The Cost of Reserves

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Abstract

The cost of holding reserves is often estimated as the sovereign spread on the risk-free return on reserves paid on the debt issued to purchase them, which ignores the benign effect of reserves on the spread. This paper illustrates this numerically, showing that these costs, as typically measured, may have been considerably overstated.

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I. Introduction

The recent surge in the stock of international reserves in developing economies has been attributed to two main reasons: (i) prevent real exchange rate appreciation as a result of capital inflows, either due to the "mercantilist" objective of preserving competitiveness, or to avoid a potential overvaluation that may eventually create downside risks; (ii) create a dollar liquidity buffer to cope with —and ultimately discourage— self-fulfilling liquidity runs in economies with substantial dollar liabilities. The evidence so far has favored the second motive.[2]

However, this type of self-insurance entails a "cost of carry", namely, the return that the government has to pay in excess of the return on liquid foreign assets to fund the purchase of reserves. Absent any maturity mismatch between reserves and debt, this excess return is equal to the sovereign risk premium.[3] This cost, it has been argued, could be substantive and may justify alternative forms of liquidity insurance.

One aspect that has been so far overlooked by the literature may shed a more positive light on reserve hoarding in indebted countries. Since the sovereign risk premium reflects the probability of default (including due to the liquidity run that reserves are meant to insure against), an increase in reserves not only reduces the probability of incurring a costly crisis but also reduces the spread paid on the full stock of sovereign debt, adding to the marginal benefits of reserve accumulation. This note illustrates this aspect numerically.

II. The marginal cost of reserves

Assume for simplicity (but without loss of generality) that both the reserves and the debt issued to purchase them have a maturity of one period.[4] Then, the sovereign spread r is characterized by:

$$1+r^f = \left(1+r^f+\rho\right)[1-p(R,D)] + \left(1+r^f+\rho\right)\left(1-H\right)\times p(R,D)$$

where r^f is the risk free rate, R is the stock of reserves, H is the haircut (computed over principal plus accrued interest) in

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[2] In particular, it shows that reserves are positively correlated with past balance of payments crises (Aizenman and Lee, 2005) and with the degree of financial dollarization (Levy Yeyati, 2006a).

[3] Reserves need to be liquid (that is, trade in a liquid market) but not necessarily short term, so that no maturity mismatch needs to be incurred. Note, however, that the argument made in this paper is also valid for the alternative approaches to the cost of reserves discussed, i.a., by Jeanne and Ranciere (2005) and Rodrick (2006).

[4] Note that all that it is needed for reserves to provide effective liquidity insurance is that the debt issued to purchase them should be longer than the flow it is intended to insure. Thus, for example, a country can insure the financing gap faced in the current period by issuing long-term debt to purchase long-term liquid foreign assets for an amount equal to this gap.

the event of default (equal to one minus the recovery ratio $V = 1 - H$), and p is the probability of a debt crisis, which we assume to depend positively on the debt level D and negative on liquid foreign assets R, from which

$$\rho(R,D) = \frac{H \times p(R,D)}{[1 - H \times p(R,D)]}\left(1 + r^f\right)$$

where

$$\rho_R(R,D) = \frac{H \times p_R(R,D)}{[1 - H \times p(R,D)]^2}\left(1 + r^f\right) = \rho_D(R,D)\frac{p_R(R,D)}{p_D(R,D)} \leq 0 .$$

Thus, the government pays a self insurance marginal cost $\rho(R,D)R$ (that is, the yield on the marginal unit of debt issued to purchase the marginal unit of reserves) to avoid a crisis that costs C, and, in so doing, reduces the spread $\rho(R,D)$ that it pays on the rest of the debt. More precisely, we can express the government loss function as

$$L(R,D) = \left[r^f + \rho(R;D)\right]D + p(R,D)K - r^f R + k$$

which equals the debt service plus the expected cost of a crisis minus the return on reserves plus a constant *k* that conflates other arguments of the government utility that are independent of reserves and debt stocks.

In turn, recalling that one unit of reserves entails one additional unit of debt ($\frac{\partial D}{\partial R} = 1$),

$$\frac{\partial L(R,D)}{\partial R} = [p_R(R,D) + p_D(R,D)]K + \rho(R,D) + [\rho_R(R,D) + \rho_D(R,D)]D$$

The first two terms represent the well-known tradeoff between the self-insurance benefits associated with a lower crisis propensity, and the costs of carry measured as the spread the country has to pay to finance reserve holdings, whereas the last term represents the (positive) spillovers on debt service, which should be netted out from the cost of carry. The net marginal cost of reserves is thus given by

$$C'(R,D) = \rho(R,D) + [\rho_R(R,D) + \rho_D(R,D)]D$$

More precisely, denoting the elasticities of the sovereign spread with respect to reserves and debt as

$$\frac{\rho_R(R,D)}{\rho(R,D)} \times R = \beta_R$$

And

$$\frac{\rho_D(R,D)}{\rho(R,D)} \times D = \beta_D$$

we obtain that the marginal cost of reserves is given by

$$C'(R,D) = \rho(R,D)\left[1 + \left(\frac{\beta_R}{\omega} + \beta_D\right)\right]$$

where $\omega = \frac{R}{D}$ is the ratio of reserves to sovereign debt with the private sector (more precisely, the debt stock on which the sovereign spread is paid).

Note that if $\rho_R(R,D) \le 0 \le \rho_D(R,D)$, as expected, the way in which the marginal cost of reserves compares with the sovereign spreads will depend on the relative elasticities and the ratio between reserves and sovereign debt. In particular, the spread would overstate the marginal cost of reserves whenever $\frac{\beta_R}{\omega} + \beta_D < 0$.

III. An empirical illustration

To illustrate the idea numerically, I build on González Rozada and Levy Yeyati's (2005) model of emerging market spreads, which focuses on two exogenous global factors (the international risk-free rate, and the global risk aversion), to which I add the stock of reserves and sovereign external debt with the private sector (lagged to reduce potential endogeneity concerns), as well as credit ratings (to control for other country-specific, time-varying characteristics).[5] [6] Table 1 reports the results.

The first regression simply replicates the original model for the sample for which debt and reserves data are available. Column 2 and 3 include reserves and debt one at a time. The elasticity with respect to reserves, β_R, is reassuringly stable at roughly 48% (meaning that, ceteris paribus, a 1% increase in reserves leads to a 0.48% decline in spreads), while the elasticity with respect to the debt stock, β_D, is about 16%.

In particular, for the sample average reserve-to-external debt ratio ω = 79%, the previous estimates indicate that the marginal cost of reserves is only 55% of the sovereign spread. This implies that, for a country facing a spread of 300 bps, the marginal cost of reserves is only 166 bps. Alternatively, these estimates imply that the purchase of reserves entails a net financial saving for values of the reserve-to-debt ratio ω below $-\frac{\beta_R}{1+\beta_D} = 41\%$.[7]

As noted, one potential reason why reserve accumulation coincides with a decline in sovereign spread relates to a standard mercantilist argument: to protect local producers from foreign competition, according to which reserves are purchased to mitigate the real appreciation of the local currency in good times —exactly when one would expect sovereign spreads to go down. This, in turn, begs the question of whether the reported benign effect of reserves on spreads is capturing the insurance benefits of liquidity, or just the presence of omitted common factors such as improved terms of trade that increase the supply of foreign currency and induce the government to intervene to avoid a rapid appreciation of the currency.

I control for that possibility in columns 4 to 6, where I include the lag of the country's terms of trade (*TOT*) together with two alternative proxies for the supply of foreign exchange: the real exchange rate (*RER*), and the exchange rate devaluation in the previous period (Δ*ER*). These two variables should be seen as complementary: whereas the real exchange rate is expected to

[5] Sovereign spreads are J. P. Morgan's Emerging Market Bond Index (EMBI) spreads. The international rate and the global risk aversion are proxied by the yield on the 10-year U.S. Treasury Note, and the High Yield Corporate spread index compiled by J. P. Morgan (see Table 3 for variable definitions and sources). Debt stocks are from the World Bank's GDF. All variables are in logs. All regressions are based on monthly data, include country fixed effects and exclude observations for countries in default.

[6] Note that I exclude official debt for this calculation: since it is typically priced independently of the sovereign spread, including it would understate the sensitivity of spreads (and, in turn, overstate the effect of debt stocks). Finally, it should be noted that ratings tend to be largely endogenous to spreads (as shown by González Rozada and Levy Yeyati, 2005); however, this does not bias the coefficients of interest.

[7] A priori, one would expect this elasticity to change with the stock of reserves: if extreme shocks are less frequent, the effect of additional reserves on the probability of default as a result of a liquidity shock would decline with the existing stock of reserves. However, including interaction of the stock of reserves with the reserve-to-debt ratio (a proxy for the size of the liquidity buffer) does not alter the previous estimates (Levy Yeyati 2006c).

reflect low frequency real shocks, the nominal depreciation is more likely to react to high frequency speculative movements.[8] Together with the terms of trade, they should control for the incidence of macroeconomic shocks in the link between reserves accumulation and spreads. The results are reassuring. On the one hand, the additional controls are significant and display the expected sign even when included together: high terms of trade, low RER and nominal appreciations all lead to lower ratings and a decline in sovereign spreads. On the other hand, the estimated elasticity of spreads with respect to reserves is minimally changed.[9]

The previous exercise abstracts from the impact of both reserves and debt on *perceived* risk (as captured in the model by the credit rating). Predictably, both variables influence ratings significantly and in the expected direction: reserves improve ratings whereas debt worsens them (column 5). With this in mind, an alternative estimate of the marginal cost of reserves (inclusive of the impact through ratings) is provided in column 6, where an elasticity of about 54% leads to an average cost of reserves of just 31% of the sovereign spread (and even below that figure for highly indebted countries with low reserves-to debt ratios).[10]

If, as argued above, self-insurance against a dollar liquidity shortage is the main driver behind reserve accumulation, the extent to which reserves affect spreads should reflect the presence of the foreign currency mismatch that is at the core of the exposure to liquidity runs. While an encompassing measure of this exposure is difficult to produce given the available data, one can test this hypothesis in an indirect way using a crude proxy suggested by the literature, the ratio of onshore dollar deposits over total bank deposits, which has been shown to be closely correlated with other sources of foreign currency exposure.[11]

I examine this in columns 7 to 12, where the stock of reserves is interacted with the deposit dollarization ratio (*DD*), which, as expected, increases the sovereign spread. While the effect of *DD* on the elasticity of spreads to reserves fails to be significant at conventional levels (column 7), *DD* does increase the benign effect of reserves on credit ratings (column 8) and, through this channel, on spreads (column 9) when the latter are not conditioned by the rating, thus providing support for the self insurance hypothesis.

An alternative approach to the same theme is reported in the last three columns, where I replicate the previous exercise using a peg dummy that identifies countries with a de facto pegged exchange rate regime in the previous year. Two implicit assumptions motivate this test. On the one hand, to the extent that a peg is perceived as an implicit exchange rate guarantee, it would induce a mispricing of currency risk that would tend to generate currency mismatches. If so, pegs would be associated with a stronger insurance effect of reserves. On the other hand, the political costs of abandoning the peg (or the real costs of defending it) combine with to the balance sheet costs of a foreign currency liquidity run, compounding the benefits of holding liquid foreign assets. At any rate, the results show that the effect of reserves on sovereign spreads are indeed larger under pegged regimes, again in line with the self insurance view of reserve accumulation.

IV. Conclusion

Recent studies that have emphasized the costs of accumulating reserves for self-insurance purposes have overlooked a potentially important (benign) side-effect: the impact of the resulting lower spreads on the service costs of the stock of sovereign debt. In this note, I argue that this side effect could easily reduce the marginal cost of reserves substantially —by more that 50% according

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[8] Lower real exchange rates should be associated with a benign environment conducive to low spreads and a more intensive mercantilist intervention. Alternatively, large swings in the nominal exchange rates may signal more closely the speculative response of market players that typically flood the country with foreign exchange during a boom (thereby inducing, again, a mercantilist reserve accumulation).

[9] Both β_R and β_D are smaller. As a result, the marginal cost of reserves is ultimately comparable with that find in the previous table.

[10] Note that virtually identical coefficients are obtained by adding to the direct effect from column 3 the effect on ratings from column 4 compounded by the effect of ratings on spreads found in column 3.

to the calculations reported here. It should be noted, additionally, that this computation provides a lower bound to the benefits of reserves in terms of lower financing costs, since it does not incorporate similar gains in the private sector —where borrowing costs are typically bounded below by those of the sovereign.

While these findings do not deny the fact that self-insurance is costly and should be considered as a second best solution in a context of imperfect international financial markets, they certainly shed a different light on the cost-benefit that should inform the decision about the optimal amount of reserves. Needless to say, these estimates could be refined to take into account country specific characteristics (the currency and maturity composition of sovereign debt, among other things, should certainly influence the impact of liquid reserves). However, they help to illustrate the main message of this note, namely, that the cost of reserves, as typically measured, may have been considerably overstated.

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[11] De Nicoló et al. (2003) show that the loans dollarization largely mirrors deposit dollarization, while Cowen et al. (2006) show the same for the dollar ratio of domestic sovereign debt.

Table 1. Elasticities of emerging market spreads to reserves and debt stocks

	Spread				Rating	Spread		Rating	Spread		Rating	Spread
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Risk aversion	0.995	0.828	0.851	0.751	0.098	0.672	0.87	0.098	0.767	0.837	0.083	0.739
	(24.11)**	(23.67)**	(23.45)**	(21.55)**	(7.72)**	(17.96)**	(21.31)**	(6.38)**	(15.40)**	(21.74)**	(5.80)**	(17.47)**
Credit rating	-1.583	-1.182	-1.165	-0.809			-1.048			-1.186		
	(8.84)**	(7.50)**	(7.58)**	(6.86)**			(6.72)**			(7.88)**		
10YT	0.866	0.562	0.606	0.557	0.159	0.428	0.785	0.158	0.62	0.674	0.217	0.417
	(14.44)**	(8.38)**	(9.30)**	(6.10)**	(5.33)**	(4.67)**	(10.29)**	(5.67)**	(7.84)**	(9.01)**	(7.59)**	(6.10)**
Reserves(-1)		-0.485	-0.484	-0.391	0.189	-0.544	-0.342	0.11	-0.457	-0.422	0.258	-0.728
		(9.65)**	(9.99)**	(8.81)**	(6.54)**	(13.48)**	(5.77)**	(3.18)**	(6.98)**	(8.75)**	(9.19)**	(17.81)**
Sov. Debt(-1)			0.163	0.029	-0.111	0.118	0.315	-0.164	0.487	0.284	-0.058	0.353
			(3.31)**	-0.35	(4.31)**	-1.24	(5.45)**	(8.85)**	(8.32)**	(6.61)**	(3.41)**	(7.80)**
ToT(-1)				-0.471	0.289	-0.705						
				(4.41)**	(7.40)**	(6.37)**						
RER(-1)				0.463	-0.364	0.758						
				(4.37)**	(9.48)**	(7.03)**						
ΔER(-1)				0.812	0.364	0.517						
				(2.71)**	(3.44)**	-1.68						
Reserves(-1) * DD(-1)							-0.156	0.23	-0.398			
							-1.33	(3.03)**	(3.12)**			
DD(-1)							2.393	-2.171	4.667			
							(3.60)**	(9.09)**	(6.29)**			
Reserves(-1) * Peg(-1)										-0.114	-0.004	-0.109
										(5.19)**	-0.27	(3.37)**
Peg(-1)										-0.096	-0.01	-0.084
										-1.45	-0.28	-0.88
Constant	1.532	3.311	2.574	13.573	-5.117	17.714	0.5	2.136	-1.737	2.214	0.981	1.05
	(2.98)**	(9.18)**	(6.20)**	(5.02)**	(4.71)**	(6.12)**	-0.73	(9.02)**	(2.60)**	(5.10)**	(4.90)**	(2.48)*
Observations	1210	1210	1210	1086	1086	1086	944	944	944	1210	1210	1210
R-squared	0.91	0.92	0.92	0.93	0.9	0.92	0.92	0.88	0.9	0.93	0.89	0.91

Robust t statistics in parentheses. Default observations are excluded. All regressions include country fixed effects. Errors robust to heteroskedasticity clustered by time. All variables are expressed in logs, except ΔER(-1), DD and Peg. DD (-1) = dollar over total domestic bank deposits in the previous year (source: Levy Yeyati, 2006b). Peg = 1 whenever the country has a de facto pegged exchange rate regime in the previous year (source: Levy Yeyati-Sturzenegger, 2005). * significant at 5%; ** significant at 1%.