Title

Asymmetric stabilizing impact of international reserves

Authors

Lee, Dongwon
Kim, Kyungkeun
Lee, Dong Won

Publication Date

2024-10-18

DOI

10.1080/13504851.2018.1438579

Peer reviewed

Asymmetric stabilizing impact of international reserves

Kyungkeun Kim [a] and Dongwon Lee [b,*]

[a] *The Bank of Korea, 39 Namdaemun-ro, Jung-gu, Seoul, 04531, Republic of Korea*
[b] *Department of Economics, University of California, Riverside, CA 92521, United States*

This version: February 4, 2018

ABSTRACT

This paper studies international reserves' nominal exchange rate stabilizing impact in emerging markets and developing countries, with a particular focus on its nonlinearity and asymmetry across different states of the economy. Using the fixed-effects and dynamic panel threshold models, we find the reserves to short-term debt threshold ratio after which the marginal stabilizing effect of reserves begins to fall during tranquil times. Such diminishing returns, however, do not appear to exist even at the excessive level of reserves during the global financial crisis, partly justifying precautionary demand for international reserves. These results call for extending reserve pooling or swap arrangements to enhance efficiency of reserve management by holding adequate, rather than excess, international reserves with an access to emergency lending during the crisis.

Keywords: Diminishing returns; exchange rate volatility; global financial crisis; international reserves

JEL classification: F31; F33

* Corresponding author. Tel.: +1-951-827-1505; fax: +1-951-827-5685.
E-mail addresses: kkkim@bok.or.kr (K. Kim), dwlee@ucr.edu (D. Lee).

I. Introduction

The most widely used benchmark for an adequate level of international reserves suggests that countries hold liquid reserves equal to a full coverage of foreign liabilities maturing within a year (Greenspan-Guidotti rule). However, the amount of reserves in some countries, particularly in East Asian emerging markets, has far deviated from this benchmark rule after the financial crises of the late 1990s. Two popular arguments for this excess reserve hoarding are (1) a precautionary motive to hedge against future sudden capital reversals and (2) a mercantilist motive to keep export competitiveness (Aizenman and Lee, 2007). Both motives are intimately linked to dampening exchange rate movements, which motivates our focus on the reserve adequacy ratio and its signaling effect on the nominal exchange rate volatility.

Larger stockpiles of reserves may signify that a country has more capacity for foreign exchange intervention. In such a country, the required risk premium may be lower for holding domestic currency assets. In fact, countries with more reserves relative to short-term debt have generally better weathered the 2008-09 financial crisis (Bussière et al., 2015). Nevertheless, the self-insurance through reserve build-up can involve considerable opportunity costs when there is a wide spread between the rate of return on domestic credit and the risk-free rate.[1] In addition, a nonlinear reserve effect on the exchange rate volatility may raise the efficiency concern of amassing massive reserves (see Hviding et al., 2004).

In order to further explore efficiency aspects of FX intervention operations with excess reserves in emerging and developing economies, this paper proposes fixed-effects (FE) and dynamic panel threshold models and studies the following questions. Is there a particular reserve-

[1] Rodrik (2006) estimates the cost of excess reserves in developing countries to be around 1% of their GDP in 2004.

to-debt ratio after which the marginal exchange rate stabilizing effect begins to fall? And, did this point of decreasing returns change during the recent global financial crisis (GFC)?

II. Panel threshold model specification

We develop a threshold regression model by adding international reserves and GFC to the standard determinants of nominal exchange rate volatility.[2] The model takes the following form:

$$\begin{aligned}\mathrm{vol\_}NEER_{it} &= \alpha_1 RA_{it-1} + \alpha_2\left[RA_{it-1} \times I_{(R/D)>\mathrm{p}}\right] + \alpha_3\left[RA_{it-1} \times Crisis\right] \\ &\quad + \alpha_4\left[RA_{it-1} \times I_{(R/D)>\mathrm{p}} \times Crisis\right] + \boldsymbol{X}_{it-1}\boldsymbol{\beta} + \gamma Peg + \delta Crisis + \theta_i + \varepsilon_{it} \qquad (1)\end{aligned}$$

The volatility of the nominal effective exchange rate ($NEER$) for country *i* and year *t*, $\mathrm{vol\_}NEER_{it}$, is measured by the standard deviation of monthly log differences $\left(= \mathrm{std.dev.}\left[\ln\left(NEER_{it,m}\right) - \ln\left(NEER_{it,m-1}\right)\right],\ m = 2, \ldots, 12\right)$. The variable of interest, RA_{it-1}, is the reserve adequacy defined as a log ratio of international reserves (R) to short-term external debt (D) maturing within one year. The indicator function $I_{(R/D)>\mathrm{p}}$ takes the value of one if the ratio R_{it-1}/D_{it-1} is bigger than the designated percentile p. The vector $\boldsymbol{X}_{it-1}$ contains real GDP growth ($Growth$), the volatility of money growth ($\mathrm{vol\_}M2$) constructed in the same way as the $NEER$ volatility, the log ratio of total trade to GDP ($Trade$), broad money $M2$ to GDP to proxy for local financial development ($FinDev$), and the Chinn-Ito index to capture financial openness ($FinOpen$). The dummy variables Peg and $Crisis$ respectively account for the fixed exchange

[2] See Bayoumi and Eichengreen (1998), Cady and Gonzalez-Garcia (2007), and Devereux and Lane (2003) for modeling the nominal exchange rate volatility. International reserves and their asymmetric stabilizing impacts were not examined in these studies.

rate regime and 2008-09 GFC.[3] The term θ_i is a country-fixed effect, and ε_{it} is an i.i.d. disturbance. Lagging independent variables by one period helps reduce a potential endogeneity bias associated with reverse causality.

Our annual data cover an unbalanced panel of 43 emerging markets and developing countries over the period 2000-2015.[4] In estimating Equation (1), the residuals may suffer from cross-sectional correlation due to the exchange rate volatility effect of common global shocks such as world business cycles and cross-country spillovers. Thus, the FE panel data regression model uses autocorrelation, heteroscedasticity, and spatial correlation robust Driscoll and Kraay (1998) standard errors. The second estimation strategy adds a lagged dependent variable to Equation (1) to control for possible persistence in the currency volatility. The two-step system generalized method of moments (GMM) estimator (Arellano and Bover, 1995; Blundell and Bond, 1998) is applied to deal with the dynamic specification and potential endogeneity issues, using the Windmeijer (2005) robust standard errors to correct for the finite sample bias. In our GMM estimates, the *p*-values of the Hansen over-identification and second-order autocorrelation tests confirm the overall validity of the instruments.

III. Empirical results

As a first step, we follow a standard approach in the literature and examine a potential nonlinear effect of reserve adequacy ratio on the exchange rate volatility by replacing the indicator function I in Equation (1) by RA_{it-1} to introduce quadratic terms.

---

[3] See Table A1 in Appendix A for data sources. Following the fine classification of Ilzetzki et al. (2017), a country belongs to the category of peggers in a given year if it takes a de facto peg or pre announced horizontal band with margins of no larger than $\pm 2\%$.

[4] Appendix B presents the list of sample countries.

The results are summarized in Table 1. We present results for the FE OLS estimation in columns (1) and (2) and for the two-step system GMM estimation in columns (3) and (4). These two estimations produce qualitatively similar results and generate a broadly consistent interpretation.

In both static and dynamic specifications, a significantly negative coefficient $\hat{\alpha}_1$ verifies that a high level of reserve holdings is expected to reduce the currency volatility during normal times. However, positive $\hat{\alpha}_2$ indicates that such mitigating effect appears to be weaker as the reserves to short-term external debt ratio rises. This implies the presence of diminishing returns to reserves accumulation in smoothing exchange rate movements.

On the other hand, as reported in columns (2) and (4) with combined coefficients $\hat{\alpha}_1 + \hat{\alpha}_3$ being greater than $\hat{\alpha}_1$, the exchange rate stabilizing effect of reserves sufficiently declines during crisis times. This is not surprising because countries were exposed to severe global financial turbulence that brings about large swings in exchange rates and increased vulnerability to external shocks during the GFC.[5] Moreover, a negative sign of combined coefficients $\hat{\alpha}_2 + \hat{\alpha}_4$ suggests that decreasing returns to reserve hoarding do not seem to exist during volatile times.

[Table 1 near here]

Regarding other control variables, trade openness and fixed exchange rate regime are statistically significant across different specifications with the expected negative sign. According to the FE estimator, the exchange rate volatility is also negatively related to the output growth.

[5] Similarly, Fratzscher (2009) reports that a majority of emerging market economies experienced a sharp currency depreciation against the US dollar in the period July 2008-January 2009 despite the fact that they were not the origin of the crisis.

The next step is to introduce a threshold analysis by letting the smoothing effect vary at the different levels of reserves. The negative $\hat{\alpha}_1$ in Table 2 again demonstrates that the reserves generally act as a buffer for exchange rate instability during tranquil periods. Note that at each specified reserve-to-debt threshold ratio, $\hat{\alpha}_2$ is supposed to be statistically significant and positive if a buffering function of reserve stock declines at the margin. As shown by positive $\hat{\alpha}_2$ in columns (2)-(4), the diminishing returns kick in once the reserve adequacy ratio exceeds a threshold of the 60th percentile during normal times, which is a level roughly 2.4 times higher than the Greenspan-Guidotti benchmark.[6]

[Table 2 near here]

We investigate next whether reserves exhibit a similar nonlinear effect during the GFC. From positive $\hat{\alpha}_3$ in Table 2 columns (3) and (4), we see that the reserves' mitigating impact on exchange rate volatility becomes weaker at the relatively high reserve-to-debt ratios when global financial stress arises. At the same time, unlike tranquil periods, combined coefficients $\hat{\alpha}_2 + \hat{\alpha}_4$ in columns (3) and (4) show that diminishing returns with respect to exchange rate stabilization do not seem to exist at the high level of reserves (above the 75th percentile) during stress times. In other words, the marginal currency volatility lessening effect of reserve build-up does not decline even at the excessive level of reserves in crisis times.

[6] We find no evidence of decreasing returns at the lower than 60th percentile during tranquil periods from both FE OLS and system GMM estimations.

Lastly, columns (5)–(8) of Table 2 present that when a dynamic adjustment is controlled for, the FE estimation results basically hold with a diminishing returns threshold at the 60th percentile in good times, but an increasing returns threshold at the 45th percentile in bad times.

We interpret this result as follows: while excess reserves can generally facilitate continued rollover of external debt and can better cushion the currency volatility effects of macroeconomic shocks by supporting market participants' confidence, they involve a certain degree of efficiency loss in the form of the diminishing returns during normal times.

IV. Conclusion

This paper presents that the vast stockpile of international reserves exhibits the asymmetric exchange rate stabilizing impact depending on the state of the economy. Amassing excess reserves, especially when they are more than twice as much as the Greenspan-Guidotti benchmark level, is inefficient during normal times due to the apparent presence of decreasing returns in buffering exchange rate fluctuations. However, such diminishing returns to massive reserves barely exist when global financial stress arises, partly justifying precautionary demand for international reserves. These results call for amending benchmark optimal reserves to reflect diminishing returns and their state-dependency. Additionally, the results also suggest that extending reserve pooling or swap arrangements could enhance efficiency of reserve management. With an access to emergency lending, countries could endure the infrequent yet devastating future global financial crisis with adequate, rather than excess, international reserves.[7]

[7] Admittedly, countries are likely to have different views on the optimal hoarding of international reserves and the advantages of reserve pooling, as precautionary and mercantilist motives have different weights in their policy objective functions.

References

Aizenman, J., and J. Lee. 2007. “International reserves: Precautionary versus mercantilist views, theory and evidence.” *Open Economies Review* 18: 191-214.

Arellano, M., and O. Bover. 1995. “Another look at the instrumental variable estimation of error-components models.” *Journal of Econometrics* 68: 29-51.

Bayoumi, T., and B. Eichengreen. 1998. “Exchange rate volatility and intervention: Implications of the theory of optimum currency areas.” *Journal of International Economics* 45: 191-209.

Blundell, R., and S. Bond. 1998. “Initial conditions and moment restrictions in dynamic panel data models.” *Journal of Econometrics* 87: 115-143.

Bussière, M., G. Cheng, M. D. Chinn, and N. Lisack. 2015. “For a few dollars more: Reserves and growth in times of crises.” *Journal of International Money and Finance* 52: 127-145.

Cady, J., and J. Gonzalez-Garcia. 2007. “Exchange rate volatility and reserves transparency.” *IMF Staff Papers* 54: 741-754.

Chinn, M.D., and H. Ito. 2006. “What matters for financial development? Capital controls, institutions, and interactions.” *Journal of Development Economics* 81: 163-192.

Devereux, M. B., and P. R. Lane. 2003. “Understanding bilateral exchange rate volatility.” *Journal of International Economics* 60: 109-132.

Driscoll, J. C., and A. C. Kraay. 1998. “Consistent covariance matrix estimation with spatially dependent panel data.” *Review of Economics and Statistics* 80: 549-560.

Fratzscher, M. 2009. “What explains global exchange rate movements during the financial crisis?” *Journal of International Money and Finance* 28: 1390-1407.

Hviding, K., M. Nowak, and L. A. Ricci. 2004. “Can higher reserves help reduce exchange rate volatility?” IMF Working Paper No. 04/189.

Ilzetzki, E., C. Reinhart, and K. Rogoff. 2017. “Exchange arrangements entering the 21st century: Which anchor will hold?” NBER Working Paper No. 23134.

Rodrik, D. 2006. “The social cost of foreign exchange reserves.” *International Economic Journal* 20: 253-266.

Windmeijer, F. 2005. “A finite sample correction for the variance of linear efficient two-step GMM estimators.” *Journal of Econometrics* 126: 25-51.

Appendix A

Table A1. Data sources.

Variable	Source
$NEER$	BIS and IMF IFS
R	World Bank WDI
D	World Bank WDI and Joint BIS-IMF-OECD-WB External Debt Hub
$Growth$	World Bank WDI
$M2$	IMF IFS and St. Louis Fed’s FRED database
$Trade$	World Bank WDI
$FinDev$	World Bank WDI
$FinOpen$	Chinn-Ito (2006) index
Peg	Ilzetzki et al. (2017)

Note: M2 data are unavailable for Philippines and thus replaced with M3.

Appendix B

Sample countries:

Argentina, Armenia, Brazil, Bulgaria, Central African Republic, Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Czech Republic, Dominica, Dominican Republic, Democratic Republic of the Congo, Gabon, Georgia, Ghana, Grenada, Guyana, Hungary, India, Indonesia, Korea, Lebanon, Macedonia, Malawi, Malaysia, Mexico, Moldova, Nicaragua, Pakistan, Paraguay, Philippines, Poland, Romania, Russia, South Africa, St. Lucia, Togo, Turkey, Ukraine, Venezuela, and Zambia.

Table 1. Exchange rate volatility and reserve adequacy: nonlinear relationship.

	Fixed-effect estimation		System GMM	
	(1)	(2)	(3)	(4)
RA ($\hat{\alpha}_1$)	-0.017^a	-0.021^a	-0.013^b	-0.033^a
	(0.005)	(0.005)	(0.006)	(0.011)
RA^2 ($\hat{\alpha}_2$)	$\mathbf{0.005}^a$	$\mathbf{0.006}^a$	$\mathbf{0.003}^c$	$\mathbf{0.009}^b$
	(0.001)	(0.001)	(0.002)	(0.004)
$RA \times Crisis$ ($\hat{\alpha}_3$)		0.022^a		0.099^c
		(0.004)		(0.051)
$RA^2 \times Crisis$ ($\hat{\alpha}_4$)		$\mathbf{-0.008}^a$		$\mathbf{-0.031}^c$
		(0.001)		(0.018)
$Growth$	-0.001^b	-0.001^b	0.00001	-0.0001
	(0.0003)	(0.0003)	(0.0001)	(0.0001)
vol_$M2$	0.220	0.221	0.154	0.138
	(0.185)	(0.185)	(0.128)	(0.114)
$Trade$	-0.010^a	-0.010^b	-0.010^a	-0.007^a
	(0.004)	(0.004)	(0.003)	(0.003)
$FinDev$	0.001	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
$FinOpen$	-0.008	-0.009^c	-0.002	-0.002
	(0.005)	(0.005)	(0.003)	(0.004)
Peg	-0.009^b	-0.009^b	-0.007^a	-0.007^a
	(0.004)	(0.004)	(0.002)	(0.002)
$Crisis$	0.007^a	-0.006	0.002	-0.059^c
	(0.003)	(0.005)	(0.002)	(0.033)
vol_$NEER(-1)$			0.158^b	0.162^b
			(0.071)	(0.078)
R^2 within	0.14	0.15		
Hansen test (p-value)			0.43	0.60
AR(1)/AR(2) test (p-value)			0.04/0.77	0.05/0.49
Observations	597	597	597	597

Note: The dependent variable is the volatility of the nominal effective exchange rate (vol_$NEER$). Each independent variable stands for reserve adequacy (RA), global financial crisis ($Crisis$), real GDP growth ($Growth$), volatility of the money growth (vol_$M2$), total trade as a share of GDP ($Trade$), financial development ($FinDev$), financial openness ($FinOpen$), and fixed exchange rate regime (Peg). All specifications include country-fixed effects. Driscoll-Kraay standard errors are reported in parentheses in columns (1) and (2), and Windmeijer standard errors in columns (3) and (4). *a*, *b*, *c* represent significance at the 1%, 5% and 10% level, respectively.

Table 2. Exchange rate volatility and reserve adequacy: threshold analysis.

	Fixed-effect estimation				System GMM			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	> p45	> p60	> p75	> p90	> p45	> p60	> p75	> p90
RA ($\hat{\alpha}_1$)	0.002	-0.006^a	-0.008^a	-0.005^c	-0.011^b	-0.017^a	-0.014^a	-0.010^a
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.006)	(0.003)	(0.003)
$RA \times I_{R/D>\text{p45}}$ ($\hat{\alpha}_2$)	-0.002^c				0.004			
	(0.001)				(0.003)			
$RA \times I_{R/D>\text{p60}}$ ($\hat{\alpha}_2$)		$\mathbf{0.004}^a$				$\mathbf{0.007}^b$		
		(0.001)				(0.003)		
$RA \times I_{R/D>\text{p75}}$ ($\hat{\alpha}_2$)			$\mathbf{0.005}^a$				$\mathbf{0.006}^a$	
			(0.002)				(0.002)	
$RA \times I_{R/D>\text{p90}}$ ($\hat{\alpha}_2$)				$\mathbf{0.003}^c$				$\mathbf{0.005}^a$
				(0.002)				(0.002)
$RA \times Crisis$ ($\hat{\alpha}_3$)	-0.008^a	0.002	0.012^a	0.005^b	0.051^c	0.079^b	0.059^a	0.028^a
	(0.002)	(0.003)	(0.003)	(0.002)	(0.026)	(0.038)	(0.016)	(0.010)
$RA \times I_{R/D>\text{p45}} \times Crisis$ ($\hat{\alpha}_4$)	0.007^a				$\mathbf{-0.023}^c$			
	(0.002)				(0.013)			
$RA \times I_{R/D>\text{p60}} \times Crisis$ ($\hat{\alpha}_4$)		-0.001				$\mathbf{-0.037}^c$		
		(0.002)				(0.019)		
$RA \times I_{R/D>\text{p75}} \times Crisis$ ($\hat{\alpha}_4$)			$\mathbf{-0.009}^a$				$\mathbf{-0.030}^a$	
			(0.002)				(0.008)	
$RA \times I_{R/D>\text{p90}} \times Crisis$ ($\hat{\alpha}_4$)				$\mathbf{-0.005}^a$				$\mathbf{-0.014}^b$
				(0.002)				(0.006)
R^2 within	0.12	0.13	0.14	0.13				
Hansen test (p-value)					0.41	0.17	0.50	0.39
AR(1)/AR(2) test (p-value)					0.03/0.65	0.03/0.29	0.03/0.59	0.04/0.59
Observations	597	597	597	597	597	597	597	597

Note: See Table 1 for a description of the dependent and independent variables and the estimation methods. p45, p60, p75, and p90 correspond to reserve-to-debt ratios of 1.89, 2.41, 3.24, and 6.21 respectively at time $t-1$. The coefficient estimates of the other control variables that appear in Table 1 are suppressed to save space.