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The Drivers Behind Reserve Asset Hoarding in CEECs

Determinanty gromadzenia aktywów rezerwowych
w krajach Europy Środkowo-Wschodniej

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Abstract

The buoyant economies of Central and Eastern European Countries (CEECs) have experienced substantial foreign investment and financial integration over the recent decades, accompanied by a significant accumulation of international reserves. The study demonstrates that membership in the European Union and the euro area are key factors differentiating reserve asset policies across the region with respect to internal and external vulnerabilities. Internal risks associated with the size of the domestic financial system affect all the countries considered, with the strongest impact on EU candidate countries and the weakest on euro area Member States. External risks stem from the foreign exposure of domestic equities and investment fund shares, which is of importance for the euro area CEECs, while non-euro area EU Member States and EU candidate countries are vulnerable to short-term external debt. Exchange rate misalignment is found to be a significant driver of reserves stockpiling in countries with independent monetary policies, with the most significant impact observed for non-euro area EU Member States. Finally, the propensity to import and opportunity cost prove to be insignificant.

Streszczenie

W prężnie rozwijających się gospodarkach krajów Europy Środkowo-Wschodniej nastąpiły w ostatnich dekadach nasilone inwestycje zagraniczne i integracja finansowa, którym towarzyszyło masowe gromadzenie rezerw walutowych. Wyniki badania wskazują, że członkostwo w strefie euro i przystąpienie do Unii Europejskiej były kluczowymi czynnikami różnicującymi politykę dotyczącą aktywów rezerwowych w regionie Europy Środkowo-Wschodniej pod względem postrzeganej wrażliwości wewnętrznej i zewnętrznej. Ryzyko wewnętrzne wynikające z rozmiaru krajowego systemu finansowego odnosi się do wszystkich rozpatrywanych krajów, przy czym największego wpływu doświadczają kraje ubiegające się o wejście do UE, a najmniejszego państwa członkowskie strefy euro. Ryzyka zewnętrzne wynikają z ekspozycji zagranicznej krajowego rynku akcji i udziałów w funduszach inwestycyjnych, co jest istotne dla krajów Europy Środkowo-Wschodniej ze strefy euro, podczas gdy państwa członkowskie UE spoza strefy euro i państwa ubiegające się o wejście do UE są narażone na ryzyko związane z krótkoterminowym zadłużeniem zagranicznym. Stwierdzono ponadto, że wahania kursów walutowych są istotnym czynnikiem prowadzącym do gromadzenia rezerw w krajach o niezależnej polityce pieniężnej,

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przy czym największy wpływ tego czynnika zaobserwowano w państwach członkowskich UE spoza strefy euro. Ustalono również, że zarówno importochłonność danej gospodarki, jak i koszt alternatywny związany z gromadzeniem rezerw nie wywierały istotnego statystycznie wpływu na poziom rezerw.

Introduction

The rapid growth of international reserves in developing economies observed over the recent decades has accelerated further since the financial crises experienced by Latin American and Asian countries in the 1990s. Reserve asset stocks of emerging market economies relative to GDP have been doubling every decade since the 1980s, reaching almost 30% of GDP in the 2010s as compared to 5% of GDP in the 1980s [Ghosh et al., 2014; Arslan, Cantú, 2019]. The sharp accumulation of reserve assets is specific to emerging economies, as the average ratio of reserve assets to GDP for advanced economies has been steady, as noted by Obstfeld et al. [2010]. As a result, a growing body of literature has emerged to identify the drivers of the phenomenon; however, empirical studies published to date employ a truly global perspective, with East Asian and Latin American countries being the focal point of attention. An important exception is a paper by Rybinski and Krynska [2010], who studied reserve assets management practices also for the Central and Eastern Europe region.

The Central and Eastern Europe (CEE) region, encompassing the Baltic states, the Visegrád Group and the Balkans, has undergone significant changes and experienced rapid economic growth in the decades following the collapse of communism, with highly intensified international trade and increased capital flows marking consecutive steps of the region's recovery. Most CEE countries joined the European Union (EU) in the 2000s, but only some of the New Member States (NMS) adopted the common currency – the euro. All the aforementioned issues, combined with the process of globalisation, the diversity of supply chains, and geopolitical risks, raise questions with regard to the region's specifics in the context of reserve assets policy. Since the region has faced common challenges and undergone a similar economic transformation, it should be considered separately from other developing regions.

A unique feature of the CEE region is the fact that the NMS are obliged to adopt the common currency. Since the vast majority of the NMS's international trade goes into the common market, adopting the common currency may have significant consequences for the accumulation of reserve assets. Apart from the obvious reason that upon joining the euro area (EA) the euro becomes the domestic currency for invoicing international trade within the European Single Market, there are also other arguments. First of all, it can be assumed that membership in the euro area, in which the European Central Bank (ECB) is responsible for monetary policy and ensures liquidity in the currency markets of the Member States, should (i) boost financial credibility, (ii) significantly reduce the volatility of the effective exchange rate, and (iii) limit the risk of sudden capital outflows. All of these can be considered as important drivers of reserve assets accumulation.

Although the CEE region has experienced fairly similar economic development in recent decades, membership in a trade union and/or monetary union may result in significant differences in reserve asset policies, with different motives taken into account for countries within and outside the monetary union. Consequently, the analysed CEE countries are divided into three groups. Firstly, the group of NMS that joined the euro area, consisting of the Baltic States, Slovakia, Slovenia and Croatia. Secondly, the group of NMS with a single currency derogation, including the Visegrád Group (except Slovakia), Bulgaria and Romania. Thirdly, the group of European Union candidate countries comprises the remaining Balkan countries that are not yet members.

An important characteristic of the CEE region is that the process of economic recovery and transformation has led to current account deficits, financed by the inflow of foreign direct and portfolio investment. As a result, the balance of payments framework and capital account liabilities measured by the international investment position should be an important reference point when considering the demand for international reserve assets, and may distinguish the CEE region from other developing regions running trade surpluses. The different

strategies of developing regions with regard to economic growth, i.e. whether it should be based on a trade surplus or rather supported by human capital, knowledge and innovation, substantiate the need for separate modelling of the demand for reserves in CEE countries.

In view of the above arguments, this paper aims to address the following questions. First, what is the effect of joining the euro area monetary union on the demand for reserves? Next, are there differences between NMS that are euro area members, NMS with a single currency derogation, and EU candidate countries in terms of reserve assets policy? Furthermore, is there heterogeneity across the region with respect to internal/external vulnerabilities that underpin the accumulation of international reserve assets? Finally, are financial motives related to opportunity cost and exchange rate misalignment important drivers of reserve demand?

The remainder of this paper is organised as follows. Section 2 provides a brief overview of the literature and the approaches to modelling demand for reserve assets. Section 3 compares reserve asset behaviour for the three subgroups of countries in the region. Section 4 considers the specification and econometric framework of the empirical analysis. Section 5 presents the empirical findings and discusses the heterogeneity of the underlying mechanism across regions and time periods. Section 6 outlines the concluding remarks.

A brief survey of approaches to reserve demand modelling

The concept of international reserve assets can be traced back to Keynes's revolutionary and utopian concept of a new global currency he called "Bancor" and the International Clearing Union, which was to serve as a world central bank. Keynes's proposal was intended to alleviate global trade imbalances and speculative capital flight. However, Keynes's plan never materialised, as the International Monetary Fund Articles of Agreement were signed at the United Nations conference in Bretton Woods in 1944, resulting in the establishment of a new post-war system in which the US dollar became the anchor currency, convertible to gold, and other currencies were pegged to the dollar. This agreement established the post-war framework for international financial markets and set up the US dollar as the world reserve currency.

In his seminal paper on post-war demand for reserve assets, [Triffin \[1946\]](#) argued that individual countries' reserve assets should be determined in line with imports, as a key component of the balance of payments, with a simple rule of four months of import cover emerging as a minimum benchmark for reserve asset determination. This simple rule was augmented by the [IMF \[1953\]](#) with additional criteria being suggested, including quality of monetary and fiscal policies, the economic development stage, quality of the financial sector and exchange rate policy. It was therefore stressed that when assessing reserve assets adequacy, the simple rule of import cover needs to be augmented by country specifics related to governance quality in general.

Apart from the obvious need for assessing the minimum benchmark for reserve asset accumulation, in order to smooth output and consumption under balance of payments imbalances, the issue of the upper boundary remained unsolved until [Heller \[1966\]](#) pointed to a significant opportunity cost associated with holding large stocks of reserves. Essentially, he postulated that the benefits to the economy from mitigating external imbalances should be balanced against an opportunity cost, measured by the difference between the rate of return on reserves and the so-called social return on capital, approximated by the long-term interest rate on government bonds. This approach highlighted the need for optimisation models to solve the problem of the optimal level of reserve assets, resulting in the propensity to import, opportunity cost, a scale variable (output), and external payments variability being considered the main determinants of reserve asset demand.

Subsequently, after the collapse of the Bretton Woods system, it was observed that the transition from a pegged exchange rate to a floating exchange rate regime reduced the demand for reserve assets [[Frenkel, 1983](#)]. Although the effect varied depending on the stage of economic development, the decline in demand for reserves was mainly observed in developed countries, with the exchange rate regime found to be an important driver of reserve demand. Moreover, the stage of economic development and the status of an oil exporter were found to be significant [[Heller, Khan, 1978](#)]. The impact of exchange rate variability and capital mobil-

ity on reserve demand has been investigated by [Eichengreen and Frankel \[1996\]](#), who suggested that there is no unambiguous effect of capital mobility. They argued that capital mobility may result in a more volatile exchange rate, on the one hand, while on the other hand, capital mobility may facilitate the reduction of external deficits.

There is no exaggeration in the statement that the financial crises experienced by Latin American and East Asian countries in the 1990s redefined the approach to reserve demand determination, reviving research interest in the topic. First and foremost, it was noted that capital account vulnerabilities arising from equity liabilities and short-term external indebtedness should be of utmost importance for reserve assets determination, which was clearly an obvious and immediate conclusion given the sharp increase in capital flight, itself a consequence of increased capital mobility. The need for “insurance” against capital account shocks was highlighted independently by Guidotti and Greenspan in 1999. Guidotti proposed that reserve stocks should be able to cover short-term liabilities within the year ahead. In other words, he suggested that a country’s reserve stock should be managed in such a way as to cover a one-year lack of access to the international capital market. Similar arguments were put forward by Greenspan, augmented by the proposition that external liabilities’ maturity should exceed three years. Therefore, a simple rule of one year of cover of short-term debt for developing countries, the so-called Guidotti-Greenspan rule, was subsequently introduced.

Although the significance of capital account vulnerabilities has been widely recognised, the Guidotti-Greenspan rule did receive some critique, with the [IMF \[2000; 2001\]](#) stressing that a simple indicator based on short-term debt may be insufficient to properly define all types of risks associated with the balance of payments framework for reserve assets demand. Therefore, [de Beaufort Wijnholds and Kapteyn \[2001\]](#) proposed a new benchmark, intended to reflect both considered sources of reserve demand, i.e. the external drains due to short-term debt, and the internal drains owing to capital flight. The simple benchmark proposed by [de Beaufort Wijnholds and Kapteyn \[2001\]](#), consisting of the sum of 100% of short-term external debt plus 10–20% of broad money aggregate, was the first combined rule for assessing reserve assets adequacy, as opposed to the aforementioned simple rule of four months of import cover or the Guidotti-Greenspan rule.

The significantly accelerated pace of reserve asset hoarding in the 2000s in the East Asian countries, following the financial crises experienced at the end of the 1990s, sheds new light on another potential driver underpinning the process, namely the mercantilist motive. This view assumes that reserve assets are accumulated in order to maintain price competitiveness in international trade and sustain export-led economic growth [[de Beaufort Wijnholds, Søndergaard, 2007](#)]. Clearly, the mercantilist view on reserve asset accumulation considers it a by-product of mercantilism itself, rather than an instrument of state policy. Notwithstanding, [Aizenman and Lee \[2007\]](#) examined the significance of variables associated with the mercantilist motive in post-Asian crisis reserve hoarding. They found the influence of this motive to be almost negligible and dwarfed by variables related to the precautionary motive. Therefore, potential internal and/or external drains proved to be of utmost importance for reserve accumulation, as opposed to the mercantilist views.

The preponderant role of the precautionary motive for reserve asset holdings has been confirmed in numerous empirical contributions, including by [Obstfeld et al. \[2010\]](#), who found that inclusion of variables representing financial stability and financial openness improves the explanation of the international reserves accumulation. Additionally, [Delatte and Fouquau \[2012\]](#) found some evidence of coefficient instability and smooth breaks for variables representing precautionary motive, while studying reserve asset stocks held by low-income and middle-income countries in 1981–2007. Shifting motives for reserve asset holdings in emerging market economies were examined by [Ghosh et al. \[2014, 2017\]](#), who argue that in the 1980s reserve stocks were held as “insurance” against current account shocks, in the 1990s capital account shocks gained importance, while in the 2000s mercantilist motives were at play, especially in the case of East Asian countries.

The significance of the Global Financial Crisis (GFC) for reserve asset hoarding was examined by [Aizenman et al. \[2015\]](#), who found severe instabilities with respect to the motives for reserve accumulation before, during and after the GFC in emerging economies in East Asia, Latin America, the “Fragile Five”, and BRICS

member states. Specifically, the results of the study by [Aizenman et al. \[2015\]](#) indicate that during the GFC, certain motives lose their importance or even have an opposite effect due to the extraordinary market conditions caused by the financial turmoil. The results of the papers mentioned above substantiate the need for investigation into the stability of motives for reserve asset determination, especially if periods of financial distress are to be considered.

The role of reserve assets in the context of real exchange rate shock buffering was investigated by [Aizenman et al. \[2024\]](#) for a panel of over 110 countries for the years 2001–2020. They concluded that in the case of countries with weak financial institutions, reserve assets may act as a shield against adverse external conditions, including terms-of-trade shocks, additionally claiming that the buffer effect is more pronounced for countries with intermediate levels of financial openness. Similar claims have been put forward by [Saadaoui \[2024\]](#) and [Aizenman and Saadaoui \[2026\]](#), who argued that reserve assets play a key role in maintaining exchange rate stability in less developed financial markets.

[Dąbrowski \[2021\]](#) stressed the need for distinguishing between an actively managed component of foreign exchange reserves and a passive component, consisting of valuation changes and interest income on reserves. On the one hand, the distinction between active and passive components of foreign exchange reserves may be significant for a better understanding of crisis management and short-run changes of foreign exchange reserves during periods of financial turmoil, while on the other hand, in the case of long-run reserve asset determination these factors may be largely anticipated by central banks.

The need for optimisation models to solve the problem of the optimal level of reserve assets has been more recently addressed by [Jeanne and Rancière \[2011\]](#), who proposed a model that maximises a consumer welfare utility function and provides an explicit formula for the optimal level of reserves. Even though the approach by [Jeanne and Rancière \[2011\]](#) builds on a well-defined closed-form mathematical model, it suffers from significant limitations. First of all, it is highly sensitive to parameter calibration, since all crucial parameters of the model, including the probability of sudden stops in capital flows, the risk-aversion parameter and the output loss ratio, need to be calibrated. Moreover, the proposed approach oversimplifies some key elements of real economies, such as the investment process and real exchange rate fluctuations, which are not considered explicitly. Finally, it struggles to explain the reserve holdings of East Asian emerging markets.

Another formula for assessing reserve adequacy, the so-called ARA metric, was proposed in consecutive papers by the [IMF \[2011, 2013, 2014\]](#). The IMF's ARA approach stresses that reserve demand for a country depends on the shocks it faces, which are different for low-income economies, emerging markets and advanced economies. The explicit formula for the ARA metric is a combined rule that is the weighted sum of four components: short-term debt, other portfolio liabilities, broad money and exports. The 10th percentiles of observed distributions of outflows for each component during periods of exchange market pressure are initially used for the derivation of weights. Moreover, the weights are different with respect to the exchange rate regime and are updated in the consecutive papers. Contrary to the proposition of [Jeanne and Rancière \[2011\]](#), the main strong points of the ARA metric are its empirical foundations. Nevertheless, the global perspective of the ARA approach seems to ignore country- or region-specific factors, and is thus of limited applicability to diverse economies facing nuanced potential vulnerabilities, and may be considered only as a starting point for assessing reserve adequacy for a given country or region.

Recent research on reserve assets management and its drivers has been provided by publications of the [Bank for International Settlements \(BIS\) \[2019\]](#) and the World Bank [[Ballon Carneiro et al., 2021](#)]. The former publication, with insightful papers by BIS staff and 22 chapters from central bank representatives of the main emerging economies, affords a view on modern motives of central bankers for reserve asset accumulation. Specifically, [Arslan and Cantú \[2019\]](#) found that from a global perspective, precautionary motives associated with current account vulnerabilities and capital account openness matter most. Moreover, they state that the motive related to exchange rate overvaluation clearly prevails over exchange rate variability. In line with these arguments, [Berłowska et al. \[2019\]](#), representing the National Bank of Poland, state that the primary

role of reserve assets in Poland is to enhance financial credibility within the context of a floating exchange rate regime. In fact, exchange rate interventions were infrequent, and a broader set of measures was implemented only in the years 2008–2009, in the aftermath of the GFC. [Mora and Schmidt \[2019\]](#), representing the Czech National Bank, stress that the CNB used reserves primarily for assuring price stability in the context of exchange rate misalignments. Therefore, tightening or easing monetary conditions is intended to prevent currency from excessive weakening or strengthening. Furthermore, [Mora and Schmidt \[2019\]](#) highlight the unprecedented growth of reserve assets in Czechia by three and a half times, as the exchange rate commitment was in place between November 2013 and April 2017. Similarly to the arguments put forward by [Berłowska et al. \[2019\]](#), they emphasise the role of reserve stocks during periods of financial turmoil.

The paper by [Ballon Carneiro et al. \[2021\]](#) is focused on reserve asset management practices rather than reserve asset determination. Moreover, to preserve anonymity, it provides results of a central bank survey on a very aggregated level with four somewhat *ad hoc* geographic regions of the global economy. Nevertheless, as the results reflect inputs from more than 100 central banks, it is worth mentioning that significant differences are observed with respect to the exchange rate regime, country income group and size of a given economy. The paper by [Ballon Carneiro et al. \[2021\]](#) highlights the role of reserve assets in the face of capital flights and sharp falls in current account items, thus enabling countries to confront adverse conditions during periods of financial distress.

Reserve assets determination in the context of a monetary union, especially the euro area, has been considered in the existing literature only from two points of view. The first is simply the prospect of the euro as a reserve currency on par with the US dollar [[Eichengreen, 1998](#); [Galati, Wooldridge, 2009](#)]. The other strand of papers focuses on defining and allocating reserve holdings within a currency union and its member countries in the context of balance-of-payments and international investment position statements, e.g. the [IMF \[2004\]](#). Problems associated with reserve asset definition, exclusion of intra-union claims, allocation, transfer of ownership, union-level vs national-level reserves, “imputed reserves”, etc. have been addressed by the Currency Union Technical Expert Group of the IMF and in several ECB publications.

Extensive review indicates that there are no articles that explicitly analyse the motives behind reserve asset policies in CEE countries in the context of their euro area membership. This fact substantiates the need to conduct research in this area. In particular, this paper addresses the issue of potential heterogeneity in reserve asset policies within the CEE region, in line with the questions posed in the introduction.

International reserves in the CEE region

The analysis examines annual data for a panel of 16 CEE countries over the period 2003–2024. The following figures cover the full initial dataset starting in 2000, although the turn of the century in the CEE region is characterised by the still ongoing disinflation process, the economic and financial aftermath of ethnic tensions due to the breakup of Yugoslavia, as well as certain issues related to the quality of data and missing information. Therefore, the data for the turbulent years 2000–2002 has been disregarded to prevent parameter instability.

The countries are divided into three subgroups. The first consists of euro area NMS, i.e. Estonia, Latvia, Lithuania, Slovakia, Slovenia and Croatia. The second comprises the EU NMS with a single currency derogation, namely Poland, Czechia, Hungary, Romania and Bulgaria. However, two caveats must be made. Bulgaria is an acceding member of the euro area, with an expected accession date of 2026. Furthermore, Czechia followed an exchange rate commitment between November 2013 and April 2017, which resulted in a massive increase in reserve holdings, more than tripling in this short period. It is clear that in the case of an extended exchange rate commitment, reserves should be treated as a by-product of monetary policy rather than an instrument of long-run macroeconomic policy. Therefore, Czechia was excluded from the empirical analysis of the euro area CEE subpanel. The third group includes the remaining Balkan countries, i.e. Bosnia and Herzegovina, Serbia, Albania, North Macedonia and Moldova. Montenegro and Kosovo were

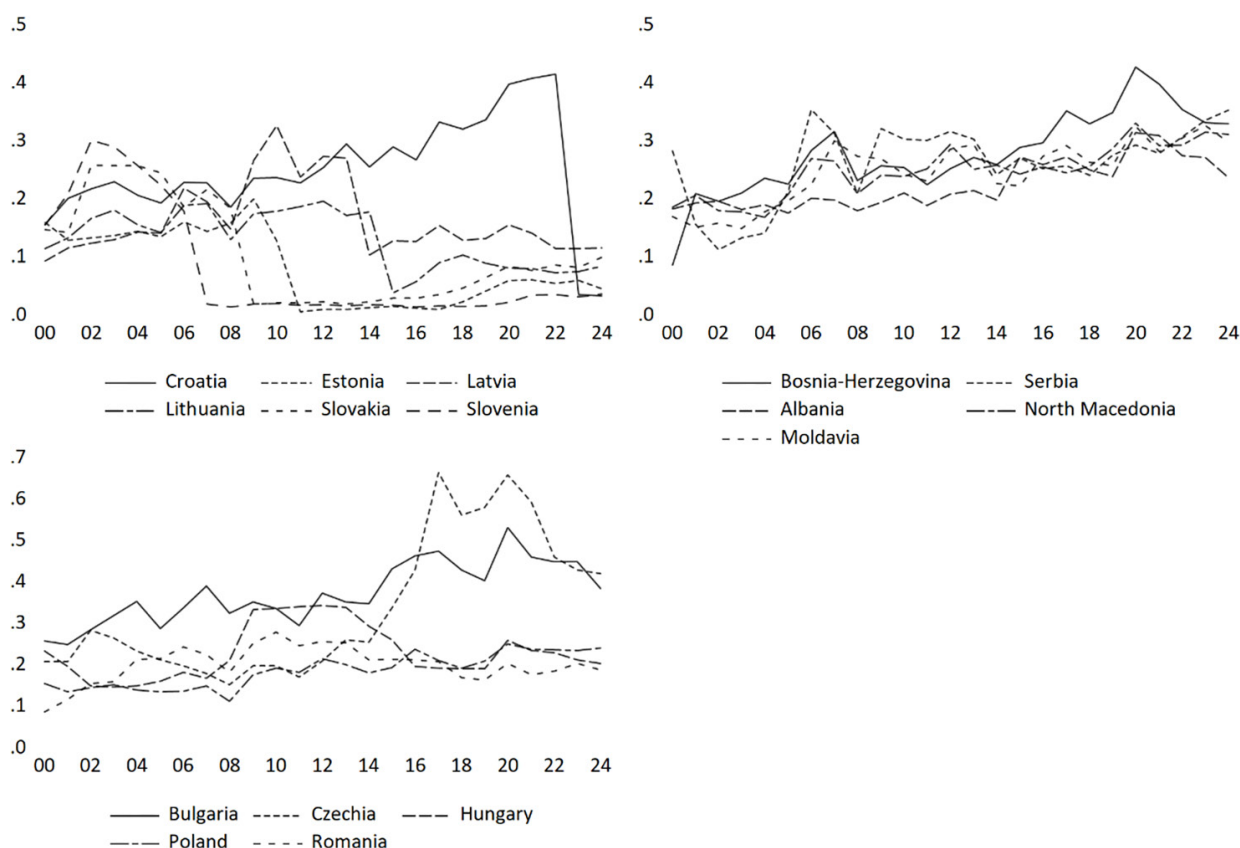
excluded from the sample due to their relatively recent independence, unilateral euroisation, missing data and the relatively small scale of their domestic economies. The definitions and sources of the data are provided in Table A1 in the Appendix.

Significant aspects of reserve demand in the CEE region likely result from (i) entering the common market and (ii) adopting the single currency. The enlargement of the EU in 2004 to include the Baltic states, the Visegrád Group and Slovenia, and in subsequent years also Bulgaria, Romania and Croatia, created a favourable framework for the intensification of international trade, especially within the common market. Similarly, as a result of the accession of Slovenia (2007), Slovakia (2009), Estonia (2011), Latvia (2014), Lithuania (2015) and Croatia (2023) to the euro area, preceded in the previous years by entering the ERM I/II mechanism, it can be assumed that a favourable environment for capital flows, investments and overall financial credibility has emerged. Since entering a trade union or currency union may have significant consequences for reserve asset policy, these facts have been captured in the regression analysis by appropriate dummy variables.

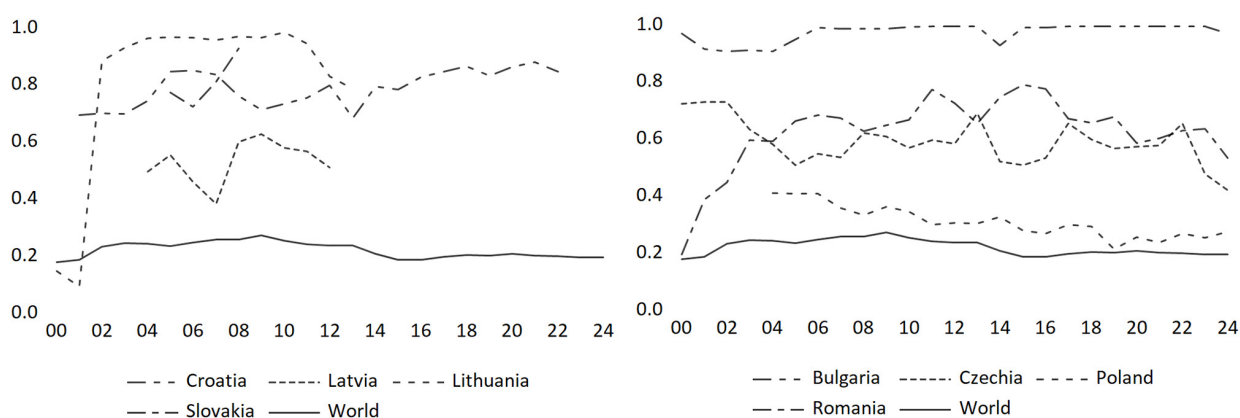
An important aspect in the accumulation of reserve assets is the way in which reserves are created. This can be achieved by foreign exchange market interventions (unsterilised buildup) and by issuing debt that may be denominated in foreign currency or intended for the local market. [Sosa-Padilla and Sturzenegger \[2023\]](#) argue that the issuance of domestic debt reduces sovereign spreads, contrary to reserve accumulation through foreign borrowing. Furthermore, the NMS experienced significant inflows of EU funds. As a result, in the case of some NMS, including Poland as the biggest beneficiary of the EU fund transfers, reserve asset buildup was achieved primarily by the positive balance of external flows, due to EU funds to a large extent [[Berłowska et al., 2019](#)]. Conversely, in the case of other NMS and the EU candidate countries [[Mora, Schmidt, 2019](#)], foreign exchange market interventions played a key role in reserve hoarding. Nevertheless, this is solely the technical way the reserve assets are built up. As described in the previous section, there is a general consensus in the literature that the reserve assets are accumulated owing to specific motives and not just passive stock-flow conversion. However, specific management practices, such as currency composition, asset allocation diversification and/or tranching, are beyond the scope of the paper.

Moreover, as highlighted in the literature and in surveys conducted by the [BIS \[2019\]](#) and the World Bank [[Ballon Carneiro et al., 2021](#)], the exchange rate regime may be an important driver of reserve demand. To this end, it should be noted that most CEE countries that have not entered the euro area follow floating or managed floating exchange rate regimes. The only exceptions are Bulgaria and Bosnia and Herzegovina, which have a fixed exchange rate and whose currencies were pegged to the German mark, and consequently the euro since the introduction of the common currency. Owing to the fact that both countries consistently manage their currency in line with a currency board mechanism, the fixed exchange rate regime effect is unidentifiable within the framework of country-fixed effects. Moreover, additional dummy variables suggested by the literature, which are intended to capture the effects associated with the fact that a given country possesses a Sovereign Wealth Fund [[Aizenman et al., 2015](#)], which in practice often may be considered as a substitute for official reserve assets and/or being a net oil exporter, are unnecessary, as none of the CEE countries fall into the categories mentioned above.

The variable of interest is the ratio of international reserves to GDP. Using GDP as a scaling variable is a natural choice to facilitate international comparison of economies, which may be of different size. Clearly, it is commonly assumed in the literature that the demand for reserves is expressed as a percentage of GDP (e.g. [Delatte, Fouquau \[2012\]](#), [Aizenman et al. \[2015\]](#), [Ghosh et al. \[2014, 2017\]](#)). It should be noted that scaling reserves by GDP has an additional benefit, as it aims to reduce potential endogeneity issues, primarily due to GDP and trade-variable nexus. Nevertheless, the validity of this assumption was verified by a preliminary data analysis, which clearly confirmed a unit long-run elasticity of reserves to GDP (results are available upon request). Figure 1 presents the evolution of reserve assets to GDP in CEE countries, hereafter referred to simply as reserves.

Figure 1. Reserves to GDP in CEE countries

Source: Author's own elaboration.

Figure 2. Share of euro in reserves

Notes: Data source: IMF and EBC databases. The data prior to 2004–2006 are retrieved from annual reports of central banks of the CEE region.
Source: Author's own elaboration.

It can be easily observed in Figure 1 that reserve demand in CEE countries follow a strong upward trend in general, which is consistent with the findings of previous studies for global panels of reserves for emerging economies, e.g. [Ghosh et al. \[2014\]](#) and [Arslan and Cantú \[2019\]](#). Both countries with a fixed exchange rate, i.e. Bulgaria and Bosnia and Herzegovina, have the highest reserve holdings on average, which is in line with theory-based expectations. Moreover, some important observations regarding reserve asset accumulation can be made at first glance. The upper left graph of Figure 1 reveals a steep decline in reserve holdings

as a country enters the euro area. The largest decrease can be observed for Croatia, with reserves dropping by more than ten times, from almost 42% of GDP in 2022 to less than 4% in the following year. A similar evolution of reserve assets can be seen in the case of the Baltic states, Slovakia and Slovenia, where reserve stocks decrease from a range of 20 to 30% of GDP to a level of 1 to 10%. This may to a large extent be well substantiated by the fact that reserve stocks in these countries were held primarily in euro (see Figure 2, left graph). Notwithstanding, in general the decline in reserves is even sharper than solely due to euroisation. In fact, for most countries joining the euro area, including the Baltic states, Slovakia and Slovenia, reserve asset policies seem to be slightly adjusted even before accession, in the years leading up to the accession. This necessitates an insight into a potentially different approach to reserve asset accumulation for the euro area NMSs and the rest of the CEE countries.

Regarding the NMSs that maintain their own currencies, it may be easily noted that the general upward trend is disturbed by the behaviour of reserve holdings in Czechia, since this country followed the exchange rate commitment between November 2013 and April 2017. For this reason, Czechia has been excluded from the empirical analysis of the sub-panel of euro area CEE countries. Moreover, it should be noted that the transitory increase in reserve assets in Hungary in the years 2008–2014 should be attributed to an IMF and ECB bailout and austerity measures for Hungary, including the Stand-by Arrangement signed with the IMF in 2008 and the bilateral repo facility with the ECB created in the same year [Gupta, 2023]. As the repo line was gradually converted into a swap line in the following years, which in turn is not considered an official reserve asset according to the IMF methodology, the reserve assets decreased subsequently. Interestingly, the ECB bailout of Hungary in 2008 seems to suggest that central banks of NMSs with a single currency derogation might consider the ECB a lender of last resort, even if they are not members of the euro area. This fact is considered a feature that may distinguish the reserve asset policies of these countries from those of EU candidate countries, in addition to their participation in the common market. Finally, it should be noted that the NMSs with a single currency derogation follow somewhat different patterns of the currency composition of reserve assets (see Figure 2, right graph). Specifically, Poland reduced its allocation of reserve assets in euros from 35–40% in the 2000s to 25–28% in the 2020s, while Czechia and Romania hold roughly twice as much as Poland. Bulgaria stockpiles almost all of its reserves in euros due to its currency board regime.

The third subgroup, consisting of the EU candidate countries, seems to share a similar behaviour of reserve assets accumulation. The impact of financial turmoil and capital flights due to the GFC, and more recently because of the Russian aggression against Ukraine, seems to be reflected in a common general pattern of reserve evolution. However, the homogeneity assumption underpinning the aforementioned statement needs to be verified at the stage of panel regression analysis, for each of the subgroups considered.

Specification and econometric framework

Following the discussion in the sections above, the analysis accounts for five general motives of reserve demand in CEE countries. Firstly, internal financial vulnerability is considered, proxied by a broad monetary aggregate relative to GDP, which is intended to capture the size of the domestic financial system and potential internal drains due to residents' capital outflows, as stressed by [de Beaufort Wijnholds and Kapteyn \[2001\]](#).

The next two motives are related to both sides of the Balance of Payments (BoP) framework, with Current Account (CA) vulnerability represented by the ratio of imports to GDP, which measures a given country's propensity to import. This is intended to reflect [Triffin's \[1946\]](#) point of view, which may be even more likely owing to the process of economic globalisation and increased importance of global value chains for international trade. Since workers' remittance transfers, which are done by residents and non-residents and are recorded as items within primary and secondary income respectively, are relatively small in scale, they are not considered potential drivers. Moreover, sudden stops in these flows during periods of financial distress appear unlikely.

The other side of balance of payments, i.e. Capital Account – KA (financial account as renamed by the IMF's 6th BoP's manual, capital account henceforth) and its counterpart in the International Investment Position (IIP) introduces a wide range of potential drivers of reserve holdings. First of all, in line with the arguments put forward by Guidotti and Greenspan, the ratio of short-term external debt to GDP is included, which is designed to reflect a temporary lack of access to international capital markets. It should be stressed that remaining debt is utilised rather than the outstanding position, and therefore both principal and interest payments of up to one year maturity are incorporated. Secondly, foreign engagement in equity markets and investment funds, as represented in the international investment position, is considered, and it is measured by direct and portfolio equity and investment fund shares liabilities relative to GDP. This is intended to explain potential drains due to foreign investment. Since individual countries use different approaches to record a non-greenfield part of the foreign investment, both direct and portfolio equity and investment fund shares liabilities are utilised. Thirdly, the ratio of other investment liabilities to GDP is included, which is consistent with the ARA metric concept. It should be noted that other investments consist of non-residents' bank account balances, merchant credits, technical reserves and other short-term financial liabilities, which may potentially lead to reserve asset drains. Fourthly, financial derivative liabilities related to GDP are considered, though it should be highlighted that these stocks are relatively small and are usually settled in cash, on a net payment basis, without physical delivery of the underlying assets.

The fourth motive taken into account involves financial arguments. Firstly, in line with [Heller's \[1966\]](#) proposition, the opportunity cost is included, proxied by the spread between domestic and US long-term government bond yield. Although the argument underpinning inclusion of this variable into the information set seems to be well founded on the theoretical basis of optimisation approaches, it needs to be noted that there is little empirical evidence supporting a significant influence of opportunity cost on reserves demand in the literature hitherto. Secondly, exchange rate misalignment is considered, measured by deviations from the Purchasing Power Parity (PPP) induced effective exchange rate steady-state. This is intended to reflect the fact that reserves seem to be used on an occasional basis for ensuring price stability in the context of exchange rate misalignments, as suggested by [Berłowska et al. \[2019\]](#) and [Mora and Schmidt \[2019\]](#). The use of the Real Effective Exchange Rate (REER) as an indicator of the steady-state is due to the fact that this is an unambiguous measure, as opposed to more sophisticated approaches to exchange rate modelling, based on CHEER, BEER or FEER frameworks. Moreover, the REER measure is widely considered in the context of reserve asset management strategies prepared by central banks. Finally, as examined by [Ca'Zorzi et al. \[2021\]](#), the simple PPP-based measure of equilibrium exchange rate provides predictive power that is at least as good as that of more sophisticated counterparts, which allow for the capture of short-run imbalances. Therefore, given the use of annual data, the current REER level (PPP exchange rate deviation) is considered a measure of the long-run steady state for the reserve asset accumulation process.

Finally, following the arguments mentioned in the previous section, the last motive incorporated into the analysis involves membership in a (i) trade union and (ii) monetary union. To this end, dummy variables are included to reflect the status of a given country with respect to membership in the European Union and the euro area. Additionally, a dummy is introduced for the Global Financial Crisis that occurred in 2008 and might have affected reserve holdings of many emerging economies to some extent.

The empirical analysis of drivers determining reserve assets accumulation needs to be preceded by a careful verification of dynamic properties of data generating processes. To this end, a first-generation panel unit root test derived by [Im et al. \[2003\]](#) and its second-generation augmentation proposed by [Pesaran \[2007\]](#), which allows for cross-section dependence, are utilised. In addition, the stationarity test proposed by [Hadri \[2000\]](#), which is a panel counterpart of the test proposed by [Kwiatkowski et al. \[1992\]](#) for the case of time-series, is employed. The use of both the unit root test and the stationarity test is intended to enhance confidence in the test results, as a well-known feature of unit root tests is their poor performance in small sample sizes. The results presented in Table 1 confirm that the processes generating data are nonstationary and integrated

of order one. The indications of the Hadri test for equity and investment fund shares and other investments are borderline in the case of the null hypothesis of $I(2)$ – ness, although both first- and second-generation unit root tests reject the $I(2)$ – ness of the data-generating processes. The results presented in Table 1 cover the whole panel of 16 CEE countries, as it should improve the performance of the tests. However, the indications for $I(1)$ – ness remain basically unchanged if the three aforementioned subpanels are considered separately.

Table 1. Unit root and stationarity tests

	IPS	CIPS	Hadri
first difference			
Reserve demand	–13.94 (0.00)	–2.49 (<0.01)	0.46 (0.32)
Size of financial system	–7.20 (0.00)	–2.54 (<0.01)	1.14 (0.13)
Propensity to import	–9.12 (0.00)	–3.05 (<0.01)	0.40 (0.35)
Short-term external indebtedness	–5.10 (0.00)	–2.76 (<0.01)	–0.15 (0.56)
Equity and investment fund shares	–4.60 (0.00)	–3.06 (<0.01)	1.61 (0.05)
Other investment	–2.68 (0.00)	–2.55 (<0.01)	1.63 (0.05)
Financial derivatives	–7.73 (0.00)	–2.72 (<0.01)	–1.44 (0.92)
Opportunity cost	–6.16 (0.00)	–3.70 (<0.01)	1.11 (0.13)
Exchange rate misalignment	–3.61 (0.00)	–2.32 (<0.05)	1.39 (0.08)
level			
Reserve demand	–1.33 (0.09)	–1.92 (>0.10)	7.75 (0.00)
Size of financial system	–0.67 (0.25)	–1.83 (>0.10)	6.38 (0.00)
Propensity to import	–1.06 (0.14)	–1.49 (>0.10)	5.21 (0.00)
Short-term external indebtedness	–0.15 (0.44)	–1.96 (>0.10)	8.11 (0.00)
Equity and investment fund shares	0.67 (0.75)	–1.83 (>0.10)	7.68 (0.00)
Other investment	0.16 (0.56)	–2.02 (>0.10)	9.04 (0.00)
Financial derivatives	–0.46 (0.32)	–1.39 (>0.10)	2.80 (0.00)
Opportunity cost	–1.05 (0.15)	–1.95 (>0.10)	2.30 (0.01)
Exchange rate misalignment	1.89 (0.97)	–1.27 (>0.10)	5.14 (0.00)

Notes: The 1%, 5% and 10% critical values for the CIPS test with $I=16$ and $T=23$ are –2.45, – 2.25 and –2.13 respectively.

Source: Author's own elaboration.

Table 2. Cointegration tests

	(1)		(2)		(3)	
	Kao	Pedroni	Kao	Pedroni	Kao	Pedroni
Pooled ADF-type test	–2.83 (0.00)	x	–2.53 (0.01)	–1.95 (0.03)	–2.29 (0.01)	–1.70 (0.04)
Mean-group ADF-type test		x		–1.95 (0.03)		–2.05 (0.02)
Reserve demand	+		+		+	
Size of financial system	+		+		+	
Propensity to import	+		–		–	
Short-term external indebtedness	+		+		+	
Equity and investment fund shares	+		+		+	
Other investment	+		+		–	
Financial derivatives	+		+		–	
Opportunity cost	+		–		–	
Exchange rate misalignment	+		+		+	

Notes: Both the Kao and Pedroni residual-based tests employ an ADF-type test regression and t-ratio; the pooled test assumes homogeneous slope coefficients, while the mean-group test (based on panel averaging) allows for heterogeneous slope coefficients. The plus and minus signs indicate the inclusion/exclusion of a given variable in/from the information set, respectively.

Source: Author's own elaboration.

The nonstationarity of the processes generating the analysed data poses the problem of spurious regression that affects inference on panel processes as well, though in a slightly different manner than in a purely time-series setting [Entorf, 1997]. Although the additional cross-sectional dimension increases the asymptotic growth rate of signal, which results in (asymptotic) consistency of the OLS estimator, the distribution of t -ratios remains degenerate. This fact requires the use of a cointegration test to verify the coannihilation of stochastic trends, the presence of which was confirmed by the indications of the unit root and stationarity tests. To this end, the panel residual-based ADF-type cointegration tests proposed by Kao [1999] and Pedroni [1999] are employed (see Table 2). Both tests confirm the cointegration property, irrespective of the type of panel cointegration test augmentation and underlying assumptions about slope coefficient heterogeneity, based on panel pooling or averaging. Moreover, cointegration holds for the full set of variables considered initially (see case 1), as well as for reduced sets of variables (see cases 2 and 3).

The next consequence of the identified nonstationarity of the processes generating the data is a requirement to employ methods that are appropriate with respect to a given number of cross-sections (I) and the sample size in the time-series dimension (T). Two main approaches are considered to estimate the long-run relationship describing the determination of reserve assets. Firstly, in the case of the full-sample panel regressions based on all the considered CEE countries ($I=16$), Parks' feasible generalised least squares (FGLS) estimator with cross-sectional weights and panel corrected standard errors is used. This allows not only for measuring the magnitude of the impact of consecutive drivers due to the first four aforementioned motives, but also the significance of supranational trade and currency unions, as regards reserve assets accumulation. It should be stressed that considering the euro area membership introduces a time-invariant variable into the information set, meaning the choice of estimation methods that can be used is limited. For example, the DOLS and FMOLS methods, which perform well in small samples, cannot be applied. Similarly, the CCE method, which allows for strong cross-sectional dependence of the error term, cannot be applied either. Nevertheless, the full-sample panel regressions are based on over 350 observations and the Pesaran CD test indicates a lack of (strong) cross-sectional dependence of the error term. As a robustness check, LSDV (the results available upon request) was employed, which is consistent in the case of double-indexed nonstationary processes [Entorf, 1997]. Secondly, in the case of the subgroup panel regressions, for which small sample performance of a given estimator matters, a static framework is employed for estimating the cointegration relationship. Namely, the Dynamic OLS (DOLS) method based on Stock's leads-and-lags estimator, and the Fully Modified OLS (FMOLS) method developed by Phillips in the context of time-series. Both methods mentioned above seem to perform relatively well in small samples ($T=22$, $I=4, 5, 6$), although the FMOLS estimator tends to be more robust for the case of multiple regressors [Pedroni, 2001]. It should be noted that the use of dynamic frameworks for panel datasets, based on an ARDL model or a VAR model, which can give additional insight into the speed of adjustment to equilibrium and short-run co-movements, is limited to panels with large T .

An important issue in panel regression analysis is the assumption of slope coefficients homogeneity and the choice between a pooled and a mean group estimator. On the one hand, if slope coefficients are homogeneous, then both the mean group and the pooled estimator are consistent, although only the latter is efficient. On the other hand, if slope coefficients are heterogeneous, then the pooled estimator is inconsistent, thereby implying the use of the mean group estimator, which is consistent and efficient within this framework. In order to properly distinguish between both cases, a Hausman-type test can be calculated. A prerequisite in the case of multiple regressors analysis is that the covariance matrix difference, which enters the test statistic, needs to be checked for positive semi-definiteness. As highlighted by Schreiber [2008], the Hausman test can be negative not only in small samples due to different residual variance estimator precisions, but even asymptotically. Additionally, the homogeneity of the slope coefficients can be examined by comparing the sign and magnitude of estimated coefficients for individual cross-sections.

Finally, an assumption of utmost importance for the validity of the results is the absence of cross-sectional correlation. If this is not fulfilled, then the techniques based on common factor prefiltering may be used or the cross-sectional means may be subtracted from the dataset. Conversely, the preferred empirical strategy is

based on inclusion of all significant drivers of reserve demand, which should largely mitigate the problem. To address this problem and avoid misleading estimates, [Pesaran's \[2021\]](#) cross-sectional dependence test is used to verify the lack of (strong) cross-sectional correlation.

Empirical findings

The empirical analysis proceeds as follows. Firstly, the dependence of reserve demand on the consecutive motives enumerated in the previous chapter is examined using the FGLS method over the full sample of 16 CEE countries and the period 2003–2024. In doing so, both strategies, i.e. from specific to general and from general to specific, are applied as a sensitivity analysis of the results. Nevertheless, since a large sample of over 350 observations is used, the results remain robust, leading to the same specification in both cases. Next, the stability of results with respect to time-series and cross-sectional dimensions is examined. Therefore, the same model is fitted to subsamples covering (i) the years preceding the GFC, i.e. 2003–2007, (ii) the period of financial turmoil in the euro area following the GFC, i.e. 2008–2013, and (iii) the period following the euro area sovereign debt crisis, i.e. 2014–2024. Similarly, the model is run across the three considered subgroups of CEE countries. In each case, residual cross-sectional dependence is verified by means of the Pesaran CD test. The results are presented in Table 3.

As mentioned above, the model is built in steps, by starting with the internal financial vulnerability motive, represented by the size of the domestic financial system and measured by the ratio of the broad money supply to GDP, and the motive of supranational trade and/or monetary union membership, quantified by appropriate dummy variables. Moreover, an impulse dummy variable representing the 2008 shock due to the GFC is considered, which might also affect the international reserve stocks. The results reported in column (1) of Table 3 confirm the size of the domestic financial system combined with euro area membership as crucial drivers of reserve demand, with such a simple model explaining as much as 80% of reserve asset behaviour in the CEE countries. Interestingly, it should be noted that only membership in the monetary union seems to be statistically significant, not participation in the common market. This result seems to suggest that financial integration, rather than international trade intensification, is the key factor in reserves policy. Surprisingly, the immediate impact of the GFC in 2008 on the reserve asset stocks is statistically insignificant.

Next, the current account vulnerability is included, represented by the propensity to import and measured by the ratio of imports to GDP. The results in column (2) of the table reveal that the propensity to import does not significantly determine the evolution of reserve assets. This finding seems to be consistent with the previous one, regarding the lack of significant impact of the common market membership. Therefore, the extensive involvement of CEE countries in pan-European trade and a potential sudden suspension of international trade are not significant factors shaping the reserve asset policy. This is interpreted as evidence that the new EU Member States and candidate countries are so closely integrated within the intra-European trade unions and free trade agreements, primarily through the European Union, that the prospect of trade wars or just trade barriers is not a significant determinant of reserve asset policy in the region.

Regarding capital account vulnerability (see columns (3) and (4) of Table 3), short-term indebtedness and foreign exposure of the domestic stock market and investment fund shares are found to be significant, although adding these variables only slightly increases the explanation of the evolution of reserve assets. Nevertheless, the identified external drains vulnerabilities are statistically significant, and their inclusion leads to a reduction in the estimate of internal drains vulnerability to a value close to the weight used in the ARA metric of the IMF, which is 0.3. The results point to the insignificance of foreign exposure due to other investment and financial derivatives. Given that other investment includes bank account balances, merchant credits, reserves and other short-term liabilities largely related to international trade, this result appears consistent with previous ones, indicating a lack of significance for the motive associated with trade integration. The insignificance of foreign exposure related to financial derivatives seems to be primarily due to the relatively small scale of actual flows, which are done on the basis of net payments.

Table 3. Determinants of reserve demand, NMSs and EU candidate countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	money	money imports	money KA	money debt equity	MoneyKA, opp. cost ex. vol.	money debt equity ex. vol.	pre-GFC 03-07	post-GFC 08-13	post-EA crisis 14-24	EA	EU non-EA	non-EU	full
Internal financial vulnerability													
Size of financial system (broad money to GDP)	0.365 (0.014)	0.376 (0.013)	0.281 (0.013)	0.298 (0.013)	0.267 (0.013)	0.269 (0.013)	0.205 (0.070)	0.127 (0.046)	0.238 (0.035)	0.102 (0.022)	0.264 (0.044)	0.343 (0.037)	0.287 (0.012)
Current account vulnerability													
Propensity to import (imports to GDP)		-0.034 (0.019)											-0.066 (0.035)
Capital account vulnerability													
Short-term external indebtedness (short-term debt to GDP)			0.148 (0.013)	0.126 (0.011)	0.137 (0.010)	0.135 (0.010)	0.048 (0.071)	0.121 (0.032)	0.097 (0.023)	0.028 (0.026)	0.190 (0.064)	0.150 (0.063)	0.198 (0.015)
Equity and investment fund shares (direct & portfolio equity liab. to GDP)			0.063 (0.007)	0.059 (0.007)	0.058 (0.007)	0.058 (0.007)	0.005 (0.010)	0.211 (0.047)	0.004 (0.020)	0.095 (0.028)	0.016 (0.019)	0.017 (0.026)	0.077 (0.007)
Other investment (other investment liab. to GDP)			-0.031 (0.017)										-0.053 (0.028)
Financial derivatives (financial derivatives liab. to GDP)			0.288 (0.169)										0.214 (0.118)
Financial variables													
Opportunity cost (long-term gov. bond yield spread w/ US)					0.000 (0.001)								0.000 (0.001)
Exchange rate misalignment (REER index)					0.084 (0.008)	0.083 (0.007)	0.078 (0.062)	-0.252 (0.070)	0.094 (0.021)	0.034 (0.035)	0.109 (0.40)	0.097 (0.017)	0.074 (0.008)
Supranational union dummies													
EU	-0.012 (0.007)	-0.004 (0.006)											-0.025 (0.016)
EA	-0.185 (0.003)	-0.182 (0.003)	-0.188 (0.003)	-0.187 (0.003)	-0.195 (0.003)	-0.194 (0.003)	-0.216 (0.055)	-0.143 (0.018)	-0.227 (0.029)	-0.160 (0.007)			-0.192 (0.003)
Constant	0.033 (0.009)	0.054 (0.010)	0.017 (0.009)	0.000 (0.009)	-0.065 (0.011)	-0.065 (0.011)	0.099 (0.046)	0.269 (0.086)	0.004 (0.031)	0.053 (0.034)	-0.047 (0.058)	-0.042 (0.028)	-0.008 (0.013)
GFC (2008 year dummy)	-0.008 (0.011)	-0.002 (0.012)											-0.019 (0.021)
Observations	352	352	352	352	352	352	80	96	176	132	110	110	352
Countries	16	16	16	16	16	16	16	16	16	6	5	5	16
R ²	0.80	0.80	0.82	0.81	0.82	0.82	0.73	0.96	0.92	0.85	0.75	0.65	0.83
R ² , weighted	0.97	0.97	0.97	0.97	0.97	0.97	0.84	0.98	0.96	0.90	0.77	0.73	0.97
Pesaran CD test (p-value)	-0.15 (0.88)	-0.14 (0.89)	-0.04 (0.97)	-0.21 (0.84)	-0.13 (0.90)	-0.17 (0.86)	1.17 (0.24)	-0.79 (0.43)	0.78 (0.44)	1.24 (0.22)	-0.87 (0.38)	-0.15 (0.88)	-0.29 (0.77)

Source: Author's own elaboration.

Finally, of the two financial variables considered, namely the opportunity cost, represented by long-term government bond yield spread with the US, and the exchange rate misalignment, measured by the deviation from the equilibrium path induced by the PPP, only the latter turns out to be significant (see column (5) of the table). The former is not surprising, as empirical studies to date have typically shown the irrelevance of the opportunity cost. In other words, the costs of production and consumption curtailments due to a currency crisis are so high that the cost of maintaining reserves is negligible. As regards the exchange rate misalignment, this motive turns out to be significant, with a 20% overvaluation (deviation from the steady-state) leading to an increase in reserve demand relative to GDP of 1.7 percentage points on average. It seems that in the case of CEE countries this effect may reflect both a precautionary motive related to potential speculative attacks in the case of a heavily overvalued currency and a mercantilist motive associated with maintaining price competitiveness in international trade.

To sum up, the model built over the full sample of 16 CEE countries and the period 2003–2024 (see column (6) of Table 3) indicates the significance of four motives for reserve assets accumulation in CEE countries. Firstly, internal financial vulnerability due to the size of the domestic financial system. Secondly, external financial vulnerability owing to external short-term indebtedness and foreign liabilities related to the stock market and investment fund shares. Thirdly, the motive associated with exchange rate overvaluation, which in turn is undesirable from a precautionary, macroprudential and mercantilist policy perspective. Fourthly, membership in the euro area, which is undoubtedly a factor of the utmost importance in shaping reserve asset policy.

It should be emphasised that the estimated impact of euro area membership on the stock of reserve assets, which amounts to almost 20% of the reserves-to-GDP ratio, is enormous compared to the 20–25% of resources held on average by the countries of the CEE region before joining the euro area. As mentioned in Section 3, the CEE countries joining the euro area experienced a very sharp decline in their reserves, reaching single-digit reserve-to-GDP ratios, in some cases even as low as 1–2% of GDP. This effect can be considered a significant benefit of entering the euro area, although it is probably not the most salient feature of euro area membership.

Turning to examination of the stability of the results with respect to time-series and cross-sectional dimensions, the model given in column (6) of Table 3 is fitted to the aforementioned three subsamples, covering (i) the period preceding the GFC, (ii) the period covering the financial turmoil in the euro area after the GFC, and (iii) the period following the euro area sovereign debt crisis. The results are presented in columns (7)–(9) of the table, respectively. As regards the period preceding the GFC and contrary to the full sample outcomes, the results point to a lack of significance of the capital account vulnerabilities as well as the exchange rate overvaluation motive, though the coefficient associated with the latter has a correct sign and magnitude. Nevertheless, it should be stressed that this short sample of 80 observations covers only five years with somewhat diversified economic performance among the countries considered. Therefore, the insignificance of these motives in the period preceding the GFC may purely be down to a small-sample-size effect.

Shifting focus to the next period covering the financial turmoil in the euro area after the GFC (see column (8) of the table), it can be easily seen that the demand for reserves is characterised by a strongly increased influence of foreign exposure on the domestic market of equities and investment fund shares, which is more than three times larger compared to the period 2003–2024, while the impact of the short-term external debt is similar, as compared to the full sample estimate. Primarily, this is at the expense of the significance of internal vulnerability due to domestic capital drains. These results indicate that during periods of financial distress, reserve assets policies are focused on external sources of risk related to capital account liabilities, while the coefficient associated with exchange rate misalignment becomes negative. This may be seen as a surprising or unexpected estimate. However, in the aftermath of the GFC, CEE countries experienced heavy depreciation of their currencies both in real and nominal terms [Kębtowski, 2011; Kębtowski, Welfe, 2010, 2012]. As a result, it seems a plausible explanation that despite capital flights and extraordinary circumstances in inter-

national financial markets, the emphasis was on intensifying the accumulation of reserve assets. This was indeed the case in most CEE countries, in spite of the significant depreciation of their currencies. Finally, the decline in the impact of euro area membership in the period following the GFC can be attributed to the fact that the only two countries to join the euro area during this period were Estonia and Slovakia, both of which had relatively low reserves-to-GDP ratios, which also slightly declined in the one to two years preceding the euro area accession.

The process underlying the accumulation of reserves appears to have stabilised in the years following the euro area sovereign debt crisis (see column (9) of Table 3). The estimated effects of internal and external vulnerabilities, as well as the exchange rate misalignment on reserve holdings, are similar to their full sample counterparts, with the exception of the coefficient associated with euro area membership, although the latter is purely due to the general upward trend in the accumulation of reserves in the countries under consideration. Moreover, the impact of foreign exposure on the domestic market of equities and investment fund shares, which intensified during the euro area crisis, decreases and becomes statistically insignificant in the years following the euro area economic recovery.

To examine the cross-sectional stability of the results, the three aforementioned subgroups of CEE countries are considered, namely (i) the euro area NMSs, (ii) the NMSs with a single currency derogation, and (iii) the EU candidate countries. The results presented in columns (10)–(12) of Table 3 clearly point to significant differences in reserve demand with respect to the status of the euro area and European Union membership. Since the samples used for each subgroup cover slightly over 100 observations, more robust techniques of panel cointegration analysis with small I and T are employed.

As the small sample performance of the methods is of importance, the following inference strategy is conducted. Firstly, both methods with superior small-sample performance, i.e. the DOLS and the FMOLS, are used. For each of these methods, a mean group (MG) and a pooled weighted (PW) regression are run to cover both the heterogeneous-slope-coefficients case and the homogeneous case. In order to establish which of the estimators is both consistent and efficient, a Hausman-type test is calculated, with a prior check for positive semi-definiteness of the covariance matrix difference (see the discussion in the previous section). Therefore, results of either a mean group or a pooled weighted estimator are reported, according to the indication of the Hausman test. Additionally, the cross-sectional distribution of country-specific regression results is analysed to investigate patterns of long-run coefficient dispersion. The aim is to identify cases when the majority of individual estimates for a given coefficient are concentrated around a similar value, although an individual regression points to an outlying result, sometimes even with the opposite sign.

Table 4 summarises the results of reserves demand determination with respect to the five motives mentioned above for the euro area NMS. A mean group estimator based on both the considered methods points to the significance of membership in the euro area, the results of the FMOLS method confirm the significance of internal financial vulnerability, while propensity to import and opportunity cost are insignificant (see column (1) of the table). It seems that the DOLS method struggles with only four regressors included. It should be noted that the FMOLS employs nonparametric corrections for endogeneity and serial correlation biases; thus, the effective sample is larger than the DOLS, which instead uses leads and lags. Moreover, Croatia had to be removed from the DOLS regression due to unidentifiability of leads of euro area membership. The inclusion of four capital account vulnerability sources in the next step resulted in inconclusive results, as both of the methods struggled with multiple regressions including six drivers. Therefore, as mentioned above, patterns of long-run coefficient dispersion were investigated, and robustness checks were conducted, also by dropping the countries with outlying observations. The main steps of this iterative procedure are reported in columns (3)–(5). Finally, the specification presented in the last column of the table is achieved.

Table 4. Determinants of reserve demand, EA members

	(1)		(2)		(3)		(4)		(5)	
	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS
	MG	MG	MG	MG	MG	MG	PW	PW	PW	PW
Internal financial vulnerability										
Size of financial system (broad money to GDP)	0.085 (0.180)	0.279 (0.036)	0.231 (0.071)	0.279 (0.037)	0.057 (0.112)	0.077 (0.024)	0.072 (0.039)	0.171 (0.044)	0.079 (0.032)	0.170 (0.043)
Current account vulnerability										
Propensity to import (imports to GDP)	0.274 (0.237)	0.031 (0.037)								
Capital account vulnerability										
Short-term external indebtedness (short-term debt to GDP)					-0.467 (0.087)	-0.021 (0.022)	0.019 (0.053)	-0.034 (0.061)		
Equity and investment fund shares (direct & portfolio equity liab. to GDP)					0.422 (0.131)	-0.003 (0.022)	0.141 (0.049)	0.147 (0.055)	0.141 (0.049)	0.103 (0.052)
Other investment (other investment liab. to GDP)					0.353 (0.073)	0.028 (0.019)				
Financial variables										
Financial derivatives (financial derivatives liab. to GDP)					-6.760 (3.540)	0.537 (0.535)				
Opportunity cost (long-term gov. bond yield spread w/ US)	0.006 (0.003)	0.003 (0.002)								
EA	-0.163 (0.019)	-0.186 (0.007)	-0.170 (0.011)	-0.191 (0.008)	-0.181 (0.014)	-0.186 (0.004)	-0.159 (0.008)	-0.170 (0.050)	-0.154 (0.008)	-0.146 (0.051)
Observations	105	132	105	132	105	132	105	132	105	132
Countries	5	6	5	6	5	6	5	6	5	6
Pesaran CD test (p-value)	-0.86 (0.39)	1.41 (0.16)	-0.30 (0.76)	0.96 (0.34)	1.78 (0.07)	0.99 (0.32)	-0.66 (0.51)	-0.10 (0.92)	-0.72 (0.47)	0.49 (0.62)
Hausman test (p-value)	non-PSD (-)	non-PSD (-)	non-PSD (-)	non-PSD (-)	156.56 (0.00)	non-PSD (-)	7.01 (0.14)	7.35 (0.12)	2.09 (0.55)	1.91 (0.59)

Notes: Countries included: Croatia, Estonia, Latvia, Lithuania, Slovakia and Slovenia. Since Croatia joined the euro area in 2023, it has been excluded from the Stock-Watson leads-and-lags estimator (DOLS).
Source: Author's own elaboration.

Table 5. Determinants of reserve demand, non-EA members of the EU

	(1)			(2)			(3)			(4)			(5)		
	DOLS	FMOLS	PW	DOLS	FMOLS	PW	DOLS	FMOLS	PW	DOLS	FMOLS	PW	DOLS	FMOLS	PW
	MG	PW		PW	MG		PW	MG		PW			PW		
Internal financial vulnerability															
Size of financial system (broad money to GDP)	0.242 (0.177)	0.427 (0.071)	0.318 (0.055)		0.249 (0.065)		0.429 (0.282)	0.148 (0.053)		0.356 (0.095)	0.343 (0.051)		0.309 (0.044)	0.324 (0.046)	
Current account vulnerability															
Propensity to import (imports to GDP)	0.021 (0.251)	-0.168 (0.097)													
Capital account vulnerability															
Short-term external indebtedness (short-term debt to GDP)							0.341 (0.398)	0.087 (0.084)		0.223 (0.107)	0.165 (0.070)		0.256 (0.098)	0.169 (0.069)	
Equity and investment fund shares (direct & portfolio equity liab. to GDP)							0.044 (0.103)	0.203 (0.145)		-0.035 (0.048)	-0.069 (0.110)				
Other investment (other investment liab. to GDP)							0.176 (0.207)	0.080 (0.052)							
Financial derivatives (financial derivatives liab. to GDP)							-3.086 (3.514)	-3.828 (2.685)							
Financial variables															
Opportunity cost (long-term gov. bond yield spread w/ US)	-0.002 (0.004)	0.059 (0.086)													
Exchange rate misalignment (REER)	0.183 (0.166)	0.102 (0.055)	0.115 (0.051)		0.153 (0.063)		0.281 (0.270)	0.177 (0.065)		0.129 (0.053)	0.099 (0.056)		0.093 (0.046)	0.124 (0.050)	
Observations	84	88	84	88	88	88	84	88	88	84	88	88	84	88	88
Countries	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Pesaran CD test (p-value)	-0.04 (0.96)	1.61 (0.11)	0.45 (0.66)		0.74 (0.46)		-0.32 (0.75)	-0.81 (0.42)		-0.87 (0.38)	0.20 (0.84)		-0.50 (0.62)	0.35 (0.73)	
Hausman test (p-value)	non-PSD (-)	4.77 (0.31)	3.25 (0.20)		10.99 (0.00)		3.17 (0.79)	75.29 (0.00)		0.26 (0.99)	0.79 (0.94)		4.81 (0.19)	3.98 (0.26)	

Notes: Countries included: Bulgaria, Hungary, Poland and Romania. Czechia has been dropped due to its exchange rate commitment during the period November 2013 to April 2017.

Source: Author's own elaboration.

Table 6. Determinants of reserve demand, EU candidate countries

	(1)			(2)			(3)			(4)			(5)		
	DOLS	FMOLS	MG	DOLS	FMOLS	MG	DOLS	FMOLS	MG	DOLS	FMOLS	PW	DOLS	FMOLS	PW
	MG	MG		PW	MG		MG	MG		PW	PW		PW		
Internal financial vulnerability															
Size of financial system (broad money to GDP)	0.307 (0.216)	0.417 (0.034)		0.403 (0.045)	0.344 (0.045)		0.715 (0.261)	0.339 (0.051)		0.452 (0.045)	0.395 (0.044)		0.405 (0.044)	0.403 (0.042)	
Current account vulnerability															
Propensity to import (imports to GDP)	-0.050 (0.305)	-0.067 (0.036)													
Capital account vulnerability															
Short-term external indebtedness (short-term debt to GDP)							-0.060 (0.246)	-0.274 (0.090)		0.161 (0.070)	0.140 (0.064)		0.177 (0.047)	0.125 (0.064)	
Equity and investment fund shares (direct & portfolio equity liab. to GDP)							-0.459 (0.181)	0.145 (0.054)		-0.108 (0.066)	-0.031 (0.048)				
Other investment (other investment liab. to GDP)							0.088 (0.161)	0.190 (0.039)							
Financial derivatives (financial derivatives liab. to GDP)							-9.565 (116.74)	-24.566 (20.32)							
Financial variables															
Opportunity cost (long-term gov. bond yield spread w/ US)	-0.006 (0.006)	-0.001 (0.001)													
Exchange rate misalignment (REER)	0.209 (0.360)	-0.005 (0.036)		0.095 (0.031)	0.075 (0.053)		-0.063 (0.207)	0.113 (0.049)		0.054 (0.030)	0.092 (0.042)		0.094 (0.044)	0.084 (0.042)	
Observations	105	110	5	105	110	5	84	88	4*	105	110	5	105	110	5
Countries	5	5	5	5	5	5	4*	4*	4*	5	5	5	5	5	5
Pesaran CD test (p-value)	-1.40 (0.16)	1.09 (0.27)		-0.39 (0.70)	0.60 (0.55)		-0.49 (0.62)	0.76 (0.45)		1.88 (0.06)	1.94 (0.05)		0.01 (0.99)	1.72 (0.09)	
Hausman test (p-value)	22.66 (0.00)	14.51 (0.01)		3.05 (0.22)	17.09 (0.00)		17.62 (0.01)	364.13 (0.00)		6.31 (0.18)	4.41 (0.35)		0.23 (0.91)	2.79 (0.43)	

Notes: Countries included: Albania, Bosnia and Herzegovina, Moldova, North Macedonia and Serbia.

* North Macedonia has been dropped due to estimation errors.

Source: Author's own elaboration.

Similarly to the results of the full sample model reported in column (6) of Table 3, the results for the euro area NMSs presented in column (5) of Table 4 confirm the significance of internal financial vulnerability, although the coefficient estimates, which range from 0.08 to 0.17, are lower than the full sample estimate of 0.28. This outcome seems to mimic the fact that residents of euro area member countries may be less inclined to outflow their capital during periods of financial distress. With respect to capital account vulnerability, the only driver is the foreign exposure of domestic equities and investment fund shares, with estimates ranging from 0.10 to 0.14, compared to 0.05 for the full sample estimate. The insignificance of short-term external debt seems to reflect the fact that these countries can rely on the ECB as a provider of liquidity. Finally, the motive related to euro area membership is clearly a key driver of reserve demand for these countries.

The results for the NMSs with a single currency derogation presented in Table 5 are somewhat different from those specific for the euro area NMSs. Firstly, the impact of internal financial vulnerability is comparable to the full sample estimate. The primary driver of reserve demand due to capital account vulnerability is the short-term external debt. The coefficient estimates vary from 0.17 to 0.26 (see column (5) of Table 5), compared to a slightly lower value of 0.14 for the full sample estimate (see column (6) of Table 3). Contrary to the case of the euro area NMSs discussed above, the foreign exposure of the domestic equities and investment fund shares does not affect reserve demand, which seems to suggest that an equities-driven full-blown currency crisis, similar to those in East Asian countries at the turn of the century, is not expected to occur in NMSs with a single currency derogation.

The exchange rate misalignment for the NMSs with a single currency derogation has been found to be significant. According to the results (see column (5) of Table 5), a 20% overvaluation should lead to an increase in the demand for reserves relative to GDP, with an estimated impact of 1.9–2.5 percentage points based on the outcomes of the DOLS and the FMOLS methods, which is almost 10% of reserve assets in absolute terms. The finding of relatively high importance of exchange rate overvaluation on reserve asset holdings seems to be in line with the motives mentioned in the surveys of CEE-region central banks [Berłowska et al., 2019; Mora, Schmidt, 2019]. Clearly, the need for maintaining price stability and competitiveness in international trade is one of the key factors shaping the economic performance of these countries. Therefore, not only is a precautionary and macroprudential approach warranted here, but a mercantilist perspective seems to underpin this motive as well.

Turning to the EU candidate countries, the general pattern of determinants remains the same as compared to the NMSs with a single currency derogation. Notwithstanding, the impact of internal and external vulnerabilities, as well as exchange rate misalignment, differs considerably. The coefficient estimate of 0.4 related to internal financial vulnerability is higher than the full sample estimate of 0.28 and the estimate for the NMSs with a single currency derogation, which is 0.31–0.32. The estimated impact of external short-term debt for the EU candidate countries is 0.13–0.18, lower than the 0.17–0.26 in the case of the NMSs with a single currency derogation. Therefore, potential capital outflows by residents seem to be a key factor in the case of EU candidate countries, while capital account vulnerability is lower than in the case of the NMSs with a single currency derogation, although higher than for the euro area NMSs. As regards the impact of exchange rate misalignment, the estimate for EU candidate countries of 0.08–0.09 is slightly lower than for the NMSs with a single currency derogation, and similar to the full sample estimate.

It needs to be stressed that formal inference regarding whether subgroup coefficient estimates on the same factors are significantly different would require an SEM/SUR regression on all significant regressors in order to properly calculate a test statistic. However, due to the sample size of the dataset under consideration and the poor performance of these estimators, the multivariate framework is considered inadmissible here. In fact, even in the case of the univariate framework with four or more drivers included, both estimators struggled in terms of performance. Conversely, a simpler approach based on non-overlapping confidence intervals would provide an oversized test. Therefore, a formal verification of subgroup dissimilarities is left to future research based on longer time spans.

Conclusions

Over the last decades following the fall of communism, CEE countries have experienced significant economic recovery and transformation, leading to increased foreign investment and financial integration. Successive stages of this process were marked by the fact that most CEE countries joined the European Union, with some of them also joining the euro area. All of this occurred against the broader backdrop of growing global trade and intensifying capital flows, which had an impact on all state-level macroeconomic policies, and reserve asset policies were no exception. To this end, the process underlying reserve assets stockpiling in the CEE countries, which exhibited rather dynamic behaviour, was investigated. It was found that the mechanism determining the demand for reserves varies across subgroups of the CEE countries, with membership in the euro area and the EU being the main differentiating factors. In fact, not only does the estimated magnitude of drivers vary, but there are also important differences in the determinants themselves.

First and foremost, the key factor shaping the demand for reserve assets is membership in the euro area, which was to be expected. Joining the euro area not only has an immediate and immense impact on the stock of reserve assets, but also creates a favourable financial framework that significantly changes the process underlying reserves policy. Specifically, the internal financial vulnerability resulting from the size of the domestic financial system is lower than for other countries in the CEE region, while the highest estimated impact occurs for the EU candidate countries. Moreover, external risks associated with capital account liabilities differ across the subgroups considered. The analysis demonstrates that the demand for reserves in euro area EU Member States depends on the foreign exposure to domestic equities and investment fund shares. In the case of the new EU Member States with a single currency derogation and the EU candidate countries, short-term external debt is a key factor with regard to external vulnerability.

Moreover, the results point to a significant impact of exchange rate misalignment in the case of non-euro area CEE countries. It can be argued that this channel of reserve asset policy can be motivated by a precautionary, macroprudential and mercantilist approach to macroeconomic policy. Furthermore, in none of the three subgroups considered were opportunity cost and propensity to import found to be significant drivers of reserve assets stockpiling.

Finally, while the stability of the results in the time-series dimension was examined on the full sample of 16 CEE countries, no attempt was made in this paper to verify potentially changing motives for the accumulation of reserve assets in the subgroups or just individual countries. It therefore appears that 22 annual observations even for 5–6 countries are not enough to draw reliable conclusions on the matter. This is a promising topic for future research.

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Appendix

Table A1. Data sources and definitions

Variable	Definition	Units	Source
International reserves	Official reserve assets	current billion US\$	IMF
Gross domestic product	Gross domestic product	current billion US\$	World Bank
Broad money	M2	current billion US\$	World Bank
Imports	Imports of goods and services	current billion US\$	World Bank
Short-term external debt	External debt with remaining majority up to 1 year, principal plus interest payments	current billion US\$	IMF
Equity and investment fund shares	Equity and investment fund shares liabilities, direct and portfolio investment	current billion US\$	IMF
Other investment	Other investment liabilities	current billion US\$	IMF
Financial derivatives	Financial derivatives liabilities	current billion US\$	IMF
Opportunity cost	10-year government bond interest rate differential with US	percentages per annum	Eurostat

cont. Table A1

Variable	Definition	Units	Source
Exchange rate misalignment	Real effective exchange rate (increase amounts to appreciation)	index, 2010 = 1	World Bank and author's own calculation
EU	Dummy variable equal to 1 if a country is the European Union Member State in a given year and zero otherwise	0–1	Author's own calculation
EA	Dummy variable equal to 1 if a country is the euro area member state in a given year and zero otherwise	0–1	Author's own calculation
GFC	Dummy variable equal to 1 in 2008 and zero otherwise	0–1	Author's own calculation

Notes: All variables in US\$ are transformed to GDP ratios. For all variables, the missing data from the early 2000's and 2024 were retrieved from annual reports and/or databases of central banks.

Source: Author's own elaboration.