long-term debt. This debt has to be paid back in full in the final period with a financial cost equal to $R_0^* R_1^* (1 + \tau^*)$, where we interpret τ^* as the term premium.

Once the central bank issues its debt at $t = 0$, it immediately lends F back to foreign borrowers in international markets in exchange for a one-period return equal to R_0^*. Thus, the central bank starts $t = 1$ with an foreign reserves stock equal to $R_0^* F$ which can be used to lend again at the world rate R_1^*, either to foreign borrowers or, if necessary, to domestic banks.

In the final period, the central bank collects $R_0^* R_1^* F$ to pay back its outstanding long-term debt. Since the amount that the central bank collects is not sufficient to fully redeem its debt, we assume that the remainder–equal to $\tau^* R_0^* R_1^* F$–is paid using a transfer from the government.

2.2 Equilibrium

In equilibrium, Equation 4 can bind for some states of θ. In particular, note that for a given R_1, the economy's pleadgeability falls with high realizations of θ. As a result, high θ's are states with relatively tighter external financial conditions for this economy, increasing

[6] Note that we are excluding the possibility of the C.B to issue short-term debt at $t = 1$. This assumption is necessary to generate a positive official demand for reserves.

the likelihood of a binding collateral constraint.

Let's start by considering a value of θ such that the collateral constraint is not binding at $t = 1$. In this state, domestic banks lend to their economy at the world rate,[7] and the real exchange rate, the price of capital, and the level of capital are at their frictionless levels. We denote these levels as X_{1f}, Q_{1f}, and K_{2f}, respectively.

For a given C_0, chosen at $t = 0$, and τ_b, set by the government, the demand for domestic loans when the constraint is not binding is given by

$$L_{1f} = L_{1f}^H + L_{1f}^F$$
$$L_{1f} = R_0^* C_0 + \tau_b + Q_{2f} K_{2f}$$

In equilibrium, the constraint does not bind for a given θ as long as the demand for domestic loans L_{1f} is less than a multiple $\frac{1}{\theta}$ of banks net worth evaluated with X_{1f}. As shown by Céspedes and Chang (2024), it is possible to determine an endogenous threshold of θ, namely $\hat{\theta}$, such that the constraint is not binding if $\theta \leq \hat{\theta}$, and is binding otherwise. To find $\hat{\theta}$, we set L_{1f} equal to $\frac{1}{\hat{\theta}}(T + X_{1f} N)$ to get

$$\hat{\theta} \equiv \frac{T + X_{1f} N}{R_0^* C_0 + Q_{2f} K_{2f} + \tau_b} \tag{6}$$

Equation 6 shows that greater consumption C_0 and, more importantly, a greater tax burden reduces $\hat{\theta}$. This is, a greater tax burden increases the probability of a crisis in this economy. Conversely, if higher taxes on households increase the probability of a crisis, then lower taxes reduce it. Therefore, there is room for fiscal policy to have an beneficial effect over $\hat{\theta}$.

[7] This is the case of the initial period ($R_0 = R_0^*$) since, by assumption, D_0 is not subject to a collateral constraint.

If we consider states of θ where the collateral constraint is binding, the economy can increase its pledgeable net worth and attract more foreign lending, by raising the domestic interest rate, R_1, above the world rate, R_0^*. At the same time, a greater R_1 reduces the optimal demand for capital, (Equation 2) which implies lower borrowing taken by domestic firms. Thus, a spread in interest rates simultaneously attracts more external resources and curbs domestic borrowing. In this scenario, for any possible level of external borrowing, R_1 endogenously adjusts to guarantee that Equation 4 binds.

Competitive equilibrium. A competitive equilibrium with foreign reserves and fiscal policy is given by $C_0 \geq 0$, $F \geq 0$, a Fiscal Policy set Γ and, for all possible states (of θ and hence of the economy) $s = 1, 2, ..., n$, $R_{1s} \geq R_1^*$, and non-negative K_{2s}, Q_{1s}, X_{1s}, and I_{Ws} that satisfy Equations 1, 2, 3, 4, 5, and

$$C_{2s} = ZK_{2s}^{\alpha} + R_1^*T - R_1^*I_{Ws} - R_0^*R_1^*C_0 - R_1^*\tau_b - \tau_2 \tag{7}$$

$$\frac{R_1^*}{R_1^* - (1-\theta_s)R_{1s}}[T + X_1N + R_0^*F] - (R_0^*C_0 + Q_{1s}K_{2s} + \tau_b) \geq 0, = \text{if } R_{1s} > R_1^* \tag{8}$$

The central bank, which takes as given C_0 and Γ, chooses F to maximize households lifetime utility. This is done by comparing the utility of each competitive equilibrium for all the different levels of F.

Equation 8 highlights the two different policies that can be used to relax the economy's financial constraint. The first policy is liquidity provision using reserves, a policy that increases banks net worth and, through this channel, domestic lending. The second policy consists of measures to reduce households tax burden from periods 0 and 1.

Now that we have defined the competitive equilibrium conditions, we proceed to analyze the optimal foreign reserves policy and its interaction with the SWF. Two assumptions are key for the following analysis. First, when maximizing, the central bank takes as given the fiscal policy set–Γ–and, second, it acts as a lender of last resort.

3 SWF Policy and the Optimal Level of Reserves

In this section, we explore the qualitative outcomes of our model via simulation analysis. We parameterized the model to assess how various sovereign wealth fund (SWF) policies influence the optimal levels of foreign reserves and their associated welfare implications. Additionally, we conduct counterfactual scenario analyses and sensitivity tests.

In our benchmark, we set most of the parameters equal to those in Céspedes and Chang (2024). The world real interest rate, R_t^*, is set to one in both periods 0 and 1. The share of the non-tradable input in the capital production function, γ, is 0.5. We assume the weight of capital in the production function for tradable goods, α, to be 0.8. Regarding the household's preferences, we set the intertemporal discount factor, β, to 0.95, and the elasticity of substitution in consumption, σ, to 2. For the parameter θ, we assume a uniformly distributed grid with 150 points ranging from 0.3 to 0.8. Similarly, we define an equally spaced grid for foreign reserves with 150 points between 0 and 2. The Bank's non-tradable endowment is set to 1, and the tradable endowment is set to 0.2. We assign a value of 2 to the productivity of capital, Z, to ensure that the frictionless marginal productivity of capital is greater than 1.

For the parameters in the fiscal rule, we set government expenditures, G equal to 0.3 in each period, and the size of the SWF, A, to 0.1. The term premium of holding reserves, τ, is equal to 0.02. We perform extensive sensitivity analysis about the value of these parameters to study their role in determining the interaction between the presence of the SWF, its policy, and the optimal level of foreign reserves. Table 1 summarizes our parametrization of the model.

Table 1: Summary of Model Parameters

Parameter Name	**Symbol**	**Value/Range**
Structural Parameters		
World real interest rate	R_t^*	1 (both periods)
Share of non-tradable input in capital production	γ	0.5
Weight of capital in tradable goods production	α	0.8
Intertemporal discount factor	β	0.95
Elasticity of substitution in consumption	σ	2
Bank's non-tradable endowment	N	1
Bank's tradable endowment	T	0.2
Productivity of capital	Z	2
Government expenditures	G	0.3 (each period)
Size of Sovereign Wealth Fund	A	0.1
Term premium of holding reserves	τ	0.02
Grid Parameters		
Grid points for θ	θ	150 points, range [0.3, 0.8]
Grid points for foreign reserves	F	150 points, range [0, 2]

3.1 The Laissez-Faire Equilibrium

To analyze the Laissez-Faire equilibrium (LF)–i.e. the one corresponding to an equilibrium without any type policy intervention during a financial crisis–it is worth noticing that economy in our model is distorted by the financial friction and the effects of wasteful government spending. In consequence, initial consumption, C_0, is contingent on both the realization of θ_s, and the *tax burden* implied by the government's expenditure path in the absence of a SWF, which is

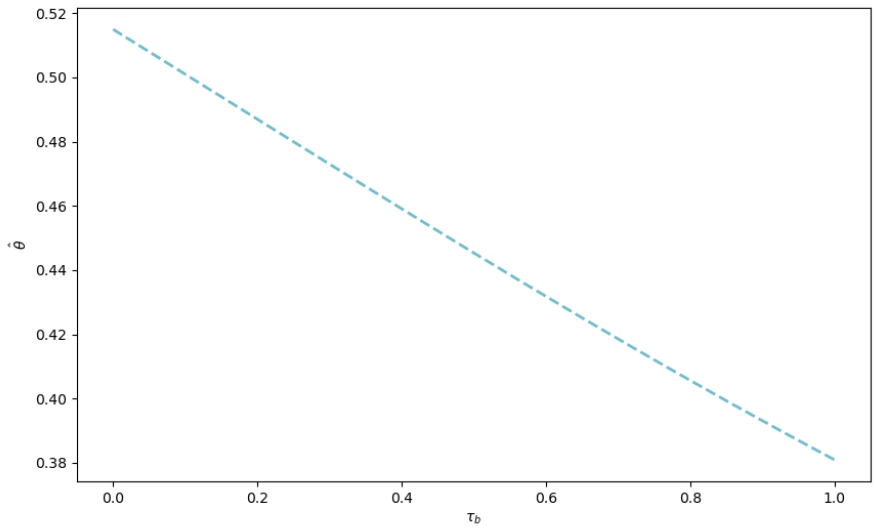
$$\tau_b^{LF} = R_0^* G_0 + G_1$$

As shown before, the threshold $\hat{\theta}$ in the LF model is given by:

$$\hat{\theta}_{LF} = \frac{T + X_1 * N}{R_0^* C_0 + Q_1 K_2 + \tau_b}$$

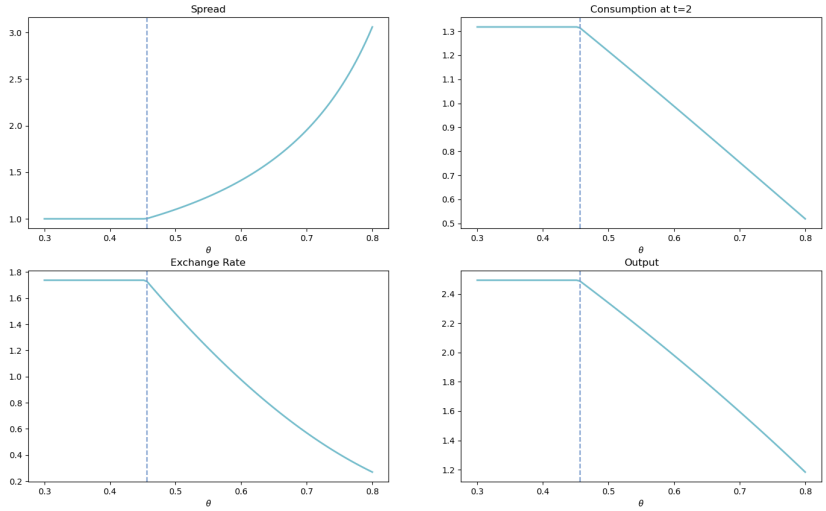
Figure 2 shows that $\hat{\theta}$ is a decreasing function τ_b. As households pay higher taxes, their optimal consumption in period 0 falls but their borrowing needs increase as they need to finance their tax payments. Higher aggregate debt moves the economy closer to facing a binding collateral constraint. In our benchmark parametrization, the threshold $\hat{\theta}_{LF}$ in this equilibrium is 0.45 with a tax burden equal to 0.6. Figure 3 illustrates the aggregate effects of a financial crisis. Once the constraint binds, spreads increase and the real exchange rate depreciates, increasing the cost of domestic borrowing. This forces firms to reduce investment which, in turn, lowers output. As a result, consumption falls. A representative household in a LF economy would experience a welfare gain equivalent to 18.5 percent of lifetime consumption from switching to a frictionless economy.

Figure 2: Threshold $\hat{\theta}$ as a Function of the *Tax Burden*



Note: In this plot, the LF equilibrium is solved for a grid of values $G_t \in [0, 0.5] \; \forall \; t = 0, 1, 2$. For each case, we assume that $G_0 = G_1 = G_2$.

Figure 3: Laissez-Faire: Financial Crises



Note: Laissez-Faire equilibrium for different values of θ. Benchmark parameterization.

3.2 The Central Bank, Foreign Reserves Policy and the Government with no SWF

We now turn to analyze an equilibrium in an economy with an optimal response from the central bank, by accumulating foreign reserves and intervening, in the absence of a SWF. In an economy where the government does not have a SWF, its expenditures are financed with the tax policy: $\tau_0 = G_0$, $\tau_1 = G_1$, $\tau_2 = G_2 + \tau^* R_0^* R_1^* F$. Therefore, the *tax burden* in this economy, namely τ_b^{RR}, remains equal to the amount the household needs to borrow in order to pay for taxes. This is, $\tau_b^{RR} = \tau_b^{LF}$.

Akin to Céspedes and Chang (2024), the central bank in this economy can mitigate the effects of financial friction if it has access to international liquidity markets. Contingent on the costs of accumulating reserves, τ^*, the central bank can borrow sufficient resources to strengthen the balance sheet of domestic banks. In an equilibrium with a foreign reserves

policy, the threshold $\hat{\theta}$ is characterized by:

$$\hat{\theta} = \frac{T + X_1 * N + R_0^* F}{R_0^* C_0 + Q_1 K_2 + \tau_b} \tag{9}$$

Taking the government's fiscal policy as given, the central bank can relax the collateral constraint by lending banks $R_0^* F$, allowing them to use these resources to leverage their borrowing. Figure 4 shows that, as the central bank accumulates more foreign reserves, the threshold $\hat{\theta}_{RR}$ increases, eventually reaching a point where the probability of facing a binding collateral constraint becomes zero. In fact, if the cost of accumulating reserves were zero, the central bank's solution would be trivial.

In our benchmark parameterization, we set $\tau^* = 0.02$, and the central bank chooses the level of foreign reserves that maximizes the household's expected discounted utility, taking this cost into account. Consequently, the optimal level of foreign reserves is 32 percent of GDP, which increases $\hat{\theta}_{RR}$ to 0.71, compared to $\hat{\theta}_{LF} = 0.45$, and lowers the probability of facing a financial crisis from 73 percent in the LF equilibrium to 17.3 percent.

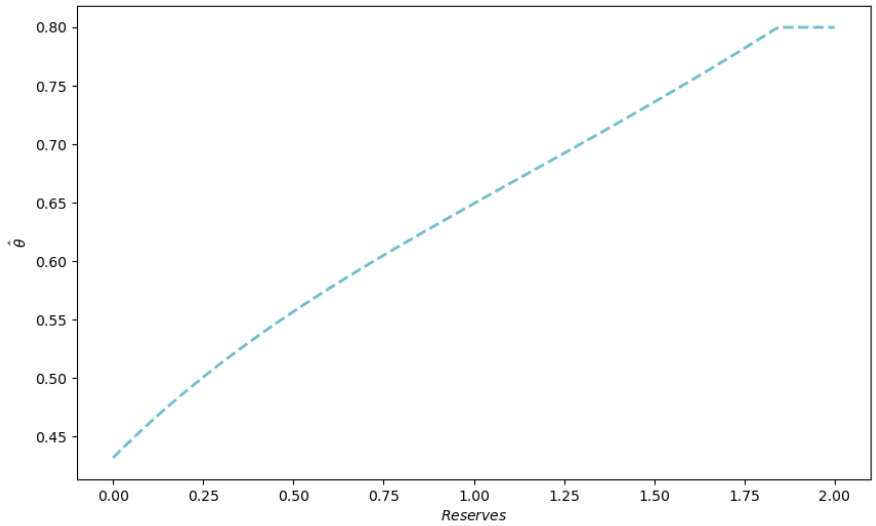
The central bank is capable of mitigating most, but not all, of the externality created by the collateral constraint. The welfare gain of transitioning from this economy to a frictionless one would be 12 percent of lifetime consumption, which indicates that households are better of than those in the LF economy because their lifetime utility is closer to that in the frictionless world.. At this point, 90 percent of the remaining welfare difference is explained by the inefficiency in consumption created by our assumption of wasteful fiscal spending.

3.3 SWFs and Central Banks's Foreign Reserves Policy

To introduce the presence of a SWF into our model, we examine several fiscal policies that correspond to different types of SWFs documented across countrys.[8] First, we study a

[8] In section 4 below, explain the different types of SWFs and provide evidence of their presence, by type, across countries.

Figure 4: Threshold $\hat{\theta}$ as a Function of Foreign Reserves



Note: In this plot, the central bank implements foreign reserves policy to provide liquidity to banks in periods where the collateral constraint would bind otherwise. For numbers above the upper-bound of the distribution of θ, the probability of a financial crises is zero.

SWF dedicated exclusively to transferring wealth to future generations. This fund functions as a Savings SWF, where resources are allocated for long-term distribution and not used for any other purpose. Next, we consider two approaches to implementing a SWF aimed at stabilizing the economy during periods of financial stress. For each scenario, we assess the impact of the SWF on the optimal level of foreign reserves and the associated welfare implications.

3.3.1 Savings SWFs

Consider now a Savings SWF, such that it has no explicit obligations other than the inter-temporal redistribution of wealth. This type of funds include examples like Singapore's Government Investment Corporation (GIC Private Ltd) and Korea's Investment Corporation (KIC).

In this world, the government receives A as an endowment in period $t = 0$ and invests it in international markets at a return rate of R_t^* for $t = 0, 1$. In period 2, the government

redistributes the SWF to households as a tax subsidy. Therefore, the tax path consistent with the fiscal rule and using A as a savings SWF is:

$$\tau_0 = G_0,\ \tau_1 = G_1,\ \tau_2 = G_2 + \tau^* R_0^* R_1^* F - R_0^* R_1^* A$$

In this case, the presence of the fund does not have any stabilization effects since the *tax burden* in this economy, $\tau_b^{sav} = R_0^* \tau_0 + \tau_1$, remains the same as in the LF equilibrium. The central bank chooses the same foreign reserves policy as in the previous case (32 percent of GDP), and the economy faces the same likelihood of financial crises. However, the welfare implications are significantly different.

A household in the frictionless equilibrium enjoys 5.13 percent more lifetime consumption than a household in this equilibrium, which is about 7 percentage points less than in the model with reserves but without a SWF. In other words, households in this economy are better off than those in the economy with foreign reserves policy by the central bank but no SWF. This welfare gain is driven by the wealth transfer from the savings SWF in the final period, which helps reduce the tax-induced distortions. Approximately 80 percent of the remaining welfare loss is due to the tax burden, with the remaining 20 percent stemming from the cost of holding reserves.

3.3.2 Stabilization SWFs: Counter-Cyclical Policy

Now we turn to analyze the role of a stabilization SWF. A stabilization SWF acts as a buffer to insulate the economy from market shocks.[9]

The first type of stabilization fund we study is the one implementing a counter-cyclical policy. In normal times, the SWF remains inactive and resources are saved for redistribution in the last period. However, in times of financial distress, the fund subsidizes the household

[9]See López (2023) for a similar conception of stabilization SWF.

through fiscal transfers. If the financial constraint binds, fiscal policy is given by:

$$\tau_0 = G_0,\ \tau_1 = \max\left(0,\ G1 - R_0^* A\right),\ \tau_2 = G_2 + \tau^* R_0^* R_1^* F - \max\left(0,\ R_1^*(R_0^* A - G_1)\right)$$

The household's tax burden in this economy is:

$$\tau_b^{stab} = R_0^* \tau_0 + \max\left(0,\ G1 - R_0^* A\right)$$

This burden is a decreasing function of the size of the SWF, A. As the government reduces tax duties, the household requires less financing, which in turn relaxes the collateral constraint. Given the intervention of the SWF, the central bank still employs an foreign reserves policy to stabilize the economy if the government efforts are not sufficient to avoid facing a binding financial constraint. Due to the effort of the SWF to stabilize the economy, the central bank chooses to accumulate less foreign reserves than in the previous two scenarios. Specifically, in our benchmark parameterization, the optimal level of foreign reserves in this economy is 28.7 percent of GDP—3.3 percentage points lower than in the previous scenarios.

Given the actions of the SWF and the central bank, stabilization is achieved through both the the numerator and denominator of Equation 9. Compared with the two previous scenarios, this additional effort reduces the probability of financial crises slightly, bringing it down to 17.2 percent. The welfare gain for a household in this economy transitioning to a frictionless economy is approximately 10 percent of lifetime consumption—about 2 percentage points less than in the equilibrium without a SWF, but 5 percentage points more than in the equilibrium with the savings SWF. This implies that households are better off in this economy than in the world with foreign reserves policy and no SWF, but worse off than in the economy with a savings SWF instead of this type of stabilization SWF.

The welfare gains of the counter-cyclical stabilization SWF relative to a LF economy, and to an economy with foreign reserves policy and no SWF, are primarily driven by the

reduction of the externality created by taxation. However, these results indicate that, given the presence of a central bank willing to intervene during financial crises, the timing of fiscal transfers is crucial.

3.3.3 Stabilization SWFs: Liquidity Provision

As an alternative to counter-cyclical stabilization, the SWF could implement a policy that directly provides liquidity to banks, similar to the actions of a central bank during financial crises. In this scenario, the resources of the SWF would clearly function as a substitute for foreign reserves, as there is no cost associated with their use.

If the collateral constraint is binding in period $t = 1$, the SWF can lend resources to banks at the international interest rate, R_1^*. Banks can use this resources, in addition to the loans provided by the central bank, to leverage their borrowing in international markets. In this case, Equation 8 now becomes:

$$\frac{R_1^*}{R_1^* - (1-\theta_s)R_{1s}}[T + X_1 N + R_0^* F + R_0^* A] - (R_0^* C_0 + Q_{1s} K_{2s} + \tau_b) \geq 0, = \text{if } R_1 > R_1^* \quad (10)$$

As Banks fully repay their loans in period $t = 2$, the fiscal policy implemented by the government follows the path:

$$\tau_0 = G_0,\ \tau_1 = G_1,\ \tau_2 = G_2 + \tau^* R_0^* R_1^* F - R_1^* R_0^* A$$

Therefore, the household receives the same wealth transfer in $t = 2$ as in the economy with the savings SWF. Since the tax burden in this economy, τ_b^{liq}, is not affected by the SWF's intervention, $\tau_b^{liq} = \tau_b^{sav}$. Furthermore, in equilibrium, the threshold $\hat{\theta}_{liq}$ is defined by:

$$\hat{\theta}_{liq} = \frac{T + X_1 * N + R_0^*(F + A)}{R_0^* C_0 + Q_1 K_2 + \tau_b^{sav}} \quad (11)$$

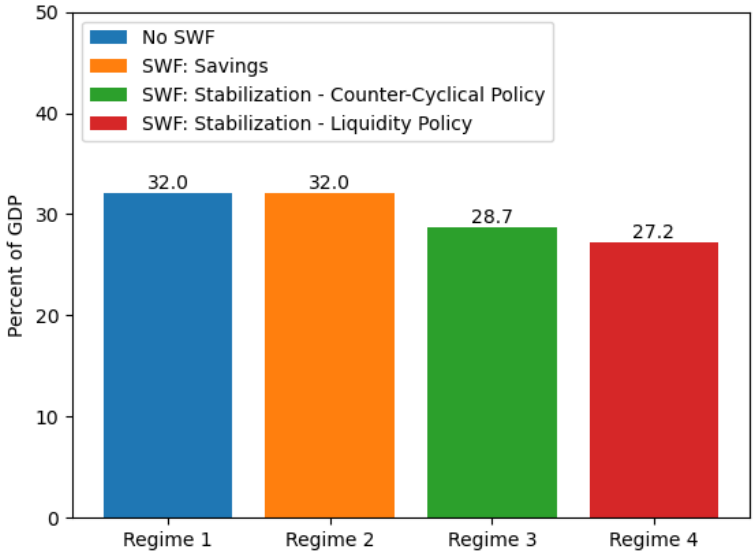
With this type of stabilization fund, the central bank chooses about 27 percent of GDP as foreign reserves—1.5 percentage point less than in the economy where the SWF stabilizes the cycle with direct transfers to households. Given the SWF's intervention and the marginal cost of using reserves, the central bank opts to rely more on the SWF, substituting away from borrowing foreign liquidity.

The substitution between the SWF and foreign reserves, F, slightly increases the probability of financial crises to 17.5 percent. However, the combined effort of the central bank and the SWF to stabilize the economy also reduces fiscal and financial distortions, resulting in a similar welfare loss-5.07 percent of lifetime consumption-as in the economy with the savings SWF.

Taking stock of the model's main results. Figure 5 summarizes the results for the optimal level of foreign reserves in each of the three SWF regimes and the regime withouth a SWF. The first regime, corresponds to the case where there is a foreign reserves policy implemented by the central bank, in absence of a SWF. The second regime is that with a savings-type SWF. As mentioned above, in these two economies, the foreign reserves to GDP ratio is the same. Regimes 3 and 4 correspond to those with a stabilizing SWF. While in the former regime the SWF stabilizes the economy by providing direct transfers to households in case of financial distress, in the latter the SWF provides liquidity to banks. Regardless of the type of stabilization, *an economy with a stabilizing SWF has a lower reserves to GDP ratio than an economy without it* (either because it only has a savings SWF or because it does not have any SWF at all). This is the first main result of our model.

In terms of welfare, the best regime is the one that is closer to the frictionless economy. This is, the regime where the household has lower welfare gains of transitioning from a world under a given regime to the frictionless world. As mentioned above, the regime with the savings fund, and the one with the stabilization fund that provides liquidity to banks in crisis times are both tied as the best regimes in terms of welfare.

Figure 5: Optimal Foreign Reserves as % of GDP



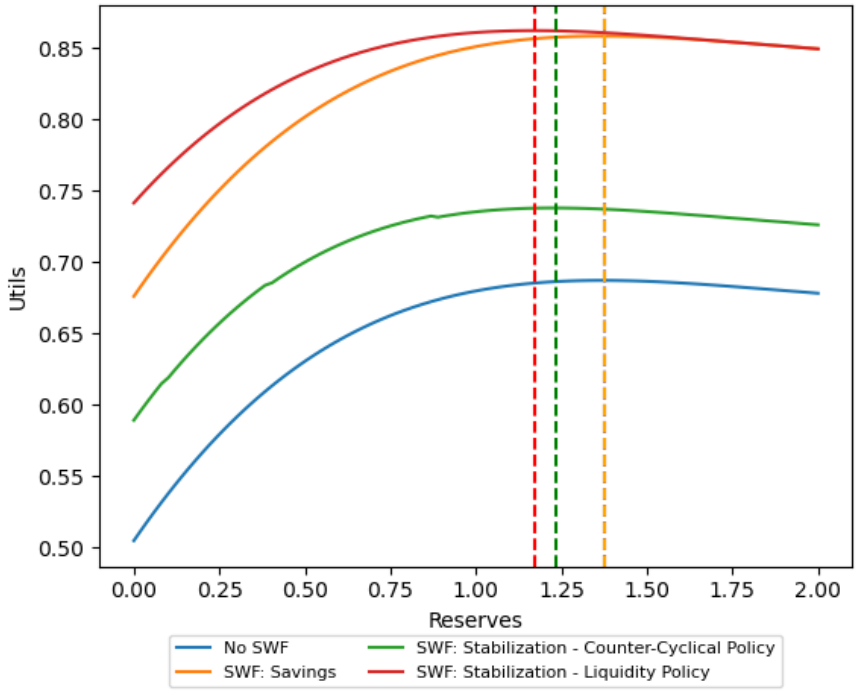
Note: In this plot, we compare the optimal level of foreign reserves chosen by the central bank while implementing the F-Reserves policy. The central bank takes as given the government's use of the SWF.

Figure 6 compares the household's expected discounted utility across different regimes relative to the amount of foreign reserves held by the central bank. The vertical lines correspond to the optimal level of reserves in each regime. In this case, the liquidity stabilization-SWF regime and the savings-SWF regime yield the same welfare. However, for any other level of reserves below the optimal level for the savings-SWF regime, the liquidity stabilization SWF-regime implies higher welfare. Moreover, both at the optimal level of each regime, and for all levels of foreign reserves, *the regime where the SWF stabilizes the economy by providing liquidity to banks welfare-dominates a regime where the SWF stabilizes the economy via direct transfers to households.* This is the second main result of our model.

4 Empirical Evidence

In this section, through a panel fixed-effects identification, we provide cross-country empirical evidence that supports the model's implications for the relationship between SWFs,

Figure 6: Expected Discounted Utility and Foreign Reserves



Note: This plot summarizes the impact of different foreign reserve and SWF policies on the household's expected discounted utility. The dashed lines indicates the optimal level of reserves in each economy.

their type, and the accumulation of foreign reserves.

We show that, on average, countries with a stabilizing SWF accumulate less reserves than those without it. Furthermore, we show that this result is driven by more independent central banks, supporting the crucial assumption in the model that the central bank acts independently from the government by taking its actions as given. While these results should be taken as empirical relationships without any causal claim, they point out in the direction of the main results of the model.

4.1 Data

The main data source is Acosta-Henao, Martínez, and Rondón-Moreno (2025). This work constructs a novel comprehensive dataset documenting the presence of a national SWF in 86 countries at a yearly frequency between 1970 and 2022. This is, a dummy variable–

namely SWF_t^i–that takes the value of 1 if there is at least one SWF operating in country i during year t. In total, there are 114 national SWFs in the sample. More importantly, this dataset provides a classification of each SWF's purpose. In the data, a SWF can be either a stabilization fund–a dummy variable, $StabSWF_t^i$, that is equal to 1 if the fund can be used by the government for macroeconomic stabilization purposes–, a savings or other purpose fund–a dummy variable, $NonStabSWF_t^i$, that is equal to 1 if the fund has a long-term savings purpose, other specified objective (e.g. strategic purposes)–, or other non-specified objective.[10]

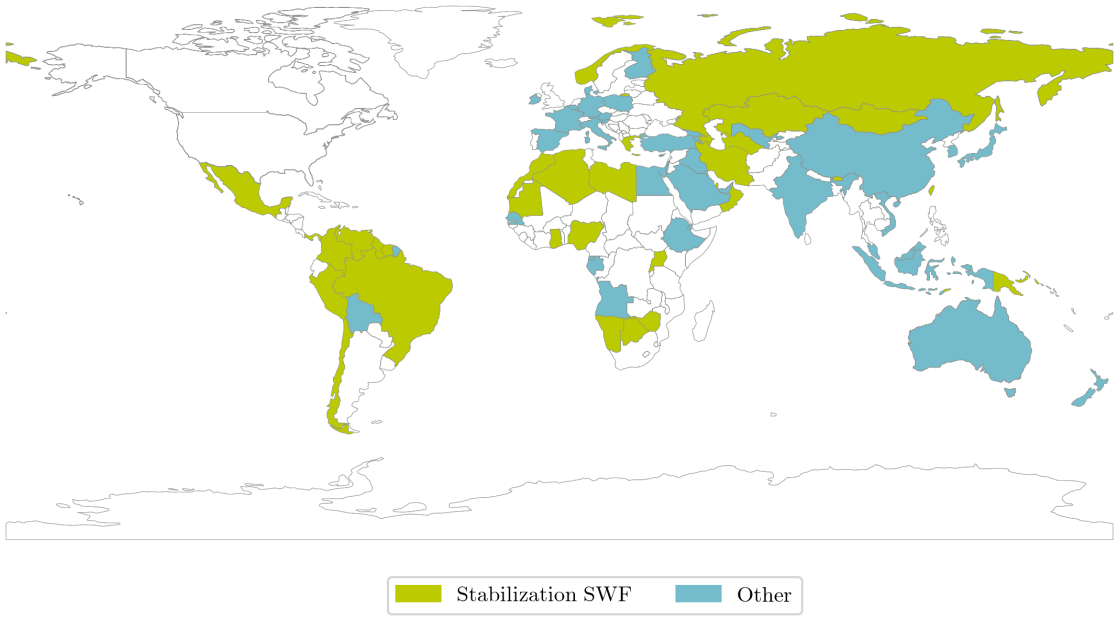
Figure 7 provides the most resent snapshot of the presence and type of SWFs around the world. The figure shows the countries with the presence of at least one SWF in 2022. Those in green are categorized as stabilization SWFs, and those in blue have other purposes. The rest are countries for which there is no SWF reported in that year.

We complement the data on SWFs and their type with a comprehensive set of macroeconomic variables. When studying the relationship between SWFs, their type, and the accumulation of foreign reserves, these macroeconomic variables allow us to construct the dependent variable of interest in our study–the foreign reserves to GDP ratio–and to control for other determinants of foreign reserves holdings across countries that are well known in the literature.

For all 86 countries from 1970 to 2022 we construct series of: the foreign reserves to GDP ratio from the 2023 updated dataset from Lane and Milesi-Ferretti (2001); the monetary base, M2, as a fraction of GDP; the Chinn-Ito index, which indicates the degree of mobility in capital flows; the (log of) population; the real per capita GDP in dollars; the yearly nominal exchange rate depreciation rate with respect to the U.S. dollar; and the exports of

[10]The primary data on sovereign wealth funds (SWFs) by country originates from the International Forum of Sovereign Wealth Funds (IFSWF) Data Project, supplemented with official sources such as the IMF, World Bank, OECD, and national Ministries of Finance. The classification results from a thorough text analysis of the statutes governing each SWF in the sample. See Acosta-Henao et al. (2025) for further details on these data.

Figure 7: Countries with SWF by type in 2022



commodities as a fraction of GDP. The source of these data, namely our baseline variables, is the World Bank´s Development Indicators (WDI).

To complement the baseline variables, we include other variables that allow us to study different motives of reserves accumulation other than the influence of a SWF. Those motives, with their respective additional variables, are: 1) Trade: Imports as share of GDP; and exports volume, from the WDI. 2) Financial Stabilization: Dummies that categories countries as either hard peggers, soft peggers, or none; the short-term debt as share of GDP, all from the International Monetary Fund (IMF); and the average of foreign reserves to GDP ratio from all other countries (i.e. the keeping up with the Joneses effect) which we construct for each country. 3) Mercantilist: Terms of trade index; and GDP growth rate, from the WDI. 4) Financial development: Domestic, private foreign, and public foreign, financial liabilities as share of GDP, all from the IMF. 5) Fiscal: Government gross debt as a share of GDP, and government net lending as a share of GDP, all from the IMF's World Economic Outlook.

Since the model assumes an independent central bank that takes as given the actions

of the government, we also include a variable that documents the degree of central bank independence per country each year. We take the central bank independence index from Garriga (2024). This variable, CBI_t^i, is a continuous variable between 0 and 1 that averages a set of different dichotomous attributes of central bank independence using *de joure* measures. Thus, a central bank has higher independence the higher the value of this variable is.

4.2 Cross-Country Estimates

As a starting point, we first document how the presence of any type of SWF relates to the accumulation of foreign reserves. For this purpose, we estimate

$$r_{it} = \alpha_i + \alpha_t + \beta SWF_{t-1}^i + \delta CBI_{t-1}^i + \Gamma X_{it-1} + \epsilon_{it} \tag{12}$$

Where r_{it} is the foreign reserves to GDP ratio of country i in year t, α_i and α_t are country and time fixed effects, SWF_{t-1}^i is a dummy variable that takes the value of one if there is a SWF in country i during year $t-1$, CBI_{t-1}^i is the index of central by independex from Garriga (2024), X_{it-1} is the set of lagged country-level macroeconomic controls described in the previous section with their corresponding vector of coefficients, Γ, and ϵ_{it} is the mean-zero *i.i.d.* disturbance. Even though this regression aims to document the correlation between the presence of a SWF and foreign reserves, controlling for lagged explanatory variables together with country and time fixed effects contributes to deal with reverse causality concerns.[11]

The coefficient of interest in Equation 12 is β, which captures the average difference in reserves to GDP ratio between countries with the presence of a SWF and countries without it that is not explained by either time-invariant country characteristics, a common shock in a given year, or different country-level macroeconomic characteristics. Column 1 in Table 2 shows the result of this estimate, which is significant at a 95% level of confidence. On average

[11] For instance, the possibility of a SWF emerging within a country as a response to its level of reserves. Yet, it is hard to consider this a plausible scenario if the fund was set in period $t-1$ and we analyze how its presence relates to foreign reserves in t, as described by Equation 12.

countries with a SWF have a foreign reserves to GDP ratio 2.5 pp lower than countries without any type of SWF.

Table 2: Foreign Reserves to GDP, SWFs, and Central Bank Independence

	(1) Res/GDP	(2) Res/GDP	(3) Res/GDP	(4) Res/GDP	(5) Res/GDP	(6) Res/GDP
SWF^i_{t-1}	-0.025**	-0.012				
	(0.012)	(0.010)				
CBI^i_{t-1}	0.031	0.070	0.032	0.075*	0.031	0.077*
	(0.025)	(0.043)	(0.025)	(0.042)	(0.027)	(0.042)
$StabSWF^i_{t-1}$			-0.026**	-0.004	0.011	0.065**
			(0.010)	(0.011)	(0.018)	(0.025)
$StabSWF^i_{t-1}$ x CBI^i_{t-1}					-0.067*	-0.123**
					(0.040)	(0.047)
$NonStabSWF^i_{t-1}$			-0.028	-0.031**	-0.082	-0.040*
			(0.019)	(0.014)	(0.069)	(0.024)
$NonStabSWF^i_{t-1}$ x CBI^i_{t-1}					0.095	0.022
					(0.100)	(0.042)
Standard Controls	✓	✓	✓	✓	✓	✓
Fiscal Controls	✗	✓	✗	✓	✗	✓
Year Fixed Effect	✓	✓	✓	✓	✓	✓
Country Fixed Effect	✓	✓	✓	✓	✓	✓
Observations	1987	1326	1987	1326	1987	1326
R^2	0.895	0.916	0.897	0.917	0.898	0.919

Note: All regressions include country, year fixed effects and standard controls. Columns (2), (4), and (6) include fiscal controls. We only include countries with more than 15 observations and a population size greater than one million. Country-clustered standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

This results indicates that, once a SWF is set, a country is expected on average to accumulate a lower level of reserves. Yet, this does not imply that creating a SWF causes a country to accumulate less foreign reserves. Documenting the reasons by which SWFs endogenously emerge goes beyond the scope of this work. However, we might conjecture that SWFs are related to fiscal policy reasons.

Column 2 in Table 2 includes a set of fiscal variables as controls. In this case, the mean estimate of β is still negative but now it is not significant at any standard level, which indicates that fiscal factors are highly related to the presence of the SWF. In our model, both the SWF and the fiscal policy set–taxes, government expenditure, and government's savings–are exogenously determined in each regime. In this sense, the results of Column 2

are aligned with the view fiscal policy and SWFs are both defined by the same agent, the government, as in the model. Furthermore, they also suggest that when considering a wider set of fiscal policy variables, as in the model, the relationship between SWFs and foreign reserves is not clear. Therefore, now we turn to analyzing one more layer of SWFs across countries by considering their type.

We exploit this novel dataset in a dimension that had not been documented before, the purpose of the SWF. By having categories of SWFs by their type, we can tests directly the implication of the model regarding the relationship between the type of fund and the accumulation of reserves. This is, we are able to test whether there is cross-country evidence that an economy with a stabilization SWF has lower foreign reserves to GDP than an economy without it. For this, we estimate

$$r_{it} = \alpha_i + \alpha_t + \delta CBI^i_{t-1} + \eta StabSWF^i_{t-1} + \zeta NonStabSWF^i_{t-1} + \Gamma X_{it-1} + u_{it} \tag{13}$$

Compared to Equation 12, Equation 13 now includes the dummies $StabSWF^i_{t-1}$ and $NonStabSWF^i_{t-1}$, where the first one takes the value of 1 if the country has a SWF with a stabilization purpose and the second one takes the value of 1 if the country has a fund with a non-stabilization purpose. Notice that the variable SWF^i_t does not appear in this specification because it is absorbed by these two dummies.

Column 3 in Table 2 shows the result of estimating Equation 13. On average, countries with a stabilization SWF have 2.6 pp less foreign reserves to GDP tan countries without that type of fund. This result is aligned with the first main result of the model, where any type of stabilization fund yields lower optimal reserves than any other regime. However, when we include fiscal controls, as shown in Column 4 of the table, this not significant. Notice also that the central bank independence, and the presence of other type of SWF become significant. The first, indicating that countries with more independent central banks accumulate on average more reserves, and the second indicating that countries with the

presence of non-stabilizing SWFs have on average less reserves.

In the model, a crucial assumption is the independence of the Central Bank. On one hand, the government is modeled as simply an exogenous set of fiscal trajectories that might be or not affected by how the SWF is–also exogenously–defined. However, the optimal foreign reserves policy is the result of an optimizing response by the central bank. In other words, the central bank simply takes the government actions as given, and optimizes based on all information available. As a result, and considering the results of Column 4 in Table 2, it is of high relevance to delve deeper into the relationship of central bank independence, SWFs, and the accumulation of foreign reserves. We now estimate

$$r_{it} = \alpha_i + \alpha_t + \delta CBI^i_{t-1} + \eta StabSWF^i_{t-1} + \psi StabSWF^i_{t-1} \times CBI^i_{t-1} + \zeta NonStabSWF^i_{t-1} + \upsilon NonStabSWF^i_{t-1} \times CBI^i_{t-1} + \Gamma X_{it-1} + u_{it} \quad (14)$$

where we now include the interactions of the central bank independence variable with both types of funds. The coefficient ψ is the marginal effect of central bank independence when there is a stabilization SWF. The coefficient υ, is the marginal effect of central bank independence when there is any other type of fund.

The results of estimating Equation 14 are in Column 5 of Table 2. At the 90% level of confidence, there is a significant negative effect of central bank independence when there is a stabilization SWF. In the limit case of the central bank independence variable, where it takes the maximum value of one (i.e., a completely independent central bank), countries with a stabilization SWF and an independence central bank have on average 6.7 pp less foreign reserves to GDP than the rest. Hence, central bank independence is arguably a crucial aspect determining the relationship between SWFs and foreign reserves.

The last column of Table 2, Column 6, includes now the previously mentioned fiscal controls. The main takeaway of this estimation is that, not only the previous result for the

interaction between $StabSWF_t^i$ and CBI_t^i hold, but it is also larger–about twice the value as in Column 5–and more significant, now at a 95% level of confidence.

This last result supports the fact that the first main result of the model, where countries with a stabilizing SWF have lower foreign reserves than the rest, hinges on an independent optimizing behavior from the central bank. Which, in turn, act as a lender of last resort. Therefore, altogether, the empirical results provided in this section provide support–with no casual claim–to the relationship between SWFs, their type, and the accumulation of foreign reserves by a country's central bank.

5 Conclusion

In this study, we explore the role of external public savings, such as Sovereign Wealth Funds, as potential stabilizing tools and their interaction with central banks' reserve accumulation policies. Our results show that assets under management by a stabilization SWF can partially substitute foreign reserves. Moreover, using a novel dataset, we provide empirical evidence showing that central bank independence is key for this result. Specifically, greater central bank independence is associated with a lower reserves-to-GDP ratio in countries with a stabilization SWF compared to others.

Potential extensions of this work include analyzing how the optimal foreign reserve accumulation policy changes when the SWF emerges endogenously, investigating potential commitment issues related to the fund's long-term objectives, and expanding our theoretical model to an infinite-period framework to provide deeper insights into the normative implications of SWF design and its interaction with central bank policy.

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