The Capital Structure of Nations*

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Abstract

We take a corporate finance approach to the question of countries' funding of investments via foreign-currency denominated debt or domestic-currency claims. We ask what is the optimal capital structure of a nation? A key conceptual innovation we introduce is an analogy between a nation's money-claims and corporate equity. What a nation's money and a firm's equity have in common is that they both are claims on residual output. Pursuing this analogy, we show that a nation's optimal funding structure can be characterized as the solution to a tradeoff between inflation costs and expected default costs. Our corporate finance perspective provides a unified framework connecting corporate finance, monetary economics, and international finance. It yields new insights into such issues as the costs and benefits of foreign exchange reserves and the optimal currency composition of sovereign debt.

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1 Introduction

The latest, prolonged, Greek debt crisis, and the astonishing Argentina sovereign-debt legal imbroglio following the 2014 ruling of the US Southern District Court in New York, have injected new life in the idea of creating a sovereign-debt restructuring scheme for nations akin to corporate bankruptcy. In policy discussions and scholarly writings on sovereign-debt restructuring the analogy with corporate debt is taken for granted. Another, related, parallel is also made between countries and companies. Yet, as common as these analogies are, they do not extend to the financial structure of nations and firms. The topic of this paper is to explore such an analogy, and thereby to address the general question of the optimal capital structure of nations.

The choice of capital structure to maximize the value of a firm is sometimes formulated more narrowly as a choice of optimal leverage. How high should the ratio of debt to total assets be? What is the optimal interest coverage ratio? For nations this question is typically formulated as a debt sustainability problem and a target range for the debt-to-GDP ratio. But even this narrower framing must touch on the issue of when and how much a firm should rely on equity versus debt financing for its investments. This is where the analogy between the financial structure a corporation and a nation appears to break down. For, what is the analog of corporate equity for a nation?

The idea we put forward in this paper is that the *fiat money* of a nation and other money-like debt claims may be seen as a close equivalent to the common stock of a corporation. At the simplest, albeit somewhat abstract level, shares in a company, just as units of fiat money, entitle the owner to a pro-rata share of output. For a company, the output is profits net of interest expenses and taxes. For a nation, the output is real production of goods and services net of any debt obligations. This is the abstract equivalence between fiat money and corporate equity we will develop in this paper.

Most formal analyses of capital structure in corporate finance define corporate equity in somewhat narrow terms, as simply the pro-rata right to residual cash-flows, after all other claims on the corporation have been paid. Voting rights attached to common stock and the corporate control dimension of common stock instruments are often disregarded in formal models. Under such a stylized representation of equity the parallel with fiat money is most compelling, especially in a static model. Abstracting from control considerations of corporations is convenient as it allows us to also abstract from politics considerations for nations. Still, even after suppressing governance issues, there remain important differences, which mainly have to do with the fact that fiat money is not only a store of value but also a means of exchange.

The classic theory of optimal capital structure for corporations, the static trade-off theory, which pits the tax advantages of debt against expected costs of financial distress, is clearly not applicable to nations, since there is no tax advantage for sovereign debt. If one were to literally apply the prescription of the static tradeoff theory to nations then nations should never rely on debt financing, given that debt has no advantages. Much more relevant for nations is the pecking order theory of corporate financing of Myers and Majluf (1984) and Myers (1984), which pits the (informational) dilution cost advantages of debt against financial distress costs or debt-overhang costs (Myers, 1977). According to this theory, nations like corporations should fund their investments and other expenditures first with internal funds (or tax revenues), then with debt, and finally with equity.

The analog of dilution costs of equity for the owners of a firm is inflation costs for the holders of fiat money issued by a nation. If a company issues new shares to new shareholders at a price below their true value, then the value of the shares held by existing shareholders is diluted in proportion to the transfer of value to the new shareholders. Similarly, when a nation prints more money while adding less real output than the purchasing power of money, then existing holders of money are also diluted in proportion to the transfer of value from the new issue. The only difference is that in the case of fiat money the cost of dilution takes the form of debasement of the value of the currency, or equivalently a rise in the price of real goods. Hence, the theory we develop in this paper for the optimal financial structure of a nation pits the inflation cost of money against the default and debt-overhang costs of debt.

An important general contribution of a theory of the capital structure of nations such as the one we propose, is that it makes an explicit comparison between the benefits of printing money (what money buys) and the costs (higher inflation). Thus, if the benefits of printing money are substantial (for example, financing a valuable investment or avoiding a buildup of unsustainable debts) then they may justify paying some inflation costs. As Myers and Majluf (1984) makes clear, it may be optimal for a firm to issue new equity to fund a new valuable investment even at the cost of diluting ownership, and even if the new equity offering results in a stock price drop.

Another related contribution of our theory is that it emphasizes the process by which fiat money enters the economy. The stock of fiat money is not increased by dropping money from a helicopter, but by purchasing real goods and services with the newly printed money. Thus, the key determinant of the effects of the increase in the money base on prices is the value of the goods that are purchased with the new money issue. By focusing on what money buys, our theory also emphasizes the tight link between the costs of inflation and redistribution of wealth. In our model there is no cost of inflation without redistribution. The cost of inflation (if there is any) is the transfer of wealth (if there is one) from existing holders of money to the new holders of money. As is the case in Myers and Majluf (1984), where a new equity issue involves no dilution of existing shareholders if it is a rights issue, if a nation issues new money to all existing holders of money in proportion to their holdings then there is no cost of inflation.

To elaborate further on the similarities and differences between fiat money and equity, a stock split just like a change in currency denomination should have neutral effects in a frictionless economic environment. A stock split could affect the market capitalization of a company in practice by improving secondary market liquidity. But, similar effects can also be found for national economies following the re-denomination of the national currency. An important difference between fiat money and common stock, however, is that there is no periodic dividend payment attached to money. Unlike for stocks, a key dimension of a monetary economy is the velocity of circulation of money, an issue we will not be able to explore in this paper, as we mostly confine ourselves to a static analysis.

The basic model we consider has three periods, as is the case for a vast theoretical literature in corporate finance. In period zero the nation undertakes investments, which for illustration we take to be infrastructure investments. These investments improve the production technology of the nation. To adhere closely to our analogy between firms and nations, we consider financing of these investments either through (foreign-currency) debt or through fiat money issuance. The nation is run by a representative risk-neutral agent, who maximizes the utility of households' life-time consumption. This representative agent thus issues claims in period zero to finance infrastructure investments against period two output. Production takes place in period one and requires a real consumption good as an input (say wheat). This real good is purchased from a representative household with money held by the representative firm. Thus, money plays the dual role of means of exchange and store of value. Realized output in period two is stochastic and is sold to the representative household (after subtracting any foreign-currency debt obligations) against money saved by the representative household from period one to period two.

We begin our analysis by considering a frictionless economy and show that an analog of the Modigliani-Miller theorem can be established for a nation. In an ideal frictionless economy it does not matter how the nation funds its investments. It obtains the same final expected utility for the representative household by financing its investments by printing money or by issuing debt. As in all corporate finance theories, capital structure for the nation only matters in the presence of frictions. We introduce two types of frictions. First, if the nation relies on debt financing, we introduce a classic willingness to repay problem. If realized output in period two is too low relative to the nation's debt burden then the nation prefers to default on its debt obligations even if it incurs a deadweight output loss as a result of the default. Second, if the nation relies on equity financing (printing money), we introduce differences of beliefs between international investors, who offer investment goods in exchange for money, and domestic households regarding the nation's future monetary policy. The more the nation relies on printing money the more investors worry about future inflation. When investors have an exaggerated fear of inflation they will undervalue the nation's currency and thus increase the cost of funding investments by printing money. The representative agent of the nation then trades off the dilution costs of money against the expected default of debt to determine an optimal capital structure of the nation. This, in a nutshell, is the core of our capital structure theory.

Although our basic model borrows several elements of the pecking-order theory of Myers (1984), one important difference in our modeling of the costs of equity is that we do not impose rational expectations on investors and the representative household. Instead, we follow Dittmar and Thakor (2007) and the 'market-driven' corporate finance literature (Baker, 2009) to introduce a more realistic, behavioral, perspective on expectation formation, which in particular allows for differences of opinion between foreign investors and domestic households, as in Scheinkman and Xiong (2003).[1]

Throughout our analysis we exogenously fix the world interest rate and normalize it to equal zero, so that, in accordance with the Friedman rule (1969), the

[1] Malmendier and Nagel (2014) find evidence that individual inflation expectations are far from rational and are heavily influenced by individuals' personal past experiences with inflation.

optimal quantity of money in our frictionless model is indeterminate. However, in our model with frictions, the optimal quantity of money will depend on a subtle tradeoff between inflation and expected debt default costs. In general, there is no simple rule for the evolution of the optimal quantity of money in an economy with frictions. How much a nation should rely on printing money as opposed to debt financing depends on the value of investments to be funded, the evolution of differences of beliefs between domestic households and international investors on the risk of inflation, and the expected risk of default on the nation's debt.

Related Literature. Our paper is related to the literature in international finance around the idea of the *original sin*. This is a term introduced by Eichengreen, Hausmann and Panniza (2003) to refer to the observation that until recently most emerging market countries would only issue foreign-currency denominated debt. They argue that it was impossible for most of these countries to borrow from international investors in the form of domestic-currency debt. Another, by now vast, related literature in international finance and macroeconomics is the limited commitment, or willingness-to-pay, literature following Eaton and Gersovitz (1981) and Bulow and Rogoff (1989). Besides the limited commitment problem that constrains sovereign borrowing, another widely examined problem in the international finance literature following Calvo (1988) is self-fulfilling debt crises, which expose sovereigns who borrow in the form of foreign-currency debt to substantial financial risk (see Chang and Velasco, 2000, Burnside, Eichenbaum and Rebelo, 2001, Cole and Kehoe, 2000, Jeanne and Wyplosz, 2001, Jeanne and Zettelmeyer, 2002, and Jeanne, 2009). Our model is not set up to capture this type of financial risk and we entirely abstract from these important considerations. Our paper also contributes to the growing literature on foreign exchange reserves, which distinguishes between two explanations for the recent build-up of reserves: beggar-thy-neighbor policies (Dooley, Folkerts-Landau and Garber, 2004) and precautionary savings (Jeanne, 2007). Finally, our paper builds on the debt overhang literature in both corporate finance

(Myers, 1977) and international finance (Sachs, 1984, and Krugman, 1988).

The remainder of the paper is structured as follows. Section 2 develops the basic model. Section 3 verifies that the classical quantity theory of money holds in our setup. Section 4 establishes a Modigliani-Miller theorem for nations. Section 5 introduces the basic frictions of 'willingness to inflate' and 'willingness to repay' and derives the optimal capital structure of nations. Section 6 addresses the issues of debt overhang and financial constraints of nations. Section 7 considers empirical predictions of the basic theory, and section 8 concludes.

2 Model

We consider a nation with a small open economy, operating over three periods. In the initial period (date 0) the nation can undertake an (infrastructure) investment of size $k > 0$, which improves its productivity. In the intermediate period (date 1) the nation allocates its initial endowment of goods w between consumption c_1 and inputs for production. In the final period (date 2) output is realized and consumed.

We begin by describing the economy at dates 1 and 2, assuming that no investment has been undertaken at date 0. We can think of these two dates as representing a short time window of the life-cycle of an infinitely lived country. The economy comprises a continuum of identical consumers and firms operating in perfectly competitive markets. Consumers are assumed to be risk-neutral and to maximize total life-time consumption. Consumers require a minimum subsistence consumption in each period, which we normalize to equal 0, so that we must have $c_t \geq 0$, $t = 1, 2$. Their utility function is:

$$U(c_1, c_2) = \beta c_1 + c_2, \tag{1}$$

where $\beta < 1$, so that consumers have a preference for late rather than early consumption. Consumers' initial endowment of goods at date 1 is $w > 0$. They can store their initial endowment or sell it to firms. Storage, however, results in some depreciation: if the endowment w is stored from period 1 to period 2 it depreciates to δw, where $\delta < 1$. For most of our analysis we can set $\delta = \beta$ without loss of generality.

The representative competitive firm uses the consumption good as an input into production. Its production function is given by

$$y \equiv \theta f(x),$$

with $f' > 0$, $f'' < 0$, where θ is a productivity shock with p.d.f. $h(\cdot)$ and c.d.f. $H(\cdot)$ on the support $[\theta_L, \theta_H]$ (with $\theta_L > 0$), and x denotes the quantity of input used by the firm in production. Inputs are sold by consumers to firms for money at date 1, and firms' initial endowment of fiat money is $m > 0$. Firms purchase consumers' initial endowment of inputs using cash at date 1, and consumers use the saved cash to purchase firms' output at date 2.

Firms are owned by entrepreneurs, whose objective is to maximize date 2 output, as their date 2 consumption is a fraction $\psi \in (0, 1)$ of final output. To minimize the number parameters to keep track of, we let $\theta f(x) = \theta(1 - \psi)F(x)$ denote the final output to be brought to the market, net of the entrepreneur's consumption (that is, output gross of entrepreneurial consumption is $\theta F(x)$). Let m_2 denote the representative firm's holdings of cash at the end of period 2, then the continuation value for the firm is given by $V(m_2)$, which is strictly increasing in m_2. The value $V(m_2)$ can be thought of as the present discounted value of future entrepreneurial consumption streams. To be able to consume, entrepreneurs must be able to produce. And to be able to produce they must be able to purchase inputs. This they can only do against fiat money. If m_2 represents the expected money holdings of the representative firm, then the value of money holdings m_i for an individual firm i is given by $\hat{V}(m_i; m_2)$. This value is clearly increasing in m_i – $\partial \hat{V}(m_i; m_2)/\partial m_i > 0$ – as firm i is then able to purchase more inputs in the subsequent iteration. In equilibrium all firms end up holding the same amount of money m_2 and we have $\hat{V}(m_i; m_2) \equiv V(m_2)$. Moreover, we have $V'(m_2) \equiv \partial \hat{V}(m_i; m_2)/\partial m_i > 0$. This is a simple way of solving the Hahn (1965, 1982) problem that in the final period money has no value.

3 The Classical Quantity Theory of Money

Consider first the situation where this economy functions with no infrastructure investment and no borrowing. Then the representative consumer's intertemporal optimization problem is to solve:

$$\max[\beta(w - x) + \bar{\theta} f(x)]$$

where $\bar{\theta} = E(\theta)$. We shall assume that $f'(w) > 1$, and that $\bar{\theta} \geq 1$. Under this assumption it is optimal to set $x = w$, and period 1 is entirely a *production period*, while period 2 is a *consumption period*.

To set this outcome up as a competitive equilibrium we need firms to give up all their cash m for the whole consumer endowment w in period 1 and we need consumers to purchase the entire period 2 output of firms $\theta f(w)$. If we let the price of goods in period 1 be $p_1 = \frac{m}{w}$ and the price of goods in period 2 be

$$p_2(\theta) = \frac{m}{\theta f(w)},$$

then the *value of money* in period 2 is:

$$\frac{1}{p_2(\theta)} = \frac{\theta f(w)}{m}.$$

We need to verify that the representative consumer cannot do better than sell her entire endowment for a price p_1 in period 1, and that the representative firm cannot do better than sell its entire production for a price $p_2(\theta)$ in period 2. Thus, consider the possibility that the representative consumer only sells $x < w$ of her endowment in period 1 and consumes the remainder, $c_1 = w - x$. Then her expected life-time payoff is given by:

$$\beta(w-x) + E\left[\frac{1}{p_2(\theta)}\right] p_1 x = \beta(w-x) + (\frac{m}{w}x)\left(\frac{\bar{\theta} f(w)}{m}\right)$$
$$= \beta(w-x) + \frac{\bar{\theta} f(w) x}{w} < \bar{\theta} f(w),$$

where the inequality follows from our assumption that $\bar{\theta} f'(w) > 1 > \beta$.

Similarly, suppose that the representative firm holds on to some of its cash in period 1 and only purchases $x < w$ of inputs. It can then expect to produce and sell no more than $\bar{\theta} f(x)$ of output in period 2. Its total stock of cash at the end of period 2 is then:

$$(m - p_1 x) + E[\theta f(x) p_2(\theta)] = m(1 - \frac{x}{w}) + m\frac{f(x)}{f(w)} < m,$$

where the last inequality follows from the concavity of $f(.)$ and again the assumption that $\bar{\theta} f'(w) > 1$, which together imply that $\frac{f(x)}{f(w)} < \frac{x}{w}$. Thus the equilibrium in this simple economy reduces to the representative firm purchasing all the inputs for m in period 1 and the representative consumer purchasing all the firms' output for m in period 2.

Note that this economy exhibits the classical properties of the quantity theory of money: a doubling of the stock of money m in the economy doubles the price of goods in period 1 and halves the value of money in period 2. Note also that since goods are invested productively in period 1 the value of money rises over time. In this economy the optimal quantity of money in periods 1 and 2 is indeterminate (assuming no transactions costs in printing money) given that the world interest rate is normalized to equal zero.

4 The Modigliani-Miller Theorem for Nations

Consider next the situation where the country can make infrastructure investments at date 0, which will enhance the representative firm's total output at date 2: By spending $k > 0$ on infrastructure, output is increased by a factor $Q(k)$, where we assume that $Q(0) = 1$, $Q' > 0$ and $Q'' < 0$. The country can raise k from international capital markets at a world price of 1 (since the world equilibrium interest rate is normalized to zero). It can pay for this capital by either printing money $(\Delta - 1)m$ in period 0 or by promising to repay k out of period 1 output (we assume for now that the country can commit not to default and not to print more money after the increment in the money base of $(\Delta - 1)m$).

4.1 Increase in the money base

Suppose now that the country raises k from risk-neutral foreign investors against a payment in domestic currency of $(\Delta - 1)m$. The increase $(\Delta - 1)m$ must then be at least equal to $E[p_2(\theta)]k$. In other words, the foreign sellers of capital in period 0 must be able to purchase a fraction of period 1 output that is expected to equal to k.

By investing k in infrastructure, the country's expected period 2 output is then given by $Q(k)\bar{\theta}f(w)$, and for any realization θ the period 1 price of wheat is given by:

$$p_2(\theta) = \frac{m\Delta}{\theta Q(k) f(w)}.$$

To make the problem interesting, we assume that the infrastructure investment is a positive net present value investment:

$$(Q(k) - 1)\bar{\theta}f(w) > k.$$

To simplify notation let $Q(k)f(w) = \Omega(k, w)$. The representative consumer's problem, after the infrastructure investment is made, is then given by:

$$\max_{x\geq 0}\{\beta(w-x)+p_1 xE\left[\frac{1}{p_2(\theta)}\right]\}$$

$$= \quad \max_{x\geq 0}\{\beta(w-x)+x\frac{m}{w}E\left[\frac{\theta\Omega(k,w)}{m\Delta}\right]\}$$

$$= \quad \max_{x\geq 0}\{\beta(w-x)+x\left(\frac{\Omega(k,w)}{f(w)\Delta}\right)\frac{\bar{\theta}f(w)}{w}\}$$

We shall assume and later verify that

$$\frac{\Omega(k,w)}{f(w)\Delta}\geq 1,$$

so that, it is again optimal to set $x=w$ and the representative consumer's payoff is given by

$$\frac{\bar{\theta}\Omega(k,w)}{\Delta}.$$

4.2 Debt Issue

Suppose now that the country borrows k from risk-neutral foreign investors against a promise to repay $D=k$ in period 1 output. The period 1 price of wheat for any realization θ is then:

$$p_2(\theta)=\frac{m}{[\theta\Omega(k,w)-k]}.$$

We shall assume for simplicity that

$$\theta_L\Omega(k,w)>k,$$

so that it is feasible for the country to always meet its debt obligations.

The representative consumer's problem is then:

$$= \quad \max_{x\geq 0}\{\beta(w-x)+x\frac{m}{w}E\left[\frac{\theta\Omega(k,w)-k}{m}\right]\}$$

$$= \quad \max_{x\geq 0}\{\beta(w-x)+x\frac{\bar{\theta}\Omega(k,w)-k}{w}\}$$

Recall that $\Omega(k, w) = Q(k)f(w)$, and since $Q(k) > 1$ it is *a fortiori* optimal to set $x = w$, so that the representative consumer's payoff is:

$$\bar{\theta}\Omega(k, w) - k.$$

4.3 Equivalence

Under Modigliani-Miller equivalence we should have:

$$\frac{\bar{\theta}\Omega(k, w)}{\Delta} = \bar{\theta}\Omega(k, w) - k,$$

or,

$$\Delta = \frac{\bar{\theta}\Omega(k, w)}{\bar{\theta}\Omega(k, w) - k}.$$

Now, $(\Delta - 1)m$ is set so that:

$$\frac{(\Delta - 1)m}{E[p_2(\theta)]} = k,$$

or

$$(\Delta - 1) = \frac{k}{m}E[p_2(\theta)].$$

Substituting for

$$E[p_2(\theta)] = \frac{m\Delta}{\bar{\theta}\Omega(k, w)},$$

we then obtain:

$$\Delta - 1 = \frac{k\Delta}{\bar{\theta}\Omega(k, w)},$$

or

$$\Delta = \frac{\bar{\theta}\Omega(k, w)}{\bar{\theta}\Omega(k, w) - k}.$$

Thus, as expected, when there are no frictions in capital markets it is equivalent to finance the capital raised from world markets with a domestic money issue $(\Delta - 1)m$ or with a foreign-currency denominated debt issue with a fixed promised real repayment of $D = k$. Actually, the currency denomination of the debt is irrelevant. Furthermore, the Modigliani-Miller irrelevance result extends to the case of risky debt with no deadweight costs of default, and to any combination of debt and money financing.

5 Willingness to Inflate and Willingness to Repay

In this section we enrich the model by introducing two frictions in international capital markets that limit sovereign nations' ability to raise funds from investors. A first friction that is commonly mentioned in the international finance literature is a country's willingness to repay its debts problem that raises a country's cost of issuing debt claims to foreign investors. A sovereign borrower cannot commit to honor its debts. It will only choose to repay what it promised to pay if it is in its interest to repay. As Eaton and Gersovitz (1981) and Bulow and Rogoff (1989) emphasize, a sovereign will repay only if the cost of default is higher than the servicing cost of the debt. The willingness-to-repay problem reduces a country's ability or willingness to raise funds via debt.

The second friction we introduce is what we refer to as a country's *willingness to inflate* problem. This friction has not been modeled in the international finance literature and is similar to the equity dilution cost in Myers and Majluf (1984). Just as a country cannot commit to honor its debts it cannot pledge to limit inflation. Investors may therefore be concerned about the risk of debasement of the currency and require compensation for holding claims denominated in the domestic currency (Jeanne, 2003, invokes the lack of monetary credibility as a key reason why private sector lending in emerging markets is in the form of foreign-currency debt). If investors' perceived risk of debasement is excessive then the nation may incur a dilution cost of issuing more fiat money. That is, by issuing money to foreign investors at an excessively low price the nation dilutes the value of the money balances of domestic residents. In its choice of mode of financing the nation then trades off the costs of debt stemming from the willingness to repay problem against the costs of dilution caused by an exaggerated perceived risk of money debasement.

5.1 Equity Financing and the Willingness to Inflate Problem

Consider first the situation where the country funds k by printing money (or issuing domestic currency debt). What are the costs of printing more money? In the spirit of Myers and Majluf (1984), suppose that a country may be more or less inflation prone. In period 0 it is not known for sure whether the future government in the country in period 2 will be a *monetary-dove* or a *monetary-hawk*. A *monetary-dove* government will expand the money supply in period 2 by $(\Delta_1 - 1)\Delta_0 m$ to fund, say, an increase in pay or pensions of civil servants. This future expansion in the money base is a pure transfer to domestic residents that results in a higher nominal price level. In contrast, a *monetary-hawk* government will not expand the money supply in period 2 at all, so that $\Delta_1 = 1$. Suppose that domestic residents expect to have a *monetary-dove* government in period 2 with probability $\lambda \in (0, 1)$. International investors' beliefs about the propensity of future governments to inflate do not generally coincide with those of domestic residents.

We denote by $\mu(\Delta_0) \in (0, 1)$ the conditional probability that international investors assign to a *monetary-dove* government in period 1. When the nation increases its money supply ($\Delta_0 > 1$) at date 0 international investors are likely to put more weight on the possibility that they may face a monetary-dove government. We therefore assume that $\mu' \geq 0$. However, we do not assume that international investors (or domestic residents) form rational expectations about the type of government they are likely to face. International investors' beliefs are formed on an incomplete understanding of the country's history. They may exhibit extrapolative bias, and may not fully take account of recent political and social changes in the country that might alter the likelihood of a future *monetary-dove* government of emerging. In particular, international investors' conditional beliefs $\mu(\Delta_0)$ may be incompletely revised in response to the financing choices of the country's government in period 0. For much of our analysis we shall restrict attention to the situation where $\mu(0) = \underline{\mu} < \lambda$ and $\mu(\Delta_0) > \lambda$ for a sufficiently large Δ_0.

Consider first the extreme but simpler situation where $\mu' = 0$. That is, international investors do not revise their beliefs at all in response to the country's financing choices. If the country funds infrastructure expenditures k by issuing money $(\Delta_0 - 1)m$ in period 0, the price level for any realization of θ in period 2 will then be

$$\hat{p}_2(\theta) = \frac{m\Delta_0\Delta_1}{\theta\Omega(k,w)}$$

under a *monetary-dove* government, and

$$p_2(\theta) = \frac{m\Delta_0}{\theta\Omega(k,w)}$$

under a *monetary-hawk* government.[2]

Accordingly, foreign investors will demand a payment in money $(\Delta_0 - 1)m$ in exchange for the investment k such that:

$$[\frac{\mu}{E[\hat{p}_2(\theta)]} + \frac{1-\mu}{E[p_2(\theta)]}](\Delta_0 - 1)m = k$$

where,

$$E[\hat{p}_2(\theta)] = \frac{m\Delta_0\Delta_1}{\bar{\theta}\Omega(k,w)}$$

and

$$E[p_2(\theta)] = \frac{m\Delta_0}{\bar{\theta}\Omega(k,w)}.$$

Substituting for $\hat{p}_2(\theta)$ and $p_2(\theta)$ and rearranging we obtain that:

$$\bar{\theta}\Omega(k,w)[\frac{\mu + (1-\mu)\Delta_1}{m\Delta_0\Delta_1}](\Delta_0 - 1)m = k$$

So that:

$$\Delta_0 = \frac{(\frac{\mu+(1-\mu)\Delta_1}{\Delta_1})\bar{\theta}\Omega(k,w)}{(\frac{\mu+(1-\mu)\Delta_1}{\Delta_1})\bar{\theta}\Omega(k,w) - k}. \quad (2)$$

[2] Note that we assume implicitly here that domestic consumers sell all their endowment to firms in period 1 so that $x = w$. It is optimal for domestic consumers to do so if β is low enough, which we shall assume in the remainder of the analysis.

Note that if $\mu = 0$ this boils down to the previous expression:

$$\Delta_0 = \frac{\bar{\theta}\Omega(k,w)}{\bar{\theta}\Omega(k,w) - k}.$$

And if $\mu = 1$ we have:

$$\Delta_0 = \frac{\bar{\theta}\Omega(k,w)}{\bar{\theta}\Omega(k,w) - \Delta_1 k}.$$

What is the perceived cost of the issue $(\Delta_0 - 1)m$ for domestic residents in this situation? Let $\Delta_0(k)$ be given by equation (2) and let $(\Delta_0(k) - 1)m$ be the amount of money issued to finance the investment k. While foreign investors assign a present value of k to $(\Delta_0(k) - 1)m$, domestic residents value $(\Delta_0(k) - 1)m$ at:

$$[\frac{\lambda}{E[\hat{p}_2(\theta)]} + \frac{1-\lambda}{E[p_2(\theta)]}](\Delta_0(k) - 1)m$$

or, substituting for $\hat{p}_2(\theta)$ and $p_2(\theta)$ at:

$$(\lambda + (1-\lambda)\Delta_1)\bar{\theta}\Omega(k,w)\left(\frac{\Delta_0(k) - 1}{\Delta_0(k)\Delta_1}\right).$$

Whenever $\mu > \lambda$ domestic residents will then perceive a loss in expected purchasing power from financing the infrastructure investment k with a money issue of:

$$(\mu - \lambda)\bar{\theta}\Omega(k,w)\frac{(\Delta_1 - 1)(\Delta_0(k) - 1)}{\Delta_0(k)\Delta_1}.$$

It is this cost that they will pit against the costs of debt financing in their choice of financial structure for the nation.

5.2 Debt Financing and the Willingness to Repay Problem

Consider next the situation where the country funds k by borrowing in foreign-currency denominated debt. What this means in our model is that the country promises to repay D in output in period 2 to foreign investors. However, unlike in the previous section we now let the country default on its payment if it is in its interest. When the country defaults it will suffer a deadweight output loss due to, say, (unmodeled) trade sanctions and other economic disruptions. Suppose that this cost is a percentage loss in final output $\phi > 0$, so that after default the country can only produce and consume $(1 - \phi)\theta\Omega(k, w)$. Given such a default-cost the country will choose to default on its debt obligation D if and only if

$$\theta\Omega(k, w) - D < (1 - \phi)\theta\Omega(k, w)$$

or

$$D > \phi\theta\Omega(k, w).$$

Note that the country's default decision is independent of its monetary policy. Whether the country is run by a monetary-dove or monetary-hawk government is irrelevant to the default decision, since under either government the representative resident obtains the same real output. An expansion in the money supply of $(\Delta_1 - 1)m$ in this situation involves no dilution costs, as there is no redistribution of wealth from domestic residents to foreign investors as a result of the monetary expansion. Such an increase in money supply is equivalent to a rights issue, maintaining the per-capita output share each resident can buy.

Let $\theta_D \in [\theta_L, \theta_H]$ denote the cutoff

$$\theta_D = \frac{D}{\phi\Omega(k, w)}$$

at which the country defaults, and led D be the promised debt repayment such that the country is just able to raise k to fund its investment:

$$\Pr(\theta \geq \theta_D)D = k.$$

The expected deadweight cost of foreign-currency denominated debt financing is then given by:

$$\Pr(\theta < \theta_D)E[\theta \mid \theta < \theta_D]\phi\Omega(k, w).$$

In other words, while the country is able to fund itself at perceived fair terms by issuing debt, this may involve a risk of default with the associated deadweight costs of a debt default, which are borne by the country. To the extent that debt financing of investment requires issuing risky debt, the country may prefer to fund its investment by issuing fiat money (or domestic-currency debt that can be monetized), even if it thereby incurs an excessive dilution of ownership (or debasement of the currency).

5.3 Optimal Financing

How much money and foreign-currency debt should the country issue to international investors? We assume that the country's objective is to maximize the expected lifetime utility of domestic residents.[3] The claims issued to foreign investors serve not only to fund the investment expenditure k, but also to build foreign-currency reserves that help the country smooth its terms of trade shocks. To keep the analysis tractable we shall first consider the special case where the country only seeks to raise sufficient funds to be able to undertake the investment k. In a second step we also allow the country to build reserves by issuing claims to international investors. Furthermore, we shall break down the analysis into a first question of the choice between 100% debt financing versus 100% equity financing, and a second question of the optimal ratio of debt and equity financing. For tractability and without much loss of generality we shall suppose that θ can take only two values, $\theta \in \{\theta_L, \theta_H\}$ and that $\Pr(\theta = \theta_H) = \pi \in (0,1)$.[4]

Debt Financing. When θ only takes the two values θ_L and θ_H, there are essentially only two possibilities where the country relies on foreign-currency debt

[3] Note that we do not include the value of the firm $V(m_2)$ in the objective function of the country. But, to the extent that this value represents the present discounted expected utility of consumption of (domestic) entrepreneurs, this value will be unaffected by the country's optimal financing choices, holding infrastructure investment fixed.

[4] As in Bolton and Jeanne (2007), we can carry out the analysis and obtain closed-form solutions under the assumption that θ is uniformly distributed on the interval $[\theta_L, \theta_H]$. The algebra is then more involved and less transparent, as the expected default cost is then given by the following expression:

$$\left(\theta_H - \left(\theta_H^2 - \frac{4k}{\phi\Omega(k,w)}\right)^{\frac{1}{2}}\right)\frac{\theta_H\phi\Omega(k,w)}{4} - \frac{k}{2} - \frac{\theta_L^2\phi\Omega(k,w)}{2}.$$

financing. Either the country is able to limit its indebtedness so as to always be willing to service its debt obligations, or the country issues so much debt that in the unlucky event where the low productivity shock θ_L is realized it defaults on its external debt obligations. In the former situation, the maximum debt promise the country can credibly make is given by $D = \theta_L \phi \Omega(k, w)$, so that a necessary and sufficient condition for the country to be able to fund itself with *safe debt* is:

$$\theta_L \phi \Omega(k, w) \geq k. \tag{3}$$

Suppose that this condition is violated, then the debt promise the country must make to be able to raise k through an external debt issue is given by $D = k/\pi$, and a necessary condition for *risky debt* financing is

$$\theta_H \phi \Omega(k, w) \geq \frac{k}{\pi}. \tag{4}$$

In sum, when condition (4) holds but condition (3) is violated, the country can fund itself with risky debt and incurs an expected deadweight cost of default given by:

$$(1-\pi)\theta_L \phi \Omega(k, w).$$

Equity Financing. Equity financing when θ only takes the two values θ_L and θ_H involves the following expected dilution cost:

$$(\mu - \lambda)(\pi\theta_H + (1-\pi)\theta_L)\Omega(k, w)\frac{(\Delta_1 - 1)(\Delta_0(k) - 1)}{\Delta_0(k)\Delta_1}.$$

Comparing expected default costs to expected dilution costs, we then obtain the following condition for the optimality of equity financing:

$$(\mu - \lambda)(\pi\theta_H + (1-\pi)\theta_L)\frac{(\Delta_1 - 1)(\Delta_0(k) - 1)}{\Delta_0(k)\Delta_1} < (1-\pi)\theta_L \phi \Omega(k, w). \tag{5}$$

Some simple observations follow from this condition. First, countries that have an undeserved reputation for being *monetary-doves*, for which both $(\mu - \lambda)$ and Δ_1 are large, are likely to be better off financing investments through foreign-currency denominated debt. Second, countries that are likely to face large deadweight costs of default ϕ, perhaps because they are highly financially and economically integrated in the world economy, may be better off financing their investments by printing money or issuing domestic-currency claims. Third, the lower is the productivity θ_L in a crisis, the less the country has to lose from a default and the more attractive is funding through external debt. Note that in this latter situation risky debt is attractive for the issuing country as it enables the country to obtain some consumption smoothing by, in effect, issuing a state contingent claim at relatively low cost. Risky debt in this scenario implements similar allocations as *GDP-indexed debt*.

The optimal debt-equity ratio: Consider next the optimal choice of a combination of debt and equity financing. When condition (3) holds and $\mu > \lambda$ it is obviously best for the country to fund itself entirely with safe debt. Equally obvious is the observation that when $\mu < \lambda$ it is strictly preferable for the country to fund itself entirely through 'equity' (i.e. money) issuance. In fact, the country may in this case want to issue even more 'equity' than it needs to fund its investment outlays, and build foreign exchange reserves. We will return to a discussion of foreign exchange reserves in the next subsection. For now, we will focus on the most interesting case where $\mu > \lambda$ and condition (4) holds but condition (3) is violated.

In this case the optimal amount of debt financing for the country is either safe debt combined with equity financing or risky debt and no equity financing. If it is optimal to issue safe debt combined with equity, then the country's funding structure is given by an amount of debt

$$D_L = \theta_L \phi \Omega(k, w),$$

and an amount of equity $(\Delta_0(k - D_L) - 1)m$, where

$$\Delta_0(k - D_L) = \frac{(\frac{\mu + (1-\mu)\Delta_1}{\Delta_1})\bar{\theta}\Omega(k, w)}{(\frac{\mu + (1-\mu)\Delta_1}{\Delta_1})\bar{\theta}\Omega(k, w) + \theta_L \phi \Omega(k, w) - k}. \tag{6}$$

The *interest coverage ratio* (total debt repayments over GDP) for the country is then ϕ in the crisis state, when productivity is low, and $\frac{\theta_L \phi}{\theta_H}$ in the good state, when productivity is high. When it is optimal to issue only risky debt $D_H = k/\pi$ and no equity, the interest coverage ratio in the good state is $\frac{k}{\pi\theta_H\Omega(k,w)}$.[5]

5.4 Optimal reserves

Consider next the general framework where international investors revise their beliefs in response to changes in the country's monetary base, and where $\mu' > 0$. That is, an increase in the monetary base of $d\Delta_0$ induces international investors to increase their revised beliefs by μ' that the country will have a *monetary-dove* government in period 1. This general framework allows for a richer financial policy than we have considered so far. In particular, a market timing motive for issuing equity arises in this framework that is similar to the timing of equity issuance in the 'market-driven' corporate finance literature (Baker, 2009).

To see this, note first that if it is the case that $\mu(0) = \underline{\mu} < \lambda$, so that international investors are a priori more confident than domestic residents about the risk of inflation, then it is weakly optimal for the country to issue at least an amount Δ_R in domestic currency under any circumstances, where Δ_R is given by

$$\mu(\Delta_R) = \lambda.$$

Consider for simplicity the following affine function specification for $\mu(\Delta_R)$:

$$\mu(\Delta_R) = \underline{\mu} + \gamma\Delta_R,$$

so that the minimum domestic currency issuance to build reserves is

$$\Delta_R = \frac{\lambda - \underline{\mu}}{\gamma}. \tag{8}$$

[5] Another interesting case is when $\mu > \lambda$ and neither condition (4) nor (3) holds. In this case, the country may choose to issue an amount of risky debt

$$D_H = \theta_H\phi\Omega(k,w),$$

combined with an amount of equity $(\Delta_0(k - D_H) - 1)m$ with

$$\Delta_0(k - D_H) = \frac{(\frac{\mu+(1-\mu)\Delta_1}{\Delta_1})\bar{\theta}\Omega(k,w)}{(\frac{\mu+(1-\mu)\Delta_1}{\Delta_1})\bar{\theta}\Omega(k,w) + \theta_H\phi\Omega(k,w) - k}. \tag{7}$$

By issuing an amount Δ_R of domestic currency, the country is then able to build at no cost a minimum stock of foreign-currency reserves $\underline{R}$ equal to:

$$\underline{R} = [\frac{\lambda}{E[\hat{p}_2(\theta)]} + \frac{1-\lambda}{E[p_2(\theta)]}](\Delta_R - 1)m$$

where,

$$E[\hat{p}_2(\theta)] = \frac{m\Delta_R\Delta_1}{\bar{\theta}\Omega(k,w)}$$

and

$$E[p_2(\theta)] = \frac{m\Delta_R}{\bar{\theta}\Omega(k,w)}.$$

Substituting for $\hat{p}_2(\theta)$ and $p_2(\theta)$ and rearranging we obtain that:

$$\underline{R} = \bar{\theta}\Omega(k,w)[\frac{\lambda + (1-\lambda)\Delta_1}{m\Delta_R\Delta_1}](\Delta_R - 1)m,$$

where Δ_R is given by equation (8).

These foreign-currency reserves $\underline{R}$ can, of course, be used to fund investments when valuable investment opportunities arise. But, more interestingly, they can also allow the nation to become more creditworthy, enhancing its debt capacity, as we illustrate below. A critical condition for enhancing a country's debt capacity by relying on foreign-currency reserves is that these reserves be placed in escrow at an offshore custodian bank, as for example Venezuela has done to finance its Petrolera Zuata oil-field project (see Esty and Millet, 1998). When this is the case the country stands to lose all reserves placed in escrow in the event of default on its debts. By placing foreign currency reserves in escrow, the country is then able to increase its safe debt capacity as follows. Suppose that the country places its entire foreign currency reserves $\underline{R}$ in escrow, then it is able to issue an amount of safe foreign-currency denominated debt

$$D_L = \theta_L\phi\Omega(k,w) + \underline{R}.$$

Indeed, the country will refrain from defaulting on any foreign-currency debt obligation D in the event of a bad productivity shock θ_L as long as:

$$\theta_L \Omega(k,w) + \underline{R} - D \geq \theta_L(1-\phi)\Omega(k,w)$$

The RHS of this incentive constraint is the output the country's residents would be able to consume following a default. Note that default now involves not only a lower output but also the loss of foreign-currency reserves. By pledging its foreign-currency reserves a country is thus able to expand its debt capacity and relax its financial constraints.

6 Financial Constraints and Debt Overhang

Financing costs, whether in the form of deadweight costs of default or inflation costs, may be so high that it is simply not worth investing in infrastructure. Suppose the country is already indebted at time $t = 0$ and has an outstanding stock of foreign-currency denominated debt of D_0, under what conditions is it worthwhile to invest in k? We shall address this question in the special case where $\mu' = 0$ and where $\mu > \lambda$, so that there is a perceived dilution cost in issuing domestic currency to fund k. Consider in turn equity and debt financing.

Equity Financing. When the inherited stock of debt D_0 is low enough that the country always prefers to repay any such low debt obligation, then the choice between no investment and investment is unaffected by the presence of this debt under equity financing. To see this, observe that the expected payoff under no investment is:

$$(\pi\theta_H + (1-\pi)\theta_L)\Omega(0,w) - D_0.$$

And, under equity financed investment the expected payoff is:

$$(1-\alpha(\mu))(\pi\theta_H + (1-\pi)\theta_L)\Omega(k,w) - D_0,$$

where

$$\alpha(\mu) = [\frac{\mu + (1-\mu)\Delta_1}{m\Delta_0\Delta_1}](\Delta_0 - 1)m = \frac{k}{(\pi\theta_H + (1-\pi)\theta_L)\Omega(k,w)}.$$

The country thus prefers an equity-financed investment to no investment if and only if:

$$(1-\alpha(\mu))(\pi\theta_H + (1-\pi)\theta_L)\Omega(k,w) \geq (\pi\theta_H + (1-\pi)\theta_L)\Omega(0,w),$$

a condition that is independent of D_0.

Debt Overhang. As in Myers (1977), if the inherited stock of debt D_0 is so large that the country would default in the low productivity state (in the absence of any investment) the debt D_0 could discourage the country from undertaking an equity-financed investment. To see this, suppose that

$$\phi\theta_H\Omega(0,w) > D_0 > \phi\theta_L\Omega(0,w)$$

so that the expected payoff under no investment is:

$$\pi(\theta_H\Omega(0,w) - D_0) + (1-\pi)\theta_L(1-\phi)\Omega(0,w).$$

Suppose, in addition, that:

$$D_0 \leq \phi\theta_L\Omega(k,w)$$

so that under an equity-financed investment the country's expected payoff is as before:

$$(1-\alpha(\mu))(\pi\theta_H + (1-\pi)\theta_L)\Omega(k,w) - D_0.$$

Now, whether the country decides to invest depends on the following condition:

$$(1-\alpha(\mu))(\pi\theta_H+(1-\pi)\theta_L)\Omega(k,w) \geq (\pi\theta_H+(1-\pi)\theta_L)\Omega(0,w)+(1-\pi)(D_0-\theta_L\phi\Omega(0,w))$$

By assumption, $D_0 > \phi\theta_L\Omega(0,w)$, so that for some parameter values we may have:

$$(1-\alpha(\mu))[\pi\theta_H\Omega(k,w) + (1-\pi)\theta_L\Omega(k,w)] \geq (\pi\theta_H + (1-\pi)\theta_L)\Omega(0,w)$$

and

$$(1-\alpha(\mu))(\pi\theta_H+(1-\pi)\theta_L)\Omega(k,w) < (\pi\theta_H+(1-\pi)\theta_L)\Omega(0,w)+(1-\pi)(D_0-\theta_L\phi\Omega(0,w)).$$

In such situations D_0 is so large that it *overhangs* the country's efficient investment decision.[6]

Debt Financing. Consider next debt financing. If D_0 is 'safe' $(D_0 < \phi\theta_L\Omega(0,w))$ the expected payoff under no investment is:

$$(\pi\theta_H + (1-\pi)\theta_L)\Omega(0,w) - D_0.$$

If the country adds D_1 to its inherited debt to fund the infrastructure investment, so that $(D_1 + D_0) > \phi\theta_L\Omega(k,w)$, then its expected payoff becomes:

$$\pi(\theta_H\Omega(k,w) - D_1 - D_0) + (1-\pi)(1-\phi)\theta_L\Omega(k,w),$$

where $D_1 = \frac{k}{\pi}$. The country thus prefers a debt-financed investment to no investment if and only if:

$$\pi(\theta_H\Omega(k,w) - \frac{k}{\pi} - D_0) + (1-\pi)(1-\phi)\theta_L\Omega(k,w) \geq (\pi\theta_H + (1-\pi)\theta_L)\Omega(0,w) - D_0$$

or, rearranging:

$$(\pi\theta_H + (1-\pi)\theta_L)(\Omega(k,w) - \Omega(0,w)) - k \geq (1-\pi)(\phi\theta_L\Omega(k,w) - D_0)$$

Given that $\phi\theta_L\Omega(k,w) > \phi\theta_L\Omega(0,w) > D_0$, an amount of safe inherited debt D_0 such that

$$D_0 > \phi\theta_L\Omega(k,w) - \frac{k}{\pi}$$

can potentially overhang a debt-financed infrastructure investment. In contrast to equity financing, for which there is no debt overhang problem as long as inherited debt D_0 is 'safe', under debt financing any inherited 'safe' debt that is sufficiently high to force the country into risky debt territory when it funds its investment via additional debt D_1 can result in a debt overhang problem. The point is that by adding new debt D_1 to old debt D_0 the country incurs an expected deadweight

[6] Note that the situation where $D_0 > \phi\theta_H\Omega(0,w)$ is not interesting. It would mean that the country inherits such a large stock of debt that it would default no matter what.

cost of default that acts like a tax on investment. More generally, every time the country is in a situation where an increase in indebtedness raises the risk of default, it may face a debt overhang problem if it funds its investments via debt.

If, on the other hand, the inherited stock of debt D_0 is already 'risky' ($D_0 > \phi\theta_L\Omega(0,w)$) the country prefers a debt-financed investment to no investment if and only if:

$$\pi(\theta_H\Omega(k,w)-\frac{k}{\pi}-D_0)+(1-\pi)(1-\phi)\theta_L\Omega(k,w) \geq \pi(\theta_H\Omega(0,w)-D_0)+(1-\pi)(1-\phi)\theta_L\Omega(0,w)$$

or, rearranging:

$$(\pi\theta_H + (1-\pi)(1-\phi)\theta_L)(\Omega(k,w) - \Omega(0,w)) \geq k.$$

In this case there is no debt overhang as the condition above is independent of the size of D_0. In sum, under a debt-financed investment there is no debt overhang if inherited debt is risky, while under an equity-financed investment there is no debt overhang if and only if inherited debt is safe.[7]

When inherited debt is risky, one might expect that a country would go out of its way to reduce its indebtedness in an effort to avoid any deadweight costs of default. But, this turns out not to be in domestic residents' best interests, as the main beneficiaries in any reduction in the risk of default are the holders of the inherited debt. When inherited debt is risky, it could actually be in the interest of domestic residents to increase the country's indebtedness and risk of default in order to fund valuable investments. Indeed, the main losers from such an increase in the country's indebtedness are the holders of the existing debt. Thus, debt overhang considerations in a sovereign debt context can give rise to debt dynamics where

[7] This result is not entirely robust. If there is a positive recovery value of debt after default then whether inherited debt D_0 overhangs the country's investment decision is less clear, as all the country's foreign-currency denominated debt is *pari passu*. Adding new debt D_1 to the debt stock D_0 will then involve diluting the holders of the inherited debt and thus could result in a transfer to the country. This transfer is a form of subsidy, which could encourage the country to invest even if the net present value of the investment is negative.

debt begets debt, to use an expression coined by Admati, DeMarzo, Hellwig and Pfleiderer (2014).

7 Model Predictions and Empirical Observations

How does the optimal combination of reserves, debt and equity financing, vary with underlying economic conditions? In particular, how does the choice between *safe* and *risky* debt vary with the underlying economy? The strongest predictions of the model center around the interplay of two key parameters, θ_L and ϕ. As can be seen from inequality (5), expected costs of default on foreign-currency debt are highest when both θ_L and ϕ are large, and countries for which this is the case are likely to be better off financing their investments with money even if this involves paying some inflation costs. Which countries are likely to have both high θ_L and ϕ? Clearly, more developed countries have higher productivity and therefore higher θ_L. That is, developed countries remain highly productive even in recessions or crisis times. Moreover, developed countries have more financially integrated economies and larger banking sectors. A sovereign debt default for an economy with a banking sector that is both large and highly integrated in the global economy is likely to result in a major banking crisis, and therefore the deadweight cost of default will be significantly larger when the banking sector is also affected, thus resulting in a larger ϕ.

In contrast, countries for which it is likely to be preferable to rely on risky foreign-currency debt financing are poor countries that are likely to have low productivity in a crisis and are less dependent on the banking system to operate. To the extent that these countries have a lower cost of default they might be better off issuing risky debt. If they limit themselves to only safe debt issuance D_L they would have to mostly fund their investments through domestic currency debt issuance, which could come at a high cost of dilution.

While our theoretical analysis is mostly normative and does not necessarily reflect actual financing choices by countries, it is nevertheless instructive to contrast the major observed differences in countries' financial structures and foreign currency reserve management. We begin by describing the capital structures of four countries that rely on virtually no foreign-currency debt. We compare the experience of these countries with first Argentina, a country that has heavily relied on foreign-currency debt and suffered a major debt crisis, and second the Euro Zone, which as a result of monetary union has, in effect, converted domestic-currency debt into foreign-currency debt. Finally, we compare the experience of three very different economies that have in common a policy of accumulating very large foreign-currency reserves.

7.1 Domestic-currency Debt: The U.S., U.K., China and Japan compared

A common belief is that only advanced countries and reserve-currency countries can afford to rely predominantly on domestic-currency debt. While it is true that countries whose currency is a reserve asset have an 'exorbitant privilege'[8] that allows them to issue debt denominated in their currency at favorable terms, reliance on domestic-currency debt is by no means confined to them, or to countries with advanced economies.[9] As as the comparison between the U.S., U.K., Japan and China in this section illustrates, from 1993 to 2013 the ratio of foreign-currency debt to GDP in the U.S., U.K. and Japan has never exceeded respectively, 0.05%, 1.1%, 0.14%, while for China it has not exceeded 0.5% (see Figure 1).

These four countries also look very similar in terms of their ratios of $M2+$ Domestic-currency Debt-to-GDP ratios, as Figure 2 illustrates. The $M2+$ Domestic-currency Debt measure of the money stock is closest in our view to the m ($m\Delta_0$ and $m\Delta_0\Delta_1$) variable in the model. This ratio has increased from 120% in 1993

[8] See Gourinchas and Rey (2007).

[9] Du and Schreger (2015) study the currency composition of sovereign debt of 13 emerging market countries and find that over the past decade the share of domestic-currency debt for these countries has increased from 15 to 60 percent on average.

to 180% in 2014 for the U.S., from under 100% in 1993 to nearly 250% in 2014 for the U.K., from 215% in 1993 to 300% in 2014 for Japan, and from 100% in 1993 to nearly 210% in 2014 for China. Remarkably, despite what appear to be large increases in the money stock to GDP ratio in these countries, there has been subdued inflation over this twenty-year period in each of these countries, as Figure 3 shows. Except for the financial crisis of 2008-2009, the inflation rate in the U.S. from 1993 to 2014 has hovered around 2% and never exceeded 4%. The inflation experience of the U.K. is very similar, with inflation peaking at just under 4.5% in 2011. As for Japan, its rate of inflation has, if anything, been in deflation territory over this period, hovering around 0%, with the very recent exception of a peak inflation of 2.7% in 2014. Finally, China's inflation rate over this period has come down from a peak of 24% in 1994 to hover around 3% over the remainder of this period, with another peak at 5.8% in 2008. China was able to bring down its high inflation rate in 1995 and did contract its $M2+$ Domestic-currency Debt in 1994 and 1995. This was a key step to reaffirm its reputation as a low-inflation emerging-market country, and thus preserve its ability to finance its high rate of growth and investment with domestic currency at favorable terms.

The four countries' experience, however, differs significantly in two respects. First, and most obviously the rate of GDP growth, which hovered around 3% in the U.S. and U.K. (with the exception of the financial crisis when it dropped to respectively -2.8% and -4.3% in the U.S. and U.K. and thereafter averaged around 2%), and around 1.5% for Japan (with a drop in 2009 to -5.5%). In contrast, China's GDP growth over this period started at a peak of 14% in 1993, continued at an average rate of around 10% to reach a trough of 7.3% in 2014 (and, remarkably, with a growth rate of 9.2% in 2009). Second, China's foreign-currency reserves were at 3.3% of GDP in 1993 and ended at just under 40% in 2014. Similarly, Japan's foreign currency reserves to GDP ratio shot up from 7.3% in 2000 to 26% in 2014. Meanwhile, the U.S. foreign currency reserves never exceeded 0.35% over this period and the U.K.'s reserves peaked at just under 1% in 2003.

Part of the rise in foreign currency reserves reflects the fact that China and Japan ran large current account surpluses (and the U.S. and U.K. large current account deficits). As Figure 4 highlights, China's current account over this period was in surplus, rising from 1.3% of GDP in 1994 to a peak of 10.5% in 2007 and then declining back to a surplus of 2.1% in 20014. Similarly, Japan's current account surplus was 3% of GDP in 1993, peaked at 5.1% in 2007 and subsequently declined to 0.5% in 2014. In contrast, the current accounts of the U.S. and the U.K. are almost mirror images of those of China and Japan, with the U.S. running a deficit during this entire period, starting with -1.7% of GDP in 1994, peaking at -5.8% in 2006 and declining back to -2.4% in 2014 (the U.K. had a deficit of -0.35% in 1994, -3.7% in 2008, and -5.5% in 2014). While contributing substantially to the accumulation of foreign currency reserves (roughly around 2/3), these current account surpluses alone cannot entirely explain the sharp increase in reserves in China and Japan.

In sum, China's experience resembles in many ways the financing patterns of a growth firm, which keeps its leverage low so as to preserve its financing capacity to pursue future investment opportunities, and which regularly returns to equity markets to raise new funds for investment. In contrast, the U.S., U.K. experience resembles more the financing pattern of a mature, blue-chip, company that pays out a large dividend and times the equity market to raise new funding on the cheap.

7.2 Foreign-currency Debt: Argentina

If there is one country that perfectly fits the common belief that emerging-market countries have no choice but to issue foreign-currency debt it is Argentina. The fear of inflation led Argentina to adopt a currency board, which, in effect, institutionalized reliance on foreign-currency debt. As can be seen in Figure 5, Panel A, Argentina had a ratio of foreign-currency debt to GDP of just under 10% in

1993. This ratio steadily increased and peaked at 70% in 2002, the year in which Argentina defaulted on this debt and plunged the country in a severe recession, with a GDP contraction of -11% (see Panel C). Although Argentina subsequently reached a debt restructuring agreement with a large majority of its debt holders in 2005, thus lowering its foreign-currency debt to GDP ratio to 23.5%, its continuing legal battles with hold-out creditors in effect shut out Argentina from international foreign-currency debt markets, so much so that its foreign-currency-debt-to-GDP ratio continued to decline to 7.8% in 2014.

Being shut out of international debt markets, inevitably pushed Argentina to rely more on domestic currency financing, as can be seen in Panel B of Figure 5, which plots Argentina's $M2+$ Domestic-currency Debt-to-GDP ratio. This ratio was at 20% in 2001 and thereafter jumped to hover around 38%. By defaulting on its foreign-currency debt, and thereby removing its debt-overhang, Argentina was able to clock up a relatively high GDP growth performance after 2002, as Panel C of Figure 5 reveals, but it also suffered a bout of remarkably high inflation in a global context of low inflation: Panel D of Figure 5 shows that Argentina's inflation went from 8% in 2006 to 39% in 2014! In sum, Argentina's experience is certainly a narrative of severe financial constraints, but also one of runaway public finances. There is no easy financial fix for a structural public deficit problem. The outcome is either default or inflation. It is important to note that the fundamental cause behind high inflation or hyperinflation is generally not simply an overly permissive monetary policy, but a structural excess public spending problem aided and abetted by a lax monetary policy.[10]

[10] Neil Irwin in *The Alchemists* points out that Rudolf Von Havenstein the President of the German Reichsbank from 1908 to 1923 viewed hyperinflation as "the fault of the government for running huge budget deficits", and quotes from a telling speech Havelstein gave on August 17, 1923: "The Reichbank today issues 20,000 milliard marks of new money daily. In the next week the bank will have increased this to 46,000 milliards daily...The total issue at present amounts to 63,000 milliards. In a few days we shall therefore be able to issue in one day two-thirds of the total circulation." [Neil Irwin, *The Alchemists*, 2013, pp 52]

7.3 Foreign-currency Debt: The Eurozone Experiment

Another experiment, which amounts to a conversion of domestic-currency debt into foreign-currency debt $\grave{a}$ la Argentina is the European monetary union. By separating fiscal and monetary policy, entrusting the conduct of monetary policy to an independent supra-national central bank, and by enshrining the impossibility of debt monetization into the monetary union treaty, the European monetary union, in effect, converted all existing domestic-currency debt of the member states into foreign-currency debt, thus exposing the member states to the risk of default. In addition, monetary union effectively shut down any possibility of funding investments or building foreign exchange reserves through money issuance. Thus, from a corporate finance perspective one of the important consequences of European monetary union has been the imposition of the requirement that all future financing be in the form of foreign-currency debt. It is as if a corporation put in its bylaws that no new equity issuance is possible and that all new financing of realized operating losses or investments be through debt. In light of this restriction it is not entirely surprising that following the global financial crisis of 2007-09 the Eurozone is the only set of developed countries that has as a consequence faced a sovereign debt crisis.

Figure 6 shows the dramatic effect of monetary union on the member countries' foreign-currency debt to GDP ratios. In one stroke Italy's ratio jumped from 4.5% in 1998 to 109% in 1999, Spain's ratio jumped from 4.7% to 61%, Germany's from 0% to 60%, Portugal's from 11% to 51%, and Greece's from 13% to 102%. Subsequently, this ratio continued to rise in Portugal and Greece due to the perceived low cost of borrowing. This cost was, of course, much lower than the previous interest rates on domestic currency debt, which reflected inflation risk as perceived by financial markets. Monetary union, substantially reduced, if not eliminated, this risk (see Figure 6). At the same time, financial markets priced in an implicit guarantee by the union against the risk of default by periphery countries. Spain's foreign-currency debt to GDP ratio declined up to the crisis (the debt build-up took place in the private sector) and Italy's and Germany's ratios remained stable. But the financial crisis of 2007-09 led to a further increase, which was due to a combination of a decline in the denominator (GDP) and a rise in the cost of borrowing in the periphery due to a change in financial markets' perception about the risk of default. Thus, Germany's ratio rose from 64% in 2007 to 80% in 2010; Italy's ratio rose from 100% in 2007 to 132% in 2014; Spain's ratio jumped from 35.5% in 2007 to 98% in 2014; Portugal's ratio went from 68% in 2007 to 130% in 2014, and Greece's ratio, despite a major debt write-down in the second rescue package, went from 124% in 2007 to 188% in 2014. The financial crisis made apparent a major debt-overhang problem for member countries of the Eurozone. It is thus not surprising that these countries stopped growing after the financial crisis, as Figure 7 shows. The European Central Bank's proactive policy after the financial crisis has helped reassure markets about default risk and has brought down yields across the Eurozone, but it has not helped in any significant way reduce the debt-overhang problem created by monetary union and exacerbated by the financial crisis.

7.4 Foreign-exchange Reserves: Switzerland, China and Japan compared

Another recent example of a country that has rapidly built huge foreign-currency reserves without paying any inflation cost is Switzerland, which in a period of five years, from 2007 to 2012, increased its reserves to GDP ratio from under 10% to over 70%, as can be seen in Panel A of Figure 8. Over the same time period Switzerland's M2$+$ Domestic-currency Debt to GDP ratio jumped from just over 170% to over 220% (see Panel B). Yet, inflation dropped from a rate of 2.5% in 2007 to deflation territory by 2014, as can be seen in Panel C. Finally, although Switzerland's GDP-growth rate collapsed from 4% in 2007 to -2% in 2009, as a result of the global financial crisis, thereafter it has largely recovered to pre-crisis levels, as Panel D illustrates.

It is worth emphasizing that Switzerland, surrounded by the depressed Eurozone, followed a macroeconomic path much closer to that of Asian countries, in particular China, which relied on domestic-currency debt and built foreign exchange reserves by timing the market for their currency in the midst and aftermath of the global financial crisis. As for these countries, Switzerland did not experience any inflation as a result of its massive expansion of reserves. On the contrary, this increase in reserves was accompanied by large investment outlays and high growth rates in output relative to the Eurozone. The experience of these countries illustrates that the cost of funding investment through domestic currency issuance is particularly low in periods of low inflation or deflation.

8 Conclusion

In this paper we take a corporate finance approach to the question of debt and currency financing of a nation's investments. We propose a conceptual innovation, namely that a nation's money can be seen as similar to a firm's equity. What a nation's currency and a firm's equity have in common is that they both serve as a store of value. Moreover, a nation's currency is a claim on the nation's residual output, just as a firm's equity is a claim on the firm's residual cash flow. Where currency and equity differ, is in the role of money as a medium of exchange and in the voting rights associated with common stock. But these differences may not be essential when it comes to the question of the optimal liability structure of a firm on the one hand, and the optimal liability structure of an open economy on the other. By framing the financing problem of nations as a problem similar to the financing choices of corporations we are able to make explicit the costs and benefits of printing money for a nation. In particular, we argue that if the benefits of printing money in terms of added financing of valuable investments are substantial they may justify paying the potential costs of inflation.

We have only taken a first step in the formal analysis by specifying an extremely simple static model. As compelling as the analogy between a firm and a country is, one important aspect we have oversimplified and which deserves further research is the fact that a country is not quite a company, as Krugman (1996) has observed. The non-tradeable sector of a country's economy is a closed system, which responds to monetary and fiscal stimulus when depressed. Macroeconomic stimulus involves other funding considerations, which we have abstracted from entirely.

Another area worth exploring is the dynamics of a nation's capital structure. How frequently should a nation rely on money issues? When should it build up and draw down its foreign currency reserves? And what should be the maturity of its foreign currency debt? Finally, a fundamental area which requires further analysis is governance and moral hazard problems in how nations are governed. We have assumed for simplicity that funding and investment decisions are made by the government of a nation in the best interest of its citizens. But this is hardly a realistic description of how most nations are governed. For common stock in corporations shareholders have voting rights, which they can exercise to appoint boards of directors and CEOs that pursue policies in their best interest. Corporations also restrict CEO discretion on equity issuance and buybacks, which require shareholder approval. Furthermore, corporations are disciplined by corporate law, which constrains CEOs ability to pursue policies that are detrimental to shareholder value.

Countries also have institutions that allow citizens to bring to power governments that act in their interest. But these institutions are very different from corporate governance and they do not link a citizen's (or non-citizen's) voting rights to domestic currency holdings (at least not directly). How does this separation between control rights and residual rights to the nation's output affect the question of how nations should be financed? How does it affect the discretion given to governments to print money? We leave these questions for future research.

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Figure 1: Foreign-currency Debt Securities as a Percentage of GDP

This figure plots the foreign-currency debt securities to GDP ratio for respectively the U.S., U.K., Japan and China from 1993 to 2014.

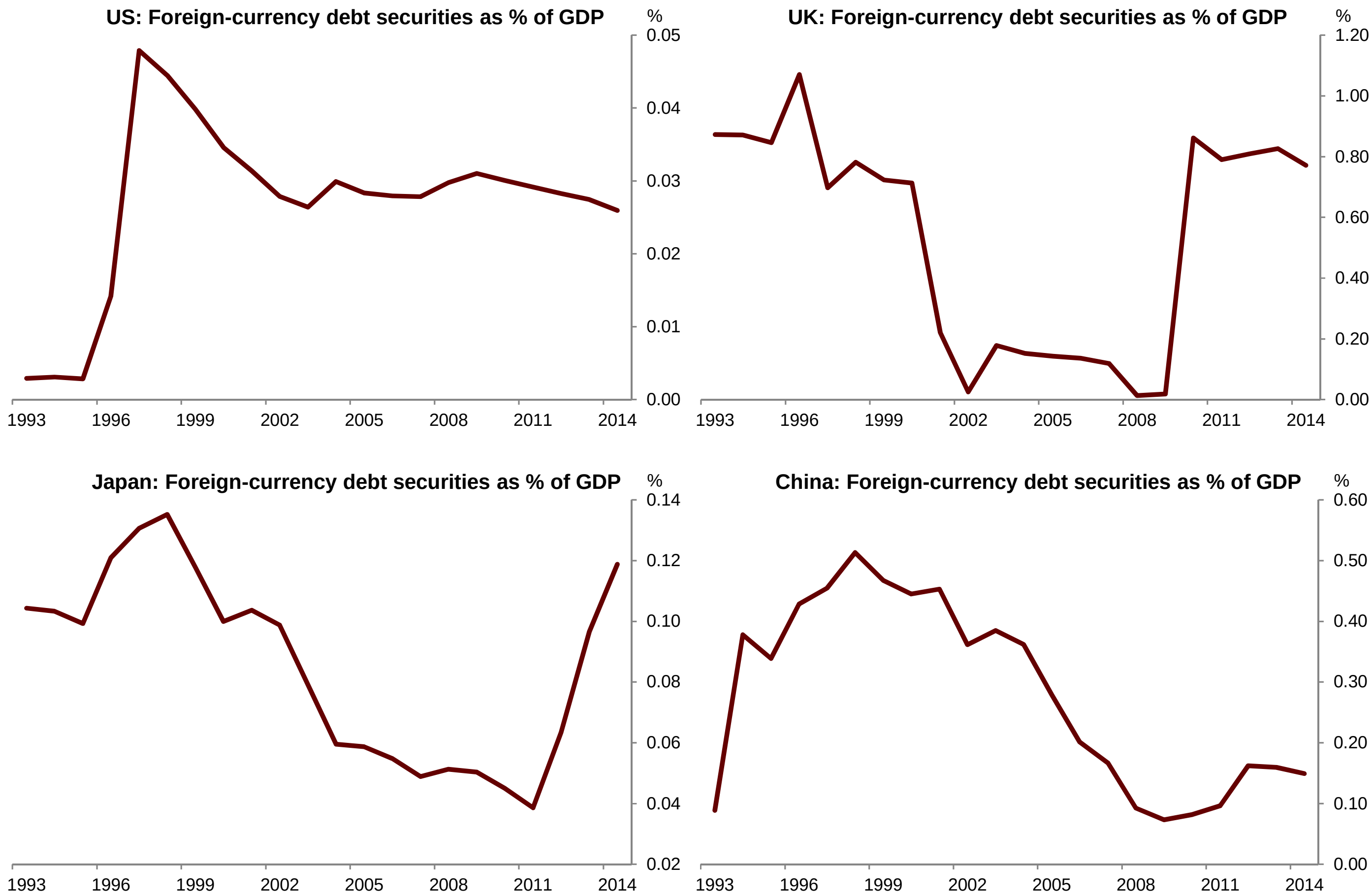

Figure 2: M2+ Domestic-currency Debt as a Percentage of GDP

This figure plots the sum of M2 and Domestic-currency Debt as a percentage of GDP for respectively the U.S., U.K., Japan and China from 1993 to 2014.

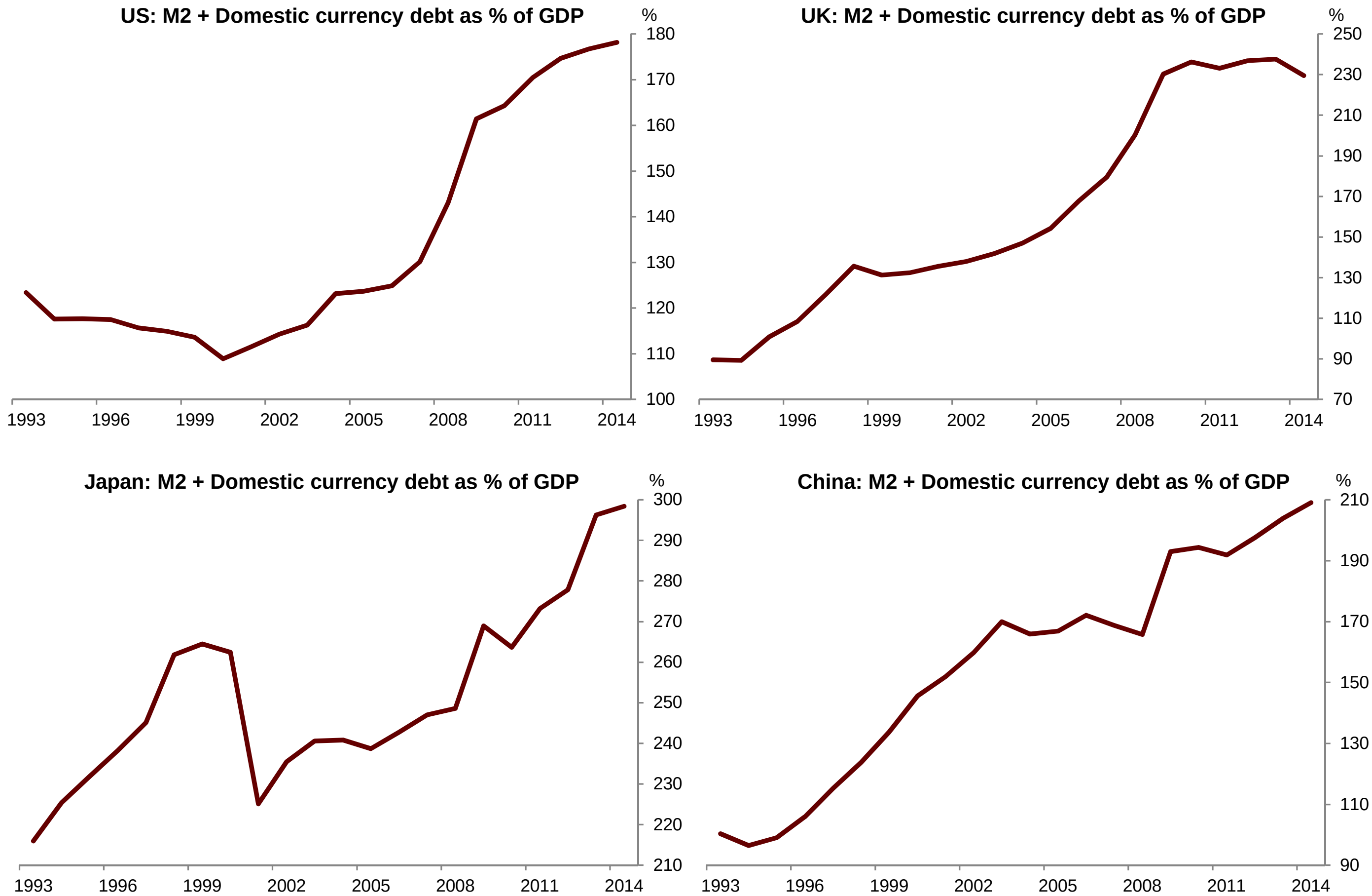

Figure 3: Inflation

This figure plots the inflation rate for respectively the U.S., U.K., Japan and China from 1993 to 2014.

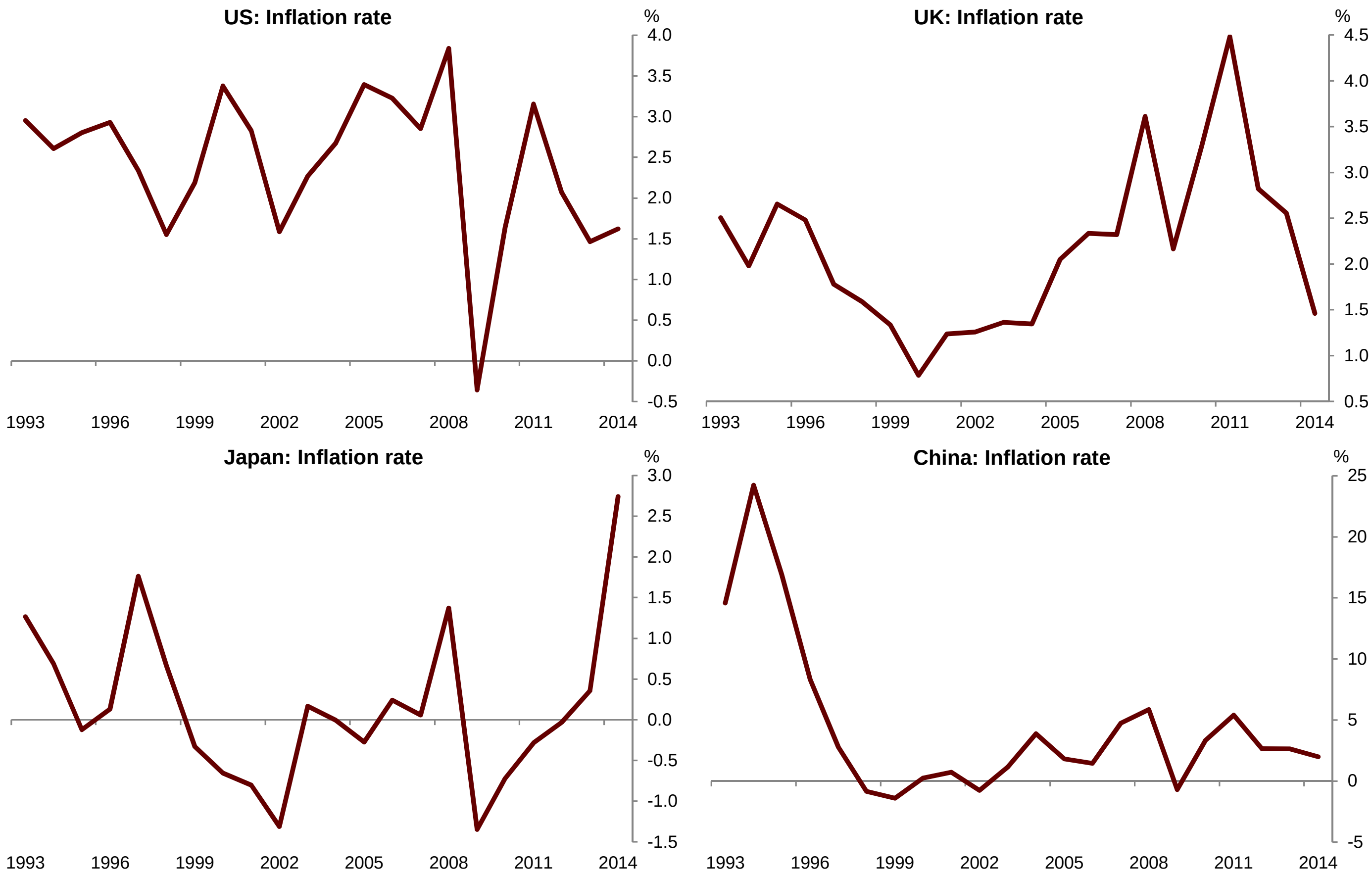

Figure 4: GDP Growth

This figure plots the GDP growth rate for respectively the U.S., U.K., Japan and China from 1993 to 2014.

Figure 5: Argentina

This figure plots the Foreign exchange reserve as a percentage of GDP, sum of M2 and Domestic-currency Debt as a percentage of GDP, inflation rate, and GDP growth rate for Argentina from 1993 to 2014.

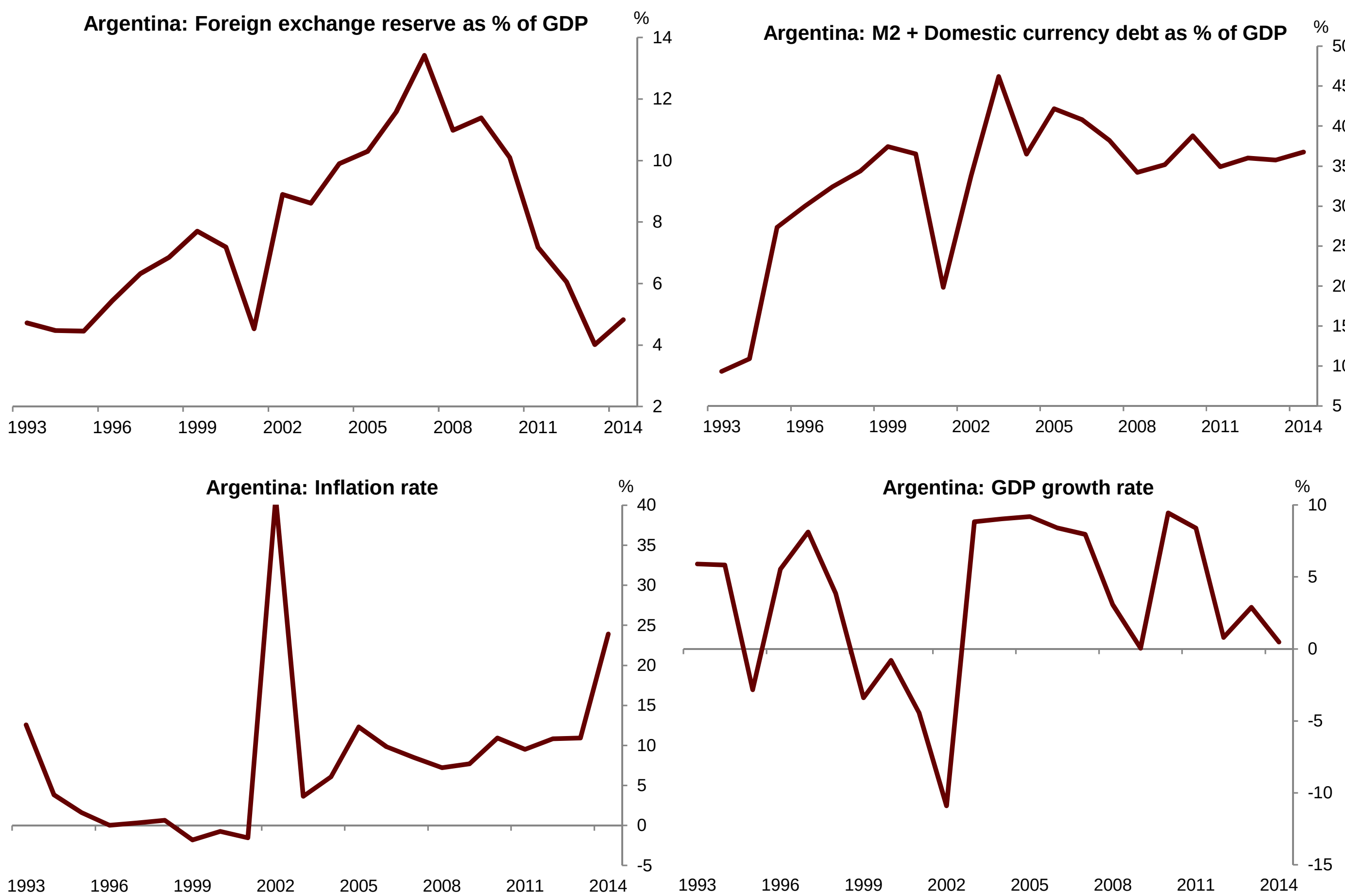

Figure 6: Foreign-currency Debt Securities as a Percentage of GDP

This figure plots the foreign-currency debt securities to GDP ratio for respectively Italy, Spain, Portugal, Germany and Greece from 1993 to 2014.

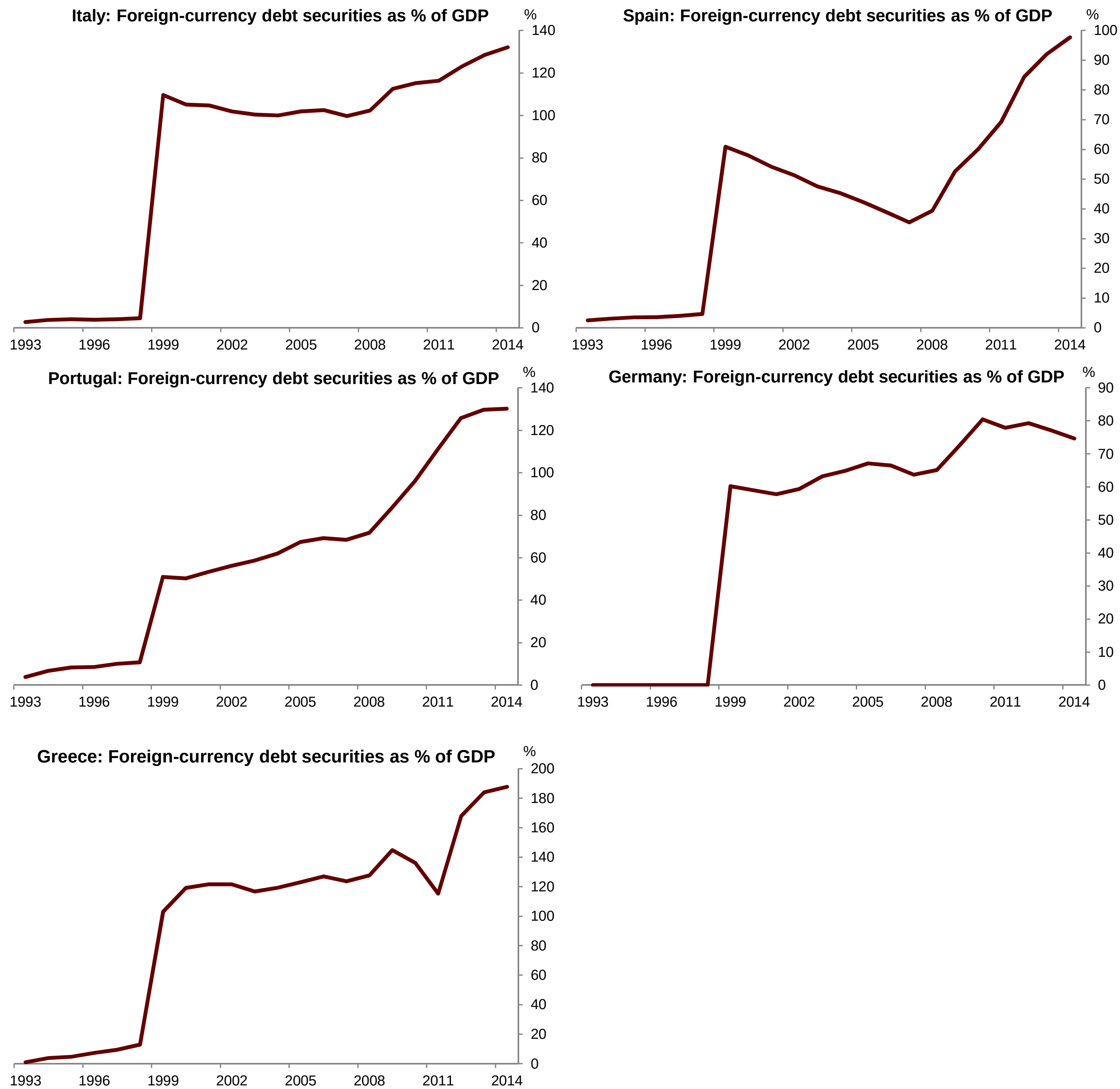

Figure 7: GDP Growth

This figure plots the GDP growth rate for respectively Italy, Spain, Portugal, Germany and Greece from 1993 to 2014.

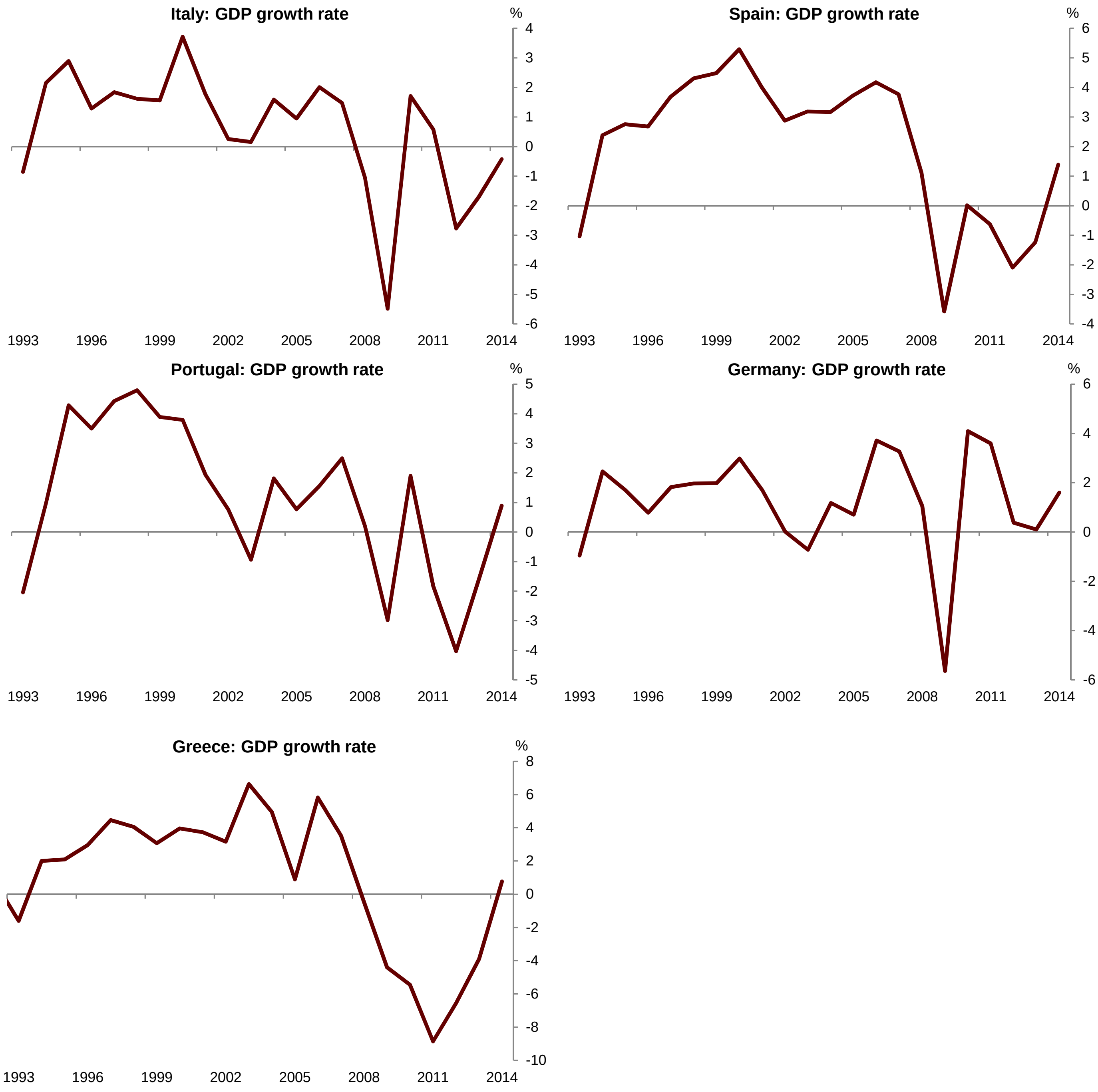

Figure 8: Switzerland

This figure plots the Foreign exchange reserve as a percentage of GDP, sum of M2 and Domestic-currency Debt as a percentage of GDP, inflation rate, and GDP growth rate for Switzerland from 1993 to 2014.