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RESEARCH ARTICLE

The demand for money and the real exchange rate misalignments in emerging European countries: A nonlinear approach

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Abstract

This paper investigates the extent to which domestic and foreign money balances in emerging European countries are influenced by foreign exchange considerations. A well-specified and stable relationship between real money demand and the exchange rate can be perceived as an important part of a successful monetary policy. This study examines the long-run determinants of real exchange rates (RERs)associated with the behavioral equilibrium exchange rate (BEER) approach and identifies currency misalignments in these countries. The misalignment is later used to test the nonlinear behavior of the demand for money. The results indicate that the RER misalignments have a significant impact on domestic money demand. When the currencies are overvalued, there is a reduction in domestic money demand, and when they are undervalued, there is an increase in domestic money demand. Furthermore, it can be concluded that overvaluation causes an increase in foreign money demand indicating a shift of preference from domestic to foreign currency.

KEYWORDS

behavioral equilibrium exchange rate, demand for money, misalignments, real exchange rates, smooth transition regression

JEL CLASSIFICATION
E41, E51, E61, F31

1 | INTRODUCTION

The demand for money has long been an essential building block for macroeconomic modeling and an important framework for successful monetary policy, and there is extensive literature on the money demand function with a great emphasis on the stability of money demand (Cziráky & Gillman, 2006; Hayo, 1999; Kumar, 2014; Lütkepohl et al., 1999; Metzler, 1963) Nevertheless, the demand for money fell out of sight with the popularity of the Taylor rule, which determined that money demand had little effect under interest-rate based monetary policies. Duca and Van Hoose (2004) discuss the de-emphasis on the demand for money that existed in literature from various aspects and concluded that with the help of better econometric methods, there has been substantial progress in the empirical analyses. They also argue that literature on the demand for money might benefit from an emerging trend toward an increased use of cross-section data in empirical studies. Since this conclusion, there has been growing interest in the money demand equations, mainly empirically, to see whether monetary aggregates have a central role to play in a complete analysis of macroeconomic implications of monetary policy, see Kumar (2014), Daniele et al. (2017), Bahmani-Oskooee et al. (2017), Mera et al. (2019), Ivanovski and Churchill (2019), Dreger et al. (2019), and Benchimol and Quereshi (2020).

Foreign exchange considerations have an important impact on domestic money holdings. Fleming (1962) identifies the importance of the exchange rate in the money demand function for an open economy in addition to income and interest rate. The relationship between exchange rate and the demand for money is useful for the design of both monetary and exchange rate policies (Marquez, 1985). If a central bank has an intention to conduct a contractionary monetary policy, this may be offset by the public having access to foreign exchange markets. For example, if there is an expectation surrounding the depreciation of domestic currency, then individuals are likely to increase their foreign money holdings in order to minimize their capital losses. This may eventually reduce demand for domestic money holdings thereby pushing down interest rates. When the expectations of the agents in the economy change according to expected future currency values, the central bank's intention for a contractionary policy may be ineffective. As a result, a well-behaved long-run money demand relationship can be identified only if the exchange rate is part of the opportunity cost included in the money demand equation (Dreger et al., 2007).

This study examines the nonlinear behavior of narrow money demand that is modeled as a function of income, interest rates, and real exchange rate (RER) misalignment. According to Laidler (1985, p. 53), Keynes's analysis suggests that money demand cannot be treated as a simple, stable, approximately linear, negative relationship with respect to the rate of interest. Nonlinearity becomes an important concept that is not neglectable especially when we include the assumption of the asymmetric impact of exchange rates. There are various reasons that may contribute to the nonlinear behavior of the demand for money, especially when the attention is on the exchange rates. The response of the demand for money to changing exchange rates operates via the wealth effect and substitution effect. The sign of the coefficient will be sensitive to which of the effect overrides the other. Furthermore, the exchange rates may not have a symmetric effect on the demand for money. For example, changes due to market participants' expectations mean

that if an appreciation of a currency increases money demand, a depreciation may not necessarily lower it. In another example, Bahmani-Oskooee and Fariditavana (2016) study nonlinear autoregressive distributed lag (ARDL) to show the symmetric effect of exchange rates on trade balance. Nonlinear ARDL approach in estimating the demand for money has been studied in various counties such as Turkey by Bahmani-Oskooee et al. (2017), Korea by Bahmani-Oskooee and Baek (2017), and Australia by Ivanovski and Churchill (2019). The method used in these studies is based on a simple linear ARDL for the symmetrical effect and nonlinear ARDL for the asymmetric effect, thereby allowing us to observe the behavior of the demand for money when the exchange rate is increasing or decreasing. One of the contributions of this study is to examine the nonlinear behavior of the demand for money by using the Smooth Threshold Autoregressive Regression (STAR). The advantage of this method is that it analyses the asymmetric behavior of misalignment on money demand, but more importantly it analyses how other explanatory variables affect demand for money when currencies are over or undervalued. Furthermore, the study includes the RER misalignments as a determinant in the real money demand model and tests whether the exchange rate misalignments have an impact both on domestic and foreign money demand. Various cointegration techniques are employed in order to estimate the fundamental exchange rate and determine misalignments for the fourteen emerging European countries (EEC).

The selection of the countries is based on geographical proximity to the EU and the eurozone. These countries all have higher productivity and growth rates with lower wages, compared to the advanced European countries. They have all experienced a rapid trade integration with the EU and they all are looking for foreign direct investment (FDI) opportunities and economic convergence in closing the large income gap. A competitive and stable RER is crucial for promoting growth and stability in emerging markets. In this respect, two important issues can be observed. First, RER has an important role in facilitating economic diversification that contributes to long-term growth of emerging and developing countries (Ocampo et al., 2009, Stiglitz and Greenwald, 2014). Second, exchange rates are important macroeconomic variables for emerging economies, especially when looking at managing cyclical swings in external financing and terms of trade (TOT) fluctuations. The vulnerability to exchange rate movements in emerging economies, especially those that are subject to strong boom–bust cycles in external financing, leads to a specific and somewhat contradictory relationship between exchange rate and monetary policy (Guzman et al., 2018). The study covers a timespan from 2000 to 2019 that includes structural changes such as the transition of some countries to market economies, joining the EU and the eurozone, and also events such as inconsistencies in the progress of modernizing the economic relations with the EU (such as the customs union with Turkey and the trade dialogues with Belarus).

The analysis includes the concept of misalignment that is mainly derived from the movement of the actual exchange rate from its fundamental (equilibrium) value. As the equilibrium RER requires a simultaneous attainment of an equilibrium in the external sector and domestic sector, misalignment will refer to an inefficiency in these sectors. Misalignments can be due to short-term overshooting of nominal and real currencies in which the overshooting by the RER of its long-run equilibrium value occurs in response to an unanticipatedly announced monetary policy shock (Buiter & Miller, 1982). The exchange rate interventions are examples of these types of shocks. They are effective in moving the RERs in the desired direction, which can be either in a corrective way or in a harmful way by causing deviations from equilibrium, seen predominately in emerging markets (Daude et al., 2016). Misalignment in RER, in this respect, is important in terms of changing the near-term exchange rate expectations, thereby affecting the demand for domestic

currency. Since central banks in many emerging economies have persistently intervened in foreign exchange rate markets, this experience by economic agents appears to be an important element for intervention to be able to have an intended effect on exchange rate expectations (Miyajima, 2013). Therefore, misalignment is an important factor in changing these expectations. It affects the present decisions in regard to holding domestic and foreign money demand; this is considered a valuable contribution to the literature on real money demand. Distinguishing equilibrium movement from misalignment has been a great challenge, and there are different approaches to measuring these misalignments. Cheung and Fujii (2011) use the difference between the national price level and real income for determining misalignment, whereas Stein and Paladino (1999) use the real fundamentals, such as social consumption and the productivity of the economy, as the determinants of the fluctuations from the equilibrium RER. On the other hand, Salto and Turrini (2010) compare current account base approaches and relative price-based approaches for estimating RER misalignment for the EU countries. It can be seen that it is quite common to use real variables such as openness, TOT, productivity, net foreign assets, government consumption, country debt services, and real interest rates to determine RER (e.g., see Fidora et al., 2021; Frait et al., 2006; Nouira and Sekkat, 2015; Palić et al., 2014). There is an ever-growing interest in recent publications that examine the effect of misalignment on macroeconomic variables such as economic activity and external imbalances (Corsetti et al., 2020; Cuestas et al., 2020; Tipoy et al., 2018).

The misalignment is an important part of the analysis, but the aim is neither to find the causes of misalignment nor the policy implications to reduce it. However, the objective and the major contribution of this paper is to measure whether the demand for money behaves asymmetrically to overvalued or undervalued exchange rates. The impact of misalignment on various macroeconomic variables such as growth, export performance and redistribution (e.g., see Aguirre & Calderon, 2005; Couharde & Sallenave, 2013; Cuestas et al., 2019; Huizinga, 1997; Jongwanich, 2009; Tipoy et al., 2018), or on RER (Fidora et al., 2021) has been studied empirically. Other studies such as Engel (2011) and Corsetti et al. (2020) establish a relationship between misalignment and monetary policy theoretically. However, there is no empirical study regarding the impact of misalignment on the demand for money. Whether it is due to the transition process or to the need for speeding up the industrialization process, there are various concerns that should be taken into account while studying the demand for money. The first concern relates to the high inflation periods in those countries making foreign transactions a particularly important variable for the real money demand. During the period of high inflation or high uncertainty, there is a tendency for these countries to replace domestic currency with foreign currency for store of value or medium of exchange purposes. As a result, exchange rates become an important part of money demand analysis. Besides, all these countries have strong economic and political relations with the EU. Economic relations appear in various forms depending on the degree of economic integration. For example, some of these countries are already members of the eurozone and others are expected to join the EU in the future. Consequently, the demand for money is important for the eurozone members and the EU members that are expected to join the monetary union. It is useful in detecting risks to price stability over the medium term thereby conducting a well-functioning monetary policy. As in all countries, the demand for money is important to maintain economic and political stability and reduce uncertainty.

The rest of the paper is organized as follows. Section 2 provides a literature review; Section 3 describes the theoretical background, and Section 4 explains the RER determinants. Finally, Section 5 presents a nonlinear estimate of the money demand function, and Section 6 concludes the analysis.

2 | LITERATURE REVIEW

There are many studies that use exchange rates to explain the movements in domestic money holdings. Petrović and Mladenović (2000) argue that a money demand model based on the exchange rate explains the Yugoslav hyperinflation better than the standard Cagan's (1956) money demand model based on the price level. Marquez (1985) examines the extent to which domestic money holdings in Venezuela are influenced by foreign exchange considerations. The idea behind both studies is based on "dollarization" or fear of floating arguments (Calvo & Reinhart, 2002). The exchange rates are not only important for real money balances in fixed exchange rate regimes, but they are also important in floating exchange rate regimes. For example, Bahmani-Oskooee and Rehman (2005) estimate the money demand function with exchange rate in Asian developing countries; Bahmani-Oskooee et al. (2017) find evidence that exchange rate changes have short-run and long-run asymmetric effects on money demand in Turkey. Bahmani-Oskooee and Tanku (2006) study the black market exchange rate in less developed countries as the determinant of money demand. Albulescu et al. (2019) include microeconomic foundations in their model and study the effect of currency substitution between the currencies of the Central and Eastern European Countries (CEECs). They conclude that the exchange rate affects money demand even in the absence of a currency substitution effect. Fidrmuc (2009) studies the money demand function in six CEECs and finds that money demand is significantly affected by the euro area interest rate and the exchange rate against the euro, which in turn is considered an indication of money demand instability. In addition to this, the previous studies provide evidence for the essential role of the exchange rate in the money demand function. Nevertheless, ambiguity about the sign of the exchange rate in the money demand function indicates the nonlinear behavior of money demand. There is empirical evidence to support that appreciation and depreciation of the domestic currency can have asymmetric effects on the money demand equation (Bahmani-Oskooee & Baek, 2017; Bahmani-Oskooee & Bahmani, 2015; Bahmani-Oskooee & Fariditavana, 2016; Ivanovski & Churchill, 2019). Hsieh and Hsing (2009) provide evidence for a nonlinear behavior in Hungary's money demand function. Karpetis et al. (2019) support this nonlinearity behavior of the demand for money by finding that optimism affects money demand positively, whereas pessimism affects it negatively.

Volatility and uncertainty in exchange rates can affect the amount of cash balances being held by the economic agents, thereby affecting money demand holdings. Volatility will cause economic agents to substitute the domestic currency for foreign currency, in turn reducing the demand for money balances. McGibany and Nourzad (1995) examine the level and volatility of exchange rates on the demand for money, and their results show that money demand responds to the volatility of relative prices and nominal exchange rates. Furthermore, Bahmani (2011) finds that exchange rate volatility has short-run effects on money demand in less developed countries. Volatility can be one possible explanation for why a country's RER is out of line with respect to its long-run equilibrium level. Another explanation can be the uncertainty in which the foreign exchange market is likely to produce the "wrong" rate (Pilbeam, 1991). There is a general agreement that maintaining the RER at the "wrong" level results in significant welfare costs (Edwards, 1989). It generates incorrect signals to economic agents and results in greater economic instability (Willet, 1986). If the currency is overvalued, it may be optimal from a private perspective, but there is a substantial cost from social welfare, and it may cause massive capital flight (Cuddington, 1986).

The Behavioral Equilibrium Exchange Rate (BEER) approach assumes that the foreign exchange market will be efficient if it fully reflects all available information. When this

assumption holds, the actual exchange rate will not deviate significantly from its equilibrium rate. The BEER is based directly on the relative price of tradables to non-tradables, and it embraces the Balassa–Samuelson (BS) approach. Moreover, the BS approach examines the movement of RER due to the changes in relative tradables productivity growth differential and relative price of non-tradable goods to tradable goods. The existing literature provides mixed evidence for the support of the BS effect (see a summary of results in Blaszkiewicz et al., 2004). For example, Égert (2003) studies the BS effect for the CEECs, and Jakab and Kovács (2000) find strong support for the BS effect in Hungary. De Gregorio and Wolf (1994) study the joint effect of productivity differentials and TOT movements on RER and the relative price of tradables. They find that productivity differentials across sectors are significant determinants for the RER, but they are not significant for real price of non-tradable goods. Melecký and Komárek (2007) use BEER model to test the equilibrium rate, and they find that the productivity differential, the real interest rate differential, TOT, and net FDI are the significant determinants. They find that the Czech koruna is undervalued by about 7% over the period of 1994–2004. Blaszkiewicz et al. (2004) do not find support for wage equalization but find evidence of the BS effect. Furthermore, Cipriani (2001) finds a weak link between the productivity growth differentials (in tradables and non-tradables sectors) and inflation rates in 10 CEECs. The following section will explain the BEER and the exchange rate misalignment in more detail.

3 | THEORETICAL BACKGROUND

The theoretical part includes the model used to determine RER misalignments and the relationship between misalignments and the demand for money.

3.1 | Real exchange rate misalignment

It is important to understand the causes of exchange rate volatility for the role of successful monetary policy implications. The volatility of exchange rates may be due to changes in nominal exchange rates caused by price differentials, money growth differentials, and interest rate differentials. Alternatively, it may be due to changes in RERs caused by changes in productivity growth rates or even due to other possible causes that affect the structure of the economy such as trade and industrial policies, the degree of capital mobility, and technological developments.

RER is defined as the relative price of the home country's basket of commodities in terms of the basket of commodities of the foreign country, when nominal exchange rates are rigid. In a floating exchange rate regime, the movement of RER represents the increased variability of nominal exchange rates alongside the variability of the ratio of the national price level (Mussa, 1986). Such a definition of the RER makes the analysis compatible with any exchange rate regime and emphasizes the importance of RER when representing the level of international competitiveness of a country. There are different approaches explaining the movement of RERs; one common approach involves the direct econometric analysis of the BEER developed by MacDonald (1997) and Clark and MacDonald (1999). The BEER approach uses the deviation of the actual exchange rate from its fundamental value (estimated equilibrium value). One of the drawbacks regarding the BEER approach is that the economic fundamentals determining the exchange rate behavior are assumed to be at their equilibrium levels. The long-run economic fundamentals in the BEER

approach are shown in the equation as

$$RER = f(TOT,\ TNT,\ RIP,\ NFA).$$

The relationship between the RER and its long-run determinants are TOT, relative price of non-traded to traded goods (TNT), relative productivity (RP), and stock of net foreign assets (NFA). The equation takes the following log-linear form:

$$rer = \sigma TOT + \rho TNT + \tau RIP + \varphi NFA. \quad (1)$$

TOT movements are potential determinants of RERs. Nevertheless, there is not necessarily a mechanical connection between TOT and RER (Lane & Milesi-Ferretti, 2002). TOT shocks and their effects on current account position have been extensively studied by using Harberger–Larusen–Metzler effect. Harberger (1950) and Laursen and Metzler (1950) conjectured that a deterioration in the TOT lowers real income subsequently causing a reduction in aggregate savings and deterioration in trade balance. This reduction in aggregate demand causing real depreciation is called the income effect of TOT shock. The Obstfeld–Svensson–Razin framework shows that under perfect capital mobility the effects of TOT shocks depend on the duration of those shocks, agents' expectations, and finally type and significance of transmission channels.[1]

Alternatively, Cashin and McDermott (1998) argue that countries that consume both importable goods and non-tradable goods influence saving decisions (substitution effects). The relationship between TOT and intertemporal relative price of consumption depends on two conditions. First, it depends on the ability of the countries, in response to TOT shock, to switch between importable goods and non-tradable goods (intratemporal substitution). An increase in the price of imports pushes demand toward non-traded goods causing an increase in the price of non-tradables, and this leads to a real appreciation. Second, it is the ability of the countries, after TOT shock, to switch between current and future consumption in response to a shift in the relative price of current consumption (intertemporal substitution). When there is an increase in overall price level due to higher import prices, there will be a shift in demand from the current consumption to future consumption. In both cases, intertemporal relative price of consumption is raised. This induces a temporary real appreciation, which raises aggregate private savings and improves the trade balance position. Therefore, σ in Equation (1) may either be positive or negative depending on the duration of the TOT and whether or not the income effect outweighs the substitution effect.

BS model assumes that the faster productivity growth at home in tradables relative to the non-tradable sector than abroad will lead to a rise in the relative price level (price of non-tradables to tradables) and, therefore, to the real appreciation of the domestic currency. Accordingly, ρ and τ in Equation (1) are expected to be positive. The model assumes that consumer demand patterns play no role in determining the relative price; when the production functions are the same in two countries, the prices of non-tradables in terms of tradables are equalized. Indeed, the BS effect argues that persistent deviations from its purchasing power parity (PPP) values are due to a sectoral labor productivity difference (Blaszkiewicz et al., 2004). In other words, an increase in production, if tastes are non-homothetic and the income elasticity of demand for non-tradables is greater than one, may put upward pressure on the relative price of non-tradables (Bergstrand,

[1] The ambiguous impact of TOT shocks on current account balance has been studied by many authors. See Svensson and Razin (1983), Eichengreen and Goulder (1991), and Ostry and Reinhart (1992) for duration of shocks; see Harkness (1982) and Levi (1983) for the agents' expectations; and see Mendoza (1995) for significance of transmission channels.

1991). If the model assumes that demand plays an important role, and income elasticity of demand for non-tradables is less than one, this will affect the size of appreciation. Furthermore, if the income elasticity of demand for tradables is greater than one, then it may even result in real depreciation.

RERs can also be affected by other macroeconomic variables other than the BS effect. NFA in portfolio balance models are also important determinants used to explain the RER movements. NFA are constructed as cumulated current account deficits/surpluses expressed in terms of gross domestic product (GDP) (Égert et al., 2006). NFA position affects risk sharing, and it plays a dynamic role in the economy; hence, the RER will be affected by the NFA as long as there is either asset accumulation or decumulation. Positive (negative) sign shows that asset accumulation (decumulation) causes real appreciation (depreciation). The larger the asset accumulation, the greater the direct effect of the NFA position on the RER dynamics will occur. Lane and Milesi-Ferretti (2002) examined the link between NFA position and RER by decomposition of this relationship into two channels. The first channel is the negative effect of an increase in the stock of NFA to GDP on the trade balance; the second channel is the negative effect of trade balance on the RER, that is, RER will be depreciated more when there is a bigger steady-state trade surplus.

NFA is associated with an appreciation of the RER (+ sign). When the economy is at a steady-state trade deficit, and there is an increase in NFA position, there is a real appreciation of the domestic currency. However, the sign is negative over the medium term if a decrease in NFA (debt creation) is linked to the appreciation of the RER (Égert et al., 2006). In addition to this, Lane and Milesi-Ferretti (2002) explain the causes of weak RER when there is persistent trade surplus during a transitional relation. The reason is due to the inverse relationship between trade balance and price of non-tradable goods. One criticism regarding this approach is that the determinants of the RER other than the trade balance remain constant; this is rather challenging, especially for countries that have not completed their liberalization.

$$mis_t = rer_t - rer_t^f. \tag{2}$$

Misalignment in the RER occurs when the actual value, *rer*, is different than its fundamental value, rer^f, in Equation (2). These unjustified departures of the actual value from its equilibrium value are a failure of simultaneously maintaining an equilibrium in the external sector and domestic sector of the economy. When the actual value is less than the fundamental value, the exchange rate is said to be overvalued causing undesirable effects on net exports and growth. When the actual value is more than the fundamental value, the exchange rate is said to be undervalued causing difficulties in controlling money supply and managing inflation.[2]

The movement of the actual rate from the equilibrium rate depends on many economic factors such as the central bank policy framework, exchange rate regimes, and political factors. Even though the distinguishing equilibrium movement from misalignment is very challenging, it is important to understand the impact of this inefficiency on the behavior of the economic actors.

[2] These explanations are valid for exchange rates represented as domestic per foreign currency. If RER is represented as foreign per domestic currency, then the currency is overvalued if actual value is greater than the fundamental value and undervalued if actual value is less than the fundamental value. The latter will be used while discussing the empirical results.

3.2 | The real money demand

The transactions-demand theory is based on the need for money to even out the differences between income and expenditure streams (Hendry & Ericsson, 1990). The definition of real money demand is determined by the real quantity expressed in terms of the volume of goods and services that money can purchase (Freidman, 1956). Due to financial innovations that are able to extend the boundaries for monetary and non-monetary assets, the transactions-demand theory with narrow money has received less attention in recent literature. This has made the role of monetary aggregates less relevant to monetary policy. Nevertheless, in terms of providing useful information for money demand, there are three reasons why narrow money is still important for this study. First, narrow money with a high degree of liquidity has a strong and timely correlation with aggregate spending than the less liquid assets held for saving purposes. This makes narrow money particularly important for understanding the behavior of price hikes. Second, monetary aggregate for narrow money $M1$ is an important indicator for monetary aggregate for broader money $M3$, and thus its analysis is useful to understand the behavior of broad money. Third, it is important to understand the money-holding behavior for assessing the welfare cost of inflation. Consequently, narrow money demand provides valuable information that has to be taken into consideration, particularly by the policymakers conducting their policies to pursue macroeconomic objectives of price stability, economic growth, and employment.

Real quantity of money depends on nominal quantity (M), and one way to calculate the real quantity of money is by dividing the nominal quantity of money by a price index (P). The aggregate real quantity of money is an increasing function of some measure of the volume of real transactions (Y). Furthermore, money demand can also be determined by the opportunity costs of holding money. The cost of holding money is interest foregone (R), and money demand declines as the opportunity cost of holding money increases. Thus, we have the following equation:

$$\frac{M}{P} = f(Y, R, \theta), \tag{3}$$

where θ shows all the other variables of interest in the money demand function. Alternatively, the exchange rate can also be considered as part of the opportunity cost (Dreger et al., 2007). The equation takes the following form when more specific functional forms are adopted.

$$m - p = \delta y + \gamma R + \eta rer, \tag{4}$$

where variables in the lower case indicate that they are in logarithms. Parameters in δ and η are income and RER elasticities, whereas γ is the semi-interest rate elasticity of real money demand. The coefficient δ is equal to 0.5 in Baumol's (1952) and Tobin's (1956) transactions-demand theory, or it can be equal to 1 in Friedman's (1956) quantity theory of money. The coefficient γ is expected to be negative. According to Hendry and Ericsson (1990), the equation may require returns on all relevant alternative assets, with non-zero costs between these assets rather than some summary measure. If components of the measure of money bear interest, the associated interest rates should also appear in R, and the corresponding elements in γ should then be positive.

The demand for money is likely to depend upon the exchange rate in addition to the level of income and the interest rate (Mundell, 1963). Money, price, interest rate, and exchange rate may be causally linked, possibly in several directions. Understanding these linkages is central to overall economic policy and generally requires a systems approach (Hendry & Ericsson, 1990). Exchange

rates affect the demand for domestic currency through the wealth effect and the currency substitution effect. For example, when there is a depreciation, there will be an increase in demand for domestic goods from abroad. This will eventually increase domestic production, resulting in higher inflation rates and an increase in money demand (causing a negative relationship between exchange rate and money demand). In contrast, the currency substitution effect explains that depreciation may reduce confidence in the domestic currency, thereby lowering money demand via switching from domestic currency to foreign currency. The relationship between demand for money and exchange rates depends highly on the magnitudes of the wealth and currency substitution effects. The relationship may be negative if the wealth effect outweighs the substitution effect or positive if the substitution effect dominates the wealth effect. The choice for the domestic currency demand is highly dependent on expectations. Therefore, the model includes RER to determine the long-run behavior of the demand for money in EEC. It is common in the literature to study the relationship between real demand for money and RER (Bahmani, 2011; Bahmani-Oskooee & Malixi, 1991; Buiter & Miller, 1982; Daniele et al., 2017; Lee & Chung, 1995).

$$MD_t = \alpha mis_t + \beta Z_t + \varepsilon_t. \tag{5}$$

The main objective of this analysis is to examine the effect of misalignment represented in Equation (2), on real money demand. Equation (5) shows the determinants of real money demand, *MD*, RER misalignments, *mis*, the control variables such as interest rate and income, *Z*, and the error term, ε. The positive value for misalignment is associated with overvaluation. When the currency is overvalued, people's demand for domestic currency falls. Essentially, overvaluation of the domestic currency means consumer prices are higher at home than abroad. The consumer expects a depreciation in the future so there will be less demand for domestic money. As higher prices may require contractionary policies causing a reduction in money supply, this relationship is consistent with the response of the central bank to overvaluation. However, a negative value in misalignment is also associated with undervaluation. When consumer prices are lower at home than abroad, it increases the production of tradables and increases expectations of domestic appreciation. In turn, increasing the demand for domestic currency. It can be said that central banks are more likely to conduct expansionary monetary policies when domestic prices are low.

4 | REAL EXCHANGE RATE DETERMINANTS IN EEC

The analysis starts with the monetary policy framework and the exchange rate regime for the EEC as they affect both the behavior of exchange rates and the demand for money. There has hardly been a change in the price stability objective of central banks. However, monetary policy instruments that shape the policy framework vary significantly across countries and time periods. The monetary policy framework is the manner in which the central banks use these instruments to pursue their objectives. In a discretionary monetary framework, the central bank is free to act depending on short-term conditions. Though, in a rule-based framework, a central bank's actions are limited according to a rule set, often counter-cyclical rules, to stimulate the economy. These rule-based policies can spur in the form of controlling monetary aggregates as in Friedman k-percent or controlling interest as in Taylor-rule type monetary policy. Inflation targeting (IT) became popular in the early 1990s, first among central banks in developing counties. After a decade, it affected other central banks in developing countries and emerging economies. Table 1 shows the monetary policy frameworks and the exchange rate regimes for the selected

TABLE 1 Monetary policy frameworks and the exchange rate regimes

	Monetary policy framework			
	Exchange Rate Anchor	***Monetary Anchor***	***Inflation Target***	**Exchange rate regime**
Belarus	2002–2011	2015		Managed float (1996)
Bulgaria	2002			Currency board (1997)
Croatia	2008			Managed float (1993)
Czech Rep.			1998	Managed float (1993), free float (2008)
Estonia	2001		2011	Currency board (1994), joined EMU (2011)
Hungary	2001		2007	Managed float (2001), free float (2008)
Latvia	2001–2013			Fixed peg arrangements (1994), joined EMU (2014)
Lithuania	2001–2014		2015	Currency board (1994), joined EMU (2015)
Poland			1999	Free Float (2000)
Romania	2001		2005	Managed float (1998), floating (2009)
Slovak Rep.	2006–2008		2005	Managed float (1998), joined EMU (2009)
Turkey		2001	2002	Free float (2001)

Source: National Central Banks and the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.

countries. Policy choices for both monetary policy frameworks are based on official statements and the International Monetary Fund (IMF)'s Annual Report on Exchange Arrangements and Exchange Restrictions. Exchange rate regimes are based on de facto regimes in IMF's Annual Report on Exchange Arrangements and Exchange Restrictions. IT is preferred by most of the EEC, except Belarus, which prefers to use monetary anchor as a monetary policy framework; Bulgaria and Croatia, both use exchange rate anchors; and Latvia.

The link between monetary policy and IT is not straightforward due to the fact that IT can be explained by neither discretionary nor rule-based frameworks. Bernanke and Mishkin (1997) identify IT as "constrained discretion." They argue that the IT framework is not a rule in the sense that the changes in policy are not reactions provoked by certain macroeconomic conditions. Instead, the IT framework relies on discretion based on structural and judgmental models that are used to determine the policy action in achieving the inflation target.

Another important policy choice that affects the nominal exchange rate and RER is the exchange rate regime. Before joining the euro area, most selected countries conducted fixed exchange rate regimes, including Estonia, Latvia, and Lithuania. RER movements can be prevented if the exchange rate movements are all related to monetary policy stability. If the movements are due to diverging structural economic developments between countries in the productivity patterns or in other trade-related factors, then the movements cannot be prevented entirely by the economic policies. Hence, structural changes will move the RER from its expected equilibrium value.

Appendix 1 shows the correlation between RER and its determinants. The negative sign for TOT is evident for all countries. This can be explained by the significant income effect that results in a real depreciation after TOT shock. A positive correlation between industrial production and RER shows support for the BS effect nearly in all countries. These results are mostly supported by the relative price of non-tradable goods. The correlation between asset accumulation and the exchange rate has shown the most inconsistent signs among countries.

The next step is to study the long-run relationship between RER and its determinants, concurrently estimating the equilibrium exchange rate required for calculating the misalignment. Every cointegration analysis starts with testing the stationarity of the variables used in the analysis. See Appendix 2 for unit root test results.[3] The next step is identifying the number of cointegration relations. Table 2 shows the results of maximum eigenvalue and trace tests, which are less than the number of variables in all countries. Serbia and Slovenia are excluded from the analysis due to the fact that the RERs are found stationary.[4] The last column provides evidence that there is at least one cointegration relation in all selected countries.[5]

Table 3 presents the cointegration coefficients of the RER model. The missing values such as the relative price of non-tradables to tradables in Belarus and NFA in Slovak Republic means that these variables are found stationary; therefore, they are excluded from the cointegration analysis. The results show a strong relationship between TOT and RER in EEC. This is consistent with

[3] Various unit root tests are employed for the variables to increase the level of confidence in the cointegration analysis. Stationarity is particularly important for the exchange rate regression as the demand for money already includes all variables in their first differences. The analysis also includes Zivot–Andrews (ZA) unit root test by including a structural break. In general, the results of the ZA test were in line with standard unit root tests, thus, not changing the overall decision.

[4] Both real effective exchange rates and calculated RERs, where nominal exchange rates deflated with price indices, are found stationary.

[5] Additionally, AR roots test show that the model imposes a certain number of unit roots for all estimations, compared to no unit root for the VAR model.

TABLE 2 Cointegration tests for RER

	l-max	95% *CV*	*l-trace*	95% *CV*	*r*
Belarus	62.46	32.12	106.06	47.86	2
Bulgaria	32.58	83.92	83.92	76.97	1
Croatia	100.69	38.33	196.80	88.80	3
Czech Rep.	63.90	33.88	141.83	69.82	2
Estonia	70.95	34.81	163.95	76.97	3
Hungary	149.17	34.81	241.04	76.97	3
Latvia	82.96	34.81	152.15	76.97	3
Lithuania	45.98	38.33	119.10	88.80	3
Poland	81.07	34.81	162.59	69.82	4
Romania	120.41	38.33	246.15	88.80	4
Slovak Rep.	63.86	28.59	122.45	54.08	3
Turkey	82.31	38.33	207.60	88.80	3

Note: *l-max* and *l-trace* are Johansen unrestricted cointegration rank test shown together with critical values (CV). *r* is the number of cointegrating vectors for trace statistics.
*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

the literature such that coefficients of TOT are largest, compared to the coefficients of the rest of the variables for all selected countries (Cuestas et al., 2020; Tsen, 2011). TOT is statistically significant in all countries except Hungary. All countries except Belarus, Bulgaria, Croatia, and Romania have a positive sign, meaning improved TOT will cause an appreciation of the RER. In other words, an adverse TOT shock will lower real income and cause a reduction in aggregate demand, and hence a real depreciation. One possible explanation for the negative signs in Belarus, Bulgaria, Croatia, and Romania is that the substitution effect outweighs the income effect. Here, consumption shifts from tradable products to non-tradable products, raising the price of non-tradable goods and causing a real appreciation. The magnitudes of the coefficients are bigger for countries with negative signs.

The following two coefficients are used to measure the BS effect: TNT, which is the price of tradable to non-tradable (domestic approach); and RP, which is the RP (international approach). Appendix 3 provides the details for all data used in the analysis. The coefficients of TNT are mostly consistent with the literature (Égert et al., 2006; Kinkyo, 2008). They provide a strong support for the BS model in countries such as Croatia, Hungary, Estonia, Romania, and Slovak Republic. The magnitudes of coefficients are significantly higher especially in Croatia, Hungary, and Slovak Republic. The coefficients for RP are statistically significant in all countries, and it clearly shows that the RP of tradables is an important determinant in explaining the RER movements. An increase in productivity differential that causes real appreciation, as the BS effect suggests, is valid only for Bulgaria, Czech Republic, Latvia, and Lithuania. The varying signs of TNT can partly be explained by the assumptions of the BS model, where it is the productivity of labor in the tradable sector that is what changes the RER, not the productivity of non-tradable goods. Therefore, this study also includes the overall productivity differences into the model to measure RER movements to include all sources of productivity differences.[6] The second and third columns in Table 3 show the determinants of the BS model that play an important role in RER movements. These

[6] The correlation between TOT and relative price of tradables and non-tradables are tested for all countries, and there is no evidence for collinearity that would otherwise cause a distortion in the model estimation.

TABLE 3 Cointegration coefficients for RER

	TOT	TNT	RP	NFA	Lags	EC
Belarus	−4.96***	–	−0.20***	0.03*	(5)	−1.63**
	(0.62)		(0.07)	(0.02)		(0.22)
Bulgaria	−8.59***	0.84***	0.29***	0.01	(4)	−0.07
	(3.07)	(0.31)	(0.10)	(0.01)		(0.05)
Croatia	−9.90*	1.31***	−0.09***	−0.09***	(4)	−0.03
	(1.04)	(0.40)	(0.11)	(0.10)		(0.03)
Czech Rep.	5.85***	−3.87***	1.66***	0.06*	(5)	−0.31***
	(2.12)	(0.88)	(0.31)	(0.04)		(0.08)
Estonia	2.62***	1.23***	−0.54***	−0.02***	(5)	0.10
	(0.64)	(0.39)	(0.09)	(0.01)		(0.08)
Hungary	7.72***	2.77***	−0.81***	−0.03***	(5)	−1.33***
	(2.72)	(0.18)	(0.20)	(0.10)		(0.12)
Latvia	8.48***	−2.39***	0.20***	−0.04*	(4)	−0.05
	(0.89)	(0.33)	(0.30)	(0.02)		(0.06)
Lithuania	1.97*	0.23*	0.56***	−0.06***	(3)	−0.01
	(1.25)	(0.15)	(0.16)	(0.00)		(0.08)
Poland	5.48***	−0.81**	−1.81***	0.17***	(3)	−0.65***
	(2.41)	(0.43)	(0.37)	(0.07)		(0.10)
Romania	−9.84***	1.03***	−0.64***	−0.09***	(5)	0.37
	(2.40)	(0.14)	(0.08)	(0.01)		(0.28)
Slovak Rep.	1.88***	1.21***	−0.31*	–	(5)	−0.12*
	(2.23)	(0.35)	(0.72)			(0.07)
Turkey	3.31**	0.90***	−4.08***	−0.25*	(5)	−0.34*
	(2.04)	(0.30)	(0.52)	(0.46)		(0.22)

Notes: The model has no deterministic trend in data, but it has intercept in Bulgaria, Estonia, Hungary, Latvia, and Slovenia. The model includes linear trend in data with intercept in Belarus, Czech Republic and Poland. Finally, it includes linear trend in data with intercept and trend in Croatia, Lithuania, Romania, and Turkey.

The last column provides the error correction terms. Standard errors are in parentheses. EC, error correction; NFA, net foreign assets; RP, relative productivity; TNT, non-traded to traded goods; TOT, terms of trade.

*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

findings support the idea that an increase in the relative price of non-tradable goods causes real appreciation in seven out of 11 countries. The findings provide a weak support for a link between increased productivity, which causes higher relative price of non-tradable goods, and real appreciation. Only four out of 13 countries show the RP causing real appreciation. It means that an increase in the RP does not cause structurally higher inflation. These results support the study of Jakab and Kovács (2000) and Cipriani (2001) and raise concern that a more detailed analysis of the link between the RP changes and relative prices of non-tradable goods is required.

The fourth column shows the long-run effect of NFA on the RER as most coefficients are found statistically significant. The sign of the coefficients varies across countries, which is similar to other studies such as Égert et al. (2006). The positive sign, for which the asset accumulation causes real appreciation, is found statistically significant only in Belarus, Bulgaria, Estonia, Latvia, Romania, and Slovakia. The magnitudes are slightly lower than other determinants, supporting

TABLE 4 Multivariate residual diagnostics

	Autocorrelation		Normality	Heteroscedasticity
	LM(1)	LM(2)	JB	White
Belarus	25.76	23.72	7.85	561.76
Bulgaria	24.53	26.63	8.54	666.50
Croatia	15.58	23.39	5.39	791.76
Czech Rep.	23.99	31.93	10.98	975.67
Estonia	19.69	20.70	17.85	893.69
Hungary	29.97	24.78	6.66	1039.16
Latvia	29.35	27.48	14.94	936.70
Lithuania	35.71	22.84	12.54	516.56
Poland	34.51	30.52	9.09	622.74
Romania	17.29	28.81	4.88	1072.20
Slovak Rep.	10.43	9.89	12.22	868.02
Turkey	34.39	31.21	17.28	1043.81

Note: LM represents the Lagrange multiplier test and JB represents Jarque–Bera test for Equation (1).

a weak effect of NFA on the RER, whereas the magnitude is slightly higher only in Hungary and Turkey. The sign is negative for most of the countries due to the inverse relationship between trade balance and the price of non-tradable goods. This is applicable to countries with rapid growth forecasts, particularly in transition economies. The results of the cointegration regressions clearly present a long-run relationship between the RER and its determinants. Nevertheless, the short-run response to the long-run equilibrium is significant in half of the estimations with a correct sign (see the last column in Table 3). The nature of these kinds of economic decisions suggests that the error correction (EC) mechanism could arise from forward-looking behavior, and it could also reflect expectations surrounding future events (Alogoskoufis & Smith, 1991). When the (EC) representations cannot adequately capture short-run expectations, then the estimated (EC) coefficient leads to misleading results (Antzoulatos, 1996). Varying expectations of the consumers and investors toward appreciating and depreciating domestic currency will further be analyzed in a nonlinear framework in Section 5.

Table 4 shows the multivariate residual diagnostic tests for RER estimations with the Johansen cointegration method. Due to space consideration, the Lagrange multiplier (LM) autocorrelation tests with only 1 and 2 lags are presented; the results show that there is no autocorrelation in country estimations. All error terms are normally distributed, and there is no heteroscedasticity.[7]

Measuring the effect of exchange rate misalignment, that is, over- or undervalued currency, on real money demand for the EEC constitutes an important contribution of this paper. RER misalignments result in severe welfare and efficiency costs, the biggest of which come from the exchange and trade controls that usually accompany overvaluation (Edwards, 1989). Table 5 shows the misalignment of the RER, which is obtained by using the error term estimates in Equation (2).

[7] Alternatively, the stability tests are employed for RER model by using multiple structural breaks with unknown dates. The results show that joining euro did not cause any structural breaks in countries such as Estonia, Latvia, and Lithuania, which became part of the eurozone within the timeframe selected for the study. One possible explanation is that these countries have already aligned their economies with the eurozone members, and they maintained exchange rate and price stability long before the actual date. The tests results are not reported due to space consideration, but they are available upon request.

TABLE 5 Descriptive statistics for the RER misalignments

	Mean								
	Before crisis	**Crisis**	**After crisis**	**Maximum**	**Minimum**	**S.D.**	**Skewness**	**Kurtosis**	**JB**
Belarus	0.0071	−0.0125	−0.0021	0.1266	−0.1869	0.06	−0.50	3.27	3.31
Bulgaria	−0.0004	0.0083	−0.0014	0.0356	−0.0286	0.01	0.27	3.49	1.64
Croatia	−0.0004	0.0033	−0.0004	0.0179	−0.0221	0.01	0.04	2.87	0.07
Czech Rep.	0.0001	−0.0029	0.0006	0.0406	−0.0299	0.01	0.21	3.41	1.09
Estonia	−0.0001	0.0026	−0.0004	0.0267	−0.0233	0.01	0.11	3.14	0.20
Hungary	0.0002	0.0013	−0.0004	0.0534	−0.0490	0.02	0.04	2.61	0.50
Latvia	−0.0003	0.0039	−0.0006	0.0221	−0.0191	0.01	0.20	2.70	0.81
Lithuania	−0.0019	0.0106	−0.0008	0.0422	−0.0467	0.02	−0.17	4.00	3.00
Poland	0.0036	−0.0049	−0.0015	0.0762	−0.0846	0.03	−0.17	2.90	5.87
Romania	−0.0009	0.0043	−0.0002	0.0297	−0.0346	0.01	−0.02	2.39	1.14
Slovak Rep.	−0.0004	0.0045	−0.0007	0.0289	−0.0324	0.01	−0.30	3.84	3.32
Turkey	0.0014	0.0056	−0.0020	0.1046	−0.1557	0.05	−0.39	3.51	2.69

It represents the deviation of the actual value from its fundamental value. The negative signs show currencies that are undervalued, and the positive signs show the ones that are overvalued. The average values of the misalignment are calculated between three different time periods: before the crisis (2001–2007), during the European debt crisis (2008–2009), and the post-crisis period (2009–2019)[8]. Table 5 showed that the RERs in seven out of 12 countries were undervalued before the crisis. The highest misalignments were in Belarus and Poland, and both currencies were overvalued during the pre-crisis period. Belarus had by far the highest misaligned currency among all other currencies During the crisis period, misalignments, in absolute values, were significantly greater, and all countries, except Belarus, Czech Republic, and Poland, had overvalued their currencies. The greatest misaligned currencies were in Belarus, Lithuania, and Bulgaria. Since the financial crisis, all currencies except in the Czech Republic were undervalued, the highest misalignments being in Belarus, Turkey, Poland, and Bulgaria. One possible explanation for a more harmonized behavior of the national currencies could be attributed to the fact that five of these currencies were replaced by the euro. There had been a significant increase in the speed of reserve accumulation in European countries since the 2008 Financial Crisis, so countries were likely to respond more aggressively to an exchange rate appreciation (Uz Akdogan, 2020). There is clear evidence that the behavior of the RER was different before, during, and after the crisis. This might question the stability of the coefficients, particularly in the money demand model, and support the idea of using nonlinear estimations to deal with such problems.

5 | NONLINEAR ESTIMATE OF THE MONEY DEMAND FUNCTION

The main aim of the analysis is to examine the nonlinear behavior of money demand to RER misalignments. Various economic developments experienced by the EEC lead to structural breaks and regime shifts in the demand for money. Nonlinearity or regime-switching behavior for those

[8] The European debt crisis had a prolonged impact on these economies; thus, the crisis period used here is useful to show the initial response of misalignment to the crisis.

"catching-up" economies will allow us to identify different regimes that are endogenously determined from the data (Cheikh & Zaied, 2020). Initial data analysis starts with the scatter diagram in Figure 1, and it shows the nonlinear relationship between money demand, which is represented in the horizontal axis, and RER misalignment, which is represented in the vertical axis.[9]

The nonlinear behavior of money demand to RER misalignments is tested by using the STAR time series model (Teräsvirta, 1994). One of the advantages of the STAR model application is to allow testing for the state-dependent behavior of money demand. Following Cuestas et al. (2020), the equation becomes as follows:

$$\Delta MD_t = \mu_t + \left[\pi_0 \Delta \widehat{MIS}_t + \Pi' \Delta V_t\right](1 - F(s_i;\gamma,c)) + \left[\lambda_0 \Delta \widehat{MIS}_t + \Lambda' \Delta V_t\right](F(s_i;\gamma,c)) + u_t, \tag{6}$$

where $F(.)$ is the transition function used to estimate the nonlinear model. The vector V includes variables of the lagged-dependent variable and other explanatory variables such as fundamental exchange rate, income, and interest rate. Π and Λ represent the 1 x K vectors of coefficients. $F(.)$ is a continuous function that is bounded between 0 and 1 so that the coefficients vary between two regimes, and the transition from one regime to the other is smooth. The coefficient of the misalignments varies between π and λ, and the coefficients of the other explanatory variables from vector $V(v_k)$ vary between π_k and λ_k (with $k = 1, 2, \ldots K$).

It is a common choice for the transition function to take the first-order logistic function as (Dijk et al., 2002; Granger & Teräsvirta, 1993; Teräsvirta, 1994)

$$F(s_i;\gamma,c) = [1 + exp(-\gamma(s_t - c))]^{-1}, \ \gamma > 0, \tag{7}$$

where the parameter restriction is an identifying restriction. The transition function implies that the regime-switching model allows two regimes, associated with the extreme values of the transition function so that the function changes monotonically. The function becomes either $F(-\infty) = 0$ or $F(\infty) = 1$, while $F(c;\gamma,c) = 0.5$. $F(.)$ contains a transition variable, s_t, a slope parameter, γ, and the location (threshold) parameter, c. The exchange rate misalignment is selected as a transition variable, and the slope parameter determines the speed and smoothness of the change of intercept and the coefficients from one regime to another. As γ becomes very large, the change of function from 0 to 1 becomes instantaneous at $s_t = c$ (Dijk et al., 2002). When $\gamma \to 0$, the model becomes closer to being linear, and when $\gamma = 0$, all coefficients present a linear relationship (Fok et al., 2005). The location parameter shows the threshold between two regimes, and it determines the point at which the regimes are equally weighted.

5.1 | Empirical results

The results of the STAR model are presented in Table 6, Panels A and B. Table 6, Panel A, shows the coefficients for two regimes where $F(.) = 0$ refers to the linear part of the model, with threshold varying regressors when there is undervaluation, and $F(.) = 1$ refers to the nonlinear part of the model when there is an overvaluation of the RER. The middle column between $F() = 0$ and

[9] The correlation between the demand for money and misalignment is more visible when misalignment is further analyzed as undervaluation and overvaluation of the domestic currency. For example, the correlation between demand for money and overvalued currency is visible in Belarus, Bulgaria, Lithuania, Poland, Slovak Republic, and Turkey. The correlation is visible for undervalued currency in Croatia, Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, and Turkey.

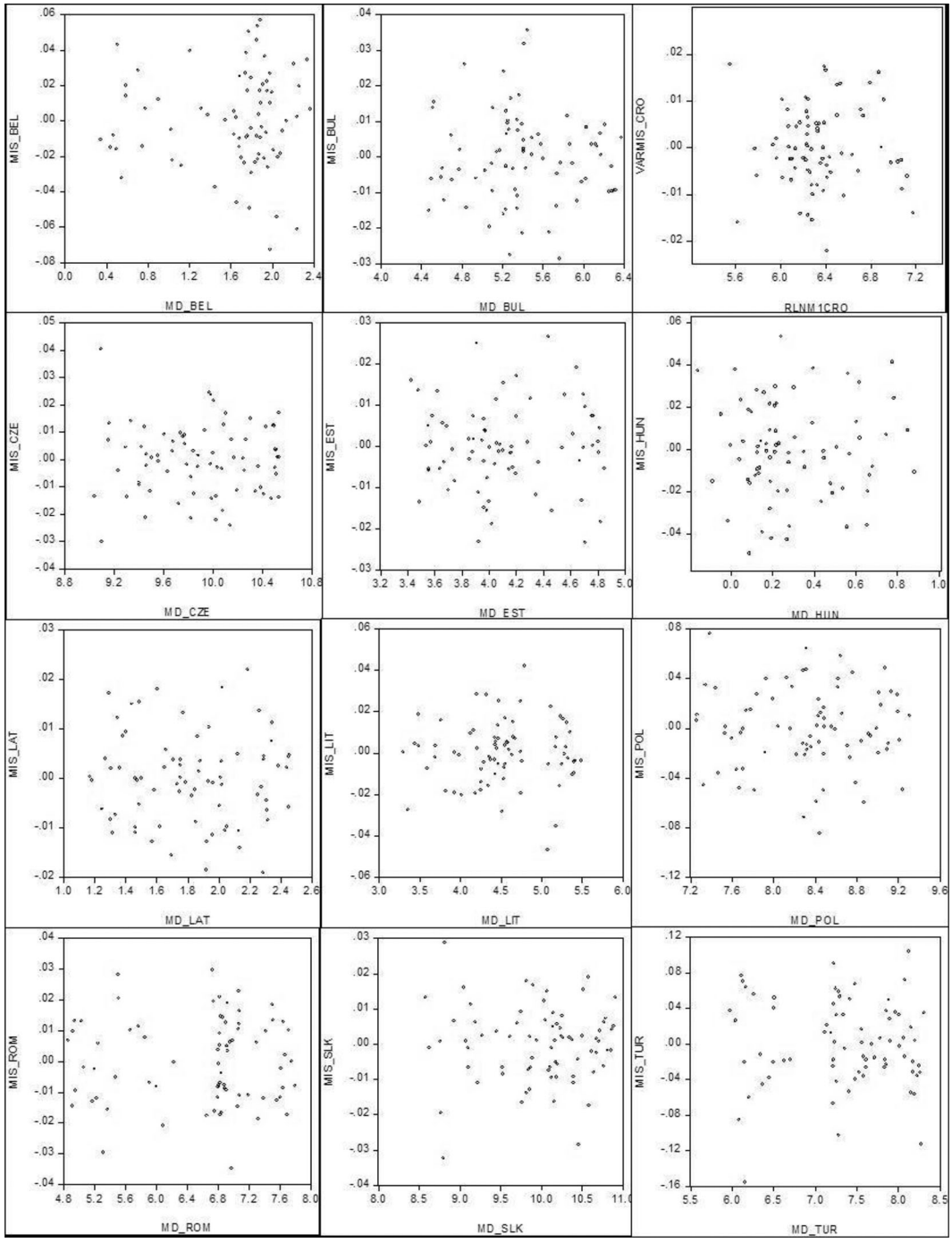

FIGURE 1 Money demand and RER misalignments.

Note: The countries included in the scatter diagram are Belarus (BEL), Bulgaria (BUL), Croatia (CRO), Czech (CZE), Estonia (EST), Hungary (HUN), Latvia (LAT), Lithuania (LIT), Poland (POL), Romania (ROM), Slovak Republic (SLK), and Turkey (TUR).

TABLE 6 Domestic money demand with Smooth Threshold Autoregressive Regression (STAR) model

	Misalignment		Lagged money demand		Fundamental exchange rate		Income		Interest rate	
Panel A	***F*() = 0**	***F*() = 1**	***F*() = 0**	***F*() = 1**	***F*() = 0**	***F*() = 1**	***F*() = 0**	***F*() = 1**	***F*() = 0**	***F*() = 1**
Belarus	−1.134***	1.455***		0.069*		0.871***	0.031*		−0.012	
	(0.28)	(0.49)		(0.04)		(0.07)	(0.02)		(0.03)	
Bulgaria	0.722**	−3.780***		0.161		−5.825***	0.009		0.022	
	(0.36)	(0.82)		(0.18)			(0.01)		(0.01)	
Croatia	4.498***	−4.679***	−0.183*	(0.97)		0.376	0.251***		−0.088***	
	(1.16)	(1.55)	(0.10)			(0.23)	(0.03)		(0.02)	
Czech Rep		−0.189**	0.216**			−0.166**	0.224***			0.239***
		(0.08)	(0.12)			(0.10)	(0.04)			(0.07)
Estonia	13.109***	−13.851***	0.119		−0.599			0.329***	−0.008	
	(2.38)	(2.39)	(0.09)		(0.55)			(0.09)	(0.02)	
Hungary		−1.925**		−0.611***		−1.012***	0.100		−0.049***	
		(0.92)		(0.08)		(0.34)	(0.18)		(0.02)	
Latvia		−20.498***		−5.275***	−0.930*			0.144***		0.557***
		(0.98)		(0.24)	(0.47)			(0.05)		(0.01)
Lithuania	0.245	−3.452**	0.014		0.102		0.159**	0.439**	−0.041***	
	(0.41)	(0.62)	(0.10)		(0.15)		(0.21)	(0.21)	(0.01)	
Poland	1.891**	−2.012**		0.220**		−0.100***	−0.010		−0.297	0.297
	(0.87)	(0.80)		(0.12)		(0.01)	(0.03)		(0.20)	(0.21)
Romania		−2.672**		2.143***	0.166		0.187***		0.001	
		(1.06)		(0.53)	(0.29)		(0.03)		(0.01)	
Slovakia	2.142***	−2.459***	−0.094**		2.436***	−2.925***	−0.038		−0.042***	
	(0.68)	(0.69)	(0.04)		(0.36)	(0.40)	(0.05)		(0.01)	
Turkey		−0.209**	0.362993	−0.421		−0.212***	0.329***		−0.008***	
		(0.09)	(1.22)	(1.27)		(0.08)	(0.06)		(0.00)	

(Continues)

TABLE 6 (Continued)

Panel B	γ	Threshold	Linearity test	Adj. R^2	Transition variable[a]
Belarus	282.37***	−0.023***	6.27***	0.32	MIS (1)
Bulgaria	1953.47**	0.018***	2.83**	0.24	MIS (2)
Croatia	653.32**	−0.021***	2.39*	0.32	MIS (1)
Czech Rep.	443.97*	−0.022***	2.73**	0.43	MIS
Estonia	835.13**	−0.024***	3.15**	0.12	MIS (1)
Hungary	760.17**	−0.016***	5.48***	0.32	MIS
Latvia	1076.95	0.020	2.32**	0.47	MIS (1)
Lithuania	3860.12	0.027	5.11***	0.42	MIS (1)
Poland	72.83**	−0.089***	2.46**	0.18	MIS
Romania	7396.96	0.019	2.66**	0.49	MIS (1)
Slovakia	259.04***	−0.018***	3.05**	0.21	MIS (2)
Turkey	554.81	−0.043***	1.96*	0.26	MIS (2)

Note: In Panel A, standard errors are in parentheses.

[a] All transition variables are at their first differences in Panel B, and parentheses show the number of lags.

*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

$F() = 1$ shows coefficients in the linear part with the threshold non-varying regressors in the STAR model.

Transition variables for each country include the misalignment variable (MIS) at level, its first lag or second lag. All regressions include the misalignment, lagged-dependent variable and other explanatory variables such as fundamental RERs, income, and interest rates. Following Colletaz and Hurlin (2006), Kadilli and Markov (2012), and Cuestas et al. (2020), it is the sign of the coefficients that can be interpreted in a direct manner. The values of the estimated coefficients will be ignored due to the fact that they are not directly interpretable. All coefficients for the misalignments are statistically significant when there is overvaluation. They are statistically significant at 1% in Belarus, Bulgaria, Croatia, Estonia, Latvia, and Slovak Republic and at 5% for the rest of the countries. When the currency is undervalued, the coefficients are statistically significant in all countries, except Lithuania. They are statistically significant at 1% in Belarus, Croatia, Estonia, and Slovak Republic and at 5% in Bulgaria and Poland. The results show that overvalued RER causes less demand for domestic currency purely because an overvaluation of the domestic currency will turn expectations into a future devaluation while reducing the current demand for domestic currency. This is consistent with the study of Ivanovski and Churchill (2019) where currency appreciations are more important than currency depreciations, particularly those supporting the expectations of the effect of exchange rate movements on demand for money. Another interpretation of the behavior of monetary aggregates includes the response of central banks toward misalignment. If the domestic currency is overvalued, meaning the consumer prices are higher at home than abroad, it is a sign of an overheated economy. According to World Bank data, some of these countries hit record growth rates such as 11.5% in Belarus (2004), 12% in Latvia (2006), 11.1% in Lithuania (2007), and 9.3% in Romania (2008). In many countries, apart from Turkey, the European debt crisis marked a record of negative growth rates at around 15% in countries such as Latvia, Lithuania, and Estonia in 2009. Turkey, on the other hand, had a gradual reduction from 11.2% in 2011, to 8.5% in 2013, then to 3.2% in 2016. The overvaluation of domestic currencies is evident in Table 5 for the periods before and during the crisis. In order to eliminate the undesirable effects of overvaluation on exports and growth, central banks conduct contractionary policies resulting in a reduction of monetary aggregates. Table 6, Panel A, shows that while the overvaluation is causing reduction in money demand, undervaluation, on the contrary, is causing an increase in demand for domestic currency. Undervaluation is associated with consumer prices being lower at home than abroad, which leads to an increase in monetary aggregates and an expansion of the production of tradables. The money demand in Belarus demonstrates a contrasting behavior, compared to the rest of the countries. One possible explanation is that it is the only country that has a monetary anchor as a policy framework, which limits the availability of monetary aggregates as a policy instrument (see Table 1).

Table 6, Panel A, allows for nonlinearities in the effect of the other determinants of money demand. There is strong evidence for the fundamental exchange rate to have a negative coefficient when there is overvaluation in most of the selected countries. The fundamental exchange rate provides evidence of nonlinearity in Slovakia, which shows a negative coefficient when the economy is running with overvaluation and a positive coefficient when there is undervaluation. Nonlinearity is evident for income with a positive sign only in Estonia and Latvia when the currency is overvalued and positive for Lithuania when the currency is both over and undervalued. For the rest of the countries in the table, it performs linear relation with the correct sign. Nonlinearity is valid for interest rate only in Czech Republic and Latvia and has a positive sign when the currency is overvalued. This means that when the currency is overvalued, increasing interest rate does not increase incentives for higher saving rates, as

TABLE 7 Foreign money demand with STAR model

	Misalignment		lagged capital outflow		Exchange rate		Income		Interest rate	
Panel A	***F*() = 0**	***F*() = 1**	***F*() = 0**	***F*() = 1**	***F*() = 0**	***F*() = 1**	***F*() = 0**	***F*() = 1**	***F*() = 0**	***F*() = 1**
Belarus	−0.002	−0.020**		−4.11289***		0.00797*	0.000*		0.000	
	(0.00)	(0.01)		(0.15)		(0.00)	(0.00)		(0.00)	
Bulgaria		0.462**		−0.58063***	1.695**	−1.58267**	0.000*	0.000**	−0.01095	0.00
		(0.23)		(0.07)	(0.77)	(0.74)	(0.00)	(0.00)	(0.01)	(0.00)
Croatia	−2.592***	2.809***		−0.45671***		−0.20582	0.038		0.001	
	(0.43)	(0.57)		(0.09)		(0.34)	(0.03)		(0.02)	
Czech Rep.	−1.156***	1.229***		−0.33797***	0.048		−0.270***	0.262***		−0.00788**
	(0.10)	(0.16)		(0.08)	(0.09)		(0.00)	(0.04)		(0.00)
Estonia	1.551*	-2.374***		−0.52339***	−0.295		−0.9584***	1.071***		−0.03926**
	(0.90)	(0.54)		(0.18)	(0.83)		(0.11)	(0.18)		(0.02)
Hungary	0.058**	2.808***	−0.43035***	3.213***	−0.01739	-1.08043***		−0.050***		−0.163***
	(0.02)	(0.19)	(0.09)	(0.12)	(0.02)	(0.01)		(0.01)		(0.01)
Latvia	0.513	−1.230*		−1.19641***	−0.526		−0.2443	0.441**	0.034	−0.17785***
	(0.51)	(0.72)		(0.27)	(0.70)		(0.16)	(0.51)	(0.03)	(0.06)
Lithuania		1.925***	−0.424***			0.581**		0.752018***		−0.0474***
		(0.67)	(0.06)			(0.22)		(0.06)		(0.00)
Poland		0.052**		−0.40***	0.033			−0.04854		0.000
		(0.02)		(0.11)	(0.04)			(0.02)		(0.00)
Romania		0.064		−0.93354***	−0.08675	0.132995		0.000		0.000
		(0.04)		(0.19)	(0.06)	(0.13)		(0.00)		(0.00)
Slovakia	−0.331	−3.118***	−0.52018***			2.894**	−0.012		−0.043***	
	(0.73)	(1.15)	(0.00)			(1.17)	(0.08)		(0.01)	
Turkey		0.066**		−1.26676**	−0.013			0.010	0.000*	
		(0.03)		(0.20)	(0.01)			(0.01)	(0.00)	

(Continues)

TABLE 7 (Continued)

Panel B	Slope	Threshold	Linearity test	Adj. R^2	Transition variable[a]
Belarus	8224.82	0.013***	9.94***	0.15	MIS (1)
Bulgaria	528.06	−0.029***	4.31**	0.32	MIS (1)
Croatia	8627.12	−0.020	3.82***	0.24	MIS (1)
Czech Rep.	6520.59	−0.027***	2.08*	0.11	MIS (1)
Estonia	709.53	−0.022***	6.17***	0.33	MIS (2)
Hungary	277.66*	0.050***	3.38***	0.52	MIS (1)
Latvia	1027.47	0.004***	2.69**	0.18	MIS (1)
Lithuania	4416.73	0.025***	2.51**	0.28	MIS
Poland	2317.33	−0.053***	5.34***	0.31	MIS (2)
Romania	167.97	−0.015***	6.91***	0.42	MIS (1)
Slovakia	69.38*	0.049***	2.86**	0.35	MIS (2)
Turkey	26.34**	0.046***	5.42***	0.34	MIS (2)

Note: In Panel A, standard errors are in parentheses.

[a] All transition variables are at their first differences in Panel B, and parentheses show the number of lags.

*, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively.

TABLE 8 The volatility of money demand

	Domestic money demand			Foreign money demand		
	Maximum	Minimum	S.D.	Maximum	Minimum	S.D.
Belarus	0.2181	−0.2563	0.0899	0.0264	−0.0027	0.0030
Bulgaria	3.9576	−7.6960	1.2194	0.1207	−0.0894	0.0341
Croatia	1.2840	−0.1818	0.1522	0.0755	−0.0794	0.0277
Czech Rep.	0.0719	−0.0791	0.0263	0.0408	−0.0520	0.0186
Estonia	0.1492	−0.2088	0.0499	0.1460	−0.1448	0.0629
Hungary	0.7555	−0.7554	0.1781	0.0338	−0.0581	0.0148
Latvia	0.1217	−0.2705	0.0630	0.1758	−0.3451	0.0751
Lithuania	0.2858	−0.1231	0.0586	0.1434	−0.1178	0.0385
Poland	0.0945	−0.0661	0.0321	0.0667	−0.0482	0.0138
Romania	0.4257	−0.1499	0.0807	0.0473	−0.0483	0.0094
Slovakia	0.1695	−0.1001	0.0478	0.2716	−0.2585	0.0762
Turkey	0.4920	−0.1502	0.0827	0.0187	−0.0167	0.0067

increasing expectations of future depreciation lead to an increase in current demand for domestic currency.

One of the advantages of the STAR model is that the value of the threshold is unknown, and it is estimated along with the other parameters. Table 6, Panel B, shows that threshold values are very similar in all selected countries with a low value of −0.02, except where it has a positive sign with a value of 0.01 in Bulgaria, and it is slightly higher in Poland with −0.09. The negative sign shows that the money demand is more persistent in undervalued regimes than the overvalued regimes, and shocks causing undervaluation do not readily decay to zero. The transition between the two regimes is very rapid given the large magnitude of γ. Furthermore, the linearity is rejected for all selected countries, confirming nonlinear behavior of money demand to misalignments and its other determinants.

Table 7 shows the domestic investors' demand for foreign assets as a proxy for foreign money demand and replaces real money demand in Equation (6) with capital outflow. Another difference in Table 7 is that the fundamental exchange rate is replaced with actual rate. There is clear evidence of nonlinearity for the behavior of foreign money demand. The results show high consistency with domestic money demand and demonstrate a similarity in terms of a significant influence of overvaluation on the determinants. When the domestic currency is overvalued, there is higher demand for foreign money in turn causing the domestic money holders to switch from domestic currency to foreign currency. However, in Estonia, Latvia, and Slovakia, the negative sign can be explained by the fact that these countries are part of eurozone and that the overvaluation caused reduction of foreign assets (which are also mostly denominated in euros). Table 8 shows the volatility of the money demand in its first difference and how the volatility of the foreign money demand is higher than domestic demand only for these three countries. Thus, for eurozone members, overvaluation causes reduction not only in domestic currency but also in foreign assets that are denominated in euros. When the currencies are undervalued in Croatia and Czech Republic, there is a reduction in demand for foreign currency. As for the other explanatory variables, overvaluation is more significant for the exchange rate with varying sign, and overvaluation increases demand for foreign money. Finally, when there is overvaluation, reduction in domestic interest rates increases demand for foreign assets; this is consistent with the theory.

6 | CONCLUSION

Financial liberalization in emerging economies has provided households with a wider variety of choices for assets and transactions, and these choices play an important role for better understanding the monetary transition mechanism. Although there is vast literature for both the impact of exchange rates on money demand and the impact of exchange rate misalignments on economic growth or trade, there is little attention paid to the role of misalignments in the demand for money.

The long-run determinants of the RERs in a group of EEC are useful in estimating the equilibrium exchange rate. Both the signs of the coefficients and the direction of the misalignments are highly consistent with results in related literature. The major focus of the analysis was to study the impact of exchange rate misalignments on the behavior of domestic and foreign money demand. The results show that misalignments have a nonlinear relationship with the demand for both domestic and foreign currency. Furthermore, this nonlinearity also affects the behavior of other money demand determinants, thus making it vital in understanding the behavior of these variables in the transmission mechanism. The undervaluation experienced before the crisis in many EEC becomes more persistent since the crisis in all of the EEC, except Czech Republic. This persistency is mainly due to the tenacious character of central banks toward overvalued currencies. Simply put, there is less demand for the domestic currency when the currency is overvalued and more demand when it is undervalued. Furthermore, the results show that there is a shift of preference from domestic to foreign currency when the domestic currency is overvalued. This explains the reason why central banks use foreign reserves as conventional monetary policy instruments not only to manage nominal exchange rate movements but also to respond to RER misalignments.

This paper brings to light some important monetary policy implications for decision-makers to take into consideration. The RER misalignments do not only impact demand for money via changing expectations, but they also impact the performance of the central bank as overvaluation limits the use of conventional monetary policy instruments. This may cause a relatively serious problem in emerging economies, especially when central banks target these misalignments with inflation and output goals.

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REFERENCES

Aguirre, A., & Calderon, C. (2005). *The real exchange rate misalignments and economic performance*. (Working Paper No. 315), Central Bank of Chile.

Albulescu, C. T., Pépin, D., & Miller, S. M. (2019). The micro-foundations of an open economy money demand: An application to the Central and Eastern European Countries (May 21, 2018). *Journal of Macroeconomics*, *60*(C), 33–45.

Alogoskoufis, G., & Smith, R. (1991). On Error Correction Models: Specification, interpretation, estimation. *Journal of Economic Surveys*, *5*(1), 97–128.

Antzoulatos, A. A. (1996). Error correction mechanism and short-run expectations. *Southern Economic Journal*, *62*(4), 845–855.

Bahmani, S. (2011). Exchange rate volatility and demand for money in less developed countries. *Journal of Economics and Finance*, *37*, 442–452.

Bahmani-Oskooee, M., & Baek, J. (2017). Do exchange rate changes have symmetric or asymmetric effects on the demand for money in Korea. *Review of Economic Analysis*, *9*(2), 155–168.

Bahmani-Oskooee, M., & Bahmani, S. (2015). Nonlinear ARDL approach and the demand for money in Iran. *Economics Bulletin*, *35*(1), 381–391.

Bahmani-Oskooee, M., & Fariditavana, H. (2016). Nonlinear ARDL approach and the J-curve phenomenon. *Open Economies Review*, *27*(1), 51–70.
Bahmani-Oskooee, M., F, H., & S, B. (2017). Do exchange rate changes have symmetric or asymmetric effects on the demand for money in Turkey? *Applied Economics*, *49*(42), 4261–4270.
Bahmani-Oskooee, M., & Malixi, M. (1991). Exchange rate sensitivity of the demand for money in developing countries. *Applied Economics*, *23*(8), 1377–1384.
Bahmani-Oskooee, M., & Rehman, H. (2005). Stability of the money demand function in Asian developing countries. *Applied Economics*, *37*, 773–792.
Bahmani-Oskooee, M., & Tanku, A. (2006). Black market exchange rate, currency substitution and the demand for money in LDCs. *Economic Systems*, *30*, 249–263.
Baumol, W. J. (1952). The transactions demand for cash: An inventory theoretic approach. *Quarterly Journal of Economics*, *66*(4), 545–556.
Benchimol, J., & Quereshi, I. (2020). Time-varying money demand and real balance effects. *Economic Modelling*, *87*, 197–211.
Bergstrand, J. H. (1991). Structural determinants of real exchange rates and national price levels: Some empirical evidence. *American Economic Review*, *81*, 325–34.
Bernanke, B. S., & Mishkin, F. S. (1997). Inflation targeting: A new framework for monetary policy? *Journal of Economic Perspectives*, *11*(2), 97–116.
Blaszkiewicz, M., Kowalski, P., Rawdanowicz, L., & Wozniak, P. (2004). *Harrod-Balassa-Samuelson effect in selected countries of Central and Eastern Europe*. Case Reports No. 57, Center for Social and Economic Research.
Buiter, W. H., & Miller, M. H. (1982). Real exchange rate overshooting and the output cost of bringing down inflation. *European Economic Review*, *18*(1), 85–123.
Cagan, P. (1956). The monetary dynamics of hyperinflation. In D. Meiselman (Ed.), *Varieties of monetary experience*. University of Chicago Press, 25–117.
Calvo, G., & Reinhart, C. (2002). Fear of floating. *The Quarterly Journal of Economics*, *117*(2), 379–408.
Cashin, P., & McDermott, C. J. (1998). *Terms of trade shocks and the current account*. (Working Paper No. WP/98/177), IMF.
Cheikh, N. B., & Zaied, Y. B. (2020). Revisiting the pass-through of exchange rate in the transition economies: New evidence from new EU member states. *Journal of International Money and Finance*, *100*, 102093.
Cheung, Y. W., & Fujii, E. (2011). Exchange rate misalignment estimates—-Sources of differences. *BOFIT Discussion Papers*, 25.
Cipriani, M. (2001). *The Balassa-Samuelson effect in transition economies, mimeo*, IMF, Washington, September.
Clark, P., & MacDonald, R. (1999). Exchange rates and economic fundamentals: A methodological comparison of BEERs and FEERs. In J. Stein, & R. MacDonald (Eds.), *Equilibrium exchange rates*. Kluwer Academic Publishers, 285-322.
Colletaz, G., & Hurlin, C. (2006). *Threshold effect in the public capital productivity: An international panel smooth transition approach*. Document de Recherche du Laboratoire d'Economie d'Orléans 2006-01. https://shs.hal.science/halshs-00008056/document
Corsetti, G., Dedola, L., & Leduc, S. (2020). *Exchange rate misalignment and external imbalances: What is the optimal monetary policy response?* (Working Paper 2020-04), Federal Reserve Bank of San Francisco.
Couharde, C., & Sallenave, A. (2013). How do currency misalignments' threshold affect economic growth? *Journal of Macroeconomics*, *36*, 106–120.
Cuddington, J. (1986). *Capital flight: Estimates, issues, and explanations*. Princeton University Press.
Cuestas, J. C., Mourelle, E., & Regis, P. J. (2020). Real exchange rate misalignments in CEECs: Have they hindered growth? *Empirica*, *47*, 733–756.
Cziráky, D., & Gillman, M. (2006). Money demand in an EU accession country: A VECM study of Croatia. *Bulletin of Economic Research*, *58*(2), 105–127.
Daniele, V., Foresti, P., & Napolitano, O. (2017). The stability of money demand in the long-run: Italy 1961–2011. *Cliometrica*, *11*, 217–244.
Daude, C., Yeyati, E. L., & Nagengast, A. (2016). On the effectiveness of exchange rate interventions in emerging markets. *Journal of International Money and Finance*, *64*, 239–261.
De Gregorio, J., & Wolf, H. C. (1994). *Terms of trade, productivity and the real exchange rate*. (Working Paper 4807), The National Bureau of Economic Research.

Dijk, D., Teräsvirta, T., & Frances, P. H. (2002). Smooth transition autoregressive index: A survey of recent developments. *Econometric Reviews*, *21*(1), 1–47.

Dreger, C., Gerdesmeier, D., & Roffia, B. (2019). Re-vitalizing money demand in the Euro area. Still valid at the zero-lower bound. *Bulletin of Economic Research*, *71*, 599–615.

Dreger, C., Reimers, H. -E., & Roffia, B. (2007). Long-run money demand in the new EU member states with exchange rate effects. *Eastern European Economics*, *45*(2), 75–94.

Duca, J. V., & VanHoose, D. (2004). Recent developments in understanding the demand for money. *Journal of Economics and Business*, *56*(4), 247–272.

Edwards, S. (1989). Exchange rate misalignment in developing countries. *The World Bank Research Observer*, *4*(1), 3–21.

Égert, B. (2003). Investigating the Balassa-Samuelson hypothesis in transition: Do we understand what we see? A panel study. *Economics of Transition and Institutional Change*, *10*(2), 273–309.

Égert, B., Lommatzsch, K., & Lahrèche-Révil, A. (2006). Real exchange rates in small open OECD and transition economies: Comparing apples with orange? *Journal of Banking and Finance*, *30*, 3393–3406.

Eichengreen, B., & Goulder, L. H. (1991). The impact of permanent and temporary import surcharges on the U.S. trade deficit. In R. E. Baldwin (Ed.) *Empirical studies of commercial policy*. University Chicago Press, 2245–286.

Engel, C. (2011). Currency misalignments and optimal monetary policy: A reexamination. *American Economic Review*, *101*, 2796–2822.

Fidora, M., Giordano, C., & Schmitz, M. (2021). Real exchange rate misalignments in the euro area. *Open Economies Review*, *32*, 71–2021.

Fidrmuc, J. (2009). Money demand and disinflation in selected CEECs during the accession to the EU. *Applied Economics*, *41*(10), 1259–1267.

Fleming, M. (1962). Domestic financial policies under fixed and floating exchange rates. *IMF Staff Papers*, *9*, 369–79.

Fok, D., van Dijk, D., & Frances, P. H. (2005). A multi-level panel STAR model for US manufacturing sectors. *Journal of Applied Economics*, *20*(6), 811–827.

Frait, J., Komárek, L., & Melecký, M. (2006). *The real exchange rate misalignment in the five central European countries*. Warwick Economic Research Papers No 739.

Freidman, M. (1956). The quantity theory of money: A restatement. In M. Friedman (Ed.), *Studies in the quantity theory of money*. University of Chicago Press, Chicago, 3–21.

Granger, C. W. J., & Teräsvirta, T. (1993). *Modelling nonlinear economic relationships*. Oxford University Press.

Guzman, M., Ocampo, J. E., & Stiglitz, J. E. (2018). Real exchange rate policies for economic development. *World Development*, *110*, 51–62.

Harberger, A. C. (1950). Currency depreciation, income and the balance of trade. *Journal of Political Economy*, *58*, 47–60.

Harkness, J. (1982). Intermediate imports, expectations and stochastic equilibrium under flexible exchange rates. *The Canadian Journal of Economics*, *15*(1), 118–143.

Hayo, B. (1999). Estimating a European demand for money. *Scottish Journal of Political Economy*, *46*(3), 221–244.

Hendry, F. D., & Ericsson, R. N. (1990). *Modelling the demand for narrow money in the United Kingdom and the United States*. Board of Governors of the Federal Reserve System International Finance Discussion Papers No. 383.

Hsieh, W. -J., & Hsing, Y. (2009). Tests of currency substitution, capital mobility and nonlinearity of Hungary's money demand function. *Applied Economics Letters*, *16*, 959–964.

Huizinga, H. (1997). Real exchange rate misalignment and redistribution. *European Economic Review*, *41*(2), 259–277.

Ivanovski, K. S. A. C. (2019). Economic policy uncertainty and the demand for money in Australia. *Applied Economics*, *51*(3), 4516–4526.

Jakab, Z. M., & Kovács, M. A. (2000). Determinants of real exchange rate fluctuations in Hungary. *Russian and East European Finance and Trade*, *36*(3), 64–94.

Jongwanich, J. (2009). *Equilibrium real exchange rate, misalignment and export performance in developing Asia*. SSRN Electronic Journal.151. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1604839

Kadilli, A., & Markov, N. (2012). *A panel smooth transition regression model for the determinants of inflation expectations and credibility in the ECB and the recent financial crisis*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1903853

Karpetis, C., Papadamou, S., Spyromitros, E., & Varelas, E. (2019). Optimism-pessimism effects on monetary demand: Theory and evidence. *Review of Behavioural Finance*, *11*(1), 23–36.

Kinkyo, T. (2008). Disorderly adjustments to the misalignments in the Korean won. *Cambridge Journal of Economics*, *32*, 111–124.

Kumar, S. (2014). Money demand income elasticity in advanced and developing countries: New evidence from meta-analysis. *Applied Economics*, *46*(16), 1873–1882.

Laidler, D. E. W. (1985). *The demand for money: Theories, evidences, and problems*. Harper & Row.

Lane, P. R., & Milesi-Ferretti, G. M. (2002). External wealth, the trade balance, and the real exchange rate. *European Economic Review*, *46*(6), 1049–1071.

Laursen, S., & Metzler, L. A. (1950). Flexible exchange rates and the theory of employment. *Review of Economics and Statistics*, *32*, 281–99.

Lee, T. H., & Chung, K. J. (1995). Further results of long-run demand for money in Korea. *International Economic Journal*, *9*, 103–113.

Levi, J. (1983). Omens from the terms of trade—expectations about the next few years. *Intereconomics*, *18*, 120–124.

Lütkepohl, H., Teräsvirta, T., & Wolters, J. (1999). Investigating stability and linearity of a German M1 money demand function. *Journal of Applied Econometrics*, *14*, 1061–1079.

MacDonald, R. (1997). *What determines real exchange rate? The long and short of it*. (Working Paper No WP/97/21), IMF.

Marquez, J. (1985). *Money demand in open economies: A currency substitution model for Venezuela*. International Finance Discussion Papers, Number 265, October 1985.

McGibany, J., & Nourzad, F. (1995). Exchange rate volatility and the demand for money in the US. *International Review of Economics and Finance*, *4*(4), 411–425.

Melecký, M., & Komárek, L. (2007). The behavioural equilibrium exchange rate of the Czech koruna. *Transition Studies Review*, *14*(1), 105–121.

Mendoza, E. G. (1995). The terms of trade, the real exchange rate, and economic fluctuations. *International Economic Review*, *36*(1), 101–137.

Mera, V. I., Pop Silaghi, M. I., & Turcu, C. (2019). Economic sentiments and money demand stability in the CEECs. *Open Economies Review*, *31*, 343–369.

Metzler, A. H. (1963). The demand for money: The evidence from the time series. *The Journal of Political Economy*, *71*(3), 219–246.

Miyajima, K. (2013). *Foreign exchange intervention and expectation in emerging economies*. (Working Paper No. 414), BIS, Bank for International Settlements.

Mundell, R. A. (1963). Capital mobility and stabilisation Policy under fixed and flexible exchange rates. *The Canadian Journal of Economics and Political Science*, *29*(4), 475–785.

Mussa, M. (1986). Nominal exchange regimes and the behaviour of RER: Evidence and implications. *Carnegie-Rochester Conference Series on Public Policy*, *25*, 117–214.

Nouira, R., & Sekkat, K. (2015). What determines the extent of real exchange rate misalignment in developing countries? *International Economics*, *141*, 135–151.

Ocampo, J. A., Rada, C., & Taylor, L. (2009). *Growth and policy in developing countries: A structuralist approach*. Columbia University Press.

Ostry, J. D., & Reinhart, C. M. (1992). Private saving and terms of trade shocks: Evidence from developing countries. *IMF Economic Review*, *39*, 495–517.

Palić, I., Dumičić, D., & Šprajaček, P. (2014). Measuring real exchange rate misalignment in Croatia: Cointegration approach. *Croatian Operational Research Review*, *5*(2), 135–148.

Petrović, P., & Z, M. (2000). Money demand and exchange rate determination under hyperinflation: Conceptual issues and evidence from Yugoslavia. *Journal of Money, Credit, and Banking*, *32*(4), 785–806.

Pilbeam, K. (1991). *Exchange rate management: Theory and evidence*. Palgrave.

Salto, M., & Turrini, A. (2010). *Comparing alternative methodologies for real exchange rate assessment*. European Economy Economic Papers 427, European Commission.

Stein, J. L., & Paladino, G. (1999). Exchange rate misalignments and crises. *Revie*,CESifo Working Paper Series, November. https://www.researchgate.net/publication/5002550_Exchange_Rate_Misalignments_And_Crises

Stiglitz, J. E., & Greenwald, B. C. (2014). *Creating a learning society: A new approach to growth, development and social progress*. Columbia University Press.

Svensson, L. E. O., & Razin, A. (1983). The terms of trade and the current account: The Harberger-Larusen-Metzler effect. *Journal of Political Economy*, *91*, 97–125.

Teräsvirta, T. (1994). Specification, estimation, and evaluation of smooth transition autoregressive models. *Journal of American Statistic Association*, *89*(425), 208–218.

Tipoy, C. K., Breitenbach, M. C., & Zerihun, M. F. (2018). Exchange rate misalignment and economic growth: On the possible transmission channels for emerging economies. *Cogent Economics and Finance*, *6*(1), 1476016.

Tobin, J. (1956). The interest-elasticity of transactions demand for cash. *Review of Economics and Statistics*, *38*(3), 241–247.

Tsen, W. H. (2011). The real exchange rate determination: An empirical investigation. *International Review of Economics and Finance*, *20*, 800–811.

Uz Akdogan, I. (2020). Understanding the dynamics of foreign reserve management: The central bank intervention policy and the exchange rate fundamentals. *International Economics*, *161*, 41–55.

Willet, T. (1986). Exchange rate volatility, international trade, and resource allocation. *Journal of International Money and Finance (Supplement)*, *5*, S101–112.

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APPENDIX

APPENDIX 1. Correlation of real exchange rate and its determinants

	TOT	TNT	RIP	NFA
Belarus	−0.724	0.300	−0.604	−0.633
Bulgaria	−0.644	−0.308	0.721	−0.016
Croatia	−0.507	0.020	0.740	−0.393
Czech Rep.	−0.732	0.304	0.758	0.676
Estonia	−0.126	0.956	0.905	0.748
Hungary	−0.808	0.523	0.261	0.198
Latvia	−0.427	−0.467	0.499	0.662
Lithuania	−0.117	0.184	0.866	0.679
Poland	−0.620	−0.391	0.090	−0.304
Romania	−0.579	−0.749	0.074	−0.341
Serbia	−0.741	0.587	−0.068	0.279
Slovak Rep	−0.782	0.879	0.876	−0.739
Slovenia	−0.375	0.447	0.345	0.231
Turkey	−0.506	0.214	−0.044	−0.627

APPENDIX 2. Unit root tests

		ADF	PP	KPSS	ZA	Break Point			ADF	PP	KPSS	ZA	Break Point
Belarus	MD	-2.14	-2.22	1.04 ***	-3.54	2005 Q1	Lithuania	MD	-1.39	-1.28	1.16 ***	-4.89 *	2008Q1
	Y	-1.62	-1.62	0.83 ***	-1.07	2017Q1		Y	-1.33	-1.12	1.16 ***	-7.68 ***	2009Q1
	R	-1.19	-1.33	1.10 ***	-3.59	2007Q3		R	-1.30	-3.18 ***	0.73 **	-3.39	2010Q1
	RER	-1.80	-2.06	0.50 **	-4.03	2007Q4		RER	-1.40	-1.37	1.12 ***	-3.91	2007Q4
	TOT	-2.15	-2.25	0.27	-3.97	2007Q4		TOT	-2.71 *	-2.29	0.31	-3.70	2007Q4
	TNT	-3.36 ***	-3.04 ***	1.21 ***	-7.67 ***	2011Q3		TNT	-2.25	-1.92	0.21	-3.71	2014Q4
	NFA	-2.19	-2.00	0.48 **	-5.74 ***	2010Q2		NFA	-0.52	-1.10	0.80 ***	-4.63	2006Q3
	IPDIF	-0.05	2.56	1.13 ***	-4.40	2013Q1		RIP	-1.73	-1.30	1.20 ***	-3.11	2006Q3
	MIS	-9.42 ***	-9.42 ***	0.04	-6.83 ***	2014Q1		MIS	-9.35 ***	-9.34 ***	0.19	-7.00 ***	2005Q4
Bulgaria	MD	-0.53	-0.25	1.16 ***	-4.43	2008Q1	Poland	MD	-1.21	-0.03	1.22 ***	-4.61	2011Q2
	Y	-1.55	-1.77	1.17 ***	-4.06	2006Q3		Y	-0.78	-1.20	1.22 ***	-4.16	2006Q3
	R	-1.79	-1.63	0.83 ***	-5.55 **	2009Q1		R	-2.36	-1.57	0.91 ***	-5.56 ***	2005Q2
	RER	-2.53	-2.53	0.98 ***	-5.63 **	2007Q3		RER	-1.96	-1.74	0.30	-4.88 *	2007Q2
	TOT	-3.25 ***	-2.45	0.25	-5.83 ***	2014Q4		TOT	-2.17	-2.17	0.22	-4.29	2014Q4
	TNT	-2.01	-2.24	0.63 **	-5.19 *	2008Q4		TNT	-2.31	-2.31	0.35 *	-3.53	2004Q3
	NFA	-2.98 **	-2.66 *	0.48 **	-4.66	2006Q3		NFA	-1.76	-0.93	0.96 ***	-4.46	2007Q2
	RIP	-2.27	-2.23	0.78 ***	-5.26 **	2009Q1		RIP	-0.24	-0.24	1.23 ***	-4.00	2012Q1
	MIS	-8.64 ***	-8.64 ***	0.12	-4.82 *	2006Q4		MIS	-8.53 ***	-8.53 ***	0.06	-4.23	2008Q4
Croatia	MD	-0.16	-5.08 ***	1.04 ***	-3.32	2009Q1	Romania	MD	-0.40	-0.56	1.11 ***	-4.36	2006Q4
	Y	-1.91	-2.13	1.04 ***	-3.44	2005Q2		Y	-1.95	-2.51	1.14 ***	-5.30 **	2009Q1
	R	-1.35	-2.32	1.04 ***	-3.82	2007Q3		R	-1.86	-5.78 ***	0.96 ***	-5.61 ***	2005Q1
	RER	-2.17	-2.51	0.26	-4.52	2010Q1		RER	-1.95	-1.72	0.39 *	-4.58	2006Q3
	TOT	-2.51	-2.20	0.52 **	-3.90	2014Q4		TOT	-2.31	-2.06	0.74 ***	-5.01 *	2014Q4
	TNT	-1.75	-1.78	0.30	-4.37	2010Q1		TNT	-2.95 ***	-2.46	0.75 ***	-3.98	2003Q4
	NFA	-0.64	*-1.51*	*0.87* **'	-5.56 **	2007Q4		NFA	-1.36	-1.43	0.59 **	-4.51	2006Q3
	RIP	-1.67	-1.99	0.23	-3.36	2010Q1		RIP	-0.44	-0.44	1.18 ***	-3.13	2004Q3
	MIS	-8.22 ***	-8.22 ***	0.06	-5.33 **	2012Q3		MIS	-9.00 ***	-8.99 ***	0.05	-6.45 ***	2004Q4
Czech Re	MD	-2.26	-6.48 ***	1.23 ***	-4.65	2010Q4	Serbia	MD	-0.65	0.03	1.12 ***	-4.16	2010Q1
	Y	-0.47	-1.56	1.17 ***	-2.83	2008Q4		Y	-2.49	-7.22 ***	1.14 ***	-6.43 ***	2008Q1
	R	-2.26	-2.19	0.86 ***	-3.11	2016Q1		R	-2.26	-2.40	0.95 ***	-6.08 ***	2005Q4
	RER	-2.34	-2.30	0.81 ***	-3.25	2007Q3		RER	-3.69 ***	-5.09 ***	0.19	-4.00	2014Q3
	TOT	-2.32	-2.06	0.46 *	-3.25	2007Q3		TOT	-2.45	-1.99	0.48 **	-4.50	2014Q4
	TNT	-0.77	-0.56	0.86 ***	-3.42	2004Q2		TNT	-2.25	-2.30	1.08 ***	-2.48	2009Q3
	NFA	-1.46	-1.22	1.16 ***	-3.05	2010Q3		NFA	-1.40	-2.35	0.53 **	-3.55	2009Q1
	RIP	-1.97	-1.85	1.17 ***	-5.56 **	2008Q3		RIP	-3.63 ***	-3.47 **	0.16	-5.48	2011Q2
	MIS	-8.91 ***	-8.91 ***	0.34	-5.27 **	2012Q2		MIS	-	-	-	-	
Estonia	MD	-0.34	-0.40	1.13 ***	-4.07	2007Q4	Slovak R	MD	-2.85 *	-3.62 ***	1.19 ***	-5.80 ***	2005Q1
	Y	-2.75 *	-2.28	1.15 **	-7.38 ***	2008Q4		Y	-2.23	-2.45	1.10 ***	-6.62 ***	2009Q1
	R	-1.92	-1.34	0.96 ***	-5.02 **	2009Q1		R	0.75	0.60	1.12 ***	-3.70	2011Q4
	RER	-1.02	-1.02	1.19 ***	-4.24	2010Q1		RER	-2.49	-2.15	0.97 ***	-3.97	2007Q2
	TOT	-2.64 *	-2.38	0.27	-4.81 *	2014Q4		TOT	-1.94	-2.04	0.54 **	-3.70	2007Q4
	TNT	0.00	-0.02	1.23 ***	-5.41 **	2013Q1		TNT	-1.13	-0.67	1.21 ***	-3.70	2007Q4
	NFA	-1.06	-1.28	0.82 ***	-5.66 **	2006Q4		NFA	-3.39 ***	-3.06 ***	0.52 **	-7.13 ***	2006Q2
	RIP	-1.66	-1.74	1.17 ***	-3.64	2008Q4		RIP	-1.14	-1.14	1.21 ***	-4.76	2007Q4
	MIS	-9.46 ***	-9.49 ***	0.04	-9.53 ***	2013Q2		MIS	-8.27 ***	-8.27 ***	0.18	-5.83 ***	2014Q3
Hungary	MD	-2.29	-3.09 ***	1.00 ***	-5.13 **	2013Q1	Slovenia	MD	-0.20	-0.18	1.21 ***	-3.05	2011Q1
	Y	-0.67	-1.73	1.19 ***	-3.21	2016Q1		Y	-1.36	-2.40	1.10 ***	-3.78	2011Q2
	R	-1.31	-1.33	1.04 ***	-4.48	2008Q1		R	-1.96	-1.67	1.14 ***	-4.56	2009Q1
	RER	-2.20	-1.86	0.35	-3.98	2007Q2		RER	-2.84 *	-14.94 ***	0.41 *	-3.56	2013Q2
	TOT	-2.54	-2.07	0.40 *	-4.00	2007Q4		TOT	-2.19	-2.01	0.58 **	-3.68	2014Q3
	TNT	-2.70 *	-3.19 ***	0.97 ***	-3.57	2004Q2		TNT	-2.32	-2.02	0.86 ***	-4.93 *	2015Q3
	NFA	-1.76	-1.13	1.04 ***	-3.73	2004Q2		NFA	-0.73	-0.40	1.09 ***	-4.28	2007Q2
	RIP	-1.37	-1.36	1.15 ***	-4.25	2008Q4		RIP	-0.55	-0.79	0.75 ***	-2.80	2012Q3
	MIS	-9.22 ***	-12.46 ***	0.18	-6.85 ***	2004Q3		MIS	-	-	-	-	
Latvia	MD	-1.23	-0.72	1.08 ***	-5.10 **	2007Q3	Turkey	MD	-0.92	-0.92	1.19 ***	-5.14 **	2005Q4
	Y	-2.32	-2.12	1.05 ***	-8.81 ***	2009Q1		Y	-1.44	-2.47	1.21 ***	-5.39 **	2008Q3
	R	-1.17	-1.18	0.89 ***	-3.17	2006Q1		R	-2.04	-1.32	0.72 **	-9.27 ***	2005Q1
	RER	-1.37	-1.23	0.72 ***	-4.03	2007Q2		RER	-2.00	-1.91	0.28	-4.57	2014Q2
	TOT	-2.41	-2.24	0.42 *	-4.13	2014Q4		TOT	-2.02	-1.85	0.69 **	-3.58	2014Q3
	TNT	-1.98	-1.97	0.71 **	-4.29	2005Q5		TNT	-1.85	-2.00	0.11	-3.76	2015Q4
	NFA	-1.23	-1.21	0.77 ***	-5.26 **	2006Q3		NFA	-2.58	-2.28	0.27	-5.01 *	2017Q1
	RIP	-1.74	-1.68	1.13 ***	-4.47	2008Q2		RIP	0.19	-0.38	1.22 ***	-4.22	2012Q2
	MIS	-8.69 ***	-8.69 ***	0.06	-6.91 ***	2004Q4		MIS	-8.61 ***	-8.61 ***	0.65	-5.18 **	2014Q2

*, **, *** denote statistically significance at 10%, 5% and 1%, respectively.
ADF reports Augmented Dickey-Fuller test statistics, PP reports Phillipts-Peron test statistics and KPSS reports Kwiatkowski-Phillips-Schmidt-Shin test statistics.
ADF and PPP have null hypothesis that the variable has a unit root, and KPSS has a null hypothesis that the variable is stationary. The variables are real money demand, income, interest rate, real exchange rate, ratio of the price of non tradables to tradables, stock of net foreign assets, industrial production differential (domestic production minus the US production) and exchange rate missalignment (difference between the actual value and the fundamental value).
ZA reports Zivot-Andrews unit unit root test with a null that the variable has a unitroot with a structural break. Chosen break point dates are reported in the last column.

APPENDIX 3. Data

1. *M*1 Monetary Aggregate: Data are obtained from the International Financial Statistics (IFS) of IMF and national central banks. Real money demand is determined by dividing M1 by the price level, consumer price index (CPI).
2. Price: Relative price of non-traded to traded goods (TNT) is calculated by the ratio of consumer price index to producer price index. CPI and PPI are obtained from IMF, Eurostat, and national central banks.
3. Aggregate income: The GDP is obtained from the IMF, Eurostat, and national central banks, and it is seasonally adjusted.
4. Exchange Rates: The real effective exchange rates are used for countries such as Bulgaria, Croatia, Czech Republic, Hungary, Latvia, Poland, Romania, Serbia, and Slovak Republic, and they are obtained from the IFS of the IMF. Data for Estonia, Lithuania, Slovenia, and Turkey are from Eurostat. Due to the stationarity of real effective exchange rates, real exchange rates are used for Hungary, Bulgaria, and Poland. They are calculated as $RER = ECPI/CPI^*$, where E is the nominal exchange rate, CPI is the domestic consumer price index, and CPI^* is the foreign consumer price index (the United States). Increases (decreases) are associated with appreciation (depreciation) to be consistent with the effective exchange rates.
5. Interest rates: These are money market interest rates obtained from the IMF and national central banks.
6. Industrial production: Industrial production index is obtained from the IFS of the IMF. It is used to calculate relative industrial production (RIP) used in Equation (4). It is calculated as $RIP = IP/IP^*$, where IP is the domestic industrial production index, and IP^* is the European production index.
7. Capital Outflow: These are financial account portfolio investments in US dollars and obtained from the IFS of the IMF. It is used as capital outflow per GDP.

Quarterly data are used, and all variables except interest rates and capital outflow are expressed in logarithmic terms. The data span is from 2000 Q1 to 2019 Q4.