BOFIT Discussion Papers
32 • 2015

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Deposit dollarization in emerging markets: modelling the hysteresis effect

Bank of Finland, BOFIT
Institute for Economies in Transition

BOFIT Discussion Papers
Editor-in-Chief Laura Solanko

BOFIT Discussion Papers 32/2015
10.11.2015

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ISBN 978-952-323-072-9
ISSN 1456-5889 (online)

Suomen Pankki
Helsinki 2015

Contents

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Abstract

We apply empirical modelling set-ups developed to capture the hysteresis effect in the data on deposit dollarization in a cross-section of emerging market economies. Specifically, we estimate a nonlinear relationship that determines two equilibrium levels of deposit dollarization depending on the current value of dollarization and previous episodes of sharp depreciation of the national currency over the past five years. When exchange rates are stable, convergence to a higher equilibrium level of dollarization begins when the 45–50% threshold of deposit dollarization is exceeded. We estimate the model for short-run dynamics of dollarization and find that the speed of convergence to the higher equilibrium implies quarterly increases of 1.2–3 percentage points in the ratio of foreign currency deposits to total deposits.

Keywords: dollarization, hysteresis, nonlinear model, emerging markets
JEL Classification: C23, E41, F31

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The views expressed in this paper are solely those of the authors and do not necessarily reflect the official position of the Bank of Russia. The authors would like to express their gratitude to Sergey Seleznev and Andrey Sinyakov for valuable assistance.

Introduction

Dollarization (i.e. the substitution of a foreign currency for one or more functions of the national currency) is typical of many emerging market economies. Although dollarization is usually associated with high inflation and depreciation of the national currency, the ensuing stabilisation does not always lead to a lessening of dollarization. This effect is called hysteresis or ratchet effect (Calvo and Vegh, 1992).

Models of the hysteresis effect are usually applied to situations of currency substitution. For this purpose, numerous theoretical models have been developed (Oomes, 2003; Guidotti and Rodriguez, 1992; Uribe 1997) for which related empirical results are available (Kamin and Ericsson, 1993; Menon, 2008; Samreth, 2011; Valev, 2010). There are also theories explaining the hysteresis effect in the dollarization of bank balance sheets (Ize and Levy-Yeyati, 2003; Duffy et al., 2006), as well as some empirical estimations of the hysteresis effect on financial dollarization: Mueller (1994), De Freitas (2003), Fernández Tellería (2006) analyse deposit dollarization; and Peiers and Wrase (1997) examine loan dollarization. Our paper focuses on the analysis of deposit dollarization given its growing relative importance for emerging markets as compared to currency substitution. Conducting a cross-country analysis (one of the main contributions of this paper) of currency substitution instead would be hampered by severe data limitations.

The rest of the paper is structured as follows. In Section 1 we will describe the cross-section of countries and the set of variables. Section 2 presents our error correction model of deposit dollarization comprising the short-run dynamics and the long-run equilibrium, as well as an alternative model of panel threshold regression. The third section describes the results of modelling and counterfactual simulation of deposit dollarization dynamics in Russian.

1 Dataset

In our estimations we studied a cross-section of 12 emerging markets over the period 1997–2013 (the choice of countries was determined by the availability of dollarization data). Accordingly, our models were estimated on the basis of time series that included (depending on model specification) about 700 observations.

The quarterly data on the exchange rate dynamics, return on deposits and money supply were obtained from the IMF International Financial Statistics. The shares of foreign currency deposits of households and non-financial corporations in total deposits were used as the deposit dollarization variables. Data on dollarization were obtained from central bank websites. All variables were seasonally adjusted using the X-12 procedure. Summary statistics of the variables are reported in the Annex 1.

Table 1 Countries in the cross-section

Country	**Time sample**	**Country**	**Time sample**
Armenia	2000 Q1 – 2013 Q4	Moldova	1997 Q1 – 2013 Q4
Hungary	1997 Q1 – 2013 Q4	Peru	1997 Q1 – 2013 Q4
Georgia	1997 Q1 – 2013 Q4	Russia	1997 Q1 – 2013 Q4
Kazakhstan	1998 Q1 – 2013 Q4	Ukraine	2003 Q1 – 2013 Q4
Macedonia	2003 Q1 – 2013 Q4	Croatia	1997 Q1 – 2013 Q4
Mexico	1999 Q1 – 2013 Q4	Czech Republic	1997 Q1 – 2013 Q4

2 Empirical results

2.1 Error correction model: long-run equilibrium

There are two factors usually considered to be triggers of the hysteresis effect. The first of these are network externalities. Network externalities exist if economic agents are more willing to use foreign currency if it is already widespread within the country. In this case, if dollarization has reached a high level in the course of depreciation of the national currency, it will not fall back during stabilisation because use of the foreign currency has already taken root in the national economy and is no longer associated with additional costs.

The second reason for the occurrence of hysteresis is depreciation expectations. In particular, the expected depreciation of the national currency makes foreign currency more attractive for savings even if the current exchange rate is fairly stable. Currency crises and hyperinflation may play a special role in shaping depreciation expectations (Baliño et al., 1999; Feige 2003).

Accordingly, we used the specification suggested by Mongardini and Mueller (2000) and Oomes (2003) to estimate the long-run dollarization equilibrium:

$$\log\left(\frac{1-d_{it}}{d_{it}}\right) = \beta_0 + \beta_1(e_{it} - ir_{it}) + \beta_2 d_{it-1} + \beta_3 d^2{}_{it-1} + \beta_4(emax_{it} - ir_{it}) + \varepsilon_{it} \qquad (1)$$

where d_{it} is deposit dollarization, e_{it} is annualised quarterly depreciation of the national currency against the USD. We defined the *emax*it variable (reflecting depreciation expectations) as the maximum exchange rate depreciation over the past five years[1] $emax_{it} = \max\{e_{it}, \dots, e_{it-20}\}$. Exchange rate depreciation rates were adjusted for the difference in yields on national-currency versus dollar deposits (ir_{it}).

We estimated the model using OLS, as in the original research by Oomes (2003): In order to verify the robustness of the estimates and take into account possible endogeneity of links between explanatory variables and dollarization, we also made estimates using the GMM method[2] and country fixed effects (FE). Our estimates are statistically significant, except for those from the GMM specification with fixed effect (however, the values of coefficients are comparable in all cases). On the whole, all the estimation methods provide similar results and confirm the robustness of the estimates.

Table 2 Long-run equilibrium model estimates

Variable	***Specification (estimation method)***			
	I (OLS)*	II (GMM)	III (OLS FE)*	IV (GMM FE)
	Coefficient (t-statistic)			
d_{it-1}	–6.36 (–21.88)	–6.78 (–11.36)	–5.42 (–16.64)	–5.18 (–1.18)
$d^2{}_{it-1}$	1.81 (5.18)	2.27 (3.25)	0.99 (2.64)	0.67 (0.21)
$emax_{it} - ir_{it}$	–0.004 (–6.51)	–0.002 (–1.64)	–0.003 (–3.9)	–0.001 (–1.23)
$e_{it} - ir_{it}$	–0.08 (–10.16)	–0.17 (–7.18)	–0.07 (–10.22)	–0.16 (–7.92)
C	2.70 (48.4)	2.78 (25.47)	2.48 (29.7)	2.44 (5.1)
R^2	**0.98**	**0.98**	**0.98**	**0.98**
J-test (p-value)	**–**	**0.64**	**–**	**0.52**
N obs	**716**	**704**	**716**	**704**

* in models estimated by OLS, t-statistics were adjusted for residuals' autocorrelation and heteroscedasticity.

[1] Authors also studied alternative estimates of currency hysteresis horizon (12 months, three years), which had inconsiderable impact on the value and scope of hysteresis effect.
[2] Two lags of e_t, ir_t, $emax_t$, d_t were used as instruments.

As shown in Oomes (2003) this model can be used to calculate long-run dollarization equilibrium. The rearranged law of motion for dollarization may be written as

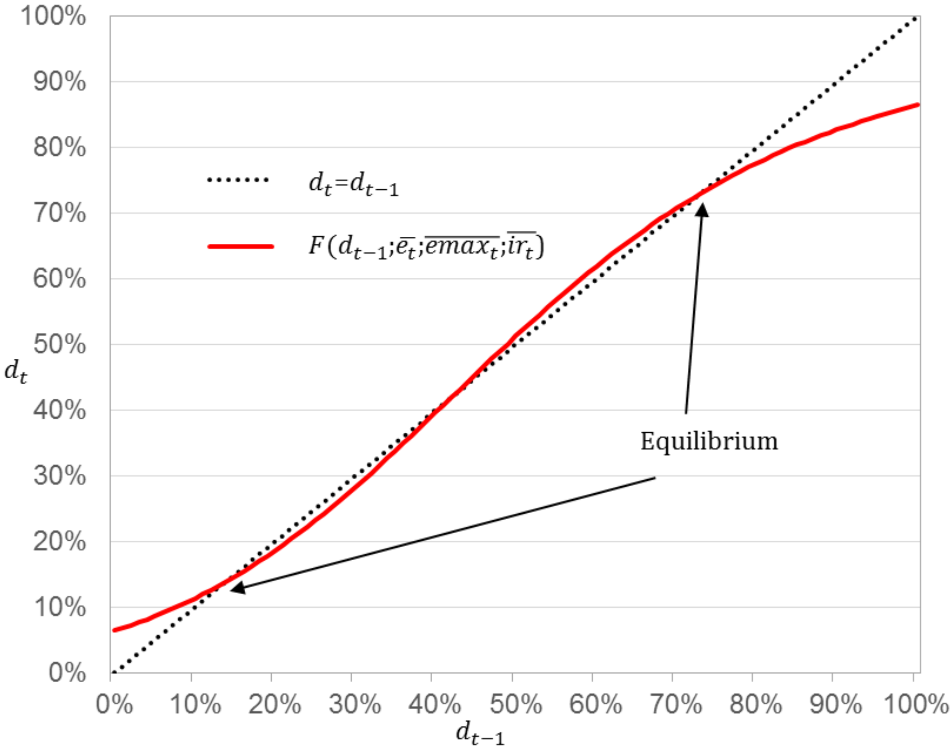
$$d_{it} = (1 + exp\{2{,}70 - 0{,}08(e_{it} - ir_{it}) - 6{,}36\, d_{it-1} + 1{,}81\, d^2{}_{it-1} - 0{,}004(emax_{it} - ir_{it})\})^{-1} \quad (2)$$

For illustrative purposes, we aggregated $(e_{it} - ir_{it})$ and $(emax_{it} - ir_{it})$ into one indicator (using the coefficients from (2) to calculate the weights) and computed an implicit indicator of yield differential between national and foreign currency deposits:

$$\text{Expected yield differential} = (e_{it} - ir_{it}) + \frac{0{,}004}{0{,}08}(emax_{it} - ir_{it}) \quad (3)$$

As long as depreciation of the exchange rate and interest rates remain unchanged, dollarization will converge towards the long-run steady state d^* that is a solution to the above equation (i.e. such that $d_t = d_{t-1}$). Typically, the nonlinear form of a dollarization model will produce two stable equilibria and one unstable equilibrium (Figure 1). The solid line reflects the relationship of the current and previous levels of dollarization (at given changes in the exchange rate and interest rate). The dotted 45 degree line reflects the condition that $d_t = d_{t-1}$.

Figure 1 Determination of dollarization equilibrium (based on equation (2) with arbitrary fixed e=0.05, emax=0.6 and ir=0)



Points of intersection of these lines are dollarization equilibria. Extreme equilibrium points are stable equilibria; the intermediate equilibrium is unstable. If dollarization at time t is less than the intermediate equilibrium point, dollarization will shift towards the lower extreme equilibrium in the next period, t+1. If dollarization at time t is exceeds the intermediate equilibrium point, dollarization will shift towards the higher extreme equilibrium in the next period, t+1.

The long-run dollarization Model I was used to calculate dollarization equilibria which vary depending on the expected yield spread (Figure 2). When yields are roughly equal, the low dollarization equilibrium is at 10–20% and the high equilibrium at 60–80%. When yields differ significantly, one equilibrium ceases to exist: the low equilibrium ceases to exist when the expected yield differential is less than –160 percentage points (p.p) (which corresponds to quarterly depreciation of the national currency by 27% when interest rates are equal); the high equilibrium ceases to exist when the expected yield differential exceeds 80 p.p. (national currency appreciation of 13% per quarter). If there are two equilibria, the direction of convergence will depend on the initial level of dollarization.

Figure 2 Dollarization equilibria

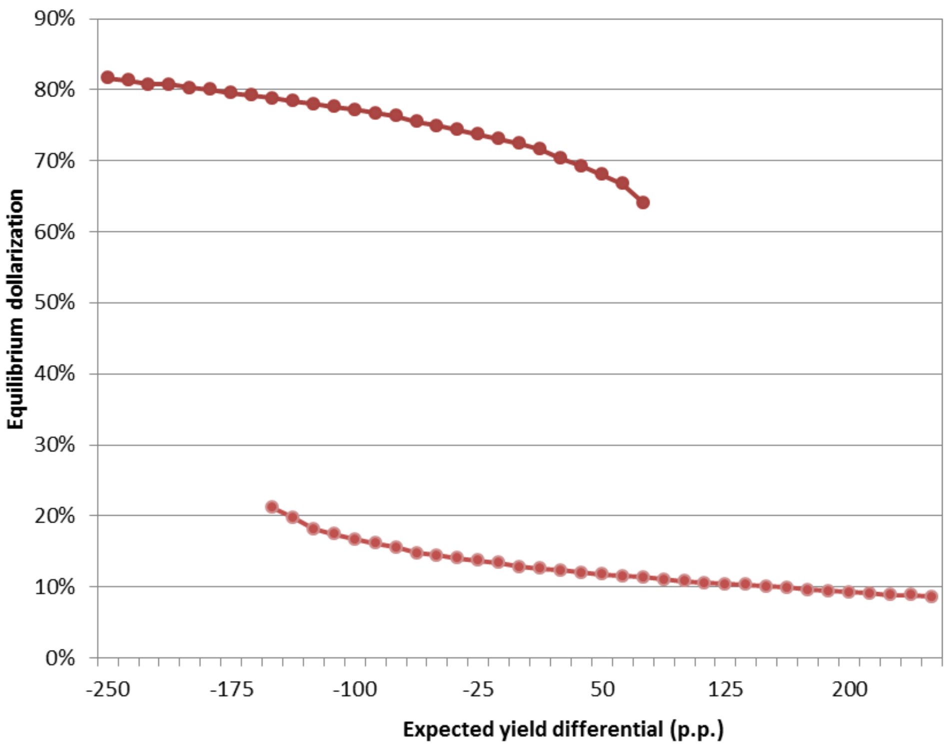
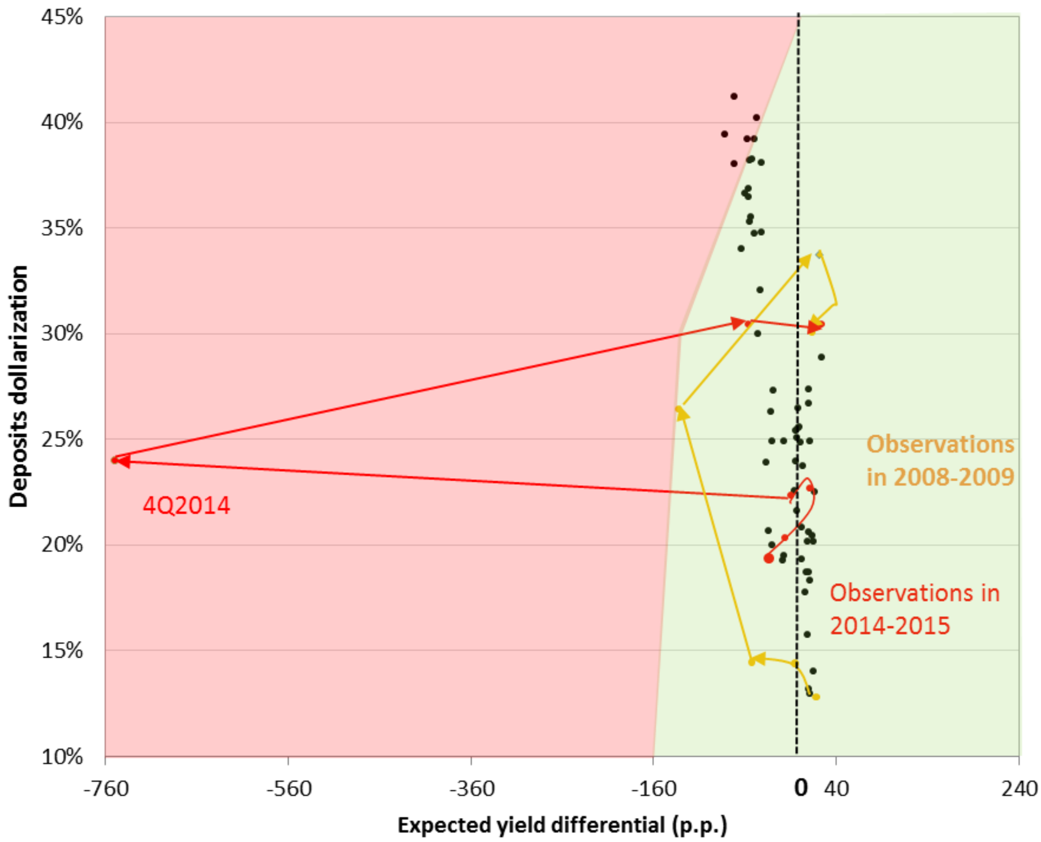


Figure 3 shows the threshold values of foreign currency deposit yield and actual dollarization that mark the dividing line between convergence to the different equilibria (together with actual observations in Russia). The estimates show that at 10% dollarization, the system will converge to the low equilibrium whenever the expected yield differential is greater than –160 p.p. As dollarization increases, this threshold declines. Thus, at 40% dollarization, convergence will be towards the low equilibrium if expected yield differential is less than 45 p.p. Notably, with equal expected returns on foreign and national-currency deposits, convergence will be towards the low equilibrium if the current dollarization does not exceed 45%.

Figure 3 Threshold values of dollarization and net return on foreign-currency deposits and actual values in Russia in 2001–2015. Red (green) area corresponds to convergence towards high (low) dollarization equilibrium.



We see that in 2001–2003 the Russian economy was likely to remain at a high dollarization level; yet it consequently managed to shift towards the lower equilibrium. In 2008–2009, and particularly in 2014–2015 the threat of convergence towards a higher long-run equilibrium level of dollarization was highly probable due to the depreciation of the national currency. Still, as the exchange rate stabilised, the expected yield differential fell back to the acceptable level and the realised dollarization increase (from 15–20% to approximately 30–35%) was insufficient for a shift towards a new equilibrium. As a result, 2010–2013 saw dollarization drop back to the 15–20% equilibrium.

For similar illustrations for other countries in the panel see the Annex 2. Notably, only a few countries have managed to shift from one equilibrium to another (Peru seems to be the most striking example).

2.2 Error correction model: short-run dynamics

In this section we will analyse the effect of the existence of several dollarization equilibria on the short-run dynamics of deposit dollarization. Our model specification and choice of variables are largely based on Neanidis and Savva (2009). We estimate the following equation:

$$\Delta d_{it} = \beta_0 + \beta_1 erf_{it} + \beta_2 mbf_{it} + \beta_3 (d^*_{it-1} - d_{it-1}) + \varepsilon_{it} \quad (4)$$

where d_{it} is deposit dollarization, erf_{it} is an exchange rate indicator, mbf_{it} is a monetary base indicator (a proxy for expanding ruble money supply)[3]. The exchange rate variable was transformed to capture the effect of revaluation as follows (for details see Honohan, 2007): $erf_{it} = (1-d_{it-1})*d_{it-1}*(E_{it}/E_{it-1}-1)$, where E_{it} is exchange rate, d_{it} is share of foreign currency deposits in total deposits. Similarly, the monetary base factor: $mbf_{it} = (1-d_{it-1})*d_{it-1} *(m_{it}/m_{it-1}-1)$, where m_t is monetary base.

We augment the model with the error correction term $d_{t-1} - d^*_{t-1}$, where d^*_{t-1} is long-run dollarization equilibrium based on Model I in Section 2.1. Interestingly, Neanidis and Savva (2009) also used an error correction term, but they modelled dollarization equilibrium as a nonlinear trend.

In order to verify the robustness of the estimates, we estimated the standard model with and without the intercept term, using de-meaned explanatory variables (this specification ensures that dollarization converges to the equilibrium level if the short-run explanatory indicators are at average levels). We tested the relevance of country fixed effects (FE). In order to control for possible endogeneity between explanatory variables and dollarization, we conducted estimation using OLS and GMM methods[4]. The resulting coefficients turned out to be statistically significant and to have the expected signs and magnitudes (Table 3).

[3] In accordance with the results obtained by Neanidis and Savva (2009), these indicators, as well as the interest rate differential, are robustly significant determinants of deposit dollarization. The interest rate indicator is statistically insignificant if included in the model. The model does not include indicators of institutional factors of dollarization, but their impact can presumably be captured by adding country fixed effects.
[4] Two lags of erf_t, ir_t, $emax_t$, mbf_t, d_t - d^*_t were used as instruments.

Importantly, the different methods yield similar estimates for the speed of convergence towards equilibrium. The value of the coefficient of the error correction term (0.02) means that, given the difference between the high and the low equilibria, about 60 p.p. (see Figure 2), the shift from one equilibrium to another will lead to 1.2 p.p. acceleration/deceleration of quarterly growth of the deposit dollarization ratio.

Table 3 Short-run dollarization model (dependent variable Δd_t)

Variables	***Specification (estimation method)***				
	I (OLS)* De-meaned *erf* and *mbf*	II (OLS)*	III (GMM)	IV (OLS FE)*	V (GMM FE)
	Coefficient (t-statistic)				
$d_{it-1} - d^*_{it-1}$	0.02 (1.75)	0.02 (4.67)	0.03 (1.53)	0.02 (4.88)	0.01 (1.73)
mbf_{it}	–0.3 (–4.73)	–0.3 (–4.59)	–0.55 (–2.26)	–0.3 (–4.48)	–0.54 (–2.36)
erf_{it}	0.78 (5.88)	0.78 (5.08)	1.35 (5.68)	0.77 (4.83)	1.35 (5.52)
C	–	0.001 (1.18)	0.003 (1.53)	0.001 (0.75)	0.003 (1.73)
R^2	**0.15**	**0.15**	**0.07**	**0.16**	**0.09**
J-test (p-value)	**–**	**–**	**0.06**	**–**	**0.08**
N obs	**681**	**681**	**645**	**681**	**645**

* – in models estimated by OLS, t-statistics were adjusted for residuals' autocorrelation and heteroscedasticity.

2.3 Threshold regression

In order to verify our findings we also specify our model of short-run changes in dollarization as a conventional panel threshold regression (see Hansen (1997, 1999); Everaert and Pozzi, (2007)) with a value switching intercept term. This set-up does not depend on the predetermined specification of the long-run equilibrium model although it implicitly assumes that there are only two possible equilibrium values of dollarization. We estimate the following equation:

$$\Delta d_{it} = \begin{cases} \beta_0 + \beta_1 erf_{it} + \beta_2 mbf_{it} + \beta_3 d_{it-1} + \varepsilon_{it}, & z_{it} > \theta \\ (\beta_0 + \beta_0') + \beta_1 erf_{it} + \beta_2 mbf_{it} + \beta_3 d_{it-1} + \varepsilon_{it}, & z_{it} \leq \theta \end{cases} \tag{5}$$

where d_{it} is dollarization at time *t* in country *i*, erf_{it} is an exchange rate indicator, mbf_{it} is a monetary base indicator, d_{it}^{*} is long-run dollarization equilibrium, ε_{it} is a regression error; z_{it} is a threshold variable; θ is a threshold value.

We consider the previous dollarization level d_{t-1} and depreciation expectations $emax_{it}$ as threshold variables. To estimate optimal θ, we tested all the values of the threshold variable z_{it} in the sample and selected those that yielded the smallest variance for the model's residuals (we also assumed that one regime should be associated with at least 15% of the observations).

We tested the null hypothesis of the absence of regime switching by means of the sup*F* statistic (Hansen,1999) and approximated its distribution using the fixed-regressor bootstrap method. The inference of the Hansen test (reported in Table 4) shows that the existence of several regimes cannot be statistically rejected at the 5% significance level.

The results of the estimates (Table 4) indicate that the effects associated with of the exchange rate and the monetary base factors turn out to be comparable for threshold regressions and the error correction models presented in Section 2.2. In the model where dollarization is used as a threshold variable, dollarization growth declines by 3 p.p. in the case of transition from high to low dollarization regime. That is higher than the estimates obtained for the models presented in Section 2.2. At the same time, the 47–48% threshold is generally in line with the borderline dollarization value for the zero expected yield spread obtained in Section 2.1 (see Chart 3)[5].

[5] Interestingly, Neanidis and Savva (2009) also allowed for difference in parametrization of their models for countries with high and low dollarization. Their arbitrary chosen 50% dollarization threshold value turns out to be rather close to the optimal one. Their estimates indicate that in highly dollarized economies quarterly increases of deposit dollarization are by 1.5-4 p.p. higher which is roughly consistent with our results.

Table 4 Threshold regression estimates with two regimes (dependent variable Δd_t)

Variables	***Threshold variable***	
	d_{it-1}	$emax_{it}$
	Coefficient (t-statistic)	
d_{it-1}	–0.06 (–6.91)	–0.008 (–1.69)
mbf_{it}	–0.25 (4.99)	–0.30 (–5.9)
erf_{it}	0.75 (8.68)	0.77 (8.55)
C	0.04 (7.56)	0.01 (3.33)
C′	–0.03 (–7.6)	–0.009 (–2.99)
θ	0.474	192
Confidence band of θ	[0.473:0.477]	[39:281]
Hansen test (F-statistic)	**52.85**	**8.77**
$\mathbf{R^2}$	**0.21**	**0.16**
N obs	**681**	**681**

t– statistics were adjusted for residuals' autocorrelation and heteroscedasticity.

The depreciation expectations indicator (*emax*) can also be used as the threshold variable. The estimates of the respective model show that the episode of depreciation of the national currency by more than 192% over the past five years increases the quarterly change in the dollarization ratio by 0.9 p.p. The confidence interval for this threshold level is, however, rather wide.

3 Counterfactual simulations of deposit dollarization developments for the Russian economy in 2014–2015

Simulations based on Model IV, presented in section 2.2, indicate that this approach enables a fairly precise out-of-sample forecast of changes in deposit dollarization in Russia in 2014–2015 when conditioned on actual exchange rate, interest rates and monetary base developments. Given the constant ruble exchange rate, constant interest rates and 6% year-on-year growth of the monetary base, one can expect convergence towards the low dollarization equilibrium of about 20% (Figure 4).

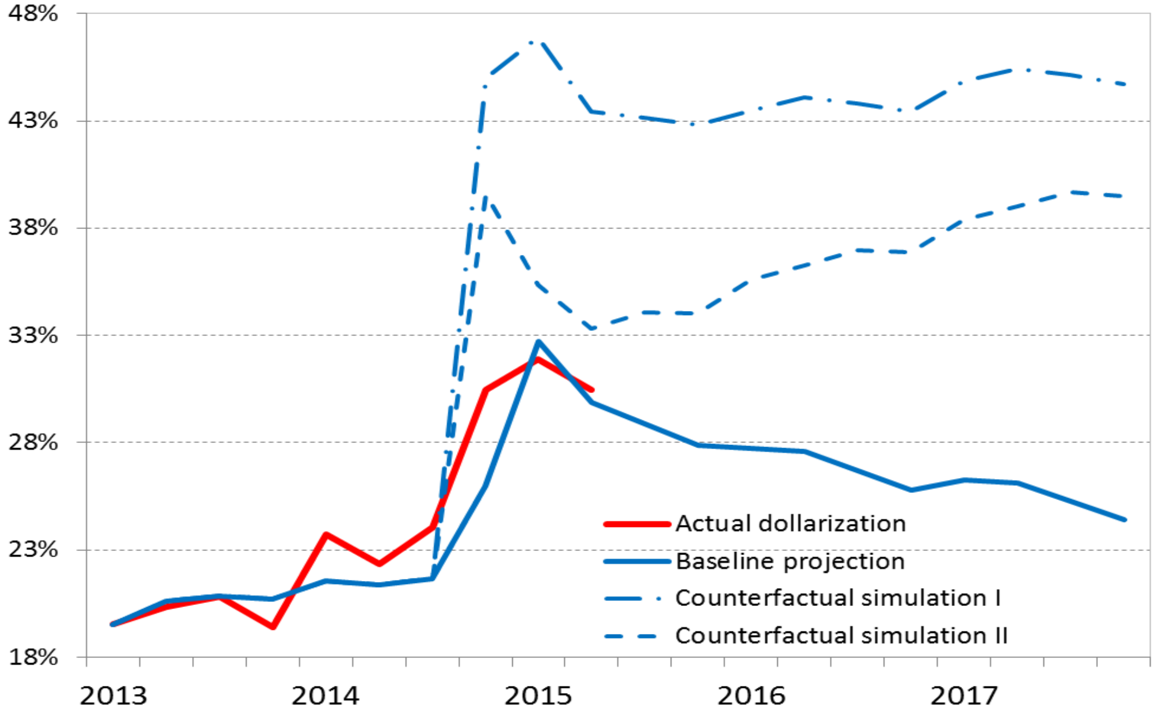
To illustrate the sensitivity of dollarization dynamics to nonlinear effects which occur during the shift towards the high dollarization equilibrium, we produced several counterfactual simulations that are based on the same assumptions, with the following exceptions.

In the first counterfactual scenario we introduce an exogenous increase in dollarization to 45% in 2014 Q4. In this case the transition towards the high long-run equilibrium is conditioned by the effect of network externalities.

In the second counterfactual scenario we introduce depreciation of the exchange rate to 90 rubles per US dollar (i.e., by approx. 230%) in 2014 Q4. This shock is sufficient for transition to the higher long-run equilibrium dollarization due to the effect of depreciation expectations.

In both scenarios there is no convergence towards the low equilibrium in 2016–2018 even though the exchange rate is stable, as in the baseline projection.

Figure 4 Counterfactual simulations of changes in deposit dollarization in Russia.



Conclusion

In this paper we have applied a modelling set-up developed to capture the hysteresis effect in dollarization to a panel of emerging markets.

For this purpose we estimated a nonlinear relation that allows us to calculate the deposit dollarization equilibrium depending on its current value and the episodes of largest depreciation of the national currency over the past five years. We concluded that there may be two deposit dollarization equilibria for transition economies: a low one of about 15% and a high one of about 75%. When the yields on foreign and national currency deposits are equal, convergence towards higher dollarization begins when the 45–50% threshold is exceeded.

Modelling short-run deposit dollarization shows that the transition from the low dollarization equilibrium to the high one results in a quarterly increase in the deposits dollarization ratio of 1.2–3 p.p. Estimations obtained via an alternative econometric method (threshold regression) confirmed the presence of two regimes in deposit dollarization.

To illustrate the sensitivity of dollarization dynamics to changes in long-run equilibrium and to analyse potential dollarization threats in Russia, we conducted counterfactual simulations for 2014–2015. We have shown that if deposit dollarization had increased in 2014 Q4 to 45% (actual increase was to 30%) or the ruble had depreciated against the US dollar by 230% (actual depreciation was 143%), the dollarization level would not have fallen back to the previous level even if the ruble exchange rate had remained stable.

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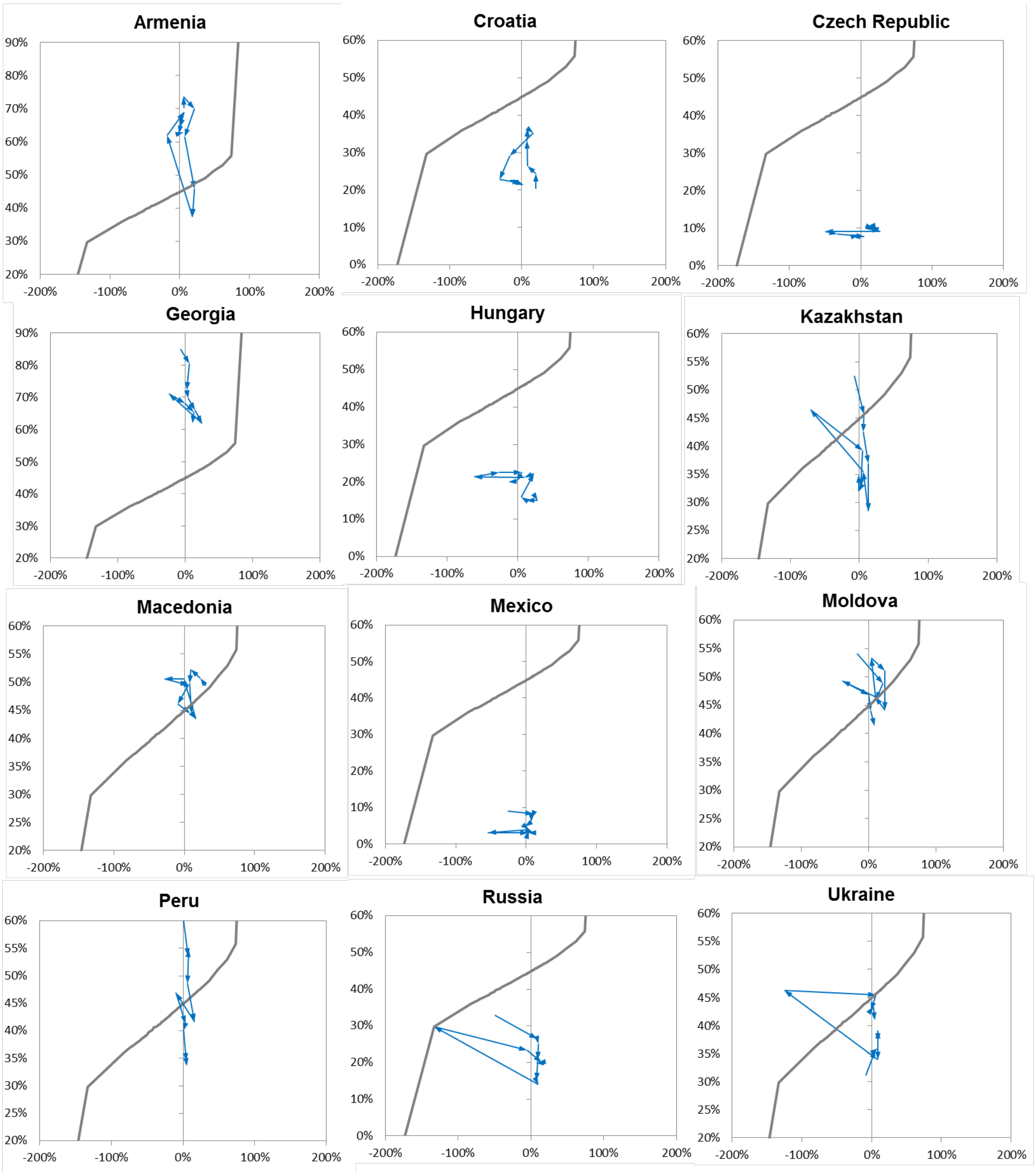
Annex 1 Summary statistics of variables

Variable	**Mean**	**Std Deviation**	**Min**	**Max**	**Obs**
Deposit dollarization (*d*)	0.43	0.21	0.07	0.86	728
Depreciation expectations (*emax*)	18.9	130.1	0.00	1232.78	816
Interest rate differential (*ir*)	0.08	0.06	0.00	0.3	816
Exchange rate (*e*)	0.07	0.55	–0.34	12.18	816
Money base factor (*mbf*)	0.01	0.02	–0.06	0.15	681
Exchange rate factor (*erf*)	0.00	0.01	–0.02	0.17	716
Equilibrium deposit dollarization (*d**)	0.42	0.30	0.12	0.93	728

Annex 2

Observed deposit dollarization (vertical axis) and expected yield differential (horizontal axis) in emerging markets in 2003–2013 (annual average).



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ISSN 1456-4564 (print) // ISSN 1456-5889 (online)