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STRATEGIES TO ACHIEVE FOREIGN EXCHANGE STABILITY NEARBY THE EUROZONE

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Abstract

Using a panel vector error correction (VAR) model, we assess foreign exchange rate stability in the Central-East European and Balkan countries. Literature defines foreign exchange stability within the Mundell-Fleming dilemma. We show that currency stability is not only reinforced by the monetary policy but also by inflation, workers' remittances and IMF support programs. We also find evidence that the balance sheet structure difference has similar impact like the conventional uncovered interest parity (UIP). Thus, this paper makes a new contribution to the debate of central bank instruments' indirect impact on exchange rate stability, while highlighting the fragility of open and small economies.

Keywords: *Foreign Exchange Rate, Small and Open Economies, Unconventional Monetary Policy, Workers' Remittances.*

INTRODUCTION

For many open and small emerging economies, inflation stability is often achieved through foreign exchange stability, by following a fixed or stabilized (like crawling peg, upper ceiling etc.) regimes. Economic activities and price formation in these economies are more prone to currency shocks due to their foreign trade and capital openness. Similarly, capital import in key currencies are still relevant for them,[1] even their deeper integration into the globalized value chain reduced some of the foreign exchange rate's impact on trade balance.[2] While euro adaption would solve this exposure, most of the CEE and Balkan Member States kept their national currencies, while only Montenegro eurolised outside the EU. Fixed and

[1] Hassan, Tarek A., and Tony Zhang. "The Economics of Currency Risk." Annual Review of Economics 13 (2021): 281-307. https://doi.org/10.1146/annurev-economics-092220-103354

[2] Fišera, Boris, and Roman Horvath. "Are Exchange Rates Less Important for Trade in a More Globalized World? Evidence for the New EU Members." Economic Systems 46, no. 1 (2022): 100868.

stabilized regimes were introduced in Bulgaria, Croatia, North-Macedonia and Serbia, while Albania, Czechia, Hungary, Poland, Romania followed a "dirty" floating regime with temporary adjustments due to "fear of floating" phenomenon.

While conventional foreign exchange theory (like the international Fisher-rule) suggests the use of sovereign premium and the inflation differential to guide foreign exchange indirectly, the introduction of unconventional monetary instruments after 2008 complicated currency valuation. The country- and time-specific allocation of long-term loans and temporary accumulations of bonds in the central bank's balance sheet, therefore this paper includes the ratio of loans and bonds to the foreign exchange reserves on the asset side, or $\frac{L+S}{FX}_{i,t}$ (central bank balance sheet structure), following Mészáros and Kiss.[3]

Another literature puzzle open and small economies is the phenomenon if worker's remittances, as there is a significant flow in the labor force from the sample countries towards the older EU Member States, which can generate an additional channel of capital inflow for them.

The paper is structured in the following way: we are introducing the theoretical model behind FX rate stability, and remittances in the Theoretical Background section. Then in the data and methods section, the sample of nine currencies[4] are introduced with a sampling period from 2016 June until 2023 December to represent the consolidation period after the introduction of the quantitative easing at the ECB and the recovery from the Eurozone's sovereign crisis in the first half of the 2010s, with the description of the panel VECM model as well. The paper then ends with the results and the concluding remarks.

Materials and Methods

FX regime

Exchange rate stability (ERS) ratio (1) indicates higher stability under higher values[5] and estimated from on the conditional standard deviation (σ) of the underlying logarithmic change of the exchange rate (S).

$$ERS_{i,t} = \frac{0.01}{0.01+\sigma_{\Delta lnS_{i,\tau_k:\tau_n}}} \quad (1)$$

Since this paper uses monthly data, the conditional volatility (σ) is estimated with a GJR-GARCH(1,1,1) model with skewed Student-T distributed error terms[6], from daily S, from the first τ_k trading day of the month until the last τ_n one.

FX rate stability can be achieved through administratively with an exchange rate anchor monetary framework under a fixed-like regime (namely currency board, crawl-like and stabilized arrangements as well as conventional peg). Otherwise, it will be used to absorb external shocks as a buffer under a floating regime, where the central bank follows an inflation targeting (IT) monetary framework.[7] The key monetary instruments for exchange rate stability will be the direct intervention from the international reserves of the central bank (using its balance sheet), or indirectly by using the key policy rate through the alteration of overall funding conditions (therefore unconventional long-term lending and asset accumulation programs

[3] Mészáros, Mercédesz, and Gábor Dávid Kiss. "Spillover Effects of Unconventional Monetary Policy on Capital Markets in the Shadow of the Eurozone: A Sample of Non-Eurozone Countries." Review of Economic Perspectives 20, no. 2 (2020): 171-195.

[4] For Hungarian, Czech, Polish, Romanian, Croatian, Bulgarian, Serbian, Albanian and North-Macedonian currencies.

[5] Aizenman, Joshua, Menzie D. Chinn, and Hiro Ito. "The Emerging Global Financial Architecture: Tracing and Evaluating New Patterns of the Trilemma Configuration." Journal of International Money and Finance 29, no. 4 (2010): 615-641. https://doi.org/10.1016/j.jimonfin.2010.01.005.

[6] Three GARCH models were compared, by looking for the lowest Bayesian Information Criteria (BIC): a GJR-GARCH(1,1,1) model with normal and one with skewed Student-T distributions, and one with APARCH(1,1,1), but the second model was selected in all the cases by the BIC minimum.

[7] Magas, István. "A pénzügyi alkalmazkodás kis, nyitott gazdaságokban a 'lehetetlen szentháromság' trilemma tükrében." Hitelintézeti Szemle 17, no. 1 (2018): 5–33. https://doi.org/10.25201/HSZ.17.1.533.

should have similar effects) to motivate the in- and outflow of foreign capital.[8] A hard peg, like a currency board arrangement, where the fixed exchange rate is combined with domestic currency issuance only against foreign exchange reserves, practically giving up the monetary control and the lender-of-last-resort functions of the central bank. Soft pegs can be conventional pegs, stabilized and crawling arrangements. The currency is allowed to fluctuate within a 2% band for 6 months under a stabilized arrangement, while crawling peg is a more official commitment with an emphasized inflation tracking.[9]

The sample economies, which are conducting majority of their trade with the Eurozone, followed two approaches in their FX frameworks: one group followed early financial account liberalization and the introduction of floating regimes and IT framework at the end of the 1990s (Czechia after 1997, Hungary after 2001, Poland after 2000 or Albania during the 1990s) (Stavarek 2009), while others maintained their hard pegs (like the Bulgarian currency board). Meanwhile there is a set of countries which switched back from managed floating to stabilized or even crawl-like arrangements during the second half of the 2010s (like Romania in 2018, Croatia in 2008, Serbia in 2016). Czech Koruna had a unique problem of excessive appreciation from the sample, meaning an upper ceiling had to be introduced between 2013 and 2017. Meanwhile North Macedonia followed a stabilized arrangement, which provided more degree of freedom for its monetary policy than a conventional peg.[10]

Remittances

Remittances, the financial transfers sent by emigrants to their countries of origin, have become crucial external financing mechanism for developing economies over the past decade.[11] With global flows reaching an estimated $800 billion in 2022, remittances have now surpassed official development assistance by threefold.[12] Although the average global remittance-to-GDP ratio stands at around 5%, regional disparities are striking. Countries such as Tajikistan report remittances constituting 50% of GDP, while other economies like Saudi Arabia see less than 1%.

The factors driving remittance flows are anchored in migration trends, economic conditions across both sending and receiving countries, and policy frameworks, particularly around immigration and financial services. The rise of digital financial platforms has reduced transaction costs and boosted remittance transfers, but regional disparities persist. For example, remittance revenues in Latin America and the Caribbean reached $155 billion in 2023, with a 13.2% increase in Central America alone. On the other hand, East Asia and the Pacific experienced more moderate growth.[13] According to the World Bank,[14] remittances to the Western Balkans increased by 10% from 2021 to 2022, reaching almost $13 billion. Two-thirds of all remittances, both in absolute terms and as a percentage of regional remittance flows, come from Serbia and Bosnia and Herzegovina. With remittances accounting for around 17% of its economy, Kosovo has the highest remittance-to-GDP ratio, followed by Bosnia with roughly 13%. Although remittances are substantial in scale and importance, the literature underscores the multidimensional impact of remittances. A broad body of evidence indicates that remittances act as a financial cushion for recipient households,

[8] Frankel, Jeffrey A. "Monetary Policy in Emerging Markets." In Handbook of Monetary Economics, edited by Benjamin Friedman and Michael Woodford, 1439–1499. Vol. 3, No. 1. North Holland: Elsevier, 2011.
[9] IMF. Revised Classification System, 2008—Definitions of Categories. International Monetary Fund, 2008. https://www.elibrary-areaer.imf.org/Documents/Exchange%20Rate%20Classification%20Methodology/ExchangeRateClassificationSystemDefinitions_2008.pdf.
[10] IMF. Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). 1999-2022. International Monetary Fund. https://www.elibrary-areaer.imf.org/Pages/Home.aspx.
[11] Foday, Joof, and Touray Sheriff. "The Impact of Remittance Flow on Real Effective Exchange Rate: Empirical Evidence from The Gambia." MPRA Paper No. 106045, University Library of Munich, Germany, 2021.
[12] World Bank. "Remittances Remain Resilient but Likely to Slow." Last modified June 13, 2023. https://www.worldbank.org/en/news/press-release/2023/06/13/remittances-remain-resilient-likely-to-slow.
[13] Ibid
[14] Ibid

smoothing consumption and alleviating poverty, particularly during economic shocks.[15] However, concerns have emerged regarding their negative macroeconomic consequences, notably through the Dutch Disease mechanism. Remittance inflows can lead to real exchange rate (RER) appreciation, which reduces total factor productivity and erodes export competitiveness.[16] Additionally, these inflows can trigger inflationary pressures, particularly when consumption increases faster than domestic supply capacities. This contributes to upward pressure on prices, intensifying inflation and contributing to short-term currency instability.

From a theoretical standpoint, remittances influence aggregate demand across both tradable and non-tradable sectors. The prices of tradable goods are externally determined by global markets, while non-tradables, such as services and locally consumed goods, are shaped by local market conditions. As recipient households tend to spend remittances primarily on non-tradable goods, the relative price of these goods tends to rise, consequently driving up the RER and placing pressure on currency stability.[17] While this increase strengthens domestic purchasing power, it simultaneously undermines export competitiveness by rendering domestically produced goods more expensive in foreign markets i.e., resulting in short-term exchange rate instability.

Moreover, remittances also affect labor market dynamics by raising reservation wages—the minimum wage workers are willing to accept—which can lead to a reallocation of labor from tradable to non-tradable sectors.[18] As wages rise in sectors that depend on lower-cost labor, such as manufacturing and agriculture, production costs increase, contributing to further erosion of export competitiveness. This can result in short-term volatility in both the labor market and the broader economy, magnifying instability in the currency.

Furthermore, from the perspective of the Mundell-Fleming model, the inflow of surplus liquidity brought on by remittance movements presents serious obstacles to exchange rate stability.[19] When this liquidity fails to be channelled into productive investments, it may lead to inflationary pressures. This effect is particularly pronounced in sectors where demand often surpasses supply, driving up prices at rates significantly higher than overall inflation.[20] Such inflationary pressures complicate monetary authorities' efforts to manage inflation while maintaining exchange rate stability. This situation creates a feedback loop: rising inflation can precipitate real exchange rate depreciation, which further undermines the competitiveness of domestic industries and intensifies structural vulnerabilities within these economies.

Remittances in countries like Hungary, Poland, and the Czech Republic contribute to foreign currency inflows, helping to alleviate external imbalances and reduce exchange rate instability. According to Barrell et al.,[21] the inflow of remittances in these countries supports currency stabilization by compensating trade deficits, making it easier for central banks to manage exchange rate pressures. In

[15] Page, John, and Richard Adams. "International Migration, Remittances and Poverty in Developing Countries." World Bank Policy Research Working Paper No. 3179, 2003. See also Yoshino, Naoyuki, Farhad Taghizadeh-Hesary, and Miyu Otsuka. "International Remittances and Poverty Reduction: Evidence from Asian Developing Countries." ADBI Working Papers 759, Asian Development Bank Institute, 2017.

[16] See Chami, Ralph, Adolfo Barajas, Connel Fillenkamp, Michael Gapen, and Peter Montiel. "Do Workers' Remittances Promote Economic Growth?" IMF Working Paper WP/09/153, 2009. See also Acosta, Pablo, Emmanuel Lartey, and Federico Mandelman. "Remittances and the Dutch Disease." Journal of International Economics 79, no. 1 (2009): 102-116.

[17] Chami, Ibid.

[18] Alcaraz, Carlo, Daniel Chiquiar, and Alejandrina Salcedo. "Remittances, Schooling, and Child Labor in Mexico." Journal of Development Economics 97, no. 1 (2012): 156-165.

[19] Mundell, Robert.A "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates." Canadian Journal of Economics and Political Science 29, no. 4 (1963): 475-485.

[20] Roy, Ripon, and Md. Mokhlesur Rahman. "An Empirical Analysis of Remittance–Inflation Relationship in Bangladesh: Post-Floating Exchange Rate Scenario." MPRA Paper No. 55190, University Library of Munich, Germany, 2014.

[21] Barrell, Ray, Dawn Holland, and Nigel Pain. "Fiscal Policy, EMU, and the Stability and Growth Pact in Hungary, Poland, and the Czech Republic." Economic Modelling 24, no. 5 (2007): 812-821.

Poland, according to Mickiewicz & Mycielska,[22] remittances have been shown to stabilize the zloty during periods of financial uncertainty.

Remittances play an even more pronounced role in the Western Balkan countries—such as North Macedonia, Serbia, and Bosnia and Herzegovina. Given their higher dependency on foreign transfers, directly influencing the stability of local currencies. According to Petreski [23] remittances in North Macedonia have helped stabilize the denar by increasing foreign reserves and mitigating the effects of trade deficits. Similarly, in Serbia, remittance inflows have acted as a buffer against currency depreciation, contributing to long-term exchange rate stability.[24]

In general, the effects of the remittances depends on the exchange rate regime in place. In flexible exchange rate regimes, remittance inflows increase the demand for domestic currency, leading to nominal exchange rate appreciation. This scenario exacerbates the Dutch Disease by making exports less competitive. Conversely, in fixed exchange rate regimes, remittances typically accumulate as foreign reserves, enhancing liquidity in the financial sector. This added liquidity may lead to inflationary pressures across both tradable and non-tradable sectors if the increase in money supply is not adequately managed.

Finally, the stability of the exchange rate becomes a critical consideration in managing remittance flows. In countries with volatile exchange rate environments, substantial remittance inflows can create uncertainty, adversely affecting investment decisions and economic planning. Exchange rate instability can deter foreign investment and impede economic growth by creating an unpredictable business climate. As remittance inflows continue to influence the domestic economy, their mismanagement can lead to further destabilization and a gradual erosion of the domestic market's competitiveness. Empirical evidence across various regions corroborates these theoretical insights, with studies demonstrating inflationary pressures and RER appreciation linked to remittance inflows.[25] Furthermore, analyses of cases such as El Salvador show how remittances redirect resources from tradable to non-tradable sectors, contributing to wage pressures and exchange rate appreciation.[26] Other notable works documenting the existence and effects of Dutch Disease include Dorantes and Pozo[27] and Chowdhury and Rabi.[28]

Literature for the Western Balkans estimates that 50% of emigrant workers remit a portion of their earnings, with remittances contributing as much as 16% of GDP in certain countries (OECD, 2021). While micro-level studies dominate the discourse, much of the research points to remittances accounting for nearly half of household income.[29] This influx of funds is largely used for daily expenses, which in turn has been

[22] Mickiewicz, Tomasz, and Dorota Mycielska. "Remittances and the Role of Small and Medium-Sized Enterprises in Development: Poland." Small Business Economics 37, no. 2 (2010): 279-293.

[23] Petreski, Marjan. "The Impact of Remittances on Economic Growth and Poverty Reduction in the Western Balkans: A Macroeconomic Perspective." Journal of Economic Integration 33, no. 1 (2018): 1120-1141. See also Petreski, Blagica, Despina Tumanoska, Jorge Davalos, and Marjan Petreski. "New Light on the Remittances-Poverty-Health Nexus in Macedonia." International Migration 56, no. 5 (2018): 26-41.

[24] Stratan, Alexandru, Mihai Chistruga, and Vladislav Clipa. "The Impact of Remittances on Economic Growth: The Case of Serbia." Eastern European Economics 53, no. 6 (2015): 456-471.

[25] Tung, Le Thanh, Pham Thi Minh Ly, Pham Thi Quynh Nhu, Pham Tien Thanh, Le Tuan Anh, Tran Thi Phi Phung. "The Impact of Remittance Inflows on Inflation: Evidence in Asian and the Pacific Developing Countries." Journal of Applied Economic Sciences 10, no. 7 (2015): 1076-1079.

[26] Acosta, Pablo, Emmanuel Lartey, and Federico Mandelman. "Remittances and the Dutch Disease." Journal of International Economics 79, no. 1 (2009): 102-116.

[27] Dorantes-Amuedo, Catalina, and Susan Pozo. "Workers' Remittances and the Real Exchange Rate: A Paradox of Gifts." World Development 32, no. 8 (2004): 1407-1417.

[28] Chowdhury Mamta Banu. and Fazle Rabbi. "Workers' Remittances and Real Exchange Rate in Bangladesh: A Cointegration Analysis." Paper presented at the 40th Australian Conference of Economists, Canberra, Australia, July 11-13, 2011.

[29] See Roberts, Bryan, Malgorzata Markiewitz, Marjan Nikolov, and Aleksandar Stojkov. A Study on Determinants and Trends in Remittance Flows in Macedonia. Center for Economic Analyses (CEA) and USAID, 2008. See also Petreski, Marjan, and Branimir Jovanovic, eds. Remittances and Development in the Western Balkans: The Cases of Macedonia, Kosovo and Bosnia-Herzegovina. Scholars' Press, 2013. See further Oruč, Nermin, Ian Jackson, and

linked to reductions in income inequality, improvements in poverty rates, and enhanced health outcomes, especially in North Macedonia.[30] Moreover, in Bosnia and Herzegovina, remittances have been found to positively influence educational attainment among recipient households.[31]

At the broader, macroeconomic level, the existing literature generally endorses the beneficial role of remittances in fostering economic development within the region. Empirical investigations by Meyer and Shera[32] and Topxhiu and Krasniqi[33] lend support to this, though their use of OLS, fixed, and random effects models introduce concerns regarding potential endogeneity, particularly in relation to trade and transaction cost factors. To address these methodological shortcomings, Tanevski and Petreski[34] (mimeo) employ an instrumental variable (IV) approach to control for endogeneity arising from the interplay of underdevelopment, migration, and remittance flows, as well as the altruistic nature of remittances. They find a significant negative effect of remittances on GDP per capita, attributing this to their role as 'social insurance' that discourages labor market participation and hinders long-term productivity.

Yet, no paper for the Western Balkans makes a contribution to the existing literature by examining foreign exchange rate stability Central-East European and Balkan countries through a panel vector error correction (VAR) model grounded in the Mundell-Fleming framework. As such, this study represents a novel effort in exploring this critical aspect including the countries of the Western Balkan.

Theoretical Model

Exchange rate stability reflects on the stability of markets' expectations about internal and external stability factors, but some of the trade or funding related shocks can be absorbed under a floating-regime.[35] A fixed rate regime delegates risk management to the central bank, while floating regimes delegation it to the private sector, with impact on prices and interest rates.[36] This paper investigates, how the differences among domestic and foreign inflation (π), interest rate (r), balance sheet structure ($\frac{L+S}{FX}$) and brain drain (remittances, re) affects foreign exchange stability (2).

A more drastic increase in price levels ($(\pi_{i,t} - \pi_{EUR,t}) > 0$) is often linked to currency depreciation by purchasing power parity hypothesis, especially in the relationship between the Eurozone and a neighboring small and open emerging economy. An inflation targeting monetary policy should react, where key policy rate will transmit to long-term lending conditions and country-specific long-term sovereign spreads ($(r_{i,t} - r_{EUR,t})$). Under quantitative easing (QE) monetary policy, long-term lending and security accumulation programs will have their impact on central banks' balance sheet structure ($\frac{L+S}{FX}$) – with an empirically undecided impact on FX stability. Workers' remittances from Balance of Payments statistics describes an additional, neither debt generating nor corporate investment capital flow.

$$ERS_{i,t} = \omega_i + \beta_1(\pi_{i,t} - \pi_{EUR,t}) + \beta_2 re_{i,t} + \beta_3\left(\frac{L+S}{FX}_{ECB,t} - \frac{L+S}{FX}_{i,t}\right) + \beta_4(r_{i,t} - r_{EUR,t}) + \gamma d_{i,t} + \varepsilon_{i,t} \quad (2)$$

Geoffrey Pugh. "The Effects of Remittances on Education in a Post Conflict Society: Evidence from Bosnia and Herzegovina." Journal of Balkan and Near Eastern Studies 21, no. 1 (2019): 90-103.

[30] Ibid

[31] Ibid

[32] Meyer, Dietmar, and Adela Shera. "The Impact of Remittances on Economic Growth: An Econometric Model." EconomiA 18, no. 2 (2017): 147-155.

[33] Topxhiu, Rahmije Mustafa, and Florentina Xhelili Krasniqi,. "The Relevance of Remittances in Fostering Economic Growth in the West Balkan Countries." Ekonomika 96, no. 2 (2017): 28–42.

[34] Tanevski, Stefan, and Marjan Petreski. "From Diaspora to Development: On Remittances and Economic Growth in the Western Balkans." Mimeo, 2024.

[35] Loc.cit., Magas

[36] Šimáková, Jana, and Daniel Stavárek. "The Effect of the Exchange Rate on Industry-Level Trade." Working Papers in Interdisciplinary Economics and Business Research, 2015. https://www.iivopf.cz/wp-content/uploads/2020/08/WPIEBRS_01_Simakova_Stavarek.pdf. See also Stavárek,. "Assessment of the Exchange Rate Convergence in Euro-Candidate Countries." Amfiteatru Economic Journal 11, no. 25 (2009): 159-180.

We can expect that a relatively higher inflation in the *i*th currency will destabilize ($\beta_1 < 0$), while a higher remittance inflow can indicate more intense brain drain and structural problems in the domestic economy ($\beta_2 < 0$). A more conservative central bank in the usage of its balance sheet should have a more stable currency ($\beta_3 > 0$). Similarly, a sovereign premium should stabilize the exchange rate under uncovered interest parity assumptions ($\beta_4 > 0$), but for emerging open and small economies, the UIP paradox signs an opposite effect ($\beta_4 < 0$).

To indicate structural changes and exogenous shocks in the model, a set of dummy variables and one exogenous variable were used ($d_{i,t}$). To represent slow growing and recession periods in the Eurozone (as the main market and capital investor for sample economies), the European Commission's Business Cycle Clock database was used. To represent the implementation of temporary foreign exchange ceilings, and the occasional exchange rate targeting monetary policies a dummy was assigned, based on the annual reports in the IMF AREAER database was used. One dummy variable represented the extreme changes of the ERS variable, based on that the actual month was smaller than the mean of the mean of the whole sample minus the possible volatility under 95% probability. To highlight the impact of IMF funding, the logarithm of the provided funds were added.

Data

Daily data (Table 1) from 2016 June until 2023 December, for the sample currencies in Euro denomination were used, to estimate the $ERS_{i,t}$, acquired from the Refinitiv Eikon database (as well as the monthly government bond yields). All central bank balance sheet data were collected from their websites, while inflation data was provided by Eurostat. De facto foreign exchange regimes were defined from the IMF AREAER database, while recession periods were defined by the European Commission.

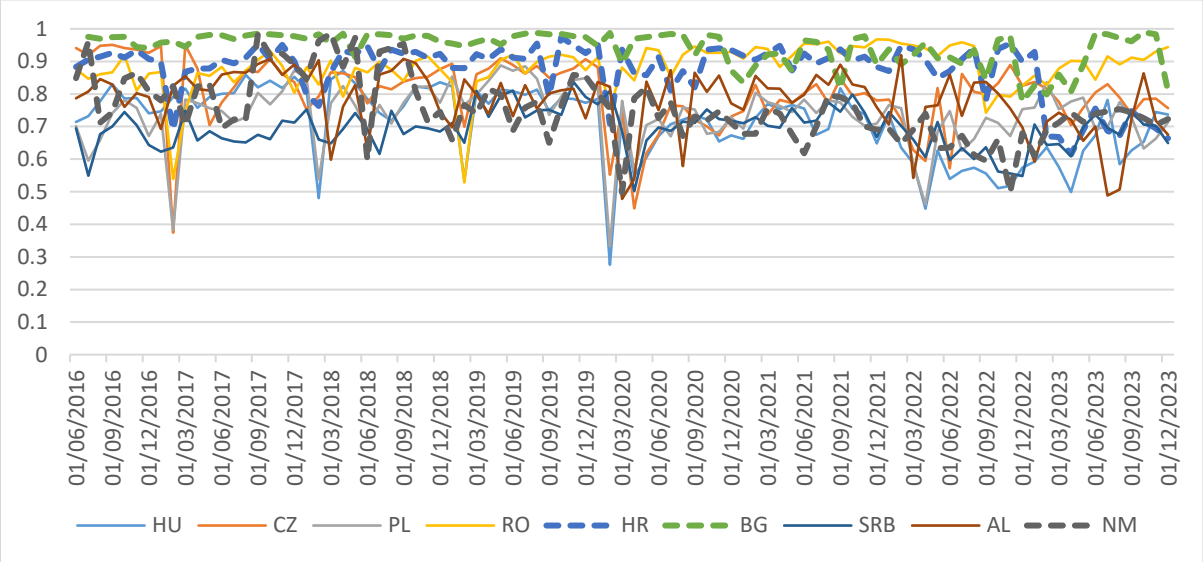
Table 1: Data sources

Variable	Notation	Source
Exchange Rate Stability	$ERS_{i,t}$	authors' estimation based on FX rates from Refinitiv Eikon
Loans (L), securities (S) to foreign exchange reserves (FX) ratio at a central banks	$\frac{L+S}{FX}_{i,t}$	central bank balance sheet data
workers' remittances	$re_{i,t}$	IMF
Inflation (customer price index)	$\pi_{i,t}$	Eurostat
Sovereign spread: 10-year sovereign bond yield of the ith country - DE 10-year sovereign bond yield	$r_{10Y,i,t}$ - $r_{10Y,DE,t}$	Refinitiv Eikon
non-floating foreign exchange regime or direct intervention (1: intervention, the currency is not following floating regime)	$d_{FX,t}$	IMF Annual Report on Exchange Arrangements and Exchange Restrictions
slow growth and recession in the Eurozone (1: recession in the EZ)	$d_{rec,EZ,t}$	European Commission Business Cycle Clock
outliers in the foreign exchange rate data (1: outlier)	$d_{FXM,i,t}$	authors' calculation

Source: author' computation

All sample currencies presented remarkable stability in most of the period of 2016-2023, especially the Bulgarian Leva and Croatian Kuna, where the central banks followed an exchange rate anchor. However, the North-Macedonian central bank showed more flexibility under the combination of exchange rate anchoring under stabilized arrangement. The rest of the currencies, where the central bank follows inflation targeting (IT) framework were less stable, regardless that their regime was floating or stabilized. Romanian Lei was unique in this terms as their central bank combined IT and crawling-like arrangement and it resulted remarkable currency stability. The Serbian central bank followed a similar IT with stabilized policy mixture, but it resulted less currency stability. Meanwhile the floating Czech, Polish and Hungarian currencies reacted more on the external shock with temporary loss of stability to absorb some of their magnitude.

Figure 1: Exchange rate stability in the sample countries



Source: authors' estimation, Matlab 2023b

Panel VECM

We employed the panel vector error correction model (panel VECM) to study endogenous relations among the cointegrated variables and showed the reaction of the Eurozone's sovereign rate to the selected macroeconomic and monetary variables by utilizing the accumulated impulse response functions and variance decomposition.

The variables are cointegrated, and there is a long-term relationship between them. Conversely, the endogenous relationship is present, and the panel VECM (4) can provide efficient estimations for the model.[37] The panel unit root tests revealed the I(1) nature for some of the input variables. The panel cointegration test revealed the existence of a long-term relationship among them. For the panel data with M variables, the following N cross-sectional units (countries; I = 1,…, N) over T periods (quarter of years; t = 1,…,k,…T) were used:

$$\Delta Y_{i,t} = \Phi D_{i,t} + \Pi Y_{i,t-1} + \sum_{t=1}^{p} \Gamma_{p-1} \Delta Y_{i,t-p+1} + \varepsilon_{i,t}. \quad (4)$$

Here, the long-run impact matrix (Π) captures adjustments toward the long-run equilibrium and contains the cointegrating relationships such as $\Pi = \Pi_1 + \cdots + \Pi_p - I_n$. Cointegrating matrix (Π) defines the multiple ways in the combination of cointegrating series. An unobserved error correction term (I_n) provides information for the long-term equilibrium level. $D_{i,t}$ contains all regressors associated with

[37] Holtz-Eakin, Douglas, Whitney Newey, and Harvey S. Rosen. "Estimating Vector Autoregressions with Panel Data." Econometrica 56, no. 6 (1988): 1371-1395. https://www.jstor.org/stable/1913103.

deterministic terms $D_{i,t} = u_{i,0} + u_{i,1}t$. Short-run deviations from the equilibrium are captured in the Γ_k short-run impact matrix. Only rank r (r < M) linear combinations are cointegrated, and k is the optimal lag length determined by the Bayesian information criterion. A stable VECM model consists of l endogenous variable and r cointegrating vectors, and the companion matrix (of the inverse roots of the characteristic AR polynomial) will contain l-r unit moduli.[38]

Effects of a unit shock on a given model variable can be estimated using impulse response functions. Moreover, variance decomposition can be used to determine the shocks, of which variables are influential in the short- and long-term evolution of certain variables by estimating the proportion of the impact of uncertainty of variable *i* on the *j*th shock after period *h*.

To identify, how the shocks from the theoretical model are affecting the outcome variable, this paper introduces Table 2 as an identity-matrix. In this hierarchical order, the market volatility index or the dollar-scarcity indicator has a widespread effect, while the country-specific relative debt-size, the redenomination risk and the inflation are affecting the monetary conditions and therefore the sovereign spread in the end.

Table 2: Identity-matrix structure

		shocks				
		$(\pi_{i,t} - \pi_{EUR,t})$	$(re_{i,t})$	$\left(\frac{L+S}{FX}_{ECB,t} - \frac{L+S}{FX}_{i,t}\right)$	$(r_{i,t} - r_{EUR,t})$	$ERS_{i,t}$
variable	$(\pi_{i,t} - \pi_{EUR,t})$	f11	0	0	0	0
	$(re_{i,t})$	f21	f22	0	0	0
	$\left(\frac{L+S}{FX}_{ECB,t} - \frac{L+S}{FX}_{i,t}\right)$	f31	f32	f33	0	0
	$(r_{i,t} - r_{EUR,t})$	f41	f42	f43	f44	0
	$ERS_{i,t}$	f51	f52	f53	f54	f55

Source: authors' edition

RESULTS

All out input data were an I(1) process under the assumption of an individual unit root process (Im, Pesaran and Shin test), what is suitable for the panel VECM model (Table 3). Meanwhile the Johansen panel cointegration test highlighted the presence of 2 cointegrating equation(s) at the 0.05 level, which was used during the estimation of the model (see Appendix 1). Its VEC specification imposed 3 unit roots, which fits the assumptions as for 5 input variables we have 2 cointegrations and 3 unit roots in the polynomials.

[38] See Ortegón, Baron, and Brayan Alexander. "Cointegration of Economic Growth and External Balance in Colombia: 1963-2016." MPRA Paper No. 87974, University Library of Munich, Germany, 2018. https://mpra.ub.uni-muenchen.de/87974/. See also Lütkepohl, Helmut, and Markus Krätzig. "VECM Analysis in JMulTi." 2005. http://www.jmulti.de/download/help/vecm.pdf.

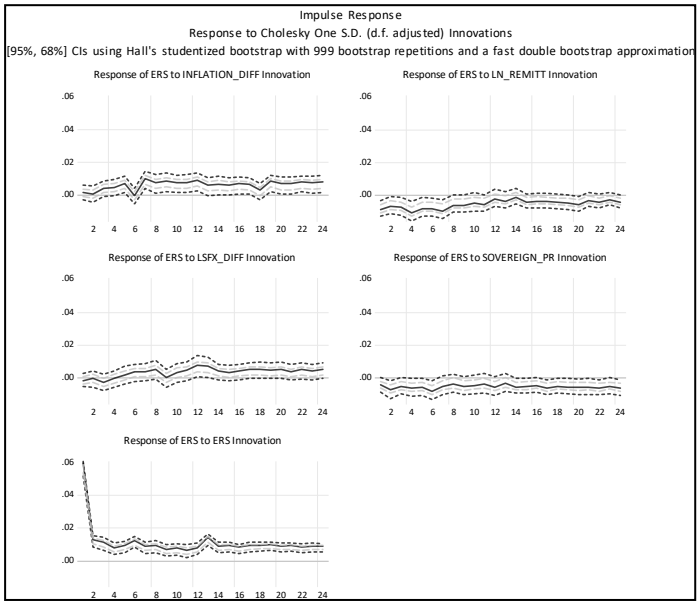
Table 3: Basic statistics of the variables

	INFLATION_DIFF	LN_REMITT	LSFX_DIFF	SOVEREIGN_PR	ERS
Median	0.1000	5.2050	4.9609	2.5100	0.8030
Std. Dev.	0.7887	1.8868	5.7536	1.5804	0.1194
Skewness	1.2547	-1.3602	-2.2730	0.4340	-0.5869
Kurtosis	8.4031	3.9075	7.6146	3.2997	3.3785
Jarque-Bera	1072.1	248.5	1267.5	25.5	51.9
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	725	725	725	725	725
	unit root tests				
Levin, Lin & Chu (p)	0.0001	0.0000	0.1228	0.0000	0.0000
Im, Pesaran and Shin W-stat (p)	0.0000	0.0000	0.0000	0.0000	0.0000

Source: authors' estimation, Eviews 14

According to the impulse response functions on Figure 2, the inflation difference had a long-term and robust positive impact on the currency stability, what is surprising as intuitively that supposed to act against it. One possible interpretation can be the nature of the time period with a long low inflationary period of the 2010s and the first COVID-19 pandemic years of 2020 and 2021, where a higher inflation can be an indicator of higher economic activity in the sample economies compared to the Eurozone. Meanwhile the remittances undermined currency stability on the short-run: despite they provide an additional funding channel for the current account balance, brain drain limits economic growth and high added value production. The weak but positive impact on the long-run at 68% confidence interval (CI), underlining that unconventional monetary instruments are undermining currency stability in open and small economies. However, the constant negative sovereign premium highlighted the presence of the uncovered interest rate paradox, underlining the dangers of FX funding in the balance sheet of domestic economic actors.

Figure 2: Impulse response functions with 68% and 95% confidence intervals



Source: authors' estimation, Eviews 14

Variance decompositions on Table 4 are highlighting the immediate short-term impact of the remittances on the currency stability with an increasing (from 2% to 10%) importance in the forst 7 months. Meanwhile inflation difference and sovereign premium had a long lasting effect with a buildup of relevance from the short-term 1-2% to 12% and 8% in the long-run. The structural differences in the central bank balance sheet contributed only by 5% on the long-run. These results are highlighting the key importance of the IT monetary policy and the usage of the interest rate instrument in term of exchange rate stability – regardless the flexibility of the foreign exchange regime.

Table 4: Variance decomposition

Period	S.E.	INFLATION_DIFF	LN_REMITT	LSFX_DIFF	SOVEREIGN_PR	ERS
1	0.06	0.09	2.11	0.11	0.51	97.18
2	0.06	0.10	3.15	0.11	1.89	94.76
3	0.06	0.47	4.31	0.31	2.45	92.46
4	0.07	0.97	6.78	0.29	3.22	88.73
5	0.07	1.94	7.86	0.35	3.80	86.05
6	0.07	1.83	8.70	0.60	5.01	83.86
7	0.07	3.63	10.03	0.79	5.20	80.36
8	0.07	4.47	10.32	1.26	5.26	78.70
9	0.08	5.60	10.66	1.21	5.58	76.94
10	0.08	6.40	10.78	1.37	5.81	75.65
11	0.08	7.21	11.03	1.65	5.87	74.24
12	0.08	8.29	10.70	2.51	6.17	72.34
13	0.08	8.49	10.41	3.11	6.06	71.92
14	0.08	8.96	10.16	3.26	6.39	71.23
15	0.08	9.29	10.16	3.33	6.65	70.56
16	0.08	9.75	10.13	3.49	6.81	69.81
17	0.09	10.09	10.04	3.76	7.16	68.95
18	0.09	9.97	10.08	4.04	7.39	68.52
19	0.09	10.62	10.06	4.21	7.56	67.54
20	0.09	10.93	10.23	4.42	7.77	66.66
21	0.09	11.26	10.12	4.50	7.99	66.13
22	0.09	11.72	10.08	4.67	8.27	65.26
23	0.09	12.11	9.94	4.77	8.42	64.76
24	0.09	12.54	9.91	4.94	8.67	63.95

Source: authors' estimation, Eviews 14

CONCLUSION

Foreign exchange stability is crucial for macro financial stability in an open and small economy. Such economies can achieve it through an administrative fixed exchange rate regime, or by hoping that a credible inflation targeting regime will have a positive impact on it. In the neighboring countries around the Eurozone both strategies are followed by a similar set of countries. We use a panel vector error correction (VAR) model to assess foreign exchange rate stability in the Central-East European and Balkan countries.

This papers aim was to extend the conventional uncovered interest rate parity and inflation difference model with the inclusion of the unconventional monetary policy (through central bank balance sheet structure) and network-effects to add market integration into the model. It was visible that central bank conservativism (being less prone to provide long term loans and to accumulate securities relative to foreign exchange reserves) translated into a more stable currency on the medium run. Similarly, deeper market integration led to a more stable currency as previous studies suggested, even before the global financial crisis of 2008. We found that currency stability is not only reinforced by the monetary policy but also by inflation, workers' remittances and IMF support programs. Moreover, workers' remittances and IMF lending programs exert a significant influence. We also found evidence that the balance sheet structure difference has similar impact like the conventional uncovered interest parity (UIP). The novelty of our paper was to use the time-variant minimum spanning-tree graph's closeness centrality to integrate this behavior into the standard regression framework.

The policy implications of these results are to highlight that unconventional instruments are not for open and small economies, since a more accommodative monetary policy will harm foreign exchange stability, and therefore trade and capital flows. Meanwhile, the uncovered interest rate parity can be extended with the LS/FX ratio difference to highlight the unconventional accommodative differences.

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APPENDIX

Appendix 1: Model diagnostics for the Panel VECM model

Table 1A: Johansen cointegration test results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	Prob.**
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None *	0.08	105.20	69.82	0.00
At most 1 *	0.04	55.83	47.86	0.01
At most 2	0.04	27.32	29.80	0.09
At most 3	0.01	5.14	15.49	0.79
At most 4	0.00	0.05	3.84	0.83
Trace test indicates 2 cointegrating equation(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Max-eigenvalue)				
Hypothesized		Max-Eigen	0.05	Prob.**
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None *	0.08	49.36	33.88	0.00
At most 1 *	0.04	28.52	27.58	0.04
At most 2 *	0.04	22.18	21.13	0.04
At most 3	0.01	5.09	14.26	0.73
At most 4	0.00	0.05	3.84	0.83
Max-eigenvalue test indicates 3 cointegrating equation(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Source: authors' estimation, Eviews 14

Table 2A: Roots of Characteristic Polynomial

Root	Modulus
1.000000 - 9.61e-16i	1.0000
1.000000 + 9.61e-16i	1.0000
1.000000	1.0000
0.483396 + 0.843527i	0.9722
0.483396 - 0.843527i	0.9722
-0.473328 + 0.828024i	0.9538
-0.473328 - 0.828024i	0.9538
0.130759 + 0.942903i	0.9519
0.130759 - 0.942903i	0.9519

0.833129 + 0.455620i	0.9496
0.833129 - 0.455620i	0.9496
-0.873912 - 0.348663i	0.9409
-0.873912 + 0.348663i	0.9409
-0.940861	0.9409
-0.038041 + 0.928473i	0.9293
-0.038041 - 0.928473i	0.9293
0.925119 + 0.069921i	0.9278
0.925119 - 0.069921i	0.9278
0.732028 + 0.565179i	0.9248
0.732028 - 0.565179i	0.9248
-0.793808 + 0.456295i	0.9156
-0.793808 - 0.456295i	0.9156
-0.899178	0.8992
-0.784300 - 0.408225i	0.8842
-0.784300 + 0.408225i	0.8842
0.870999	0.8710
0.433182 + 0.740919i	0.8583
0.433182 - 0.740919i	0.8583
-0.352427 + 0.781849i	0.8576
-0.352427 - 0.781849i	0.8576
-0.463410 - 0.721320i	0.8574
-0.463410 + 0.721320i	0.8574
0.774882 - 0.356545i	0.8530
0.774882 + 0.356545i	0.8530
-0.818254 + 0.191540i	0.8404
-0.818254 - 0.191540i	0.8404
-0.633328 + 0.551489i	0.8398
-0.633328 - 0.551489i	0.8398
0.076848 + 0.820951i	0.8245
0.076848 - 0.820951i	0.8245
-0.684130 - 0.446457i	0.8169
-0.684130 + 0.446457i	0.8169
-0.066204 - 0.808198i	0.8109
-0.066204 + 0.808198i	0.8109
0.787982 + 0.162733i	0.8046
0.787982 - 0.162733i	0.8046
0.587390 - 0.543292i	0.8001
0.587390 + 0.543292i	0.8001
0.312681 + 0.728111i	0.7924
0.312681 - 0.728111i	0.7924
-0.176053 + 0.764694i	0.7847
-0.176053 - 0.764694i	0.7847

0.611132 - 0.469619i	0.7707
0.611132 + 0.469619i	0.7707
-0.768808	0.7688
0.233103 + 0.681112i	0.7199
0.233103 - 0.681112i	0.7199
0.401468 + 0.581838i	0.7069
0.401468 - 0.581838i	0.7069
-0.373688 - 0.538279i	0.6553
-0.373688 + 0.538279i	0.6553
0.413249	0.4132
0.076346 + 0.186552i	0.2016
0.076346 - 0.186552i	0.2016
-0.197910	0.1979

Source: authors' estimation, Eviews 14