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CURRENCY MARKETS MODELS. A ROMANIA CASE STUDY APPLICATION

Abstract. *A recurrent feature of the financial crisis is the currency crisis. The paper examines, in the context of some developing European economies, the relationship between the economic-financial crisis (drastic decrease and extreme volatility of macroeconomic indicators) and the currency crisis (severe depreciation of the exchange rate). Our research findings reveal that in financial crises, the deterioration of macroeconomic fundamentals and the foreign currency exposure of the economy had played a decisive role in the formation and transmission of currency shocks and extreme exchange rate volatility. The empirical results of our study of several developing economies in Europe show an evolution of the real exchange rate corresponding to the Balassa-Samuelson effect. In our case study for Romania, the effect manifested inversely, since the increase in wages was not determined by the increase in productivity, but as a result of administrative measures. We concluded the effect of BS was manifested rather by the increase in the inflation rate and the depreciation of the local currency RON (leu) against the euro and implicitly by the deterioration of the current account. For the other countries that we studied, under the same conditions of currency crises, the real exchange rate evolution corresponds closely with the effect prescribed by Balassa-Samuelson.*

Keywords*: Balassa-Samuelson effect, productivity, exchange rate, volatility, financial crisis, public wages, fiscal policies.*

JEL Classification: F31; **O47**, **G01**

1. Introduction

Our study used impulse-response functions applied to monthly series data. We measured the short-term impact of exchange rate shocks on the inflation rate and found that a shock on the exchange rate significantly affects the rate of

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inflation. We showed that both the inflation rate and the exchange rate have a significant component of adaptive expectations, i.e. a high inflation rate or a depreciated exchange rate are transformed into inflation expectations. The Balassa-Samuelson effect implies that the advance of productivity in the tradeables goods and services sector is passed through in the increase of the prices of goods and services in the non-tradeable (non-tradable) sector, thus causing deviations from the theoretical balance prescribed by the purchasing power parity theory. Purchasing power parity holds that the differential interest rates between currencies are equal to the expected change in exchange rates. The empirical findings for the three distinct periods of the recent currency crises we studied for Romania suggest three factors that played a dominant role in currency adjustments: (1) large twin deficits which lead to periods of (2) overvaluation of the real exchange rate and (3) unsustainable (by administrative policy decision) growth in wages and incomes. Thus, we interpret the variability of the exchange rate as being directly dependent on the productivity of the sectors of commercial goods - that can be exported (tradeables) and that of non-tradeables (goods, services which by their nature can only be sold on the internal market) and on wage policies of the labor market. The result shows that wage growth policies, de-correlated by labor productivity, have an effect on inflation by a lag of 5-6 months. We also concluded that monetary policy is more effective in reducing the inflation rate, and the maximum effective transmission of a possible monetary policy shock manifests itself in 9-12 months. Our findings also detected that monetary policy appears more effective in reducing the inflation rate. As a result, an increase in money market interest rates affects the appreciation of the local currency, the RON. Through the econometric model we used, such as Vector Error Correction (VEC) – the Johansen methodology, our research has highlighted that in the short term, the uncovered interest rate parity is a valid statistical correlation, as evidenced by the VEC model presented in the research conclusion.

2. Theoretical body of knowledge to currency crises

Foreign exchange crisis research argues that, ultimately, the pressures exerted by the macroeconomic imbalances that are associated with a crisis should lead to the depreciation of the currency and thus reposition the exchange rate on a level for enhanced competitiveness of exports. Thus, Romania’s exported goods and services (tradables sector) will be quoted cheaper. At the same time, imports become more expensive and the current account deficit will improve - tend to be lower. This economic logic follows the studies of Obstfeld and Rogoff (2005) or those of Blanchard, Giavazzi, and Sa (2005). A significant body of knowledge and research found in dedicated scientific literature studies the exchange rate rebalancing effect manifested in an economic crisis. Krugman's paper (2007) argues that usually, these rebalancing processes are inevitable, they happen suddenly and unexpectedly. Scientific research and conclusions drawn from

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referenced empirical data identify a wide range of variables associated with currency crises. According to Frankel and Rose (1996), Kaminsky et al., (1998), and Kaminsky and Reinhart, (1999) some of the most important independent variables quoted by research are the deterioration of macroeconomic fundamentals, the exuberance of domestic consumer credit, the fiscal and current account deficits, the over-appreciation of the real exchange rate or the public wages increase. For the three periods we studied, Romania's behavior during the economic crisis appears to be similar to the findings of the dedicated research literature on the topic. From a historical perspective, economic research has evolved and refined in understanding the mechanisms for preventing systemic crises (in particular the currency crises) and subsequently proposed methods of applying preventive measures thereof. The first series of major crises induced by exchange rate imbalances began in the European Monetary System (1992), then in Mexico (1994), and in Southeast Asian countries, Thailand, Malaysia, Indonesia, the Philippines, and South Korea (in 1997) or Russia (1998). The economic literature distinguishes three types of financial crises: foreign exchange, banking, and external debt. A special concept in the economic theory of currency crises is represented by twin crises - the currency crisis combined with one of the banking sectors. The crises in Asia (1997), Russia (1998), or Turkey (2000) are conclusive examples thereof. Other forms of complex crises are when currency crises combined with fiscal crises, as in Brazil (1999) or foreign exchange and debt crises as in Mexico (1994) and Argentina (2001). In a financial crisis, the nominal value of assets decreases sharply and significantly, in a banking crisis the financial-banking system has major liquidity and solvency problems and in a fiscal-budgetary crisis, deficits and public debt become unsustainable. Even in the milder manifestations of an economic and financial crisis, the central bank's attempt to defend the currency leads either to a decrease in foreign exchange reserves or to a restriction of liquidity in local currency. The pervasive systemic effects of the central bank's intervention were then materializing in higher interest rates, accompanied by rising inflation expectations. According to Mills and Omarova, (2004) in this variant of crisis – a one moderated by the central bank, external variables, such as the real exchange rate, also matter significantly. As a general rule concluded from a specific literature, the correlated deterioration of these indicators proved to be a good leading precursor to an economic crisis.

More recent models of counter-measures taken by central banks suggest that local monetary authorities sometimes abandoned the high maintenance of currency parity not only due to declining reserves, but also due to the precarious evolution of other critical economic variables, such as deficits, stagflation, rising unemployment, or inflation. The most important research works on studying these oscillations are those of Egert (2003), Candelon and Kool (2006), Oomes (2005), Mihaljek and Klau (2003). The conclusions of these studies show that initially, the CEE countries recorded solid growth followed by a rapid increase in productivity, especially in their industrial sectors. Also as a direct result of the appreciation of

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the real exchange rate and lack of internal offer, the development was followed by an observable increase in the relative price of the country's non-tradable goods. Subsequent crunches, including the subprime crisis or current pandemic of the new coronavirus, no longer had the same triggers of economic unbalances. This will be the focus of our next research, as economies and exchange rates are more dependent on central banks' interventions.

3. The effects of a currency crisis

Until the currency crisis of the 1990s, the main explanatory argument was that any negative effects next to an episode of a currency depreciation would eventually be offset positively by the outcome of the monetary stimulus on net exports. Overall, the net favorable effect of a currency depreciation for export of the local production was considered prominent. Lately, in contrast with the established economic doctrine, the more recent literature also highlights the negative side effect of an economic contraction, especially in emerging and developing countries. Our research found evidence of this adverse effect in the context of the three currency crises that we studied for Romania. We concluded that, as a result of a balance of payments crisis (a currency crunch) through a depreciation of the currency, the exchange rate crisis proved to affect tangibly economic activity. We found strong evidence that implicit volatility that accompanies currency crisis then can spread to the tradable goods and services sector. In turn, this effect can stimulate a revived economic growth by correcting the temporarily overvalued currency or by lowering the exchange rate at a more stimulating level for cheaper exports of tradeable goods and services. However, the balance of payments crisis can lead to either a pronounced depreciation or to an increase in external debt financing costs. For our study period of 2008 - 2018, we divided the fluctuation of the exchange rate in Romania into three intervals in terms of correlations between economic development and the exchange rate. The first period, marked by the financial crisis of 2008 - 2009, was manifested by a depreciation of the local leu to the EUR / RON to 4.40 (as presented in figure 1). This interval exhibited the most volatile exchange rate for the entire period. By the middle of 2007, in the aftermath rational exuberance of Romania's accession to the European Union, the economy had enjoyed huge inflows of capital, both as a portfolio and as direct investments. Unfortunately, significant inflows of capital were poorly managed both by the governments which run a pro-cyclical fiscal policy and by the private sector which borrowed funds at an unsustainable pace. In a parallel economic development, the

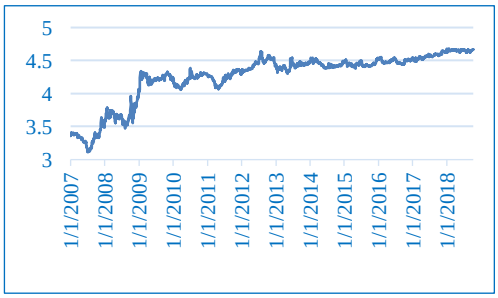

Fig. 1. EUR/RON. Source: Bloomberg

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subprime mortgage crisis in the United States of 2007 was then immediately metamorphosed into the 2008 global financial crisis. Subsequently, the uncertain economic environment led to a wave of mergers and acquisitions that were imposed by authorities both on stronger still solvent financial institutions, but also on those who, if they were not successful immediate acquisition targets, would have followed into bankruptcy. Through a global correlation of financial disruptions, the crisis became pandemic and encompassed all world economies and thus led to a halt in investment capital flows, including those allocated to Romania. The bureaucratic consequence was that in 2008, Romania's rating was downgraded from the last notch of stability - that of investment-grade (recommendation for investment), BBB- to the first notch of non-investment, (junk rating grade), category BB-. The main trigger for the downgrade was the unsustainable growth of public wages. As expected in a balance of payments crisis, Romania, to finance its two twin deficits (see Deficits in Tables 1 and 2), borrowed a substantial loan from financial institutions, for more than 10% of its GDP. The second period of the foreign exchange crisis was one of the high volatility of the EUR / RON exchange rate, between 2010 and 2013. The volatility of the EUR / RON exchange rate varied between 4.05 and 4.63, as a direct impact of the sovereign debt crisis engulfing euro area peripheral countries: Greece, Spain, Portugal, Ireland, Italy. The European sovereign debt crisis (binary alternation of periods of risk-on and risk-off) has transferred to the local Romanian economy through an elevated exchange rate variability and rising interest rates to the leu (RON).

Romania went through a deep recession, a severe economic correction of more than 7% of GDP, just after a period of prosperity with sustained growth of 7% of GDP. We studied also the third period of exchange rate trading, a one with low volatility, that started in 2014. Between 2014 - 2016, the EUR / RON exchange rate traded in a relatively narrow band: 4.40 - 4.60. Then, starting with 2016, the RON currency registered again a depreciation trend with the accompanying increase in inflation, as prescribed by Balassa-Samuelson logic. The main trigger was, again, the unsustainable growth in public (non-tradeable) wages. After the 2007 crisis, the nominal convergence process continued, with some periods of divergence.

Table 1. Budget fiscal deficits. Source: Eurostat, government statistics

% of GDP	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
EU 28	-2.5	-6.6	-6.4	-4.6	-4.3	-3.3	-2.9	-2.4	-1.7	-1.1	-0.7	-0.8
Bulgaria	1.6	-4	-3.1	-2	-0.3	-0.4	-5.4	-1.7	0.1	1.1	2	2.1
Czech	-2	-5.5	-4.2	-2.7	-3.9	-1.2	-2.1	-0.6	0.7	1.5	0.9	0.3
Poland	-3.6	-7.3	-7.4	-4.9	-3.7	-4.2	-3.6	-2.6	-2.4	-1.5	-0.2	-0.7
Hungary	-3.8	-4.8	-4.5	-5.2	-2.3	-2.6	-2.8	-2	-1.8	-2.5	-2.1	-2
Romania	**-5.4**	**-9.1**	**-6.9**	**-5.4**	**-3.7**	**-2.1**	**-1.2**	**-0.6**	**-2.6**	**-2.6**	**-2.9**	**-4.3**

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Table 2. Current account deficits. Source: Eurostat, government statistics

% of GDP	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Bulgaria	-22	-8.3	-1.7	0.3	-0.9	1.3	1.2	0.1	3.2	3.5	1.4	4
Czech	-1.9	-2.3	-3.6	-2.1	-1.6	-0.5	0.2	0.2	1.6	1.7	0.4	-0.4
Hungary	-7.1	-0.7	0.3	0.6	1.6	3.5	1.2	2.3	4.6	2.3	0	-0.8
Poland	-6.7	-4	-5.4	-5.2	-3.7	-1.3	-2.1	-0.6	-0.5	0.1	-1	0.5
Romania	**-11.4**	**-4.7**	**-5.1**	**-5**	**-4.8**	**-0.8**	**-0.2**	**-0.6**	**-1.4**	**-2.8**	**-4.4**	**-4.6**

4. Foreign exchange market fluctuations during financial crises

The global financial crisis triggered by the bankruptcy of the investment bank Lehman Brothers led to a freeze of capital flows in global markets. Romania was caught by the onset of the financial crisis in the fragile economic situation: high current account and budget deficits, strong pro-cyclical fiscal policy (in 2008, at the peak of GDP growth, Romania registered the highest budget deficit). The high exchange risk of foreign currency lending (loans mainly in foreign currency) led to a systematic increase in the financing costs of state and all economic agents. We argue that interest rates and or exchange rates have been used as tools to boost sustainable economic growth and competitiveness, and as result, the Balassa-Samuelson effect was less visible. Estimating the BS effect for CEE countries is a relevant research topic with applicability in public policies in the current challenging post-pandemic ecosystem.

Starting with the second half of 2007 (with the onset of the subprime crisis in the United States), then continuing with the bankruptcy of Lehman Brothers in September 2008 and the ensuing financial crisis, the EUR / RON exchange rate increased (the RON depreciated) from 3.11 (on July 2, 2007) to 4.32 (January 12, 2009) as presented in figure 2, source: Reuters. We analyzed the financial and money markets in that period by the following econometric parameters: (1) the country risk (by the price variability of the CDS contracts), (2) the currency risk (measured by the by historical, GARCH, and implicit volatilities) as well as by (3) the price of the Risk Reversals derivative contracts. Also, our model included the variation of money market interest rates and the variability of the RON interest rates implicit in FX Swap contracts. The risk premium, measured by the Credit Default Swap

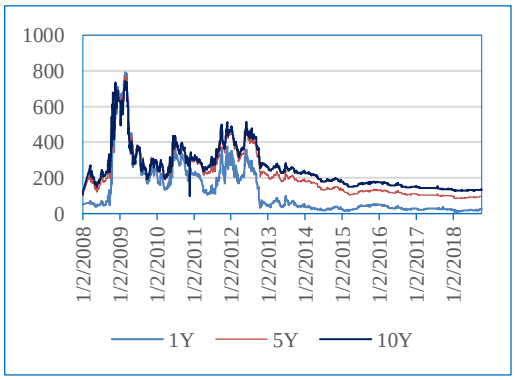

Figure 2. CDS contracts price (in bp)
Source: Reuters

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(CDS) contract prices, peaked in the first quarter of 2009, as pictured in figure 2, from a Reuters source. All of the CDS instruments for the sovereign issuer Romania, for all maturities (from 1 to 10 years) increased to 800 basis points (8%), from a typical value of 100 basis points (bps). Following the emergency financial assistance loan just contracted from international lenders, the value of CDS with the sovereign debtor Romania decreased substantially (but remained very high by historical standards), to 300-400 bps. From the second half of 2007 by end of January 2018, the EUR/RON rate continued to depreciate. Thus, investor expectations can be deduced empirically from options prices with the underlying asset the exchange rate of EUR/RON that was traded on the OTC market. Financial and banking institutions use proprietary models for evaluating options, most used being the Vanna-Volga module.

Expectations of the exchange rate volatility from the FX options transactions

Trading exchange rate risk with ATM straddle options. The strategy consists of trading in the same direction a call option and a put option, both with the same exercise price, the same maturity, and the same notional value. The exercise price is the forward rate for the option maturity (i.e. the options are at-the-money, ATM, and the option delta is 50%). The same implicit volatility is used for both options, namely the implicit volatility ATM (σ_{ATM}). Implicit volatility measure ATM (σ_{ATM}), reflects current expectations of options market of future rate volatility.

Trading exchange rate risk with Reversal Risk options. The strategy (long risk reversal) is to buy a call OTM out-of-the-money option and sell a put OTM out-of-the-money option. Both have the same maturity and notional value. For this strategy, the most used options are those with a delta coefficient value of 25% and respectively with a delta coefficient of 10%. The price of this strategy represents the difference between the implicit volatility of the call option and the implicit volatility of the put option, respectively. Thus, 25 delta the Reversal Risk price is:

$RR\ 25\Delta = \sigma_{25\Delta call} - \sigma_{25\Delta put}$ [1] and $RR\ 10\Delta = \sigma_{10\Delta call} - \sigma_{10\Delta put}$ [2]

The reversal risk price reflects the expectations of the future evolution of the exchange rate. Thus, a positive risk reversal price reflects that a call option is more expensive than a put option, i.e. the demand for calls (anticipations of an increase in the price of the underlying asset) is higher than the demand for put options (anticipations of a decrease in the price of the underlying asset). That is, expectations of an increase in the underlying asset are higher than those of a reduction in the price of the underlying asset. In the case of the EUR/RON exchange rate, a positive risk reversal implies market expectations of an increase in the EUR/RON exchange rate, i.e. of a depreciation of the RON. A negative risk reversal price implies the opposite. Risk reversal of 25 delta refers to the body of probability distribution - expectations about normal market conditions, while risk reversal of 10 delta refers to the tails of a probability distribution, that is, expectations of extreme market volatility regime.

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Trading with Butterfly strategy. It consists of buying a straddle option and selling a strangle type. Strangle is a strategy that involves trading in the same direction as a call option and a put-out-of-the-money option. Similar to risk reversal the straddle strategy is 25 delta and 10 delta. Consecutively, the Butterfly strategy is for 25 delta and 10 delta. Price of Butterfly 25 delta: $2\sigma_{ATM} - (\sigma_{25\Delta call} + \sigma_{25\Delta put})$ [3], $\sigma_{ATM} - \frac{\sigma_{25\Delta call} + \sigma_{25\Delta put}}{2}$ [4], price of a Butterfly 10 delta, $2\sigma_{ATM} - (\sigma_{10\Delta call} + \sigma_{10\Delta put})$ [5] $\sigma_{ATM} - \frac{\sigma_{10\Delta call} + \sigma_{10\Delta put}}{2}$ [6]. The price of σ_{ATM} is derived from the 3 strategies results, two equations with two unknowns, $\sigma_{25\Delta call}$ and $\sigma_{25\Delta put}$ and another two equations with two unknowns, $\sigma_{10\Delta call}$ and $\sigma_{10\Delta put}$. Solving the system of equations results in the implicit volatility values for ATM, 25 and 10 delta call and put options – 5 points of the volatility smile. F graph points are determined by interpolation. For that, the most widely used procedure is a GARCH model (Generalized Autoregressive Conditional Heteroskedasticity). A GARCH model consists of two equations that are conditioned by each other: mean evolution (first equation), and variance evolution (second equation). According to the second equation, the variance at a given time depends on previous variance(s) and recent evolution(s) of market yields (from new market information). Therefore, volatility is variable and depends on two factors, namely the long-term volatility and the new information that enters the market. Historical volatilities, implicit and those calculated by GARCH models, at 3 (most liquid) and 12 months' maturity, from Bloomberg are presented in fig.3, 4 below. According to Figures 3 and 4 charts, the implicit volatility increased substantially for the first quarter of 2009, reaching values of 30% concomitant with the maximum of the EUR/RON exchange rate. In the presented graphs, GARCH volatility followed the historical volatility pattern, but it also showed an increase in exchange rate volatility both during the 2008-2009 economic and forex crisis and during the Greek sovereign debt crunch. Thus, we concluded that the expectations for a significant depreciation of the RON are also highlighted by the evolution of the 25 delta and 10 delta risk reversal indicators of EUR/RON exchange rate for maturities of 3M and 12M, in figure 5 for risk reversals 25, in figure 6 for 10 delta, from Bloomberg data.
Thus, between December 2008 and April 2009, in the case of the 25 delta risk

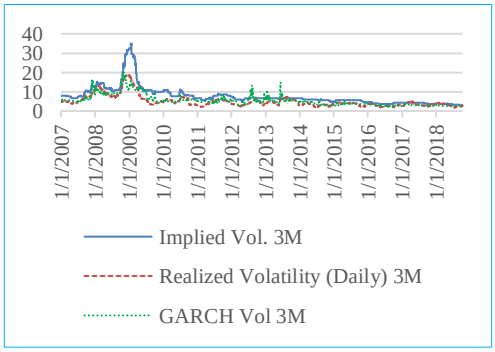

Fig. 3. EUR/RON 3M Volatility
Source: Bloomberg

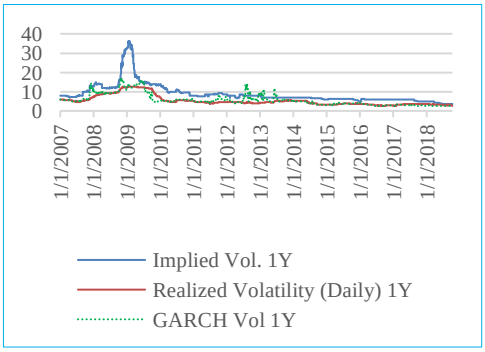

Fig. 4. EUR/RON 12M Volatility
Source: Bloomberg

reversal indicator, both 3M and 12M maturities were valued 10 percentage points.

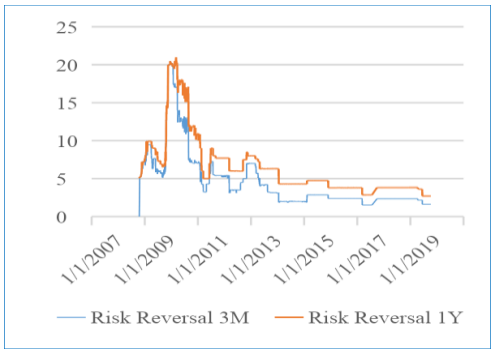

Fig. 5. Risk reversals 25 delta
Source: Bloomberg

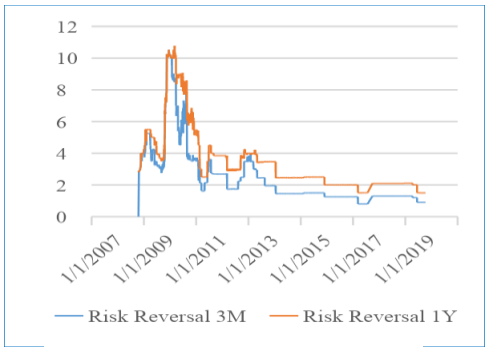

Fig. 6. Risk reversals 10 delta
Source: Bloomberg

Based on our study results, we concluded that the implicit volatility of the call options (depreciation expectations of the RON) was at least 10 percentage points higher than the implicit volatility of the put options. Further, we noted that the situation was even more dramatic in the case of the 10 delta Risk Reversal indicator, a market gauge that can be interpreted as showing the anticipation of events placed on the tail of the probability distribution (extreme). It recorded values of 20%, which means that the implicit volatility of the call options (depreciation expectations of the RON) was 20 percentage points higher than the implicit volatility of the put options.

Other indicators in the ratio of uncovered interest rate parity are money market interest rates (figure 7, with money interest rates for 3M and 12M) and Ron implicit interest rates (figure 8, with 1W, 3M, and 12M). Figures are sourced from Bloomberg data.

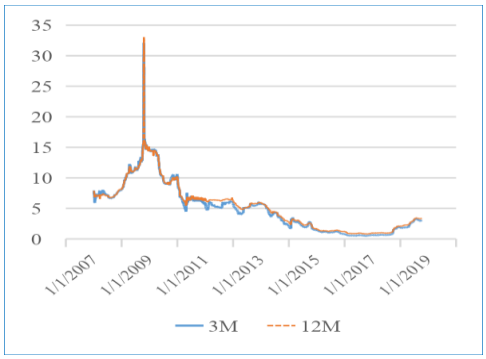

Figure 7. Ron interest, 3M, 12 M
Source: Bloomberg

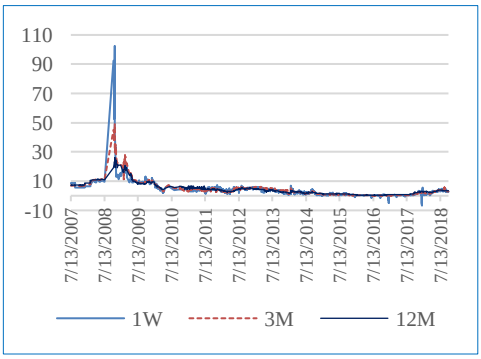

Figure 8. Ron implicit interest
Source: Bloomberg

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5. The ratio of the exchange rate to the inflation rate during economic crises

We show with our research that predominantly during the financial crisis but also subsequently, alongside this exchange rate pass-through phenomena we additionally observed a certain de-correlation between the evolution of the exchange rate and the inflation rate. The impact of the evolution of the exchange rate on the inflation rate is called the phenomenon of exchange rate pass-through. To investigate the mechanics behind this exchange rate pass-through evolution, we proposed two models of estimation based on the panel database. Our research inquired with the economic data from two estimation periods, January 2000 - June 2007 (pre-crisis) and June 2007 - March 2018, respectively. We researched the regional context and analyzed other CEE countries: Romania, Czech Republic, Hungary, and Poland. For our econometric modeling, we considered the inflation rate (CPI) as the dependent variable and we narrowed the panel of the independent variables to the inflation in the euro area (HCPI), the inflation rate in the previous month, and the evolution of the exchange rate in the previous month (tables 3, 4).

Table 3. Model 1, Ratio of the exchange rate to inflation, panel data

Dependent Variable: DLOG(CPI?)
Method: Pooled Least Squares
Sample: 2000M01 2007M06
Included observations: 90
Cross-sections included: 4
Total pool (unbalanced) observations: 358

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001387	0.000407	3.404111	0.0007
DLOG(CPI_EZ(-1))	0.607283	0.103713	5.855404	0.0000
_CZ--DLOG(ER_CZ(-1))	-0.033231	0.049623	-0.669674	0.5035
_HU--DLOG(ER_HU(-1))	-0.000578	0.036305	-0.015920	0.9873
_PL--DLOG(ER_PL(-1))	-0.016069	0.025780	-0.623322	0.5335
_RO--DLOG(ER_RO(-1))	0.101197	0.029728	3.404105	0.0007
_CZ--DLOG(CPI_CZ(-1))	0.120420	0.103957	1.158371	0.2475
_HU--DLOG(CPI_HU(-1))	0.401438	0.083096	4.831015	0.0000
_PL--DLOG(CPI_PL(-1))	0.203079	0.125885	1.613206	0.1076
_RO--DLOG(CPI_RO(-1))	0.661547	0.045904	14.41158	0.0000

R-squared	0.529153	Mean dependent var	0.005452
Adjusted R-squared	0.516976	S.D. dependent var	0.007548
S.E. of regression	0.005246	Akaike info criterion	-7.635208
Sum squared resid	0.009577	Schwarz criterion	-7.526814
Log-likelihood	1376.702	Hannan-Quinn criter.	-7.592100
F-statistic	43.45487	Durbin-Watson stat	2.127370
Prob(F-statistic)	0.000000		

Source: Eviews results for our Model 1, Exchange rate to inflation ratio, panel data

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This argument of research is explained by some Balassa-Samuelson hypotheses:
(1) Presence of unrestrained capital mobility within the two sectors of the economy and between countries, which implies that interest rate is an exogenous variable;
(2) The PPP model is verified only on the tradable goods sector. A key determinant of the exchange rate is the level of prices of tradable goods in country and abroad;
(3) The labor market is highly competitive and human capital is sufficiently mobile between the two economic sectors. That leads to the equalization of wages between the tradables and the non-tradables sector. A wage shock in one sector is also transmitted in the other sector. Under these conditions, faster productivity growth in the tradables sector than in the non-tradables sector leads to higher wages in the first sector. Due to employee mobility, wages in the non-tradables sector will tend to equal those in the tradables sector, leading to increased production costs and thus in the price of non-tradables. The wage increase was not determined by productivity growth, but by administrative measures.

Table 4. Model 2, Ratio of the exchange rate to the inflation rate, panel data

Dependent Variable: DLOG(CPI?)
Method: Pooled Least Squares
Sample (adjusted): 2007M06 2018M03
Included observations: 130 after adjustments
Cross-sections included: 4
Total pool (unbalanced) obs 519:

Variable	Coeff	Std. Error	t-Statistic	Prob.
C	0.001200	0.000207	5.793787	0.0000
DLOG(CPI_EZ(-1))	0.216167	0.037067	5.831856	0.0000
_CZ--DLOG(ER_CZ(-1))	0.035691	0.026483	1.347682	0.1784
_HU--DLOG(ER_HU(-1))	0.000821	0.018673	0.043940	0.9650
_PL--DLOG(ER_PL(-1))	0.031417	0.017723	1.772670	0.0769
_RO--DLOG(ER_RO(-1))	0.044345	0.026396	1.680003	0.0936
_CZ--DLOG(CPI_CZ(-1))	0.202391	0.081293	2.489644	0.0131
_HU--DLOG(CPI_HU(-1))	0.314330	0.073398	4.282550	0.0000
_PL--DLOG(CPI_PL(-1))	0.313617	0.100421	3.123010	0.0019
_RO--DLOG(CPI_RO(-1))	0.297737	0.063374	4.698066	0.0000

R-squared	0.156689	Mean dependent var	0.002068
Adjusted R-squared	0.141778	S.D. dependent var	0.004506
S.E. of regression	0.004174	Akaike info criterion	-8.100762
Sum squared resid	0.008868	Schwarz criterion	-8.018837
Log-likelihood	2112.148	Hannan-Quinn criter.	-8.068666
F-statistic	10.50817	Durbin-Watson stat	2.066102
Prob(F-statistic)	0.000000		

Source: Eviews results for our Model 2, Exchange rate to inflation ratio, panel data

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6. Re-visitation of Balassa-Samuelson effect: Romania, 2016 – 2018

The Balassa-Samuelson model is used as an alternative explanation of the long-term purchasing power parity (PPP) exchange rate model. Until recently, the PPP model has been the basis of most international macroeconomic theoretical models. However, according to Balassa (1964) and Samuelson (1964), the exchange rate of developing countries is undervalued compared to that suggested by the theory of purchasing power parity. As a result, during the process of convergence towards the level of economic development of industrialized countries, the exchange rate of developing countries will be appreciated in real terms. We designed our econometric approach for the empirical documentation, with a Vector Error Correction model using the Johansen methodology. Data variables our model used for statistical modeling were: Romania Consumer price index (CPI_RO) and the euro area (CPI_EZ); money market interest rates with a maturity of 3 months (ROBOR 3M and EURIBOR 3M respectively); EUR / RON exchange rate (ER_RO); average net salary in Romania (WAGEN_RO). Data were extracted from official sources: Eurostat, National Bank of Romania, International Monetary Fund, Romanian National the Institute of Statistics. Data was collected for the period: January 2007-March 2018.
The long-term (cointegration) relationships are consumer price index, nominal exchange rate, and the euro area consumer price index; nominal exchange rate, the inflation rate (i.e. real exchange rate) and average net salary; exchange rate and money market interest rates, that is ROBOR 3M and EURIBOR 3M indicators. Cointegration relations are:

Table 5. Model 3 Vector Error Correction, Johansen Methodology

Cointegration Restrictions:
B(1,1)=1, B(1,4)=0, B(1,5)=0, B(1,6)=0, B(1,7)=0, B(2,1)=-1, B(2,2)=0, B(2,3)=1, B(2,4)=0, B(2,5)=0, B(2,7)=0, B(3,1)=0, B(3,2)=0, B(3,3)=1, B(3,6)=0
Maximum iterations (500) reached.
Restrictions identify all cointegrating vectors
LR test for binding restrictions (rank = 3):

Chi-square(6)	17.34660
Probability	0.008090

Cointegrating Eq:	CointEq1	CointEq2	CointEq3
LOG(CPI_RO(-1))	1.000000	-1.000000	0.000000
LOG(CPI_EZ(-1))	-0.092488	0.000000	0.000000
	(0.03921)		
	[-2.35900]		
LOG(ER_RO(-1))	-0.605776	1.000000	1.000000
	(0.02105)		
	[-28.7802]		

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ROBOR3M(-1)	0.000000	0.000000	-0.846232 (0.09598) [-8.81636]
EURIBOR3M(-1)	0.000000	0.000000	0.590760 (0.27739) [2.12971]
LOG(WAGEN_RO_D11(-1))	0.000000	-0.085365 (0.00786) [-0.8669]	0.000000
@TREND(99M01)	0.000000	0.000000	-0.002118 (0.00020) [-10.3556]
C	-3.202247	3.701749	-1.056279

Source: VEC Johansen methodology for Model 3 Cointegration results

Interpreting the results of the research from a practical perspective

Before the financial crisis, both the impact of exchange rate fluctuations on inflation and that of inflationary expectations (adaptive expectations) were the most evident in the case of Romania. When compared to the other countries we introduced in the data panel the analysis, 60% proportion of depreciation of leu (RON) is transferred on the inflation. An increase in salaries leads to a depreciation of leu, 9% of the salary increase is transferred to the depreciation of the real exchange rate of the currency. In the long run, almost counterintuitively, accounting for the uncovered parity of the interest rate, the market interest rate in local RON (leu) is positively correlated with the market quoted EUR / RON exchange rate. This correlation explains that for Romania, an emerging country (having as rating in the analyzed period, the last notch of investment-grade, under observations), both the exchange rate and interest rates have attached substantial risk premiums, i.e. when premium increases, both interest on leu will increase and the leu will depreciate.

To explain this effect, this relation by impulse-response has conclusions:

- The inflation rate has a significant adaptive expectations component;
- A high inflation rate turns into inflationary expectations;
- An exchange rate shock significantly affects the inflation rate;
- Monetary policy is effective in reducing the inflation rate, in 9-12 months;
- A wage increase has an effect on inflation with a lag of 5-6 months;
- Also, the exchange rate has a component of adaptive anticipations;
- A money market interest rate increase has the effect of appreciating the leu, so the uncovered interest rate parity is a valid short-term correlation.

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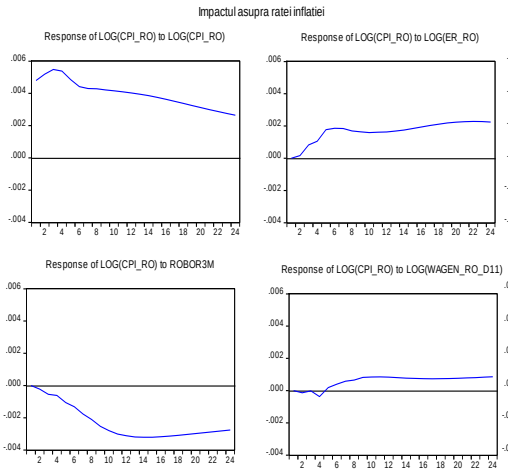

Fig. 8. Impact on inflation

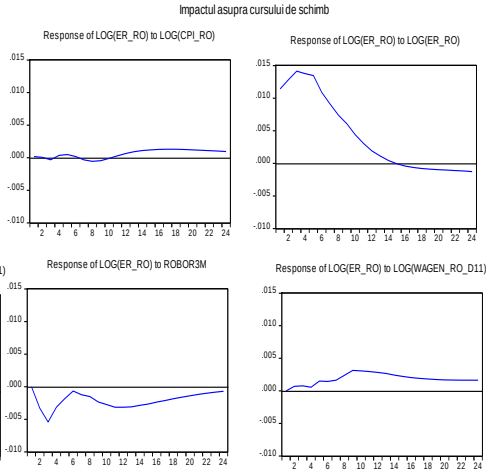

Fig 9. Impact on the exchange rate

We concluded that implicit volatility that accompanies currency crisis then can spread to the tradable goods and services sector. In turn, this effect can stimulate a revived economic growth by correcting the temporarily overvalued currency or by lowering the exchange rate at a more stimulating level for cheaper exports of tradeable goods and services. However, the balance of payments crisis can lead to either a pronounced depreciation or to an increase in external debt financing costs.

Both the inflation rate and the exchange rate have a significant component of adaptive expectations, that is a high inflation rate or a depreciated exchange rate results in inflationary expectations. In short term, any shock on the exchange rate has a direct influence on the inflation rate.

Hence, in Romania, in the time-frame we analyzed, a Balassa-Samuelson (in reverse) effect was strongly evident, as we assume that there is free movement of professionals on the labor market: an administrative increase in public (non-tradeables) wages led to an overall rise in salaries across the whole economy. This increase in wages is not linked to advances in productivity. Hence: there will be a consequential increase in demand. The rise in demand is solved via the increase in prices (inflation) and imports (as the local supply cannot respond to the sudden increase in demand). Higher imports and higher production costs for the tradeables lead to deterioration of the trade balance (and hence the current account deficit). Higher inflation and a higher deficit of current account then lead to currency depreciation.

We also assessed the consequences of a currency crisis on the real economy and we concluded that currency crises have high tangible negative costs for the economy. In an economic crisis and its accompanying foreign currency crunch, the investors increased risk aversion leads to pandemic volatility in

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financial markets. As the country's risk premium includes both interest rates and exchange rate expectations, and increased risk leads to higher interest rates and lower local currency.

Thus, currency crises can have long-term negative effects, preponderantly evident in a developing economy. However, countries that are more open to trade are likely to experience less dramatic declines in real economic growth and much faster recovery from an economic and its accompanying currency crisis. Increasing risk aversion leads to higher volatility in financial markets, as a country's risk premium is manifested in both interest and exchange rates. Risk premium increase leads to higher interest rates and currency depreciation. However, according to Balassa (1964) and Samuelson (1964), the exchange rate of developing countries is undervalued compared to that suggested by the theory of PPP. As a result, with the process of convergence towards the level of economic development of industrialized countries, the developing countries' exchange rate will be appreciated in real terms.

The article assessed through analytical models the causes of currency and associated crises and presents measures to qualify the incidence of crises in several developing European economies. We reckon that, especially after the pandemic, the economic research ability to predict the timing and magnitude of crises is limited by the complex interactions between economic fundamentals, public expectations, and governments and EU policy in terms of public benefits and wages for non-tradeables.

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