THE ACADEMY OF ECONOMIC STUDIES BUCHAREST
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Sudden Stop and Optimal Holdings of International Reserves in the CESEE Emerging Countries

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Introduction

- The recent financial crisis has underlined the need for reducing financial fragility, as global integration increased vulnerabilities associated with international capital flows. As financial transmission of shocks across countries is now faster and more complex than in previous decades, emerging market economies are particularly vulnerable to a "sudden, large and largely unexpected cut" in international capital flows, a phenomenon that has been labeled Sudden Stop. Given continued financial globalization, how emerging markets and advanced economies can protect themselves against sudden stops remains a critical topic for research and policy analysis.

- Based on a model by Calvo, Izquierdo and Loo-Kung (2013), this study aims to find the optimal holdings of international reserves, as reserves may influence both the probability and the output costs of Sudden Stop, as well.

Literature review

- Amongst the first works, Heller's (1966) study motivates the need for holding reserves. He states that liquid international reserves held by the monetary authorities are part of the total capital resources of a country. The differential between the social yield on capital invested and the yield on liquid international reserves is the appropriate concept of the opportunity cost of holding liquid international reserves.

- Calvo and Reinhart (1999) presented evidence that Sudden Stop problems have become a real issue for emerging markets. Their study focused on the policies that may reduce the incidence of crises, or at least reduce the severity of a Sudden Stop.

- Another study on assessing the optimal reserve holdings was the one of Flood and Marion (2002). A key prediction of the buffer stock model is that uncertainty influences optimal reserve holdings. They stated that greater capital mobility, while beneficial in many aspects, may have increased uncertainty in the international economy, in part by increasing the vulnerability of some countries to financial crises.

- Formulas and applications were available on an International Monetary Fund Working Paper written by Jeanne and Ranciere (2006). This paper uses a Probit model based on a set of macroeconomic variables and taking a proxy for the cost of a Sudden Stop, the difference from sample average output growth rate in Sudden Stop times.

- Another study that covers the subject of financial stability and international reserves is that of Obstfeld, Shambaugh and Taylor (2008). It highlights the importance of M2 indicator in case of financial stability model and in the understanding of international reserves growth.

Sudden Stop

- Instability ➡ high costs

- Policymakers tend to face two particular challenges, one in which they have to prevent capital flows from exacerbating overheating pressures and consequent inflation, and another to try minimizing the risk in which a long period of too easy financing conditions will affect financial stability.

- A noticeable problem may be the self-fulfilling crisis, which leads to a financial panic and unnecessarily deep recession, as rational investors have the incentive to pull capital out before others do. When investors come to expect others will abruptly cut their funds, a bad equilibrium occurs, manifesting through large withdrawals and leading to the unfolding of a severe economic crisis. More specifically, this type of thinking causes a disastrous collective outcome, although the episode could have had better returns (the outcome from the reversal in capital flows ranges from default to even a rescheduling of debt payments).

- Goldfajn(2001): "I define a sudden stop as a very large change in the supply of capital. Of course, this sudden stop is always in the negative direction. There are also problems with big booms of capital inflows in the sense that you need to know what you are doing with the big influx. But the real problem is when you get billions of dollars less from one year to the other. And most of the countries that had crises faced this challenge: Mexico, Asia, Turkey, Brazil, all of them."
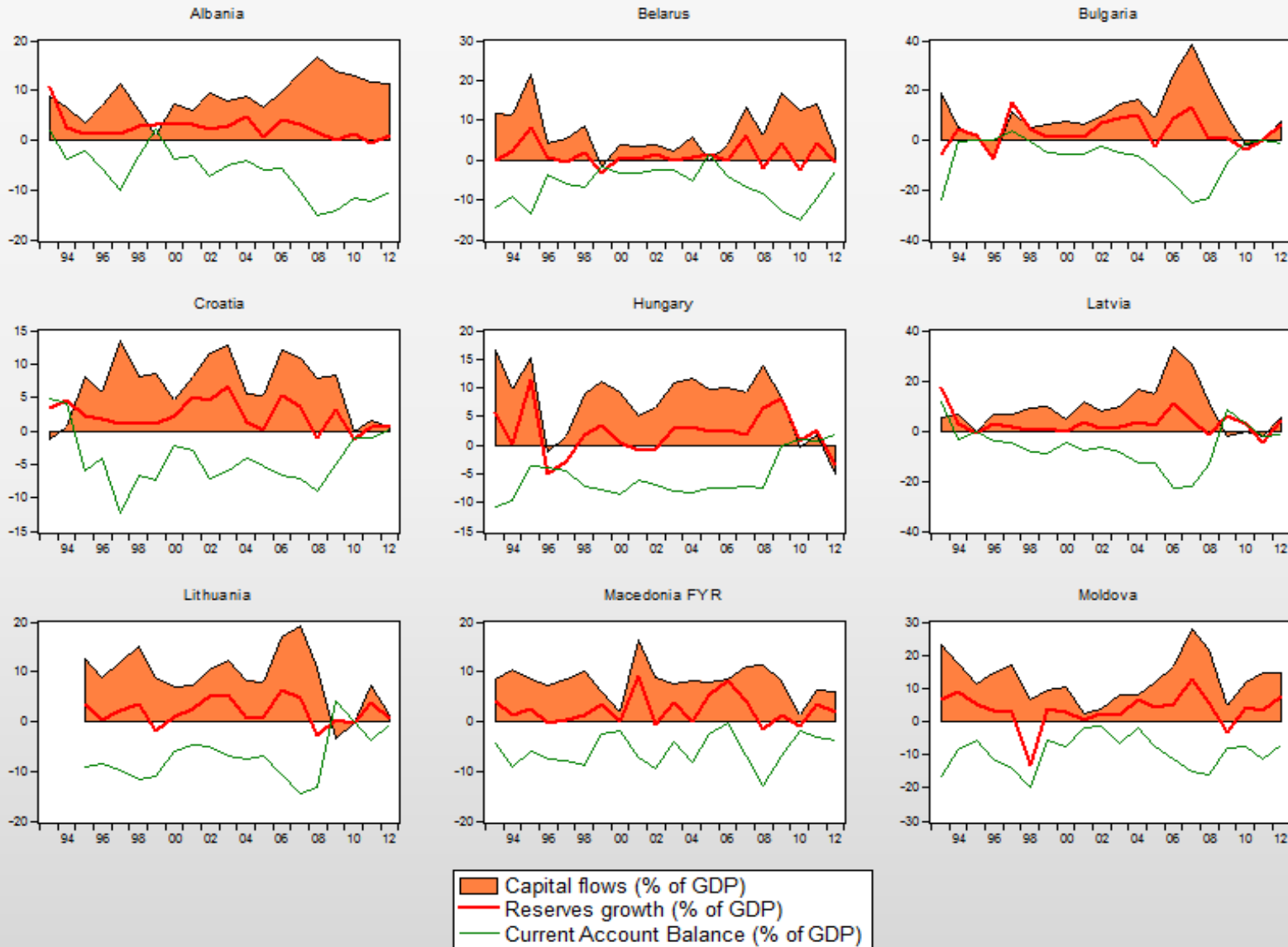
Sudden Stop

- Sudden Stop is defined, according to Calvo, Izquierdo and Loo-Kung (2013), as a "sudden, large and largely unexpected cut" in international capital flows. These international capital flows can be the source of overheating pressures.

- In order to identify a sudden stop in year t, the ratio of capital inflows to GDP. When this ratio, k_t, falls by more than 5 percentage points of GDP in comparison with the previous year, k_{t-1}, it means the country is faced with a Sudden Stop.

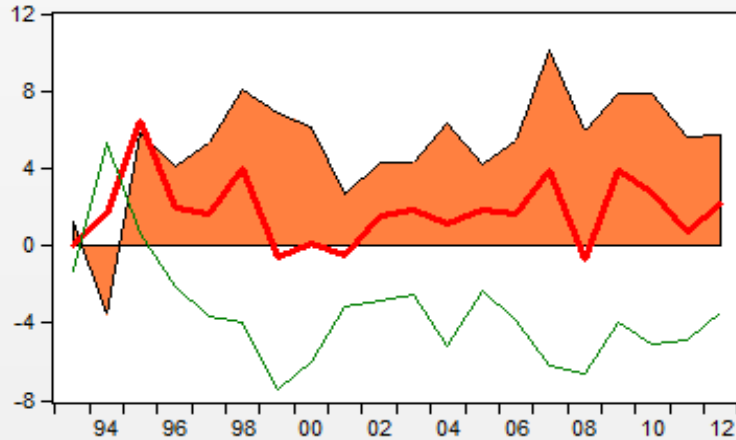$$\text{sudden stop in year } t \iff k_t < k_{t-1} - 5\%.$$

- Some known facts are that surplus from current account and surplus from capital and financial account leads to an accumulation of reserves, and that Balance of Payments is based on double-entry bookkeeping. Every transaction is recorded twice, once as a debit and once as a credit.
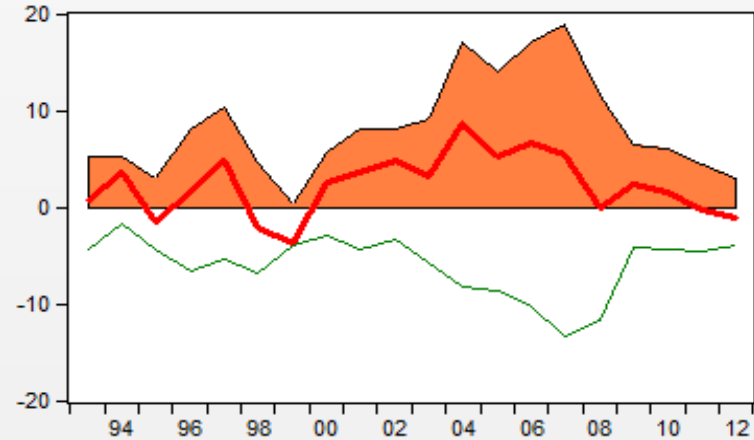
The evolution of capital flows (1)

Capital flows (% of GDP)
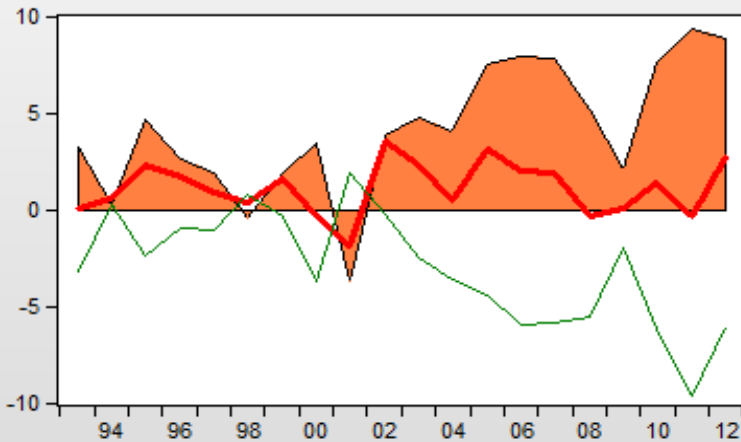Reserves growth (% of GDP)
Current Account Balance (% of GDP)

The evolution of capital flows (2)

Poland, Romania, Turkey, Ukraine

- Capital flows (% of GDP)
- Reserves growth (% of GDP)
- Current Account Balance (% of GDP)
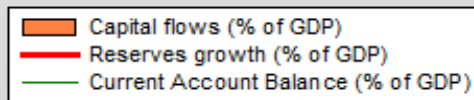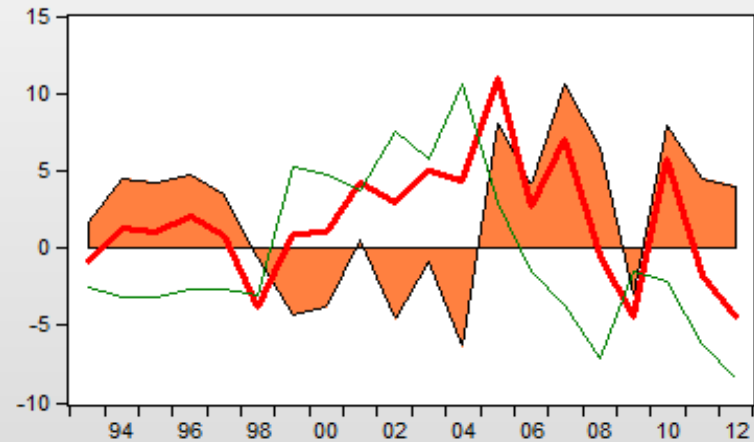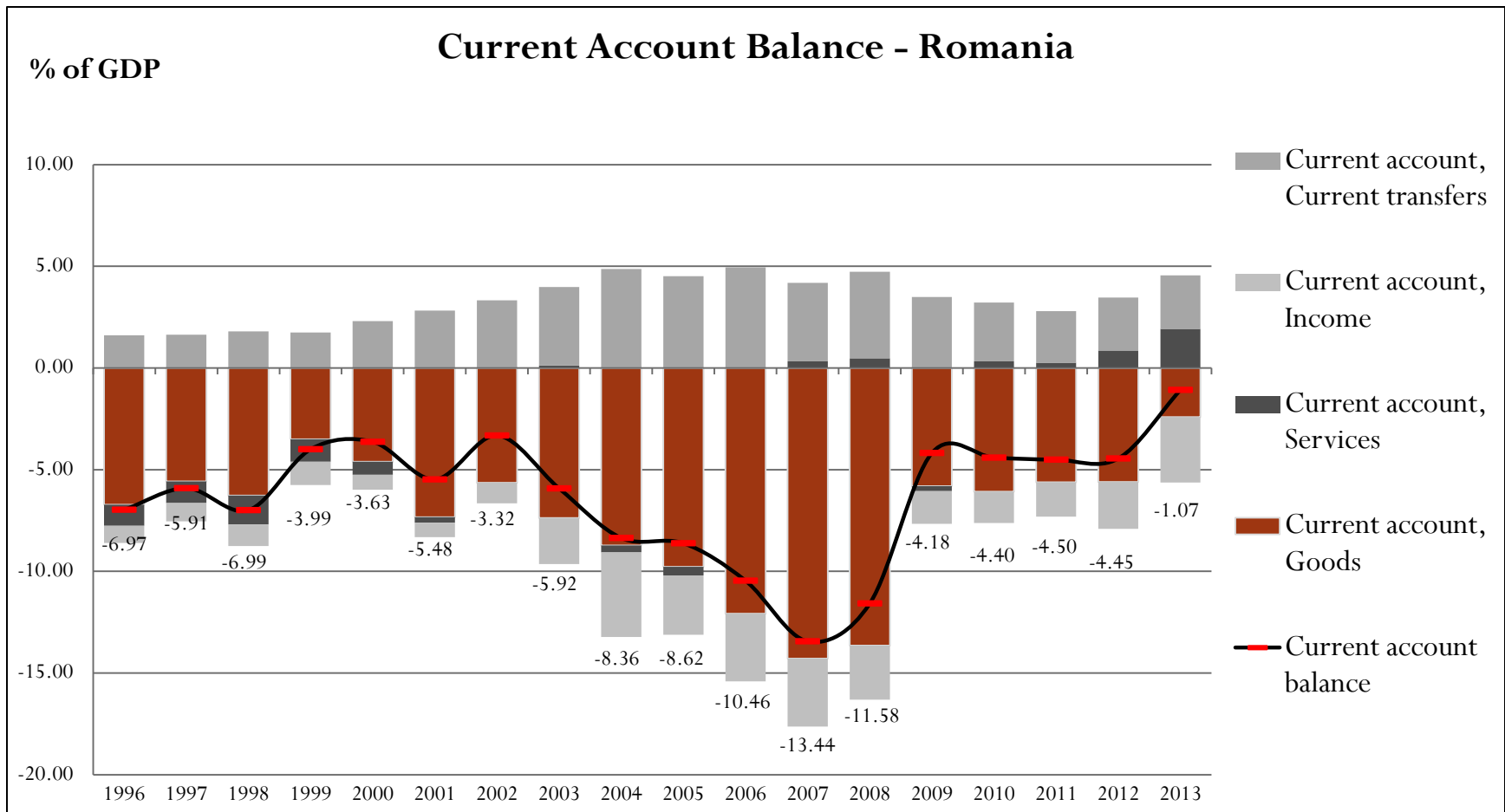
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Extended Analysis - Romania

- The analysis of Sudden Stop phenomenon extended to Romania, one of the CESEE emerging countries. The analysis extended on the Balance of Payments components and the average value of short term evolution of macroeconomic indicators before and after Sudden Stop.

- Balance of Payments is based on double-entry bookkeeping. Every transaction is recorded twice, once as a debit and once as a credit. Therefore, when discussing capital inflows, a detailed view include all the components of Balance of Payments.

Balance of Payments – Current Account Components - Romania

- Trade balance of goods played the most important role to the current account deficit.

Current Account Balance – Romania

% of GDP

Legend:
- Current account, Current transfers
- Current account, Income
- Current account, Services
- Current account, Goods
- Current account balance

Values (Current account balance):
- 1996: -6.97
- 1997: -5.91
- 1998: -6.99
- 1999: -3.99
- 2000: -3.63
- 2001: -5.48
- 2002: -3.32
- 2003: -5.92
- 2004: -8.36
- 2005: -8.62
- 2006: -10.46
- 2007: -13.44
- 2008: -11.58
- 2009: -4.18
- 2010: -4.40
- 2011: -4.50
- 2012: -4.45
- 2013: -1.07

# Balance of Payments – Financing sources to the current account deficit - Romania

- The "other investments" had the most contribution in the adjustment process.

- The International Monetary Fund has put at disposal large loan packages, but it has the disadvantage that these don't necessarily come when needed, as the International Monetary Fund disburses the funds gradually when its conditions are met. Therefore, liquidity is still an issue to be addressed, even with the support received from this institution.

Financing sources to the current account deficit – Romania
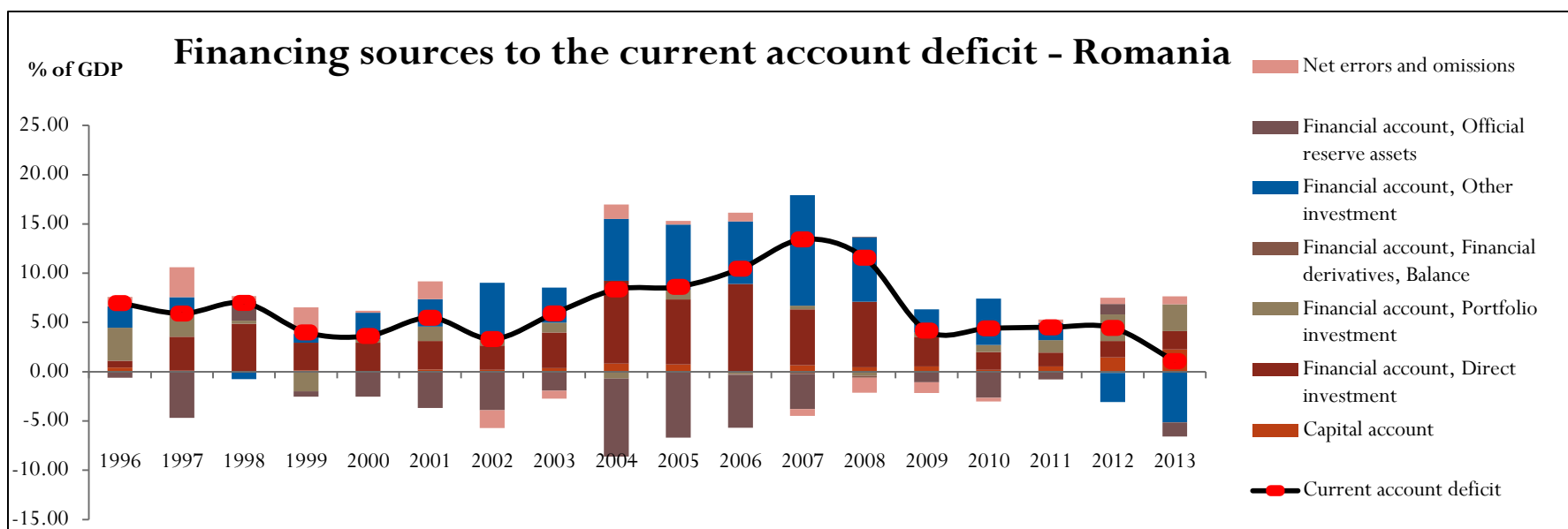
Romania – Macroeconomic indicators at t=0 SS

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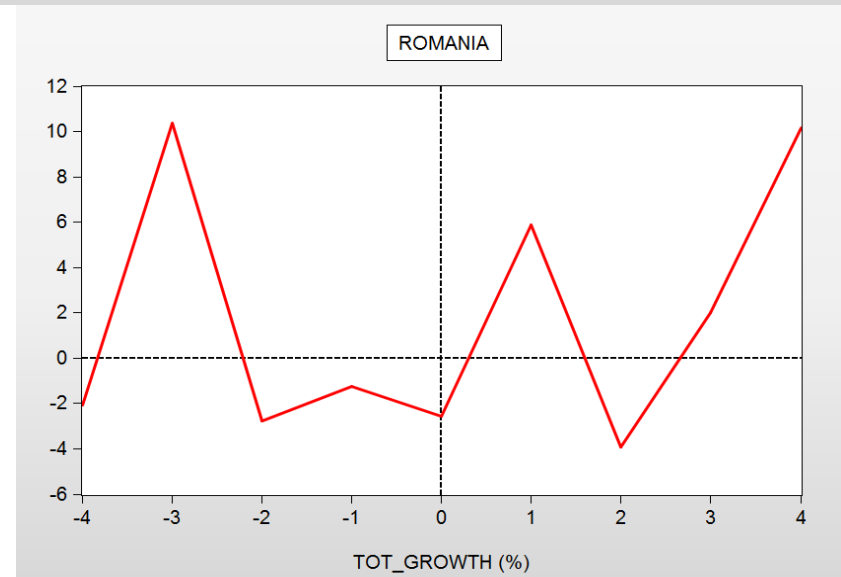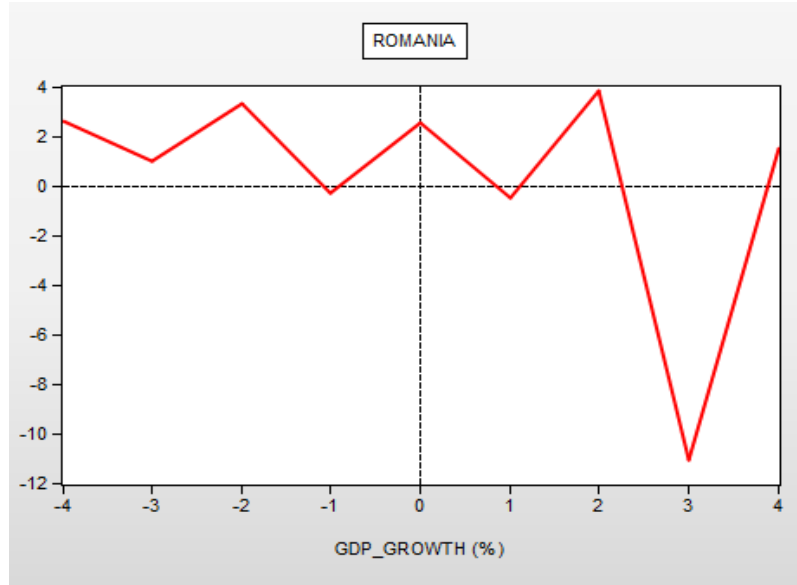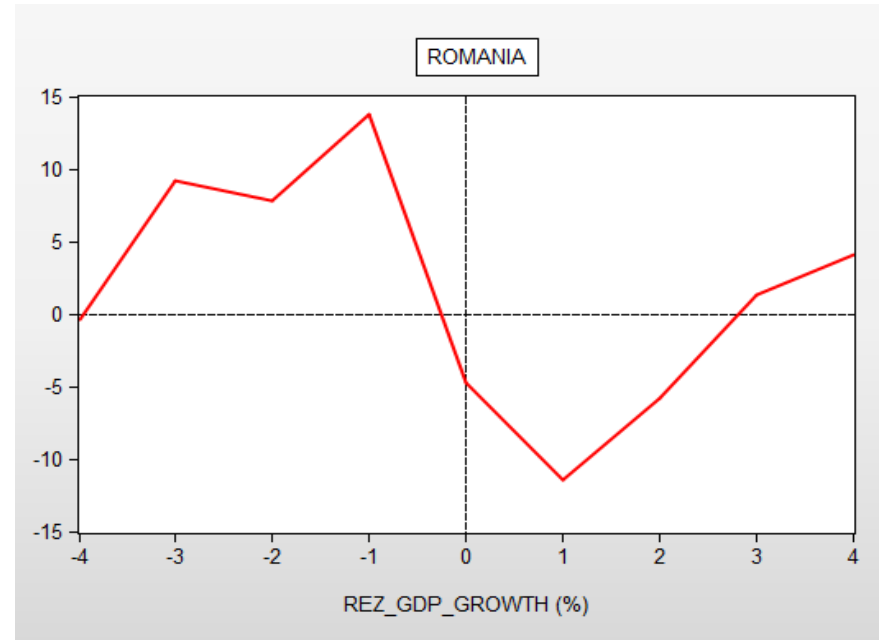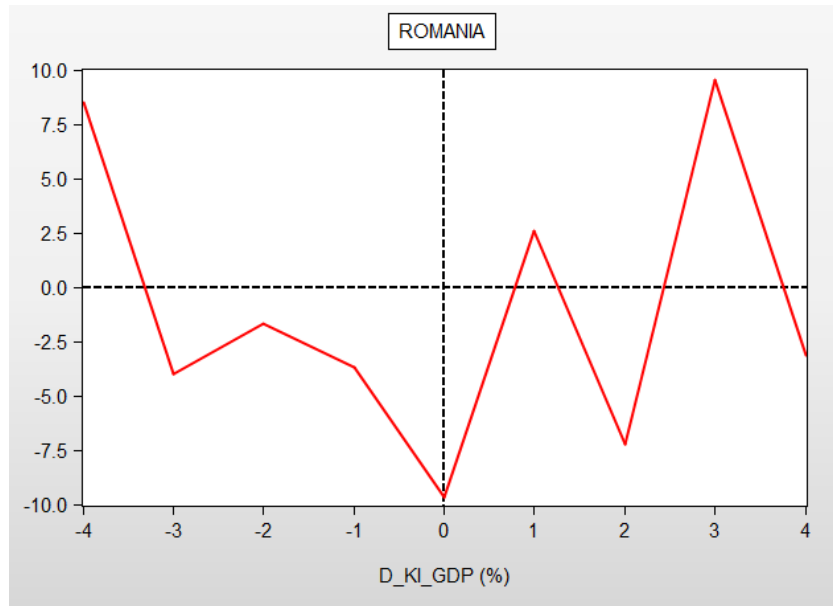
Theoretical model and formulas(1)

- The present research uses the approach of Calvo, Izquierdo and Loo-Kung (2013).

- The model is based on precautionary motive, more precisely on the influence international reserves has on Sudden Stop, as the level of international reserves can be decided by weighting the impact of reserve holdings on the expected costs of a Sudden Stop against the opportunity cost of accumulating reserves.

- Therefore, according to Calvo, Izquierdo and Loo-Kung (2013), the model yields an expression for minimizing the costs:

$$L(R) = P(SS=1|R)K(R|SS=1) + \rho R$$

where R are international reserves as a share of output, P(SS=1|R) is the probability of a Sudden Stop conditional on reserves R, K(R|SS =1) is the output cost conditional on the occurrence of a Sudden Stop, and ρR is the opportunity cost of holding reserves, where ρ is the spread of public bonds over interest earned from holding reserves.

Theoretical model and formulas(2)

As it is possible for the probability of Sudden Stop and the output cost to be shown as a function of international reserves, we can quantify optimal reserves (R*) with the aid of the loss function:

$$R^* = arg_{R>0} minL(R)$$

P(SS=1|R), the probability of Sudden Stop can be estimated through Probit models, reduced to latent variable models:

- $P(SS = 1|R)$:

$$SS = \begin{cases} 1, SS^L > 0 \\ 0, SS^L \leq 0 \end{cases}$$

$$SS^L = \alpha_0 + \alpha_1 R^* + \alpha_2 FL + X\beta + \eta + \varepsilon, \quad \varepsilon \sim N(0,1)$$

where SS is the binary response variable (the value of 1 represents the presence of Sudden Stop, and 0, otherwise), SS^L is the latent variable, FL represents foreign liabilities, X is a set of control variables (such as portfolio integration, terms of trade growth, the ratio M2-to-reserves and foreign debt as a share of GDP), η is a set of yearly time dummies and ε is the error term.

Theoretical model and formulas(3)

$$P(SS = 1|R) = P(SS^L > 0) = P(\alpha_0 + \alpha_1 R^* + \alpha_2 FL + X\beta + \eta + \varepsilon > 0)$$

$$= P(\varepsilon > -(\alpha_0 + \alpha_1 R^* + \alpha_2 FL + X\beta + \eta))$$

$$= P(\varepsilon < \alpha_0 + \alpha_1 R^* + \alpha_2 FL + X\beta + \eta)$$

Not. $A = \alpha_0 + \alpha_1 R^* + \alpha_2 FL + X\beta + \eta$

$$P(SS = 1|R) = P(\varepsilon < A) = \phi(A)s$$

$$= \int_{-\infty}^{A} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$

Another important part included in the loss function is the output cost of Sudden Stop.

- $K(R|SS = 1) = \delta_0 + \delta_1 R^* + Z\gamma + \theta$

Not. $B = \delta_0 + \delta_1 R^* + Z\gamma$

A first order condition to find the level of optimal reserves:

$$\left(\int_{-\infty}^{A} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt\right)\delta_1 + B \frac{\alpha_1}{\sqrt{2\pi}} e^{-\frac{A^2}{2}} + \rho = 0$$

Empirical estimations

- Covering 13 countries for the period 1994-2012 and annual frequency of data, we begin on estimating the optimal level of international reserves, based on the relationship between them and the phenomenon of Sudden Stop.

- The probability of Sudden Stop is estimated through Maximum Likelihood Estimator – Binary Probit - Quadratic Hill-Climbing.

- The output cost of Sudden Stop uses Hodrick-Prescott trend.

- The opportunity cost of reserves is measured by JPMorgan Emerging Markets Bond Index Plus sovereign spread, one of the most liquid emerging markets debt benchmark.
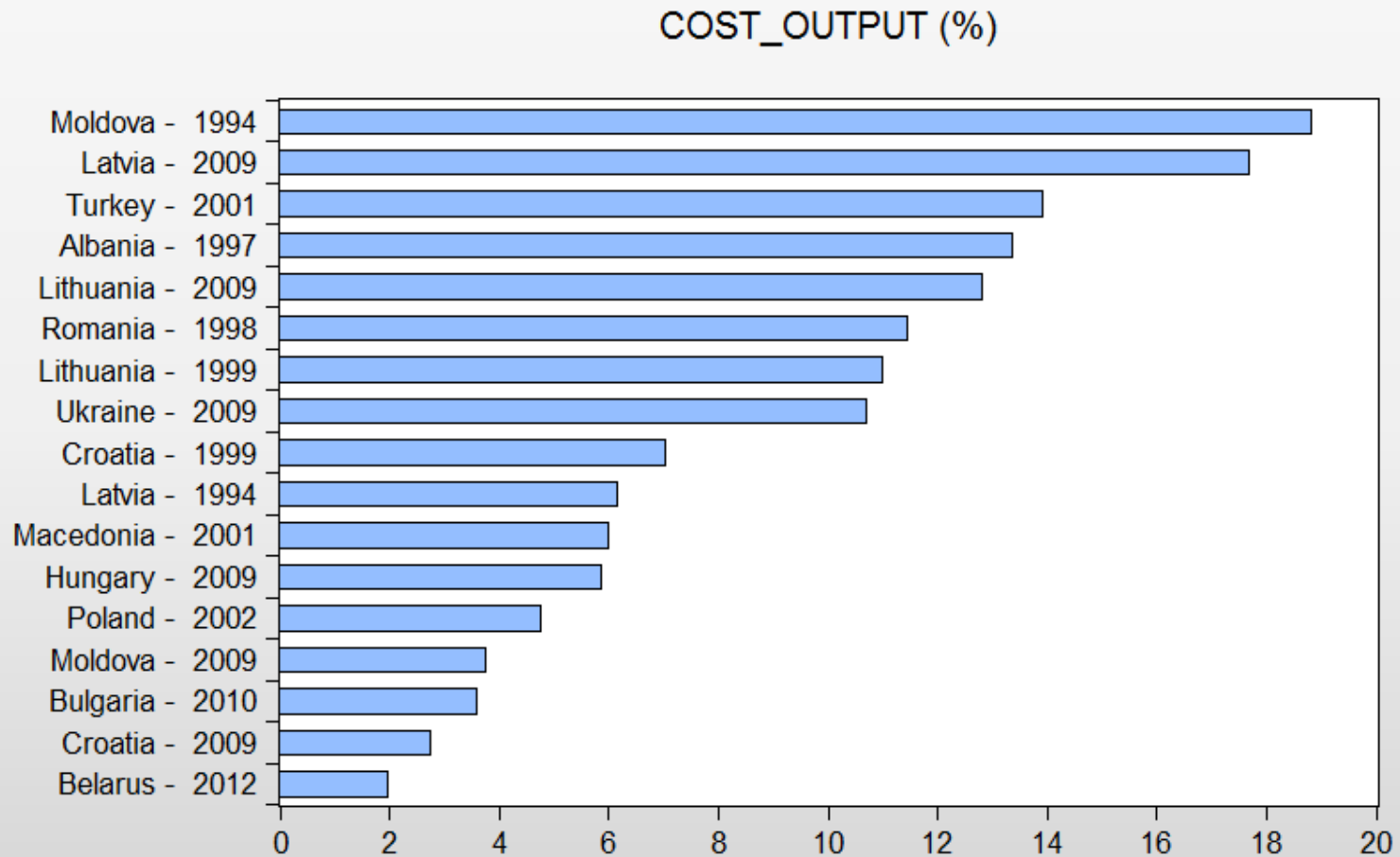
The Probit models

	PROBIT MODELS						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RER_{t-1}			1.558187	1.74012	1.250216	1.214087	-0.546478
			(1.425981)	(1.447182)	(1.428187)	(1.458272)	(1.822269)
$Reserves_t$	-11.74586***	-7.686154*	-10.16129***	-10.48524***	-10.13579***	-10.08635**	-9.927941**
	(3.871078)	(4.526035)	(3.941939)	(3.973179)	(3.928324)	(3.94932)	(5.056497)
$Foreign\_liabilities_{t-1}$	1.623896**	3.791162***	3.309497***	3.468013***	3.492679***	3.493843***	14.50722***
	(0.657513)	(0.974122)	(1.05135)	(1.07074)	(1.069073)	(1.069727)	(4.417386)
$Portfolio\_Int_{t-1}$		-11.70389*	-9.642195***	-21.22776	-22.36519*	-22.32026*	-47.34886**
		(6.40243)	(6.295372)	(13.07254)	(13.42141)	(13.43755)	(21.02116)
$(Portfolio\_Int_{t-1})^2$				105.3622	109.4617	109.4946	164.3314
				(93.54318)	(94.91587)	(94.86199)	(115.8163)
$TOT\ growth_{t-1}$					-2.104249	-2.077154	-0.668912
					(2.051361)	(2.06145)	(2.256935)
$M2_{t-1}$						-0.015515	-0.066386
						(0.128105)	(0.199524)
$External\_debt_{t-1}$							-0.322565
							(1.889776)
Constant	-1.989545***	-1.333956***	-1.389226***	-1.320955***	-1.18392***	-1.139442**	-1.195416
	(0.328654)	(0.29499)	(0.330644)	(0.338428)	(0.317284)	(0.484337)	(0.926848)
Observations	242	149	149	149	149	149	95

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time dummies were included.

The output cost(1)

- For every emerging country included in our list, we compute the present discounted sum of any contiguous negative output gaps measured as the percentage difference between observed GDP and its corresponding Hodrick-Prescott trend.

- We select only those episodes in which a Systemic Sudden Stop occurs in a 3-year window centered at T (the period immediately prior to GDP decline), so that a causal relation can be inferred.

The output cost(2)

COST_OUTPUT (%)

The output cost(3)

- The variables used in the estimation are in general the same utilized at the Probit model, as the determinants for the likelihood of Sudden Stop that turn out valid, may be good predictor for the magnitude of the crisis. Foreign liabilities, for example, in a large quantity, are a factor to default and fall in output, in the case of a Sudden Stop, in such measure that repayment becomes improbable and therefore it could be a good predictor of the likelihood of a Sudden Stop.

	OUTPUT COST				
	(1)	(2)	(3)	(4)	(5)
RER_T		-0.029072 (0.075894)	-0.161422 (0.091592)	-0.134435 (0.105121)	-0.119673 (0.126923)
$Reserves_T$	0.883003*** (0.238305)	0.844584*** (0.265092)	0.488105 (0.324515)	0.470704 (0.339212)	0.507695 (0.392267)
$Foreign\_liabilities_T$			-0.238197* (0.117903)	-0.246143* (0.123494)	-0.236158 (0.138336)
$TOT\ growth_T$				0.059406 (0.097175)	3.979387 (5.555039)
$M2_T$					0.064296 (0.014875)
Constant	0.075982*** (0.010103)	0.078966*** (0.012996)	0.132604*** (0.023616)	0.126773*** (0.026383)	0.113088 (0.06072)
Observations	17	17	12	12	12

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Optimal and Observed International Reserves
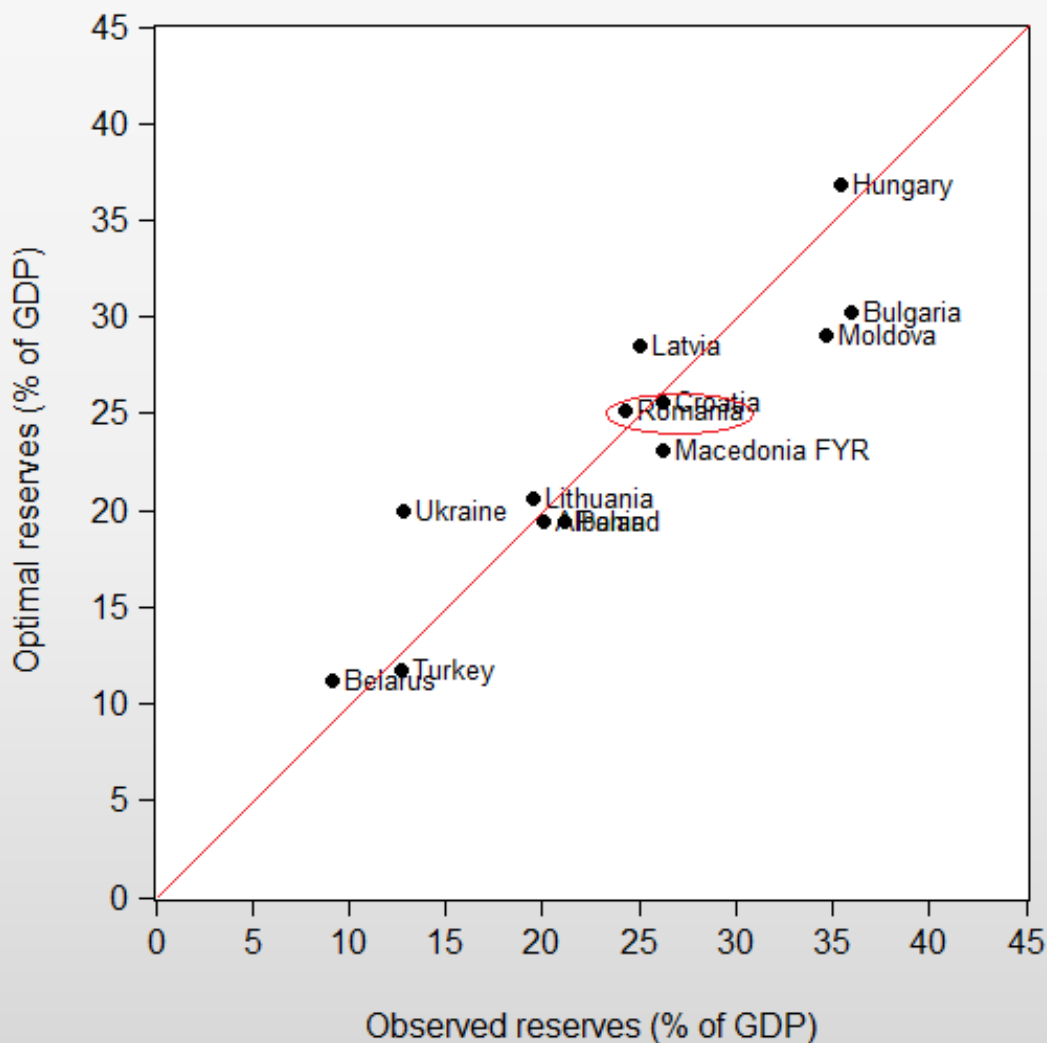
• Unfortunately, global financial crisis effects have not dissipated completely. Recent times made many countries aware of the importance of financial stability. International reserves are the ultimate rainy day fund for a country, and according to Obstfeld, Shambaugh and Taylor (2009), the crisis and panic of 2008 was a "torrential downpour".

Robustness of data

The long term relationship between variables is reassuring, as the present paper investigates the recent two decades of Sudden Stop episodes. Using information on a yearly basis, we address the question whether Sudden Stops could be prevented by an appropriate level of international reserves. The results from the robustness data tests highlight the strong relationship between Sudden Stop and international reserves.

Dependent Variable: SS
Method: Panel Fully Modified Least Squares (FMOLS)
Date: 06/09/14   Time: 03:11
Sample (adjusted): 1994 2012
Periods included: 19
Cross-sections included: 13
Total panel (unbalanced) observations: 238
Panel method: Grouped estimation
Long-run covariance estimates (Bartlett kernel, Newey-West fixed bandwidth)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESERVES	-1.235191	0.632074	-1.954187	0.0519
FOREIGN_LIABILITIES	1.765868	0.260897	6.768448	0.0000

R-squared	-0.326316	Mean dependent var		0.168067
Adjusted R-squared	-0.331936	S.D. dependent var		0.374714
S.E. of regression	0.432456	Sum squared resid		44.13623
Durbin-Watson stat	1.351235	Long-run variance		0.089154

Pairwise Granger Causality Tests
Date: 06/23/14   Time: 16:12
Sample: 1993 2012
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
RESERVES does not Granger Cause SS	226	8.54318	0.0003
SS does not Granger Cause RESERVES		3.68153	0.0267
D_FOREIGN_LIABILITIES does not Granger Cause SS	216	5.42012	0.0051
SS does not Granger Cause D_FOREIGN_LIABILITIES		5.46379	0.0049
D_FOREIGN_LIABILITIES does not Granger Cause RESERVES	216	2.12428	0.1221
RESERVES does not Granger Cause D_FOREIGN_LIABILITIES		0.40998	0.6642

Conclusions

- This paper has explored the optimality of international reserve holdings in which reserves can prevent Sudden Stop and reduce the costs of this phenomenon. The estimated model is build on the assumption that central banks desire to minimize the loss function that is computed from the likelihood of Sudden Stop, the output cost of Sudden Stop and the opportunity cost of holding international reserves.

- Remarkably, although the model is not calibrated to match the observed international reserves from the sample of countries, the optimal level of reserves, computed through the model based on the work of Calvo, Izquierdo and Loo-Kung (2013), still are close in line with the observed levels. It is possible, therefore, that policymakers consider the foreign currency denomination of assets and liabilities, as well as the current account deficit.

- Unfortunately, global financial crisis effects have not dissipated completely and a future research should be made on how the Europe Union membership influenced the self insurance plans of every emerging country. Recent times made many countries aware of the importance of financial stability, and the Europe Union members weren't immune.

- It is not unlikely to turn to the aid that accumulating international reserves provide. Emerging countries can sustain their liquidity and avoid taking the risk of balance-sheet effects, e.g., default or abrupt decline in production, by holding reserves. As previously stated in the previous pages of the study, liquidity is the main key to self-insurance, and emerging market countries may have the tools to prevent Sudden Stops, not just by avoiding bad policies.

References

- Beckmann, S., T. Scheiber and H. Stix (2011), "*How the Crisis Affected Foreign Currency Borrowing in CESEE: Microeconomic Evidence and Policy Implications*", Focus in European Economic Integration, Oesterreichische Nationalbank, Q1/11, 25–43

- Brei, M. (2007), *"The Impact of Sudden Stops on Bank Lending: Are there Cross-Sectional Differences?"*, Mimeo, Bonn Graduate School of Economics, July

- Bojesteanu, E. and A. Manu (2012), *"Disentangling the factors behind the external adjustment in the New Member States during the crisis*", Presented at The Competitiveness Research Network

- Calvo, G. and C. Reinhart (2000), "*When Capital Inflows Come to a Sudden Stop: Consequences and Policy Options*", in Reforming the International Monetary and Financial System, ed. by Peter B. Kenen and Alexander K. Swoboda (Washington: International Monetary Fund)

- Calvo, G., A. Izquierdo and L. Mejia (2008), "*Systemic Sudden Stops: The Relevance of Balance-Sheet Effects and Financial Integration*", NBER Working Paper, No. 14026

- Calvo, G., A. Izquierdo and R. Loo-Kung (2012*), "Optimal Holdings of International Reserves - With Special Reference to Balance-Sheet Effects and Sudden Stop", Mimeo, Washington, D.C.*

- Calvo, G., A. Izquierdo. and R. Loo-Kung (2013), *"Optimal Holdings of International Reserves: Self-Insurance against Sudden Stop",* Monetaria (CEMLA), 1, 1-35

- Durdu, C, E. Mendoza and M. Terrones (2007), *"Precautionary Demand for Foreign Assets in Sudden Stop Economies: An Assessment of the New Merchantilism"*, NBER Working Paper 13123.

- Edwards, S. (2005), *„Capital Controls, Sudden Stops and Current Account Reversals"*, NBER Working Paper 11170

- Feldstein, M. (1999), "*Self-Protection for Emerging Market Economies*", NBER Working Paper, No. 6907

- Flood, R. and N. Marion (2002*),"Holding International Reserves In an Era of High Capital Mobility",* in Susan M. Collins and Dani Rodrik eds., Brookings Trade Forum 2001, 1-47 (Brookings Institution Press, Washington DC).

- Frankfort-Nachmias, C. and D. Nachmias (1996), "*Research Methods in the Social Sciences*", Fifth Edition, New York: St. Martin's Press

- Furceri, D., S. Guichard and E. Rusticelli (2011), *„Episodes of Large Capital Inflows and the Likelihood of Banking and Currency Crises and Sudden Stops"*, OECD Working Paper 865

- Goldfajn, I. (2001), *"Roundtable Comments on Monetary and Regulatory Policy",* Paper presented at Domestic Finance and Global Capital in Latin America Conference, Federal Reserve Bank of Atlanta

- Jeanne, O. and R. Rancière (2006), *"The Optimal Level of International Reserves for Emerging Market Countries: Formulas and Applications"*, International Monetary Fund Working Paper 06/229.

- Heller, R. (1966), "*Optimal international reserves*", Economic Journal, Vol. 76, No. 302, 296-311

- Obstfeld, M., J. Shambaugh and Taylor, Alan M. (2008), *"Financial Stability, the Trilemma, and International Reserves"*, NBER Working Paper 14217

- Obstfeld, M., J. Shambaugh and Taylor, Alan M. (2009), *"Financial Stability, Reserves, and Central Bank Swap Lines in the Panic of 2008"*, NBER Working Paper 14826

- Punch, K. (1998), "*Introduction to Social Research. Quantitative and Qualitative Approaches*", SAGE Publications

- Radelet, S. and J. Sachs (1999), "*What Have We learned, So Far, From the Asian Financial Crisis?*", Harvard Institute for International Development, CAER Discussion Paper No. 37, Presented at the Annual Meetings of the American Economics Association (January).

Thank you!