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ESSAYS ON UNOFFICIAL EUROIZATION IN EUROPEAN TRANSITION ECONOMIES

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PRISPEVKI O NEURADNI EVROIZACIJI V EVROPSKIH TRANZICIJSKIH GOSPODARSTVIH

POVZETEK

Disertacija obravnava neuradno evroizacijo v evropskih tranzicijskih gospodarstvih z uporabo pristopa bilančnega učinka. Bilančni učinek je reakcija na neugodne spremembe deviznega tečaja, npr. na depreciacijo deviznega tečaja, in se manifestira kot višji strošek servisiranja dolga, spodbujen z visoko ravnijo obveznosti, ki so denominirane v tuji valuti. Pri analizi pomembnosti, velikosti in smeri bilančnega učinka raziskujemo vpliv neuradne evroizacije na tri glavne sektorje gospodarstva: bančni, korporativni in državni sektor.

Po uvodu, ki smo ga podali v 1. poglavju, 2. poglavje disertacije raziskuje determinante evroizacije depozitov v bančnem sektorju za 12 evropskih posttranzicijskih gospodarstev, pri čemer so uporabljeni tako linearni modeli kot modeli z vključenim pragom. Rezultati kažejo, da sta diferenciala deviznega tečaja in obrestnih mer pomembna za razlago evroizacije depozitov. Rezultati za dve državi z najvišjo makroekonomsko in institucionalno kredibilnostjo in fleksibilnimi režimi deviznih tečajev, Češko in Poljsko, ne dajejo dokazov o učinkih praga, medtem ko je bilo pri drugih državah ugotovljeno učinkovanje praga. Rezultati vektorske avtoregresije z vključenim pragom nakazujejo, da ima depreciacija močnejši učinek na evroizacijo depozitov kot apreciacija, medtem ko se razmik med obrestnimi merami bolj poveča po depreciacijah deviznega tečaja kot po apreciacijah. Poleg tega najdemo dokaze, da se evroizacija depozitov bolj spreminja pri zviševanju diferencialov obrestnih mer, kot pri zniževanju. Ti rezultati podpirajo naša pričakovanja o nelinearni dinamiki evroizacije depozitov kot posledici depreciacije deviznega tečaja in potrjujejo, da centralne banke izvajajo določeno »fear of floating« politiko.

V 3. poglavju obravnavamo empirično preizkušanje vpliva depreciacije deviznega tečaja na uspešnost sektorjev, ki jih predstavljata investicije oziroma prodaja. Meri bilančne učinke in učinke konkurenčnosti v državi, ki beleži zelo visoko raven evroizacije obveznosti. Metodologija panelnih podatkov je uporabljena za nabor podatkov 20 hrvaških nefinančnih sektorjev ob kombiniranju makroekonomskih informacij ter sektorskih finančnih podatkov. Rezultati potrjujejo, da obstajajo močni negativni učinki evroizacije

obveznosti tako na investicije kot tudi na prodajo. Poleg tega smo našli tudi negativne bilančne učinke in zelo majhne pozitivne učinke konkurenčnosti, ki prispevajo k negativnemu skupnemu učinku depreciacije deviznega tečaja na uspešnost sektorja. Prav tako smo našli dokaze o tem, da se korporativni sektor ne varuje pred izpostavljenostjo deviznega tečaja ter da je domači finančni sistem ovirajoč faktor za dinamiko korporativnih investicij. Ravno tako smo našli dokaze o asimetrijah velikosti v zvezi z razmerji bančnih posojil.

V 4. poglavju smo zasnovali empirični model *spreada* državnih obveznic in njihovih determinant, pri čemer smo se opirali na novejše teorije o pomanjkljivih kapitalskih trgih in bilančnih učinkih. Raziskujemo devet evropskih nastajajočih gospodarstev, ki trpijo zaradi »izvirnega greha«, in sicer v obdobju od 2001 – 2011, ob uporabi dinamičnih modelov korekcije napak (angl. dynamic panel error correction models), ki jih predlagajo Pesaran, Shin in Smith (1999). Ta metodologija ne le izboljšuje učinkovitost ocene in uspešnost modela, temveč omogoča tudi razlikovanje med kratkoročnimi in dolgoročnimi determinantami razmika. Opazili smo, da se dolgoročno *spread* državnih obveznic viša kot reakcija na višji delež zunanjega dolga v BDP, medtem ko se giblje nasprotni smeri, ko deleža tekočega računa in mednarodnih rezerv v BDP rasteta. Kratkoročno *spread* državnih obveznic odstopa od dolgoročnega ravnovesja, pri čemer se polovica prilagoditve zgodi v osmih mesecih. Naši rezultati kažejo, da kratkoročno gledano povečano servisiranje zunanjega dolga, ki sta ga povzročila depreciacija deviznega tečaja, npr. bilančni učinek, in tržna nestabilnost, povzročata zvišanje razmika, medtem ko večji prihodki od davkov povzročajo njihovo znižanje. Poleg tega dokazujemo, da porast *spreada* državnih obveznic ni povzročen s samim kopičenjem zunanjega dolga, temveč s čistim bilančnim učinkom.

Ključne besede: bilančni učinek, evroizacija, devizni tečaj, »izvirni greh«, *spread* državnih obveznic, tranzicijska Evropa.

ESSAYS ON UNOFFICIAL EUROIZATION IN EUROPEAN TRANSITION ECONOMIES

SUMMARY

The dissertation addresses unofficial euroization in European transition economies using the balance sheet effect framework. The balance sheet effect is a response to adverse exchange rate changes, i.e. exchange rate depreciation, and it manifests itself in higher debt servicing costs, driven by high levels of foreign currency denominated liabilities. Analysing the significance, size, and direction of the balance sheet effect, we explore the effects of unofficial euroization on three main sectors of the economy: banking, corporate, and sovereign sector.

After the introduction given in Chapter 1, Chapter 2 of the dissertation investigates determinants of deposit euroization in the banking sector for 12 European post-transition economies using both linear and threshold models. Results suggest that exchange rates and interest rate differentials are important for explaining deposit euroization. Results for two countries with highest macroeconomic and institutional credibility and flexible exchange rate regimes, the Czech Republic and Poland, suggest no evidence of threshold effects, while for other countries threshold behavior was found. Threshold vector autoregression results indicate depreciations have a stronger effect on deposit euroization than appreciations, while interest rate spreads widen more after exchange rate depreciations than after appreciations. Moreover, we find evidence that deposit euroization changes more strongly after interest rate differentials increase than after they decrease. These results corroborate our expectations of deposit euroization nonlinear dynamics in the aftermath of exchange rate depreciation, and confirm that central banks carry out a certain "fear of floating" policy.

Chapter 3 empirically tests the impact of exchange rate depreciations on sectoral performance proxied by investment or alternatively sales. It measures the balance sheet and the competitiveness effects in a country that records very high levels of liability euroization. Panel data methodology is applied on a dataset of 20 Croatian non-financial sectors combining macroeconomic and sectoral financial information. Results confirm there are strong negative liability euroization effects on both investment and sales.

Negative balance sheet effects and very small positive competitiveness effects are found as well, adding up to a negative overall exchange rate depreciation effect on sectoral performance. Moreover, we find evidence that the corporate sector does not hedge against exchange rate exposure and that the domestic financial system is a constraining factor for corporate investment dynamics. We also find proof of size asymmetries related to bank lending relationships.

In Chapter 4 we build an empirical model of sovereign spreads and its determinants, relying on recent theories of imperfect capital markets and balance sheet effects. We investigate nine European emerging economies that suffer from "original sin", over the period 2001-2011, using dynamic panel error correction models proposed by Pesaran, Shin, and Smith (1999). This methodology improves estimation efficiency and model performance, but it also allows differentiation between long-run and short-run spread determinants. We find that in the long-run, sovereign spreads increase in response to a higher share of external debt in GDP, while they move in the opposite direction when the shares of current account and international reserves in GDP rise. In the short-run, sovereign spreads deviate from the long-run equilibrium, with half of the adjustment taking place in eight months. Our results suggest that in the short-run, higher external debt service caused by exchange rate depreciation, i.e. balance sheet effect, and market volatility tend to raise spreads, while higher tax revenues tend to decrease them. Moreover, we find evidence that the rise in sovereign spread is not due to external debt accumulation itself, but due to pure balance sheet effects.

Key words: balance sheet effect, euroization, exchange rate, "original sin", sovereign spreads, transition Europe.

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1 INTRODUCTION

1.1 MOTIVATION

The turbulent beginning of the transition process and its subsequent stabilization in the last decade of the 20th century made a strong mark on a number of Central, East and South East European countries. Although some of the countries managed to fulfil the necessary criteria and joined the European Union in less than two decades, European transition economies are still struggling with numerous challenges on their way to achieving convergence towards the European core. These transition and post-transition processes inspired a completely new field of research focused on European transition economies followed through the nineties and the first decade of the new millennium. Transition economies are generally thought of as one group of countries, but differences between specific countries or regions are acknowledged in the literature on transition economies. In line with that, research allows for heterogeneity between European transition economies that emanates from history, geography, country size and the design of the political system.

One of the most obvious features of European transition economies stems from monetary policy. During the first years of the transition process, almost all countries went through changes in their monetary systems that were accompanied by turbulent shocks. Repeating episodes of inflation and hyperinflation, government seigniorage interventions and poorly developed financial markets and institutions all lead to a massive decrease in central bank, monetary policy and domestic currency credibility (Frankel, 2010). These circumstances shaped the form of future monetary policy that eventually brought a rise in central bank credibility in succeeding years. However, it has been noticed that monetary policy credibility has not yet reached the levels observed in the most developed economies (Fraga, Goldfajn, and Minella, 2003). Besides, European transition economies have shown that as time went by, their levels of monetary credibility have risen, but they have also differed between countries, depending on diverse country-specific factors.

However, there is one conspicuous factor that explains country heterogeneity, at least regarding monetary credibility. In periods of high inflation that seized over European transition economies in the late eighties and early nineties, countries switched from money targeting nominal anchor, preferred in the eighties, to exchange rate targeting. The new exchange rate anchor managed to put inflation under control and contributed to

macroeconomic stability in the last decade of the previous millennium. However, while some countries later on switched to inflation targeting, most of European transition economies decided to maintain the nominal exchange rate anchor (Chang and Velasco 2000; Frankel, 2010; Mishkin, 2000), most probably due to underdeveloped financial markets and ineffective interest rate transmission channel. Out of the so-called "fear of floating", we are still witnessing fixed and managed exchange rate regimes, as well as currency boards and pegs all over European Central, East and South East countries.

The term "fear of floating" is coined by Calvo and Reinhart (2002) as a certain central bank bias against exchange rate depreciation. In order to maintain exchange rate stability and sustain depreciatory pressures, central banks use a myriad of tools to intervene on the market and prevent exchange rate depreciation. The reason why central banks do not wish to experience exchange rate depreciation is due to the presence of significant unofficial dollarization (Levy Yeyati, 2003). Unlike official dollarization, a formal acceptance of foreign currency as its own, unofficial dollarization is a voluntary act of using foreign currency either as a medium of exchange or store of value. The former leads to currency substitution, while the latter is recognized in the literature as asset substitution (Feige and Dean, 2002). However, more relevant and widespread is the term financial dollarization, defined as the share of foreign currency assets (liabilities) in total assets (liabilities). Financial dollarization appears in the form of deposits in foreign currency or both deposits and loans indexed to the exchange rate. Indexation leads to fluctuations in the amounts of such loans and deposits with respect to exchange rate changes. For example, if the exchange rate depreciates significantly, the loan amount increases proportionally to the exchange rate change leading to a rise in debt servicing costs. If financial dollarization in the economy is large, then exchange rate depreciation would cause major difficulties with debt repayments and create instabilities primarily in the banking system. Thus, it is not surprising that central banks of highly dollarized countries exhibit "fear of floating" that enables exchange rate stability. The side effect however is that exchange rate stability expectations in turn underpin the growth of unofficial dollarization leading to a sort of a vicious circle. Dollarization is a universal term that applies to all foreign currency held in excess, not only dollars. However, in order to differentiate between research on European countries from Latin American and East Asian countries, where the dollar is the dominant currency, we will use the term euroization throughout the text, as suggested by Feige and Dean (2002).

While it is an undisputed fact that the exchange rate anchor in early nineties did bring macroeconomic stability to European transition economies, it is also a fact that rigid exchange rate regimes that persisted in the period after, provided fertile ground for propagation of unofficial euroization. There are only a few studies (Levy Yeyati, 2003; Reinhart, Rogoff, and Savastano, 2003) that emphasize the good sides of euroization, such as that it enables faster money creation and that it reduces the inflation bias. However, most of the research is unfavourable as it argues that persistent and high unofficial euroization limits the choices for monetary policy makers and that it reduces overall monetary policy effectiveness. Besides its effects on monetary policy, unofficial euroization makes households, non-exporting enterprises, and governments highly vulnerable, due to the fact that domestic agents receive their incomes in local currency and repay their debts in foreign currency. Goldstein and Turner (2004) warned of those rising and unstable currency mismatches, while Reinhart et al. (2003) showed that unofficial euroization increases the exchange rate pass-through from the nominal exchange rate to prices. Levy Yeyati (2006) argues that all of these problems result in unstable money demand, increased risks of a banking crisis, and lower output growth. One of the most concerning forms of unofficial euroization is known as "original sin", a term introduced by Eichengreen and Hausmann (1999). "Original sin" is a state in which governments cannot borrow funds in local currency, even at the domestic market, but are instead forced to issue bonds and take loans directly in foreign currency or in local currency but only under the terms that it is indexed to the exchange rate. Eichengreen, Hausmann, and Panizza (2003) noticed that countries that suffer from "original sin" eventually end up with greater exchange rate variability and gross domestic product volatility. When the government is unable to borrow in local currency and is the benchmark creditor of a country, i.e. it establishes the minimum borrowing interest rate, then enterprises are obviously in a much worse position. Not just that they are also forced to borrow in foreign currency, interest rates on corporate loans are higher than sovereign ones, as they carry a higher business risk. This builds large currency mismatches, especially for the nontradable sector, as the tradable sector has a natural hedge for its foreign currency exposure in the form of revenues from abroad.

Despite the fact that transition countries stabilized in the middle of the nineties, and inflation was subdued, unofficial euroization remained very high and as years went by it has shown great persistence (Levy Yeyati, 2003). The reasons are multiple and diverse, and the existing literature offers plenty of explanations for unofficial euroization

persistence. For example, Stix (2011) argues that currency substitution in European emerging countries is mostly a result of remittances and tourism income. Rosenberg and Tirpák (2008) emphasize that closeness to European Union and prospects for joining the European Monetary Union lead to unofficial euroization persistence. However, the main two reasons that stem from existing research are arbitrage opportunities and underdeveloped financial markets. The latter argumentation suggests that existing financial markets in the early phase of transition did not offer attractive financial and investment products in local currency, or possibilities to hedge foreign currency exposures (Feige, 2003; Levy Yeyati, 2003; Stix, 2011). Regarding arbitrage opportunities, investors take advantage of interest rate differentials in the short-run and medium-run, although the covered interest rate parity condition holds in the long-run. During the first 20 years of transition, commercial banks borrowed funds from eurozone countries at lower interest rates, and lent those euro funds to domestic borrowers at higher interest rates. This pattern of interest rate differentials that created liability euroization repeated all over transition Europe (Basso, Calvo-Gonzales and Jurgilas, 2011; Levy Yeyati, 2006; Kokenye et al., 2010; Reinhart et al., 2003; Šošić, 2012;). Lastly, Jeanne (2005) explored a related phenomenon of currency mismatches – situation in which the currency structure of assets does not coincide with the currency structure of liabilities – and argued that the main determinants of currency mismatches are financial underdevelopment and lack of monetary and sovereign credibility.

The problem of unofficial euroization was largely ignored during times of unimpeded inflow of foreign currency, but when foreign capital started to escape from European transition economies, the issue of euroization popped out. Driven by the global financial crisis, European emerging economies suffered strong exchange rate depreciations during the last quarter of 2008 and the first quarter of 2009. At that time, "flight to safety" seriously threatened macroeconomic stability of transition economies and exposed large currency mismatches and dangers of unofficial euroization (Winkler, 2009). Reinhart et al. (2003, pp. 41) noticed that "large currency mismatches remain hidden during tranquil times and wreak havoc during depreciations", and revitalized the issue of euroization in European transition economies.

A number of European transition central banks struggled and partially succeeded to lower the ratios of foreign currency deposits and credits in total amounts, during the greater part of the first decade of the new millennium. However, the Lehman Brothers collapse in

September 2008 and the initiation of a financial, and then an economic crisis, swiftly overturned the trend and re-euroized the system. Uncertainty, lack of local currency credibility and exchange rate depreciation fears urged households to save their extra incomes in euros, and forced companies and governments to issue debt in foreign currency. Only a short period of time between 2004 and 2007, European transition economies enjoyed the opportunity to issue debt in local currency and to reduce their currency mismatch. However, good times ended quickly and international lenders entrusted their assets exclusively under the terms that debtors repay them regardless of exchange rate movements. This made countries extremely vulnerable to exchange rate changes, and implicitly forced central banks to keep the exchange rate stable at all cost. A convention is that countries that suffer from high unofficial euroization, currency mismatches and potential negative effects on their balance sheets, can only minimize the costs of exchange rate depreciation expectations. If they let the exchange rate depreciate, their debt service costs will explode causing bank runs and economic crises more probable. Defending the exchange rate has a price of its own. It leads to a sort of a liquidity drain that manifests itself in rising interest rates. Therefore, unofficially euroized economies are always in a trade-off, and they are extremely vulnerable to any sort of external and internal shocks that could lead the economy into a crisis.

The described condition rests on a concept previously explored in the context of Latin American and East Asian countries. Countries that borrowed in foreign currency, but held and received assets in local currency, developed very strong currency mismatches in their balance sheets, be that household, banking, corporate or government balance sheets. When their currencies depreciated considerably, their balance sheets suffered proportionately to the level of financial euroization, leading to further exchange rate depreciations and a deeper economic crisis. Due to the fact that the shock progressed through balance sheets, it has been recognized as a balance sheet effect. This effect is a direct link between foreign currency mismatches and exchange rate dynamics, and the most elegant way to explore the culprits of euroization in emerging economies. In Section 1.2 we will present the theoretical framework of the balance sheet effect in detail and explain the links between euroization and this concept.

Unofficial euroization primarily affects monetary policy, as it limits the choices for policy makers that eventually manifest the “fear of floating” type of policy conduct, but it also impacts all sectors of the economy, the government, the corporate sector and households.

Although authors very often blame unofficial euroization for rigid exchange rate regimes, lack of competitiveness and even high interest rates, this phenomenon is still relatively underexplored. The literature on financial euroization determinants is satisfactory, but the overall knowledge on the size, direction and persistence of euroization effects on the economy is scarce and focused on Latin American and East Asian countries. The question of unofficial euroization is becoming more and more relevant in face of limiting policy options for new and future European Union members. For example, Hungary is a highly euroized country and as a European Union member it has the option of a *de iure* euroization "exit strategy" within the context of the eurozone. This is an elegant exit from threats of unofficial euroization, but in order to enter eurozone the country must comply with the Maastricht criteria. From the perspective of Hungary, the public debt ceiling set at 60 percent of GDP seems unattainable and the "exit strategy" seems to be far from reach. Therefore, Hungary and countries with similar problems must seek for different policy choices to deal with high unofficial euroization. In order to provide financial and economic stability in European emerging economies, it is necessary to address and explore these issues in more detail and possibly provide solutions for dealing with unofficial euroization.

The dissertation answers many questions related to euroization in European transition economies. It uses the concept of the balance sheet effect to explore the connection between exchange rates, exchange rate regimes, financial euroization, corporate performance and changes in sovereign yields. It measures the sign of the balance sheet effect, to detect if unofficial euroization is responsible for negative shocks in the aftermath of exchange rate depreciation. It also quantifies the size of the balance sheet effect in order to decide on the importance of financial euroization. This research also comments on country differences with respect to financial euroization and exchange rate regimes, and provides argumentation and policy implications for European transition countries. It directly measures nonlinear behaviour of financial euroization and provides evidence that exchange rate depreciation has a greater effect on financial euroization than exchange rate appreciation. Moreover, it explores the implications of currency mismatches and exchange rate depreciation on investment and sales of the corporate sector, arguing that there exists a strong negative balance sheet effect, a consequence of high and persistent financial euroization. Lastly, unofficial euroization of sovereign debt is studied and the consequences it has on country risk premium. The dissertation models European transition countries, both medium and highly euroized economies, European Union members and

candidate countries. Croatia, a highly euroized economy with large currency mismatches and very persistent financial euroization, is explored separately in the Chapter 3.

The dissertation consists of three research studies, each one focusing on a different sector of the economy. In Chapter 2 we explore the banking sector, in Chapter 3 corporate sector, while the sovereign sector is explored in Chapter 4. The liability side of banks' balance sheets is mostly made of deposits, and if those deposits are denominated in foreign currency, they create the condition known as deposit euroization. High deposit euroization can lead to possible balance sheet effects in case of exchange rate depreciation and create major costs for banks. This issue is explored and measured in Chapter 2. We provide evidence that deposit euroization reacts nonlinearly to exchange rate changes, i.e. it increases more after exchange rate depreciation than it decreases after exchange rate appreciation. This finding confirms the negative balance sheet effect for the case of banks. In Chapter 3, we use disaggregated data of the Croatian corporate sector in order to measure the direction and size of the balance sheet effect. We find that the balance sheet effect is negative for the case of Croatia, and that high foreign debt exposure of Croatian corporations reduces corporate profitability. Chapter 4 covers the sovereign sector and once again measures the balance sheet effect for nine European transition economies. Our results confirm that "original sin" adversely affects yield spreads on sovereign bonds in different European transition economies. Section 1.3 addresses these three chapters in more detail and argues specific hypotheses and contributions to existing literature.

1.2 BALANCE SHEET EFFECT FRAMEWORK

Previous literature that dealt with crises prior to the Asian and the Russian crises in the second half of nineties focused on current account imbalances as sources of financial crises. However, studies such as Dornbusch (1999), Krugman (1999, 2003), Pettis (2001), Allen, Rosenberg, Keller, Sester, and Roubini (2002), and Calvo (2003), argued that a new approach should be taken – one of the balance sheets of banks, the corporate sector and governments. What lies behind the balance sheet effect is foreign currency debt (Eichengreen and Hausmann, 1999).

There exist two types of balance sheet models, ones that use only currency mismatches and others that combine both currency and maturity mismatches. The first type of models

usually studies corporate balance sheets and their effect on investment and profitability (Aghion, Bacchetta, and Banerjee, 2000, 2001, 2004; Bacchetta, 2000; Krugman, 1999; Schneider and Tornell, 2004). The other type allows that debt is not only denominated in foreign currency but can also be short-term (a typical example would be banking deposits). In that case crises happen when depositors run to banks to withdraw their deposits (Burnside, Eichenbaum, and Rebelo, 2001a; 2001b; 2004; Chang and Velasco, 2000; Jeanne and Wyplosz, 2001). These models are appropriately corroborated by empirical evidence for banks (Luca and Petrova, 2008), enterprises (Carranza, Cayo, and Galdón-Sanchez, 2003), and governments (Berganza, Chang, and García-Herrero, 2004).

In order to explain the relationship between exchange rates and balance sheet effects, let us use a concept introduced by Jeanne and Zettelmeyer (2002). We assume a small open emerging economy that exist in only two periods, therefore $t = 1, 2$. We define the exchange rate, R_t, as the price of one unit of foreign currency in terms of local currency, so that an increase in the exchange rate reflects local currency depreciation. We also let S represent the balance sheet, or domestic net worth in terms of the foreign currency. Balance sheet effect theory links exchange rate expectations, $E(R_t)$, with domestic net worth, but the direction of this relationship can go both ways. First, exchange rate depreciation expectations erode domestic net worth when foreign currency liabilities are large and unhedged. And then a fall in net worth can initiate an economic crisis that in turn leads to exchange rate depreciation, causing a circular relationship that manifests itself as a self-fulfilling crisis. Therefore, there are three steps in the balance sheet framework. The first relation is the straightforward one, from $E(R_t)$ to S, and it arises from the balance sheet effect definition and the uncovered interest parity (UIP) condition. The UIP states that:

$$R_1 = \frac{1+i^*}{1+i} E(R_2) \,, \tag{1.1}$$

where R_1 is the exchange rate in the first period, $E(R_2)$ is the expected exchange rate in the second period, while i^* and i are foreign and local interest rates in period one, respectively. In order to connect the UIP condition with the balance sheet effect, we introduce debt denominated in local currency, D_t, and debt denominated in foreign currency, D_t^*, as well as local currency income, A_t, and foreign currency income, A_t^*.

These four streams realistically describe banks' and corporate balance sheets with respect to their currency composition. In our setting, these streams are exogenously defined, i.e. taken from the previous period. Using net present value of the balance sheet streams and exchange rate expectations, we can define net worth in foreign currency terms, or S^*, as:

$$S^* = \frac{A_2 - D_2 + (A_1 - D_1)(1+i)}{(1+i^*)E(R_2)} + \frac{A_2^* - D_2^* + (A_1^* - D_1^*)(1+i^*)}{1+i^*}. \quad (1.2)$$

Equation (1.2) simply states that net worth is a sum of inter-temporal net balance sheet streams denominated in foreign currency (as local currency net stream is divided by the expected exchange rate). Therefore, domestic net worth decreases in foreign currency terms when expectations of exchange rate depreciation rise. If $E(R_2)$ is high enough, net worth can even become negative, even if the agent (country, bank, enterprise) has enough resources to service its debt (its income stream is at least as large as the debt stream). A simple example would show that if a company is indebted in foreign currency and expects a 5-percent exchange rate depreciation, it is also facing an expectation of a 5-percent increase in the debt service cost of its foreign currency liabilities. In that respect, the income stream may not be enough to cover for debt service, and net worth then falls below zero.

The second relation describes the mechanism from net worth to economic crisis. As surveyed in Jeanne and Zettelmeyer (2002), there are two possible ways in which eroded net worth can lead to an economic crisis. One stream of literature, lead by Chang and Velasco (2000) and Jeanne and Wyplosz (2001), argues that low net worth can lead to a banking crisis that eventually may destroy the whole banking system. The other stream, lead by Krugman (1999) and Aghion et al. (2000, 2001, 2004), emphasizes that low net worth may cause a credit crunch that manifests itself in lower investments of the corporate sector. Jeanne and Wyplosz (2001) present a simple model in which they show that a fall in net worth of a bank that suffers from a currency mismatch between its assets and liabilities can cause a bank run. The most important feature of the Jeanne and Wyplosz (2001) model is that the expected exchange rate is the only determinant of a bank run. Assuming a large number of very small banks, and given their currency structure, they find evidence that the fraction of banks that are affected by a bank run is an increasing function of the expected exchange rate. Therefore, exchange rate depreciation can cause an erosion

of net worth and result in insolvency problems in the banking sector. On the other side, net worth determines the borrowing capacity of a firm, i.e. if net worth falls, the capacity to borrow and invest falls as well (Kiyotaki and Moore, 1997). Thus, expected exchange rate depreciation causes deterioration in net worth that leads to borrowing capacity shrinkage and results with a credit crunch, all propagated through the balance sheet effect. The size of the credit crunch depends on the expected exchange rate in the manner that the gap between first-best level of investment and realized investment widens with the expected exchange rate. Realized investment can then vary between zero for large expected exchange rate depreciation, and first-best level of investment, for rather small depreciations.

Lastly, an economic crisis causes exchange rate depreciation, thereby fulfilling the depreciatory expectations, and closing the loop. For this last step, literature has provided three different explanations. Krugman (1999) and Chang and Velasco (2000) simply argue that lower investment causes low supply of tradable goods, in turn affecting the current account and triggering a real exchange rate depreciation. This point of view assumes that the exchange rate depreciation is fed through the credit crunch. Aghion, Bacchetta, and Banerjee (2000, 2001) and Jeanne and Wyplosz (2001) on the other hand allow for the channel of the impact to go through either the credit crunch or the banking crisis, as long as domestic output is lower in the future. In order to account for the output loss, it is assumed that monetary authorities allow the exchange rate to depreciate. The third stream of literature explains that the exchange rate eventually depreciates due to monetization of increased public debt, driven by massive bailouts of banks caused by the banking crisis (Corsetti, Pesenti, and Roubini, 1999). To sum up, there is more than one possible channel through which the balance sheet effect can actually realize depreciatory exchange rate expectations, and close the self-fulfilling crisis loop.

The balance sheet effect is important because it has severe policy implications. Its existence and the threat of its inception, limits the choices for optimal economic policy. If banks, households, enterprises and the government have accumulated large currency mismatches in their balance sheets, an exogenous economic shock (such as a credit crunch in the United States or a fall in external demand) can be enough to trigger exchange rate depreciation and consequently cause net worth erosions, bank runs and investment stoppages. Therefore, policy makers are limited in their responses with respect to the size of the currency mismatches present in the economy. On top of that, the possibility of a self-

fulfilling crisis (step three as outlined above) puts an even tighter strain on policy makers due to the fact the economy can easily run into a serious economic crisis. This explains why a number of emerging countries that are constrained by the threat of a balance sheet effect, cannot react timely and properly to exogenous shocks.

Both existing literature and empirical data are indecisive on the role of the exchange rate regime. While some studies show that flexible exchange rate regimes encourage agents to hedge their foreign currency exposures and by that tend to decrease currency mismatches and euroization (Burnside et al., 2001a; 2004; Goldstein, 2002; Martinez and Werner, 2000), Arteta (2005a) for example has shown that flexible exchange rates increase currency mismatches because they reduce only credit but not deposit euroization. Results presented in Chapter 2 speak in favour of flexible exchange rate regimes. It was found that the Czech Republic and Poland, countries that adopted flexible exchange rate regimes, have the lowest levels of deposit euroization in emerging Europe, and that they do not show signs of nonlinear reactions of euroization to depreciatory exchange rate changes. The usual policy recommendation for dealing with currency mismatches is to go through full, official euroization. Jeanne and Zettelmeyer (2002) argue that only a full, credible, and irreversible euroization can solve the balance sheet problem and completely nullify currency mismatches. However, only two countries in emerging Europe that are not eurozone members, Montenegro and Kosovo, adopted the euro as its official currency. Other countries either have to comply with the Maastricht criteria, a task becoming more and more elusive each day, or still have to go through the long and difficult process of joining the European Union. When countries do not have the option to officially euroize, they are left with different policy choices. One of those could be the adoption of a flexible exchange rate regime, as evidence teaches us that some countries succeeded in lowering their currency mismatches when they allowed for more exchange rate flexibility. Other choices concern monetary and fiscal policy, and international lending issues.

Central banks, faced with large currency mismatches in the system, often demonstrate a certain “fear of floating” that is biased against depreciation (Calvo and Reinhart, 2002). Put differently, central banks use a myriad of tools, such as foreign exchange interventions, skipping reverse repo auctions, and administrative measures, to achieve tighter monetary policy and a stabile exchange rate. One of the most important results of such a policy, besides the targeted exchange rate, are higher domestic interest rates. Higher interest rates actually can prevent net worth from falling, but only in the case where all banks and

enterprises have positive net worth (Jeanne and Zettelmeyer, 2002). Results presented in Chapter 3 confirm these assumptions, as we have found that interest rate differentials between domestic and euro zone interest rates widen in the aftermath of exchange rate depreciation.

Just as monetary policy is effective only under specific conditions, fiscal policy also suffers from similar problems. In order to prevent a banking crisis or a fall in investment, the government can increase transfers, cut taxes, or increase investments. However, the government is, just like banks and enterprises, constrained by its net worth and can only intervene up to a certain level. Usually, countries experience a surge in country risk premiums when their net worth falls as a result of exchange rate depreciation and currency mismatches. This results with higher yields on government debt, higher servicing costs on existing debt, and constrained access to international lending markets. This puts an additional burden on external debt and makes countries even more vulnerable to economic crises. When governments can ensure only limited amounts of international loans, banks and enterprises are in a far worse position. When the central banks is not able to provide enough foreign currency reserves to ensure foreign currency liquidity through open market operations, then banks are susceptible to liquidity problems and eventually bank runs. On the other hand, when companies lack investment funds on domestic market, and they have no access to international lending markets (a phenomenon observed all around the world), they suffer from a credit crunch that also leads to economic crisis. The way out of this trap lies in expansionary fiscal policy obtained through international lending. It has been observed that it is essential for governments to keep their doors open to international loan markets when they are experiencing some liquidity and investment gap problems. Government loans, and the pricing of those loans, decide on the costs of investments for the whole corporate sector, and on the stability and solvency of the banking sector. That is why we focus on government net worth and risk premiums in Chapter 4, as that channel is essential to avoiding a lending crisis, a not-so-impossible threat in countries that suffer from currency mismatches and potential balance sheet effects.

1.3 RESEARCH FOCUS

The dissertation focuses on three main sectors of the economy and by analysing the balance sheet effect it explores the effects of unofficial euroization. We start by studying

the banking sector and its liability side, deposit euroization. By observing the effect of exchange rate depreciation on deposit euroization, we find that there exists a negative balance sheet effect induced by unofficial euroization. Similarly, we explore the corporate sector and measure the size, direction and significance of the balance sheet effect generated by high levels of liability euroization in Croatian companies. As emerging market countries usually issue foreign currency denominated bonds and build high currency mismatches, we also measure the size of the negative balance sheet effect for the government sector.

1.3.1 Banking sector

Chapter 2 addresses the banking sector and its foreign currency liabilities. The biggest share of banks' liabilities goes to deposits, and European transition economies usually have a great part of deposits denominated in foreign currency or indexed to the exchange rate. This creates a liability for banks that fluctuates together with exchange rate movements. In case the exchange rate depreciates considerably, banks' liabilities rise proportionately and possibly create problems and instabilities in the banking sector. However, even when the exchange rate stability is preserved due to central bank interventions, banks' balance sheets, the whole money market and the overall economy can be significantly affected. For example, if a central bank that manifests the "fear of floating" is exposed to depreciatory attacks on the exchange rate, it will intervene on the market to keep the exchange rate stable. Usually, the central bank turns to international reserves and sells foreign currency on the open market, or it drains the local currency liquidity by abolishing reverse repo auctions, thus preventing investors to "realize" their increased demand for foreign currency. Both ways lead to relatively more foreign currency in the system and, at least in the short-run, ensure exchange rate stability. The first option is simple and straightforward, but it implies that the country has abundant foreign currency resources that will be easily and quickly restored. The second however, is more complicated, though more common in European transition economies. When foreign currency demand starts to rise and exchange rate stability is threatened, the central bank skips a reverse repo auction or finds a different way to withhold local currency liquidity. The scarce currency in that case becomes the local one, and with the growing interbank demand for local currency, necessary to buy foreign currency, the interest rate on the local currency rises. In cases of major exchange rate pressures, local currency interest rates can grow to two-digit rates in just a few days. High interest rates eventually discourage investors to liquidate their positions and

consequently prevent exchange rate depreciation. But these monetary policy biases and occasional central bank interventions leave track on unofficial euroization and economy as a whole. One can expect that due to "fear of floating" and monetary policy bias against exchange rate depreciation, euroization and different financial and macroeconomic variables would react more strongly to exchange rate depreciation than to appreciation. This calls for a different, nonlinear approach of examining monetary policy shocks.

The literature on the effects of monetary policy on macroeconomic variables is rather new and focused mainly on developed economies. Early research concentrates on the linear effects of monetary shocks on variables like inflation and output. But the beginning of nineties brings asymmetrical models into consideration and starts exploring monetary policy from a different perspective. Cover (1992) and later Morgan (1993) found evidence that expansionary monetary policy in the United States does not affect output, but that contractionary monetary policy does have a significant effect on aggregate output. Ravn and Sola (1996) take a step further and argue that the size of the shock, and not the sign, is the deciding factor that causes the observed asymmetric behaviour. Their research implies that small changes in money supply affect output, while the big changes have no effect. Ravn and Sola (1996) therefore assume nonlinear, threshold behaviour of monetary policy. Weise (1999) combines both approaches and shows that big contractionary monetary policy shocks have larger effects than small expansionary shocks. Thoma (1994) goes further by claiming that the state of the business cycle is responsible for asymmetries in monetary policy shocks. He finds that monetary policy shocks are stronger when real economic activity is decreasing.

Just as money supply affects macroeconomic variables in a nonlinear or asymmetric way, so do exchange rate changes. Monetary policy bias caused by "fear of floating" and high levels of unofficial euroization give reason to believe that exchange rate depreciation can affect the economy or at least the financial sector in a nonlinear way. No research regarding this issue has been carried out, at least not in the proposed manner. We depict three most important monetary variables for explaining unofficial euroization and "fear of floating" in European transition economies and model unofficial euroization of the banking sector. In line with the observed central bank behaviour and the results of interventions, we incorporate exchange rate changes, interest rate differentials and deposit euroization in our model. Deposit euroization is defined as the share of foreign currency deposits in total deposits and it reflects the liability side of banks' balance sheets, the segment susceptible

to possible adverse balance sheet effects. As we measure the effect of exchange rate depreciation on banks' liabilities in foreign currency, we are indirectly measuring the balance sheet effect. Following the work of Koop, Pesaran, and Potter (1996) and Balke (2000), we build a threshold vector autoregression model (TVAR). Besides, for a robustness check we construct a linear model as a benchmark, thus making a comparison of the obtained results country-by-country possible. We present the results in a form of generalized impulse response functions that differ between sign and size and that allow for switching regimes in the aftermath of a shock. Our intention was to test if highly euroized economies and those that run a more rigid exchange rate regime react differently to exchange rate changes. Therefore we construct five different hypotheses that we empirically test in Chapter 2 of the dissertation.

H1: Deposit euroization in countries that have high levels of unofficial euroization increases in the aftermath of exchange rate depreciation.

H2: Interest rate differentials in countries that have high levels of unofficial euroization widen after exchange rate depreciation.

H3: Deposit euroization in countries that have high levels of unofficial euroization increases when the interest rate differential widens.

H4: Countries with higher levels of deposit euroization react nonlinearly to exchange rate changes.

H5: Countries that have high levels of unofficial euroization and fixed or less flexible exchange rate regimes demonstrate nonlinear responses of deposit euroization to exchange rate changes.

As expected, in Chapter 2 we find that exchange rate depreciation increases deposit euroization in European transition economies. Exchange rate depreciations make the sum of banks' liability denominated in foreign currency more expensive and thus create higher burdens on one side of the balance sheet. In seven out of ten countries we found evidence in favour of the first hypothesis. As central banks react to exchange rate depreciation pressures by squeezing excess local currency liquidity and rising interest rates, it is not surprising that we have found evidence corroborating the second hypothesis for seven out

of ten countries. The loop is closed by the third hypothesis in which deposit euroization rises through the "fear of floating" mechanism, when the interest rate differential widens. Evidence supporting this hypothesis is once again found for seven out of ten countries. Two countries that always stood out from the first three hypotheses were the Czech Republic and Poland; countries that have the lowest levels of deposit euroization from the countries we explore, countries that have introduced inflation targeting and have flexible exchange rate regimes. These two countries did not pass our formal test for existence of nonlinear responses of deposit euroization to exchange rate changes, while other eight countries did. This finding does not reject hypotheses four and five due to the fact that seven out of eight countries that passed the nonlinearity test all have some sort of a fixed or managed exchange rate regime, and much higher levels of deposit euroization than the Czech Republic and Poland. The overall conclusions of Chapter 2 suggest that there are balance sheet effects in the banking sector of highly euroized European transition economies. Moreover, these effects are nonlinear; stronger in the case of depreciation than in the case of exchange rate appreciation.

The analysis conducted in Chapter 2 and the results obtained contribute to the existing literature in several ways. First, they provide new findings about the determinants, dynamics and implications of deposit euroization in European transition economies. As opposed to scarce existing research that usually only considers macroeconomic drivers of deposit euroization, we model monetary determinants and link the "fear of floating" literature with research on unofficial euroization. The main contribution, however, is that we use a nonlinear approach and provide empirical evidence that the exchange rate changes that lead to depreciation have a larger effect on deposit euroization than do exchange rate appreciations. This study is, at least to our knowledge, the first that uses TVAR methodology in exploring financial euroization.

1.3.2 Corporate sector

In Chapter 3 we explore liability euroization of the corporate sector and directly measure the sign, size and significance of the balance sheet effect. Companies that have high shares of debt in foreign currency in total debt, recognized in the literature as liability euroization, potentially suffer from negative balance sheet effects in case that their assets are mostly denominated in local currency. When the exchange rate depreciates, their foreign debt servicing costs increase proportionately, thus harming liquidity and solvency of a

company. Although there is a consensus that exchange rate depreciation helps exports, as the relative price of exports decreases in that case, the negative balance sheet effect may dominate the positive competitiveness effect when companies' balance sheets are filled with foreign currency liabilities that are higher than foreign currency revenues. Therefore, two opposite effects occur in the aftermath of exchange rate depreciation, the negative balance sheet effect and the positive competitiveness effect. There is no consensus on which effect dominates, only that for each country an empirical examination should be carried out (Carranza et al., 2003).

The balance sheet effect and the competitiveness effect are most elegantly presented using international trade concepts, such as the concepts of price elasticities of exports and imports. In case exports of a country are highly dependent on imported inputs and capital goods, i.e. they are highly inelastic to relative price changes, relatively higher import prices caused by exchange rate depreciation could have a contractionary effect on total exports. Although this channel was recognized by Reif (2002), there is contradicting evidence, such as Duttagupta and Spilimbergo (2000), who claim that exports increase after the exchange rate depreciates. However, Reif (2002) claims that countries with high currency mismatches in their balance sheets and countries that have high liability euroization, suffer from significant negative balance sheet effects. Not just that exchange rate depreciation leads to higher foreign debt servicing costs, but it affects the companies' balance sheet and its net worth (Kiyotaki and Moore, 1997). When net worth depreciates, the collateral shrinks and credit becomes less accessible, the risk premium rises and eventually companies borrow less or borrow at higher interest rates. Consequently, this can cause a suspension in investments, create a credit crunch and spill over to the whole economy. Some of the first studies that tackled this issue were done by Krugman (1999) and Aghion et al. (2001), where research went primarily into the direction of empirical examination of whether the two effects were directly quantitatively measured. Bleakley and Cowan (2008), for example, found that Latin American countries in the nineties were not rewarded with a positive competitiveness effect when their currencies depreciated. Aguiar (2005) found evidence that the Mexican crisis in 1994 was driven by a currency crisis and a strong negative balance sheet effect. Harvey and Roper (1999) analysed Asian companies and warned that high foreign currency debt and large currency mismatches lead to a strong balance sheet effect in the Asian crisis of 1997.

We conduct a sectoral level analysis for a European transition economy that has very high liability euroization of the corporate sector, coupled with large currency mismatches. We use data at a lower level of aggregation; more specifically, data for 20 different economic sectors in Croatia. Croatia is especially interesting because it has very high and persistent financial euroization and alarming currency mismatches in the nontradable sector. Moreover, most Croatian companies are actually in the nontradable sector, implying that the natural hedge for debt denominated in foreign currency in the form of foreign currency revenues is very limited. By combining different balance sheet and financial sector data, and introducing euroization of sectoral liabilities, we measure the competitiveness and the balance sheet effect and empirically test their signs and dominance. We measure firm performance using both investment and sales and suppose that negative balance sheet effects will have adverse effects on business performance. Our intention was to show that highly euroized economic sectors are adversely affected by exchange rate depreciation through the balance sheet effect. In order to empirically confirm our expectations, we construct three different hypotheses that are discussed in detail in the Chapter 3 of the dissertation but also summarized here.

H1: Economic performance of sectors with large foreign currency denominated debt holdings is adversely affected by exchange rate depreciation.

H2: The negative balance sheet effect dominates the positive competitiveness effect in sectors with large foreign currency denominated debt holdings.

H3: Driven by low exchange rate volatility expectations rather than by matching their currency structure, companies take foreign currency loans that eventually have adverse effects on business performance.

As expected, we found evidence that exchange rate depreciation has a negative effect on business performance, primarily measured by sales. Evidence of a negative balance sheet effect suggests that sectors suffering from high liability euroization are vulnerable to exchange rate depreciation that eventually leads to performance losses. Also, we do not reject the second hypothesis, as we find that the negative balance sheet effect is stronger than the competitiveness effect. The overall effect of exchange rate depreciation in a highly euroized corporate sector is therefore negative. Empirically, this supports earlier evidence for Latin American and Asian countries and warns that highly euroized companies will not

benefit from exchange rate depreciation. Moreover, we tested the pure effect of liability euroization and found that companies that have more foreign currency denominated loans in their balance sheets suffer from lower investment and sales, even when exchange rate movements are excluded.

We also added one more hypothesis that rose in the process of empirical examination. As we noticed that size, presented by assets, affects foreign currency debt creation and the loan maturity structure, we tested whether it is possible that there are asymmetries in the lending system between banks and companies.

H4: The lending relationship between banks and companies is based on asymmetries of firm size.

We also find evidence in favour of the fourth hypothesis, as foreign currency debt creation reduces with firm size. Additionally, we find evidence that bigger companies on average have higher shares of short-term loans in their total debts. This sort of conclusions stem from banking behaviour that is typical of European transition economies, as previously partially recognized in Brown, Kirschenmann, and Ongena (2009) and Basso et al. (2011).

The results from Chapter 3 are important not just for the implementation of monetary policy with respect to unofficial euroization, but also for designing measures that will boost competitiveness, develop access to domestic capital funds and promote exchange rate hedge opportunities. However, the main contribution of the study is that it provides completely new evidence for a highly euroized European transition country on prevalence of either balance sheet or competitiveness effects. Moreover, it is the only sector-level empirical research of that kind for Croatia or, to our knowledge, for any other European transition country. Lastly, we contribute to the literature by testing for the presence of asymmetric information between banks and companies, and by that we open space for further research.

1.3.3 Sovereign sector

Chapter 4 focuses on the government and unofficial euroization of sovereign debt. The latest financial crisis revealed that troubles on financial markets spread relatively quickly to other parts of the economy, fiscal sector included. The credit crunch affected the

sovereign sector, in the way that eroding liquidity caused risk premiums to rise and increase the yields on sovereign bonds. The uncertainty surrounding the financial crisis led investors to liquidate their positions, primarily ones that originate from less developed countries that record relatively high shares of debt in GDP. In addition to that, governments struggling to revive their tottering economies are taking up more and more debt by which they are increasing sustainability and default risks and causing the costs of their debt to rise. Financial markets recognize these risks and punish countries that are perceived to be over indebted and will not be able to repay debts in timely manner (Haugh, Ollivaud, and Turner 2009). If there are exchange rate depreciation expectations included, and the country has large currency mismatches and high liability euroization, the perceived risks rise even more and lead to bigger losses for the economy (Jeanne and Wyplosz, 2001). The most obvious example is the Lehman Brothers collapse in September 2008. After the bankruptcy, European transition economies suffered sovereign bond spread widening with respect to Germany or the United States. Although sovereign spreads of these countries rose in that time, the size of the losses was not identical among different countries. Different levels of fiscal and current account imbalances, liability euroization, exchange rate expectations and other determinants caused divergence in the spreads.

It is a fact that European transition economies suffer from the "original sin" and consequently also from possible negative balance sheet effects. Therefore, exchange rate expectations in countries that hold relatively large amounts of foreign currency denominated debt is an important determinant of demand for country's bonds and the price of existing debt. The intention of issuing debt in foreign currency in the first place is to eliminate currency risks for bond holders, but at the same time it leads to higher default risks due to at least two reasons (Powell and Sturzenegger, 2003). The first reason is contagion – a phenomenon observed for example during the Asian crisis – when economic changes in one country quickly spread over to other countries in the region, driven by currency mismatches and large amounts of foreign currency debt. The other is of a fundamental nature – implying that higher exchange rate depreciation expectations in countries that experience "fear of floating" cause central banks to intervene by squeezing liquidity and rising domestic interest rates. This in turn worsens the default risk for domestic investors, but consequently also for international investors. The balance sheet effect works for the sovereign as well as for corporate or the household sector, but when the government experiences a negative balance sheet effect, it spills over to other parts of the economy very quickly, as the government is a sort of a benchmark. Therefore,

countries that suffer from "original sin" are susceptible to negative balance sheet effects when exposed to exchange rate depreciation expectations. The negative balance sheet effect in this setting manifests as a positive coefficient, i.e. the higher the balance sheet effect, the higher the sovereign spread.

Chapter 4 builds on different strands of literature and constructs a new model of sovereign spread determinants for European transition economies. We start with a small open economy, just as in Céspedes, Chang, and Velasco (2004) and Gertler, Gilchrist, and Natalucci (2007), and continue by adding two more concepts. First we introduce net worth and the collateral value concept of Kiyotaki and Moore (1997). Using net worth enables us to model the effect of exchange rate expectations and to argue that deteriorating net worth, caused by depreciation expectations, erodes collateral value and the potential of a country to issue bonds or issue bonds at lower costs. Second, we follow Berganza et al. (2004) and introduce a variable that will represent the balance sheet effect and measure its effect on sovereign spreads. However, unlike previous research, we recognize that some determinants affect spreads only in the short-run. Therefore, we build a model so that it differentiates between short-run and long-run variables, allowing for the system to deviate from equilibrium but eventually settle in the long-run (Pesaran, Shin, and Smith, 1999). This brings a lot of dynamics in the system, but it also allows differentiation across countries, at least in the short-run. We construct a panel data model of nine European transition countries and empirically test our hypotheses. The first two hypotheses arise from the model construction and "original sin" literature that corresponds to exchange rate expectations and balance sheet effects discussed in Jeanne and Wyplosz (2001).

H1: Sovereign spreads of European transition economies can be modelled in a way that allows for short-run deviations and long-run adjustment to the equilibrium.

H2: In European transition economies that suffer from the "original sin", there are negative short-run balance-sheet effects on sovereign spreads, i.e. higher balance sheet effects lead to higher sovereign spreads. These balance sheet effects are a result of exchange rate changes and not just higher foreign currency denominated debt.

As we found that the speed of adjustment terms were significant and negative, we did not reject the first hypothesis claiming that our empirical model actually deviates in the short-run and eventually adjusts to the equilibrium in the long-run. We found evidence in favour

of the second hypothesis with higher balance sheet effects leading to rising sovereign spreads that increase the costs of indebtedness. Additionally, we constructed two other hypotheses that we wanted to test in the constructed setting. More specifically, we tested whether there are other spread determinants that are important in the short-run besides the balance sheet effect. Hypotheses three and four were also supported by our empirical model.

H3: Rising market volatility increases sovereign spreads in the short-run.

H4: Temporary fiscal policy measures, such as higher tax revenues, tend to decrease sovereign spreads, but only in the short-run.

The main contribution of this chapter is that we create a model of sovereign spread determinants that takes important but usually neglected balance sheet effects into consideration. Moreover, it allows for short-run dynamics, as it is empirically observed there are variables that affect sovereign spreads only in the short-run. Moreover, as the "original sin" is a country-specific variable, potential balance sheet effects and short-run deviations that stem from it should be allowed to differ across countries. Our research therefore allows for heterogeneity across countries but homogeneity in the long-run. We also contribute to the literature by including data for the latest financial crisis and considering previously underrepresented countries such as Croatia, Serbia and Turkey.

1.4 DATA AND METHODOLOGY

Throughout the three research studies we use different measures of financial euroization, and combine them with a variety of macroeconomic, financial, and banking sector data. In the first study, we use deposit euroization as a measure of unofficial euroization of the banking sector. As the variable is defined as a share of deposits in foreign currency and deposits indexed to the exchange rate in total deposits, we model euroization of the liability side of banks' balance sheets. To our central variable we add two more variables; the exchange rate and the interest rate differential. The exchange rate is defined as the average monthly nominal exchange rate of the domestic currency to the euro, but for countries that have fixed exchange rate regimes, or a peg to the euro, we use real effective exchange rates instead. The interest rate differential is defined as the difference between

interest rates for a respective country and the euro money market interest rate. We put these three variables in a vector autoregression (VAR) context, and model them both linearly and nonlinearly. For the linear specification, we use conventional methodological tools; Johansen cointegration and the vector error correction model. However, due to the observed transition countries' bias against exchange rate depreciation, created by "fear of floating", we additionally model these three variables as a nonlinear system using TVAR methodology. TVAR methodology and the accompanying general impulse response functions provide a credible methodological setting for modeling nonlinear systems.

The following part of the dissertation deals with the corporate sector and unofficial euroization of the liability side of the balance sheet. Besides the liability euroization variable, defined as the share of foreign currency liabilities in total liabilities, we construct a variable that measures the balance sheet effect. This variable is a product of real exchange rate changes and the liability euroization variable. As we are interested in the dominance between the balance sheet and the competitiveness effect, we also construct a competitiveness effect variable, a product of real exchange rate changes and the share of business revenues from sales abroad in total business revenues from sales. The dependent variable reflects investment growth in the primary and total business revenues in the alternative specification. We also construct a leverage variable, as a ratio of total debt to total assets, as well as some other balance sheet and financial sector variables. Due to a rather short time span of eight years only, we construct our model in the panel data setting, thus improving estimation consistency.

Chapter 4 deals with the sovereign sector, and similarly to the previous chapter, we also construct a balance sheet effect variable, defined as the product of real exchange rate changes and the share of gross external debt in nominal GDP. As we are interested in measuring the effect of the balance sheet on sovereign spreads, we use sovereign spread as the dependent variable, defined as the JP Morgan Euro EMBI Global index that equals the returns for foreign currency denominated bonds and returns for United States Treasury bonds. It is observed that spreads are rather volatile in the short-run, and it turns out that there are variables that affect spreads only in the short-run, while some other variables seem to affect spreads only in the long-run. For this reason, we construct a dynamic heterogeneous panel data model suggested by Pesaran et al. (1999), allowing for the system to deviate in the short-run and settle to equilibrium in the long-run. Besides the balance sheet variable, we add a volatility index of investor sentiment and market

volatility, and the share of general government tax revenues in nominal GDP as short-run spread determinants. For the long-run we include the indebtedness variable, share of gross external debt in nominal GDP, ratio of current account balance in nominal GDP, and official international reserves divided by nominal GDP.

1.5 LIMITATIONS

The dissertation brings new evidence on the determinants, dynamics and consequences of unofficial euroization in European transition economies. It uses the balance sheet effect framework to warn of possible negative effects that might appear when exchange rate expectations rise or in the aftermath of exchange rate depreciation. Scarce existing literature regarding unofficial euroization in European transition economies and the latest financial crisis are the motivation for this research that makes it important and valuable from the aspect of policy implementation. However, there are limitations to this study and therefore plenty of space for further research.

The main limitation is that the dissertation is not theoretically founded, as it primarily relies on empirical models. The reason behind this is that the theory surrounding the balance sheet effect is incomplete and scarce. Besides the efforts of Jeanne and Wyplosz (2001), research is mainly empirical and to this day the recommendation for studying balance sheet effects or unofficial euroization is to use empirical methods. This focus on empirics puts additional weight on data, not just data quality but also the data process itself. Therefore, one of the main limitations, especially pronounced in Chapter 3, is that we should have more exchange rate variability in order to measure the balance sheet effect. As we explore Croatia in Chapter 3, a country that did not experience major exchange rate depreciation in the period examined, one could argue that we were not able to capture the pure balance sheet effect. On the other hand, Jeanne and Wyplosz (2001) provide justifiable reasons that only exchange rate expectation matter, and not the occurrence of the depreciation. The latter explanation was the one that lead us throughout studying euroization of the Croatian corporate sector.

Regarding data quality, there are a few drawbacks throughout the dissertation. First, we were not able to collect micro data on a company level for Croatia in the Chapter 3. Instead we used data on a higher level of aggregation, sectoral data, loosing a lot of important

balance sheet information. Due to this aggregation problem, our results do not entirely reflect the true nature of Croatian companies and the heterogeneity between them. The model in Chapter 4 is built around the external debt variable, instead the foreign currency denominated debt variable. In order to measure the true balance sheet effect, all sovereign foreign currency denominated debt is supposed to be included. However, it was impossible to obtain such data for a larger part of the countries we explored, so instead we decided to use the closest measure as a proxy variable.

In Chapter 2, we study several countries that have a fixed exchange rate regime or a peg to the euro. As it did not make sense to include the nominal exchange rate because we would have no variability in that case, we decided to use the real exchange rate instead. However, the real exchange rate variability then reflects the inflation differential that is not supposed to have any effect on deposit euroization if the fixed exchange rate arrangement is perceived credible. However, we follow Ize and Levy Yeyati (2005) who claim that high domestic inflation rates reduce exchange rate regime credibility and encourage investors to increase their foreign currency holdings. Lastly, one of the typical limitations when exploring European transition economies is that the data span is rather short for proper time series analysis. We tried to overcome this problem by using panel data techniques in two out of three research studies, but in order to improve the consistency of the results further, the best way would be to expand the time horizon.

1.6 STRUCTURE OF THE DOCTORAL DISSERTATION

The dissertation consists of three research studies; preceded by an introductory chapter (section 1) and succeeded by a chapter that summarizes the conclusions from the three research studies (section 5). Each research study empirically explores unofficial euroization in European transition economies using the balance sheet effect framework. The first research study (section 2) tackles unofficial euroization of the banking sector of 12 European countries, the second (section 3) addresses corporate liability euroization in Croatia, while the third study (section 4) explores the sovereign sector of nine transition countries and measures the size, sign and significance of the balance sheet effect.

In the first research study (section 2), we explore deposit euroization of the banking sector using both linear and threshold models. After the introduction where we emphasize

motivation and contributions, we provide an extensive literature review on the sources of unofficial euroization and present the theoretical background for studying euroization. Sections 2.3 and 2.4 consist of the data description and a detailed outline of methodology employed. We give special attention to the nonlinear part of the estimation process, as we find evidence that 8 out of 12 countries show signs of nonlinearity. Thus, the TVAR model and the conventional way of presenting TVAR results in the form of generalized impulse response functions are discussed in sections 2.4.2 and 2.4.3. Moreover, we discuss in detail the choice of exchange rate and the interest rate differential as our variables. Section 2.5 outlines estimation results divided in the linear part "Cointegration", and the discussion of nonlinear results or "The threshold model". At the end we give conclusions together with policy implications and recommendations (section 2.6).

Section 3 contains the second research study, an analysis of implications of liability euroization on business performance of the Croatian corporate sector. After the introduction we set out a review of existing literature on measuring the balance sheet effect of the corporate sector (section 3.2). Later on we tackle financial euroization in Croatia (section 3.3) and then describe the dynamics of the Croatian corporate sector and the institutional setting surrounding liability euroization, emphasizing that Croatia is a highly euroized economy with large currency mismatches. The methodology section presents the empirical model in which the balance sheet effect and the competitiveness effect are singled out, ensuring the measurement of their significance, size, and, and most importantly their total effect on investment or alternatively sales. Section 3.6 presents the results of three different estimation methodologies: fixed effects, random effects, and dynamic Arellano-Bond estimation. After a discussion of the robustness checks, we confirm our expectations of a negative balance sheet effect. Conclusions for this research chapter are provided in section 3.7.

The last part of the research (section 4), concerns liability euroization of the sovereign sector. We investigate the implications of external debt and exchange rate expectations on the risk premium of a country, represented by bond spreads. The introduction, with the main contributions and motivation for the research (section 4.1), is followed by an extensive description of the theoretical framework and previous empirical work (section 4.2). We describe and argue our choice of combining different theoretical and empirical concepts for modelling sovereign liability euroization. After the data description (section 4.3), we discuss panel unit root testing and dynamic panel error correction methodology

that differentiates between long-run and short-run determinants and allows for differences across countries (section 4.4). In section 4.5 we present and discuss the estimation results: panel unit root test results (section 4.5.1), baseline estimation results (section 4.5.2), and robustness check results (section 4.5.3). Some concluding remarks are given in section 4.6.

Although we study the same topic in all three research chapters, we focus on only one sector of the economy in each chapter. Therefore, section 5 provides a summary for all three research chapters and gives a concise examination of unofficial euroization in European transition economies. Conclusions are followed by references, appendices while a long abstract in Slovenian language is provided at the end.

2 THE DYNAMICS OF DEPOSIT EUROIZATION IN EUROPEAN POST-TRANSITION COUNTRIES: EVIDENCE FROM THRESHOLD VAR[1]

2.1 INTRODUCTION

In the late eighties and early nineties high inflation dominated European transition countries. In order to restrain inflation expectations that were tied to exchange rate movements, central banks preferred to use the exchange rate as the nominal anchor (Frankel, 2010; Mishkin, 2000). However, long after macroeconomic stability had been achieved, due to significant "fear of floating", exchange rate based monetary regimes continued to persist as an optimal policy choice for many European post-transition countries still pursuing currency boards, pegs, fixed, managed or even dirty floating exchange rate regimes.

As discussed in Calvo and Reinhart (2002), "fear of floating" is manifested as central banks' reluctance to allow the exchange rate to adjust significantly and rapidly, resulting in episodes of central bank interventions aimed at avoiding major devaluation shifts. Economic agents therefore anticipate exchange rate stability and eventually create very high levels of unofficial dollarization[2] (Levy Yeyati, 2003). Unlike adopting the euro as the official currency (known as official euroization), unofficial euroization is a result of voluntarily using foreign currency for different money functions: either the medium-of-exchange function that leads to currency substitution or the store-of-value function leading to asset substitution (Feige and Dean, 2002). The term asset substitution has been replaced by financial euroization (FE), defined as residents' holding of a significant share of assets or liabilities in foreign currency (Ize and Levy Yeyati, 2003). FE can be divided into deposit euroization (DE) and credit euroization (CE) with DE reflecting the propensity of the private and public sector to hold deposits in foreign currency and CE a result of commercial banks' propensity to grant loans in foreign currency or indexed to foreign currency.

[1] This chapter of dissertation has been published as Tkalec (2012) and Tkalec (2013).
[2] Throughout the text, the term euroization will be used instead of dollarization as suggested by Feige and Dean (2002).

It is argued that high levels of FE limit the choices for monetary policy makers since large exchange rate depreciations increase the cost of servicing foreign currency denominated debt and severely affect probabilities of default (Reinhart et al., 2003). As a result, central banks respond with a myriad of managed exchange rate regimes biased against depreciation. In line with that, FE indirectly affects the performance of all sectors of the economy, not just monetary policy. For example, Chang and Velasco (2000) find that detaining depreciation eventually pushes output down, Cabral (2010) warns of larger employment losses under "fear of floating" and Tsangarides (2010) reports that pegs have been recovering much slower than floaters in the latest 2010-2011 recovery phase. Although FE is a relevant economic policy issue, we still lack knowledge about the phenomenon, its determinants and influences on the economy. Especially now when an explosion of public debt in some CEE (Central and East European) countries like Hungary will make Maastricht criteria unreachable and therefore euro adoption impossible. That scenario leaves countries without the obvious "exit strategy" for dealing with FE – official euro adoption. In order to ensure financial and economic stability, it is important to understand what drives FE and how exactly it affects the economy.

Experiences from European post-transition economies show that FE decreases very slowly in periods of macroeconomic stability but increases swiftly in periods of economic uncertainty. In addition, exchange rate depreciations seem to affect FE strongly and quickly, while the opposite exchange rate changes have a much more moderate impact. This sort of FE development mimics regime dynamics, in which a variable reacts in one way when above some threshold and in a different manner when below the threshold. One possible explanation for threshold effects is the presence of transaction costs, where changing the currency structure of deposits or loans is time-consuming and usually comes with an expense. For example, switching foreign currency deposits to domestic currency deposits might be protracted if those deposits are agreed not to be withdrawn before a certain period of time elapses unless a penalty is paid. Although threshold or nonlinear effects might describe FE dynamics in partially euroized economies, no research regarding this issue has been carried out. In order to fill this gap, we test for the presence of threshold effects of deposit euroization. We investigate DE dynamics in 12 Central, Baltic and Southeastern European countries that record very high levels of financial euroization. Our model incorporates DE and two monetary variables recognized as DE drivers in the literature, the interest rate differential and the exchange rate. We would like to test how DE

reacts to changes in those monetary variables and how those responses differ depending on the level of DE and the exchange rate regime in the observed country. For each of these cases and countries we will apply TVAR which is applicable to both the linear and the nonlinear model (Balke, 2000; Koop et al., 1996). We will derive generalized impulse response functions that vary in sign and magnitude and allow regimes to switch after a shock. The goal of this research is to answer two policy questions. Specifically, we aim to explore how exchange rate changes, more precisely, exchange rate depreciations affect DE in an economy with a high level of DE. We expect to show there are nonlinearities in the DE response to exchange rate changes – stronger DE responses to depreciations than to appreciations. If those nonlinearities exist, we will investigate how they differ with respect to the prevailing exchange rate regime. In line with that, we expect stronger DE reactions to exchange rate depreciations than to appreciations in countries with fixed or managed floating exchange rate regimes.

The analysis will contribute to the existing field of knowledge in several ways. First, it will give new insights into the dynamics, characteristics and consequences of DE in European post-transition economies. In order to depict the relationships between euroization and the monetary system, we model monetary determinants of DE. We give special attention to the influence of the prevailing exchange rate regime on the level of DE since research shows there is a strong link between the two. As far as we know, there are no studies on FE determinants that use TVAR methodology. To the best of our knowledge, there is only one paper by Ivanov, Tkalec and Vizek (2011) that tests for nonlinear or threshold effects of FE in Croatia.

The remainder of the paper is organized as follows. The next section presents an overview of the existing empirical literature with an emphasis on the results for FE in European post-transition countries rather than financial dollarization in Latin America. Sections three and four describe the applied methodology and data. Results of the empirical analysis are given in section five while the last section concludes the paper.

2.2 LITERATURE

While there is no normative consensus on the effect of FE on the economy, researchers find that the relationship between the level of FE and monetary policy, trade balance and consequently output is an important one. In much of the recent literature on FE, the focus lies on detecting the determinants of euroization and the effects it has on the conduct of monetary policy. In the eighties and early nineties, unofficial euroization was considered a consequence of high inflation rates and low credibility of monetary authorities, as discussed in Levy Yeyati (2003). However, even after inflation moderated and the economy stabilized, euroization persisted (Kokenyne, Ley and Veyrune, 2010). The existing literature offers several explanations for the observed FE persistence phenomenon and Levy Yeyati (2006) summarizes them into the currency substitution view, the portfolio view, the market failure view, and the institutional view.

The currency substitution view explains FE as an outcome of a negative relationship between demand for local currency and the rate of inflation (Baliño, Bennett, and Borensztein, 1999; De Nicoló, Honohan and Ize, 2005; Savastano, 1996). The portfolio view, also known as the optimal (minimum variance) portfolio, explains that high FE levels persist (even after prices stabilize) whenever the expected volatility of the inflation rate remains high in relation to that of the real exchange rate (Ize and Levy Yeyati, 2003). This theoretical explanation assumes that uncovered interest rate parity holds given the real returns on different currencies. In short, if the variance of domestic inflation increases relative to the variance of real depreciation, the local currency becomes less attractive and FE increases.[3] The market failure view points out that the level of FE increases when market participants freely borrow and lend in foreign currency without considering major depreciation exchange rate risks. The behavior is facilitated by central banks' commitment to maintaining a stable exchange rate that creates a lower risk of borrowing and lending in foreign currency and hence increases moral hazard and asymmetric information in the system. Lastly, the institutional view explains how FE rises when economic policy makers build their credibility on a stable exchange rate rather than on a strong institutional framework or regulations that favor domestic currency. Such institutional imperfections not only increase FE but also the cost of exchange rate depreciation that in turn leads to an even stronger commitment of policy makers (De Nicoló et al., 2005; Rajan and Tokatlidis, 2005; Reinhart et et al., 2003). When testing for these theories empirically, Levy Yeyati

[3] This minimum variance theory is discussed also in De Nicoló, Honohan and Ize (2005).

(2003) finds that minimum variance portfolio is positively related,[4] while average past inflation and GDP are negatively related to DE.

The literature typically deals with dollarization in Latin America and determinants characteristic for that region, but in the last few years one witnesses a growing body of research on euroization in European post-transition countries. Therefore, a number of more recent studies on post-transition economies identify exchange rates, especially exchange rate volatility, and interest rate differentials as determinants of FE. A growing area of research considers financial integration, foreign bank presence and the accumulation of foreign liabilities as important drivers of FE in transition economies. Most of the research studies a pool of countries using panel data analysis and interprets the results for the region as a whole, sometimes without considering country-specific features. For example, Kokenyne et al. (2010) find a positive link between the real exchange rate and DE and a negative effect of increasing exchange rate volatility on both foreign exchange deposits and loans. Basso et al. (2011) show the interest rate differential has a negative effect on DE while access to foreign funds increases CE, but at the same time decreases DE. Similarly, Piontkovsky (2003) shows that relative returns on assets, defined as bank deposits in the domestic currency relative to deposits in foreign currencies, have a significant effect on the level of FE. Rosenberg and Tirpák (2008) find that rising interest rate differentials, foreign funding and openness promote CE. Luca and Petrova (2008) contradict the findings of Basso et al. (2011) since they empirically show a positive relationship between the interest rate differentials and DE and a negative relationship between exchange rate volatility and DE. Since their research is more focused on CE rather than DE, Luca and Petrova (2008) describe banks' "matching behavior" and stress the role of foreign banks in driving foreign currency holdings in transition economies. In a panel of more than a 100 countries, Carranza et al. (2003) confirm that large depreciations have a negative effect on the pass-through coefficient, with the impact being higher the greater the level of euroization. They also show that the exchange rate regime is important since countries with fixed exchange rates suffer larger balance-sheet effects after depreciations.[5] Moreover, they argue that large exchange rate depreciations can trigger a nonlinear effect on the balance sheet.

[4] Confirmed in Basso et al. (2011).

[5] A contrary view is expressed in Arteta (2005a; 2005b) in which floating regimes seem to be the ones that encourage dollarization. In addition, there is no evidence that currency crashes are more costly in highly dollarized economies.

Besides those FE drivers, panel data analysis results add some other FE determinants, such as increased access to global capital markets (Reinhart et al., 2003), closeness to the European Union (European Central Bank, 2010; Neanidis, 2010) and country size (Rosenberg and Tirpák, 2008).

Research using time series methods country-by-country is scarce when compared to panel data analysis results summarized above. Feige (2003) and Levy Yeyati (2003) claim that underdeveloped domestic financial markets are in part responsible for high FE levels in some countries. Ozsoz, Rengifo, and Salvatore (2008) estimate the probability of foreign currency intervention in five euroized post-transition economies using a volatility measure of the local exchange rate. Thereby, they demonstrate that central bank behavior is predetermined by the level of euroization. Lastly, only one study deals with micro data in European post-transition economies. Stix (2011) finds that remittances and income from tourism can have a significant impact on currency substitution in some post-transition economies and that underdevelopment of domestic financial markets drives FE.

Nevertheless, within the vast literature on euroization and related topics, these relationships are usually analyzed as part of a linear model. Although persistence of FE and observed "fear of floating" in many post-transition economies imply a nonlinear relationship between the level of FE and the exchange rate, to the best of our knowledge there are only two studies that model FE using a nonlinear framework, but neither of these studies models the responses of FE to exchange rate changes and FE feedback effects. These two studies are Heimonen (2001) and Ivanov et al. (2011). Heimonen (2001) analyzes euroization in Estonia and uses threshold cointegration to estimate portfolio shifts between two substitute currencies, euros and dollars. However, his study does not deal with FE determinants nor does it consider substitution between foreign and domestic currency. Ivanov et al. (2011) explore FE in Croatia using single equation threshold cointegration. They build different models using a great number of variables and find that nominal exchange rate changes have a strong effect on DE and that CE is affected by banks' foreign-currency-structure matching behavior. Moreover, they find threshold effects for both DE and CE. However, their research does not consider the possibility of diverse FE responses to exchange rate appreciations/depreciations nor do they consider interest rate differentials as a determinant of euroization.

Additionally, the importance of nonlinear FE behavior is clearly recognized by several studies applying a linear modelling framework, within which limited nonlinear FE features are incorporated. Thus both Rennhack and Nozaki (2006) and Neanidis and Savva (2009) use an index of asymmetry of exchange rate movements. The latter study finds positive short-run effects of depreciations decrease with the level of euroization because depreciations induce depositors to change their currency compositions in favor of foreign currencies.

2.3 DATA

We model DE with three variables using VAR and threshold VAR methodology with DE defined as the share of deposits in foreign currency (or indexed to foreign currency, where available) in total deposits. Although the most accurate way to measure DE is by surveys that collect data on a wide range of assets and liabilities in foreign currency, the problem is that those surveys either have a very short data span or are conducted on a very small number of countries. Therefore, if one wants to study DE behavior across time, the alternative is to use banks' aggregate balance sheet data that provide only levels of time and savings' deposits in foreign currency. Although DE is not a perfect measure of financial euroization because it incorporates only the liabilities side of banks' accounts, it still reflects differences in unofficial euroization between countries. Other authors also prefer DE as a proxy for financial euroization (Arteta, 2005a; Baliño et al., 1999; Levy Yeyati, 2003; Neanidis and Savva, 2009; Piontkovsky, 2003; Stix, 2011).

We include only three variables due to pragmatic reasons. As the number of coefficients in the linearity test and TVAR rises with the number of variables, the test size and power decrease. There is a long list of euroization drivers, but we are interested in those variables that capture the influence of monetary policy on DE. The most important variables that seem to affect deposit euroization and derive from the monetary system are the exchange rate and the interest rate differential. The exchange rate influences deposits when confidence in the domestic currency is low. If investors expect the exchange rate to depreciate, they will save in foreign rather than in domestic currency. Therefore, it is justifiable to expect a change in investor behavior that is caused by a reaction to nominal exchange rate changes. The variable we included in our model is the level of the bilateral

Table 1: ADF test for first differences

Country		Lags (AIC)	*t*-value (ADF)	*t*- value (lag)	AIC	Country		Lags (AIC)	*t*-value (ADF)	*t*- value (lag)	AIC	Country		Lags (AIC)	*t*-value (ADF)	*t*- value (lag)	AIC
	DE	0	-6.053***	-	-9.005		*DE*	0	-13.730***	-	-8.342		*DE*	1	-9.438***	0.0942	-8.979
Belarus	*NER*	1	-5.965***	0.0089	-8.637	Hungary	*NER*	1	-7.747***	0.0422	-9.675	Poland	*NER*	0	-7.502***	-	-9.249
	IRD	1	-3.163**	0.0951	-11.860		*IRD*	0	-8.626***	-	-1.028		*IRD*	0	-6.106***	-	-2.780
	DE	2	-3.853***	0.0430	-10.520		*DE*	8	-3.543***	0.0378	-11.350		*DE*	2	-3.000**	0.0389	-9.179
Bulgaria	*RER*	4	-4.052**	0.0345	-2.915	Latvia	*RER*	2	-3.134**	0.0283	-10.970	Romania	*NER*	0	-4.998***	-	-9.633
	IRD	4	-4.073**	0.0334	-13.810		*IRD*	11	-3.557***	0.5275	0.919		*IRD*	4	-2.975**	0.5543	0.285
	DE	3	-3.559***	0.0705	-11.690		*DE*	2	-4.491***	0.0019	-8.765		*DE*	0	-10.260***	-	-10.360
Croatia	*NER*	1	-9.669***	0.0379	-11.690	Lithuania	*RER*	1	-7.503***	0.0078	-11.020	Serbia	*NER*	0	-5.120**	-	-10.100
	IRD	2	-7.737***	0.0674	-0.511		*IRD*	0	-6.439***	-	-2.055		*IRD*	0	-7.997***	-	-2.230
	DE	1	-10.480***	0.0355	-8.244		*DE*	0	-4.408***	-	-10.520		*DE*	0	-8.245***	-	-9.406
Czech	*NER*	6	-4.710***	0.0013	-10.220	Macedonia	*RER*	0	-6.704***	-	-11.580	Turkey	*NER*	1	-6.359***	0.1119	-8.570
Republic	*IRD*	1	-6.338***	0.0771	-3.990		*IRD*	0	-3.372**	-	-2.438		*IRD*	1	-7.444***	0.0007	-0.672

Note: ADF - Augmented Dickey-Fuller; *DE* – deposit euroization; *NER* – nominal exchange rate; *RER* – real exchange rate; *IRD* – interest rate differential; constant included; maximum number of lags used – 18; optimal time lag chosen according to AIC – Akaike Information Criterion; all series are seasonally adjusted and in logarithms (except for the interest rate differential); *** null hypothesis about existence of unit root rejected at the 1% level of significance; ** hypothesis about existence of unit root rejected at the 5% level of significance.

Source: Central banks and Eurostat databases; own calculations.

exchange rate of the domestic currency to the euro calculated as a monthly average. However, for countries that have a fixed exchange rate regime, the real effective exchange rate was used instead. The interest rate differential is calculated as the difference between domestic and euro-area interest rates, where the domestic rate is either the 3-month money market interest rate or a short-run deposit rate and the euro-area rate is the 3-month money market interest rate. While the domestic interest rate reflects central bank activity and even monetary policy stance, the interest rate differential reflects a number of possible situations, from arbitrage opportunities and foreign capital inflow to perceived country risk and even high inflation rates. In addition to these two explanatory variables, we also need a threshold variable in order to distinguish between regimes in the nonlinear specification. In our case, this is an endogenous variable – deposit euroization. Since post-transition economies vary in their DE level, it seems plausible to take that variable as a reliable threshold in order to control for the level of euroization.

We investigate 12 post-transition European countries with their samples varied across countries. Those countries are Belarus, Bulgaria, Croatia, the Czech Republic, Hungary, Latvia, Lithuania, Macedonia, Poland, Romania, Serbia and Turkey. The longest data span is for Croatia – 1995:07 to 2010:11 or 185 observations – and the shortest for Macedonia – 2005:01 to 2010:12 or 72 observations. A short description of prevailing exchange rate regimes, DE levels and figures for each country can be found in Appendix A. Data are compiled from central bank statistics and Eurostat with a detailed description presented in Appendix B. All data are seasonally adjusted, with both the deposit euroization and the exchange rate in logarithms. In order to achieve stationarity, we take the first differences and test the series with augmented Dickey-Fuller unit root methodology. Results presented in Table 1 show all series are stationary in first differences.

2.4 METHODOLOGY

2.4.1 Baseline linear model

Before conducting any kind of nonlinear modelling, we first need to specify a linear model. The most usual way to determine the effects that shocks have on a number of endogenous variables is to set up a VAR model. Normally, VAR is specified in the following form:

$$y_t = \Gamma_0 + \Gamma_1 y_{t-1} + ... + \Gamma_j y_{t-j} + u_t \quad (2.1)$$

where $y_t = (y_{1t},...,y_{kt})'$ is a vector of k endogenous variables. Γ_0 is a k-dimensional vector including deterministic terms like a constant, a linear trend or even dummy variables, while the Γ_i coefficient matrix with $i = 1,..., j$ captures short-run dynamic effects. Finally, u_t is a sequence of serially uncorrelated random variables with mean zero and a constant positive variance-covariance matrix. If the variables are nonstationary, we can rewrite the VAR model in vector error correction form:

$$\Delta y_t = b_0 + b_1 t + \Pi y_{t-1} + \sum_{i=1}^{j-1} \delta \Delta y_{t-1} + u_t \quad (2.2)$$

where $\Pi = \alpha\beta'$ is a matrix representing cointegrating equations with β referring to cointegrating coefficients and α to loading coefficients. More specifically, $\Pi = I_m - \sum_{i=1}^{j} \Gamma_i$ and $\delta_i = -\sum_{i=1}^{j} \Gamma_i$. b_0 and b_1 are $k \times 1$ vectors and t denotes a time trend that can be included in the cointegrating equations. It follows that y is cointegrated of rank r if there exist r linearly independent vectors in matrix β and if $\beta' y_t$ is a stationary process. If there is a cointegrating relationship, α and β will be $(k \times r)$ matrices of rank r (Engle and Granger, 1987).

2.4.2 The threshold VAR model

The baseline linear model is misspecified when the variables actually follow a nonlinear process. Therefore, we expand the model by building a TVAR specification. TVAR is a simple way of capturing nonlinearities suggested in a number of economic and monetary policy models like Teräsvirta and Anderson (1992), Holmes and Wang (2000) and Balke (2000). The nonlinear character of TVAR models comes from a transition variable that separates the baseline VAR into different regimes (Hansen, 1996; 1997; Tsay, 1998). Each regime is then given a different autoregressive matrix and described as a linear model, but

taken together those regime-based linear models describe a nonlinear process.[6] A VAR model adjusted for the threshold specification then becomes:

$$y_t = \Gamma_1 X_t + \Gamma_2 X_t I\left[z_{t-d} \geq z^*\right] + u_t \tag{2.3}$$

where $X_t = (1, y_{t-1}, ..., y_{t-j})'$. Similarly, the vector error correction model (VECM) is described by the following equation:

$$\Delta y_t = \Gamma_1^v X_t^v + \Gamma_2^v X_t^v I\left[z_{t-d} \geq z^*\right] + u_t \tag{2.4}$$

with $X_t^v = (1, \beta' y_{t-1}, \Delta y_{t-1} ..., \Delta y_{t-j+1})'$. As usual, gamma matrices are coefficient matrices and u_t is the error matrix. The threshold variable is denoted by z_{t-d} with d being a possible time lag. In order to separate regimes, an indicator function I equals 1 if the threshold variable z_{t-d} is above the chosen threshold value z^* and 0 otherwise. Both the threshold value z^* and the delay lag d are unknown parameters and have to be determined together with other parameters. According to Hansen (1996; 1997), the transition variable can be either an endogenous or an exogenous variable.

Before the TVAR estimation, the threshold model needs to be tested for linearity using the Hansen test (Hansen, 1996; 1997). If linearity is rejected, then the endogenously chosen threshold value separates the observations of the transition variable into different regimes that are described by a linear model. The methodology allows for more than one threshold value, more than two regimes, but we will focus on the two-regime case due to simplicity and short data spans. Since this study explores countries with perceived unofficial euroization, the most justifiable candidate for the threshold variable is the level of deposit euroization. That allows us to separate countries into different groups, based on the observed level of euroization.

The Hansen linearity test requires the transition variable z to be stationary with a continuous distribution $-\infty = z_0 < z_1 < ... < z_{s-1} < \infty$ that is restricted to a bounded set

[6] The first threshold autoregressive methods were developed by Tong (1978; 1983; 1990) who approximated a nonlinear autoregressive structure by a threshold autoregression (TAR) with a small number of regimes. Later on, TAR was extended to a multivariate framework by Tsay (1998) and Hansen (1996; 1997). A number of studies for monetary policy shocks use TVAR methodology, including Balke (2000), Atanasova (2003), Calza and Sousa (2006) and Jääskelä (2007).

$Z = [\underline{z}, \overline{z}]$, with Z an interval on the full sample range of the transition variable. An interval on the transition variable is chosen to provide a minimum number of observations in each subsample and therefore ensures that the model is well identified for all possible values of $z*$. Before testing the threshold, the lag order j and the threshold delay lag d need to be determined.

If we rewrite the equation for TVAR, we get the following specification:

$$y_t = X_t(z)'\delta + u_t \tag{2.5}$$

with $X_t(z) = (X_t' X_t' I)'$ and $\delta = (\Gamma_1' \Gamma_2')'$. Following Weise (1999), we employ a general specification and allow all coefficients in the lag polynomials to change across regimes. For each possible threshold value z, the equation is estimated using the method of least squares (LS) with the relevant estimation of δ equal to:

$$\hat{\delta}(z) = (\sum_{t=1}^{T} X_t(z) X_t(z)')^{-1} (\sum_{t=1}^{T} X_t(z)) y_t \tag{2.6}$$

The related residuals are then defined as $\hat{u}_t = y_t - X_t(z)'\hat{\delta}(z)$ and the residual variance as $\hat{\sigma}_T^{\,2} = 1/t \sum_{t=1}^{T} \hat{u}_t^{\,2}$. For our threshold to be efficient we need the estimate of δ that minimizes the residual variance. Since the minimal variance itself does not guarantee nonlinearity, Hansen developed an additional test. A pointwise F-statistic is a profound linearity test specified as:

$$\begin{aligned} F_T &= \sup_{z \in Z} F_T(z) \\ F_T &= T\left(\frac{\tilde{\sigma}_T^2 - \hat{\sigma}_T^2(z)}{\hat{\sigma}_T^2(z)} \right) \end{aligned} \tag{2.7}$$

where the estimated residual variance of the corresponding linear model is denoted by $\tilde{\sigma}_T^2$.

A problem arises with the distribution of the derived F-statistic that is not standard or chi-square (Hansen, 1996) since the threshold value is not identified under the null of linearity. Therefore, it is necessary to approximate the asymptotic distribution using a bootstrap procedure. In order to obtain bootstrap F-statistics F_T^*, we need bootstrap residual

variances $\tilde{\sigma}_T^{*2}$ and $\hat{\sigma}_T^{*2}(z)$. To get those variances we take y_t^* iid $N(0,1)$ random draws and regress them on X_t and $X_t(z)$. Once we have the necessary inputs, the bootstrap F-statistic becomes:

$$F_T^* = \sup_{z \in Z} F_T^*(z)$$
$$F_T^* = T\left(\frac{\tilde{\sigma}_T^{*2} - \hat{\sigma}_T^{*2}(z)}{\hat{\sigma}_T^{*2}(z)} \right) \tag{2.8}$$

It is then possible to approximate the asymptotic null distribution of F_T. Keeping in mind that the distribution of F_T^* converges weakly in probability to the null distribution of F_T under the alternative, the asymptotic bootstrap *p*-value can be derived. The percentage of bootstrap samples for which $F_T^* > F_T$ gives the bootstrap *p*-value.[7]

We test the null hypothesis of linearity against threshold nonlinearity allowing heteroscedasticity in the error terms. Our selection of the threshold value is conditional on the choice of a minimal variance-covariance matrix of the residuals. We generate 1000 realizations of the F-statistics for each grid point and construct the empirical distribution to account for Hansen (1996).

2.4.3 Generalized impulse response

The main purpose of this empirical study is to detect how deposit euroization reacts to monetary variables, most importantly to exchange rate shocks. In order to understand the relationship between the level of DE, the exchange rate and the interest rate differential, we need to construct impulse responses for shocks in those two variables. To obtain meaningful impulse responses a structural identification is needed. The TVAR equation reveals Γ_1 and Γ_2 as "structural" contemporaneous relationships in the two regimes. Relying on Christiano, Eichenbaum, and Evans (1999), we also assume Γ_1 and Γ_2 have a recursive structure with a causal ordering of DE, the exchange rate and the interest rate differential. The recursiveness assumption is usually used to identify structural shocks in

[7] If one wants to account for heteroscedasticity, the standard F-statistic can be replaced by a heteroscedasticity-consistent Wald or Lagrange multiplier test.

VAR models, especially for monetary and financial variables (Bernanke, Gertler, and Watson, 1997; Leeper, Sim, and Zha, 1996). We use this recursive identification because of its simplicity; using more complicated identification schemes would protract the estimation considerably.

With a structural identification applied to the linear and nonlinear model, we can construct impulse responses (IR). While the linear case is straightforward, the nonlinear model requires further IR definitions that account for the nonlinearity of the system. First, the shock must depend on the entire history of the system before the point at which the shock occurs (Gallant, Rossi, and Tauchen, 1993; Koop, 1996; Koop et al., 1996). Moreover, linear IR functions are inappropriate since they are history-independent, symmetric (i.e., negative shocks are exactly the opposite of positive shocks) and proportional to the size of a shock. In a nonlinear specification, we expect that the effect of a shock is not proportional to its size or direction and that it is history-dependent. To fulfill these three conditions, we use generalized impulse response functions (GIRF) that are applicable to both the linear and the nonlinear model.[8]

Koop et al. (1996) define GIRF as the difference between two conditional expectations with a single exogenous shock ε_t:

$$\begin{aligned} GIRF = E\left[X_{t+m} | \varepsilon_t, \varepsilon_{t+1} = 0, ..., \varepsilon_{t+m} = 0, \Omega_{t-1}\right] - \\ E\left[X_{t+m} | \varepsilon_t = 0, \varepsilon_{t+1} = 0, ..., \varepsilon_{t+m} = 0, \Omega_{t-1}\right] \end{aligned} \tag{2.9}$$

where m is the forecasting horizon and Ω_{t-1} the history at time $t-1$. As mentioned, GIRF provides different results for positive and negative shocks since it allows the regimes to switch after a shock. In our case, GIRF allows the shocks in the low euroization regime to differ from shocks in a high euroization regime. Since the computation of GIRF is not trivial, we describe the algorithm step-by-step in Appendix C.

2.5 ESTIMATION RESULTS

[8] Many empirical studies that describe nonlinearities use GIRF, for example Balke (2000), Atanasova (2003), Calza and Sousa (2006) and Jääskelä (2007).

The three variables, deposit euroization (*DE*), the exchange rate (*ER*) and the interest rate differential (*IRD*), make the linear baseline reduced-form VAR model:

$$y_t = \Gamma X_t + u_t \tag{2.10}$$

where $y_t = (DE, ER, IRD)$, $\Gamma = \left(\Gamma_0, \Gamma_1, ..., \Gamma_j\right)$ and $X_t = (1, y_{t-1}, ..., y_{t-j})'$. Using this baseline model, we determine the optimal lag length using different criteria. Time series for all countries are in first differences as suggested by the ADF test and presented in Table 2. For the linear model, the Schwarz criterion suggests one or two lags in all 12 countries, while Akaike and likelihood ratio criteria propose higher orders. Since every additional parameter decreases the power of estimation significantly (Hansen, 1996), it is recommended to choose a smaller number of lags. Using only one or two lags leads to frequent rejection of the null hypothesis of no serial correlation (as suggested by the portmanteau test), so we choose to use three lags for the estimation of the nonlinear model. This structure still gives us good estimation power and better autocorrelation properties.

2.5.1 Cointegration

After defining the baseline model, we can determine the number of cointegrating relations between the series. Analysis of the cointegration rank and cointegrating matrix β is conducted using Johansen's likelihood ratio procedure (Johansen, 1991; 1995). The deterministic term appears significant for all countries except for Poland and the Czech Republic, while in the case of Lithuania we also needed to include a linear trend term. The results for trace and maximum eigenvalue tests are presented in Table 3. For Belarus, Macedonia, Romania and Serbia both tests reject cointegration implying that either there is no relationship between the variables or that the linear model is misspecified and a nonlinear model should be used instead. For all other countries both tests show there is one cointegrating relation.[9] However, linearity is misspecified in countries for which we confirm nonlinearity in the second step, so we present results for the Czech Republic and Poland only. Those two countries are the only ones that confirm cointegration and at the same time do not witness threshold effects. Resulting cointegrating vectors for all countries can be found in Table 4.

[9] The only exception is the Czech Republic for which only the trace test implies one cointegrating relation, while the max test shows no cointegrating relation.

Table 2: Lag length selection criteria

Lag	LR	FPE	AIC	SIC	HQ
Belarus					
0	NA	0.000	-13.412	-13.320	-13.375
1	575.188	0.000	-21.164	-20.796	-21.017
2	68.033	0.000	-21.913	-21.269*	-21.656*
3	18.342*	0.000	-21.954	-21.034	-21.587
4	16.842	0.000*	-21.985*	-20.789	-21.507
Bulgaria					
0	NA	0.000	-7.397	-7.312	-7.363
1	698.151	0.000	-15.503	-15.166*	-15.367*
2	17.860	0.000	-15.519	-14.928	-15.281
3	15.399	0.000	-15.512	-14.668	-15.172
4	16.374	0.000*	-15.526	-14.428	-15.084
5	6.400	0.000	-15.410	-14.059	-14.866
6	22.820	0.000	-15.536	-13.932	-14.890
7	6.227	0.000	-15.426	-13.568	-14.678
8	20.047*	0.000	-15.540*	-13.429	-14.689
Croatia					
0	NA	0.000	-15.129	-15.075	-15.107
1	58.165	0.000	-15.365	-15.149*	-15.278
2	31.921*	0.000*	-15.452*	-15.074	-15.298*
3	10.187	0.000	-15.411	-14.870	-15.192
4	10.678	0.000	-15.374	-14.672	-15.089
Czech Republic					
0	NA	0.000	-4.622	-4.558	-4.596
1	1197.06	0.000	-13.558	-13.301	-13.454
2	62.630	0.000*	-13.911*	-13.462*	-13.729*
3	11.006	0.000	-13.866	-13.224	-13.605
4	13.568	0.000	-13.844	-13.009	-13.505
5	16.744	0.000	-13.852	-12.824	-13.434
6	11.905	0.000	-13.821	-12.600	-13.325
7	15.211	0.000	-13.822	-12.409	-13.248
8	17.357*	0.000	-13.846	-12.240	-13.193
Hungary					
0	NA	0.000	-3.339	-3.275	-3.313
1	985.409	0.000	-10.672	-10.415	-10.568
2	46.012*	0.000*	-10.897*	-10.447*	-10.714*
3	16.093	0.000	-10.892	-10.249	-10.631
4	6.430	0.000	-10.812	-9.977	-10.472
Latvia					
0	NA	0.000	-15.995	-15.908	-15.960
1	691.026	0.000	-24.418	-24.071*	-24.279*
2	20.334	0.000*	-24.468	-23.860	-24.224
3	10.751	0.000	-24.399	-23.531	-24.050
4	15.884	0.000	-24.408	-23.280	-23.955
5	6.991	0.000	-24.297	-22.908	-23.738
6	16.425	0.000	-24.335	-22.686	-23.672
7	17.865	0.000	-24.409	-22.499	-23.641
8	18.951*	0.000	-24.516	-22.346	-23.644
9	12.110	0.000	-24.518*	-22.087	-23.541
Lithuania					
0	NA	0.000	-1.853	-1.788	-1.827
1	1253.95	0.000	-11.220	-10.963	-11.116

(table continues)

(continued)

Lag	LR	FPE	AIC	SIC	HQ
2	50.554	0.000	-11.480	-11.030*	-11.297*
3	6.585	0.000	-11.399	-10.757	-11.138
4	21.785	0.000	-11.444	-10.609	-11.105
5	11.259	0.000	-11.406	-10.378	-10.988
6	19.321	0.000	-11.438	-10.218	-10.942
7	36.693*	0.000*	-11.628*	-10.215	-11.054
8	7.623	0.000	-11.564	-9.958	-10.912
Macedonia					
0	NA	0.000	-15.038	-14.936	-14.998
1	36.935*	0.000*	-15.378*	-14.970*	-15.218*
2	10.374	0.000	-15.278	-14.563	-14.997
3	7.564	0.000	-15.135	-14.114	-14.733
4	12.384	0.000	-15.097	-13.770	-14.575
5	13.717	0.000	-15.103	-13.470	-14.461
6	13.307	0.000	-15.120	-13.181	-14.357
7	5.618	0.000	-14.971	-12.726	-14.088
8	4.901	0.000	-14.814	-12.263	-13.811
Poland					
0	NA	0.000	-2.192	-2.128	-2.166
1	1292.69	0.000	-11.853	-11.596	-11.748
2	51.486	0.000*	-12.119*	-11.670*	-11.937*
3	15.655	0.000	-12.111	-11.469	-11.850
4	4.091	0.000	-12.012	-11.177	-11.673
5	23.566	0.000	-12.076	-11.048	-11.658
6	18.156*	0.000	-12.099	-10.878	-11.603
7	8.071	0.000	-12.037	-10.624	-11.463
8	8.996	0.000	-11.986	-10.380	-11.333
Romania					
0	NA	0.000	-5.130	-5.025	-5.089
1	332.98*	0.000*	-10.776*	-10.357*	-10.612*
2	15.552	0.000	-10.769	-10.036	-10.483
3	5.536	0.000	-10.580	-9.533	-10.170
4	7.547	0.000	-10.441	-9.079	-9.908
Serbia					
0	NA	0.000	-8.020	-7.928	-7.983
1	486.776	0.000	-14.544	-14.176*	-14.397
2	27.995	0.000	-14.713	-14.069	-14.455
3	32.351*	0.000*	-14.966*	-14.046	-14.598*
4	7.513	0.000	-14.848	-13.652	-14.370
Turkey					
0	NA	0.028	4.953	5.018	4.979
1	1312.14	0.000	-4.930	-4.672*	-4.825
2	39.684	0.000	-5.107	-4.655	-4.923
3	20.834	0.000	-5.140	-4.494	-4.878
4	32.618	0.000	-5.274	-4.435	-4.933*
5	15.682	0.000	-5.272	-4.239	-4.853
6	20.051	0.000	-5.312	-4.085	-4.813
7	7.762	0.000	-5.247	-3.827	-4.670
8	26.410*	0.000*	-5.354*	-3.740	-4.698

Note: * indicates lag order selected by the criterion; LR – sequential modified likelihood ratio test statistic; FPE – Final Prediction Error; AIC - Akaike Information Criterion; SIC - Schwartz Information Criterion; HQ – Hannah-Quinn Information Criterion.

Source: Central banks and Eurostat databases; own calculations.

Table 3: Cointegration test results

	Number of cointegrating equations	Country	Eigen-value	Test statistic	Probab-ility#	Country	Eigen-value	Test statistic	Probab-ility#	Country	Eigen-value	Test statistic	Probab-ility#
	None		0.119	19.26	0.770		0.195	38.08	0.004**		0.139	24.48	0.046*
Trace test	At most 1		0.103	10.62	0.586		0.058	8.59	0.412		0.027	4.20	0.675
	At most 2		0.047	3.26	0.544		0.004	0.53	0.468		0.004	0.55	0.524
Maximum	None	Belarus	0.119	8.65	0.912	Hungary	0.195	29.49	0.002**	Poland	0.139	20.27	0.018*
eigenvalue	At most 1		0.103	7.36	0.633		0.058	8.06	0.381		0.027	3.65	0.684
test	At most 2		0.047	3.26	0.543		0.004	0.53	0.468		0.004	0.55	0.518
		Unrestricted constant and 4 lags.				Unrestricted constant and 2 lags.				Unrestricted constant and 2 lags.			
	None		0.248	38.63	0.019*		0.417	45.96	0.002**		0.291	27.87	0.084
Trace test	At most 1		0.095	12.41	0.421		0.157	13.61	0.208		0.073	7.21	0.560
	At most 2		0.035	3.27	0.541		0.055	3.38	0.066		0.043	2.66	0.103
Maximum	None	Bulgaria	0.248	26.22	0.011*	Latvia	0.417	32.35	0.002**	Romania	0.291	20.66	0.057
eigenvalue	At most 1		0.095	9.14	0.431		0.157	10.24	0.383		0.073	4.55	0.794
test	At most 2		0.035	3.27	0.540		0.055	3.38	0.066		0.043	2.66	0.103
		Restricted constant and 1 lag.				Restricted constant and 3 lags.				Restricted constant and 3 lags.			
	None		0.137	36.54	0.034*		0.195	38.07	0.004**		0.164	21.57	0.333
Trace test	At most 1		0.039	10.56	0.591		0.043	8.62	0.409		0.117	9.36	0.339
	At most 2		0.019	3.47	0.508		0.019	2.58	0.108		0.013	0.91	0.339
Maximum	None	Croatia	0.137	25.98	0.012*	Lithuania	0.195	29.45	0.002**	Serbia	0.164	12.21	0.540
eigenvalue	At most 1		0.039	7.10	0.663		0.043	6.04	0.614		0.117	8.45	0.343
test	At most 2		0.019	3.47	0.507		0.019	2.58	0.108		0.013	0.91	0.339
Note		Restricted constant and 8 lags.				No constant and 2 lags.				No constant and 2 lags.			
	None		0.133	25.74	0.031*		0.271	29.04	0.200		0.248	46.27	0.000**
Trace test	At most 1		0.077	9.24	0.156		0.071	7.24	0.876		0.067	12.40	0.140
	At most 2	Czech	0.000	0.00	0.990		0.031	2.17	0.743		0.034	4.16	0.042*
Maximum	None	Republic	0.133	16.50	0.076	Macedonia	0.271	21.80	0.057	Turkey	0.248	33.87	0.000**
eigenvalue	At most 1		0.077	9.24	0.110		0.071	5.06	0.873		0.067	8.25	0.362
test	At most 2		0.000	0.00	0.988		0.031	2.17	0.742		0.034	4.16	0.042*
		No constant and 7 lags.				Unrestricted constant and 2 lags.				Unrestricted constant and 2 lags.			

Note: ** denotes rejection of the hypothesis at the 0.01 level; * denotes rejection of the hypothesis at the 0.05 level; # critical values for *p*-values can be found in MacKinnon, Haug, and Michelis (1999).

Source: Central banks and Eurostat databases; own calculations.

Table 4: Cointegrating vectors

Country	Variable	Cointegration vector	Cointegrating vector with restrictions
Bulgaria	*DE*	1	1
	RER	1.335	0.107
	IRD	-0.199	-0.073
	Const.	-2.716	0
	Chi square = 2.5601 [0.1096]		
Croatia	*DE*	1	1
	NER	-1.371	-1
	IRD	-0.055	-1
	Const.	1.431	3.397
	Chi square = 3.4030 [0.1824]		
Czech Republic	*DE*	1	1
	NER	0.911	1
	IRD	0.955	1
	Chi square = 0.0777 [0.9619]		
Hungary	*DE*	1	
	NER	-6.936	
	IRD	0.018	
	No restrictions accepted.		
Latvia	*DE*	1	1
	RER	0.136	0.105
	IRD	-0.001	-0.001
	Const.	-0.058	0
	Chi square = 0.254 [0.614]		
Poland	*DE*	1	
	NER	1.132	
	IRD	-0.001	
	No restrictions accepted.		
Turkey	*DE*	1	1
	NER	-0.454	-1
	IRD	-0.014	-0.026
	Chi square = 2.475 [0.116]		

Note: all coefficients are in vector notation; *DE* – deposit euroization; *NER* – nominal exchange rate; *RER* – real exchange rate; *IRD* – interest rate differential.

Source: Central banks and Eurostat databases; own calculations.

The Czech Republic has a very high interest rate differential coefficient that we restricted to -1. Therefore, an increase of 1 percent in the interest rate differential leads to a 1 percent decrease in DE. As explained in Basso et al., (2011), a rise in domestic interest rates stimulates domestic currency savings which eventually decreases DE. The nominal exchange rate coefficient for the Czech Republic implies the same relationship, a moderation in DE after exchange rate depreciation. This result is not in accordance with our assumptions about post-transition economies in general, but since this is a country with a flexible exchange rate regime, one does not expect exchange rate changes exhibiting a strong impact on DE. Another country with a flexible exchange rate regime is Poland, with results for the nominal exchange rate very similar to the ones explained earlier. A negative coefficient of more than one suggests DE decreases by more than 1 percent after a depreciation of 1 percent. The interest rate differential coefficient is very small and positive, leading to the conclusion that a larger increase in local interest rates relative to interest rates in EMU does increase DE, but very mildly.

2.5.2 The threshold model

Recall that our threshold adjusted VAR model is specified as:

$$y_t = \Gamma_1 X_t + \Gamma_2 X_t I\left[z_{t-d} \geq z^*\right] + u_t \tag{2.11}$$

where $X_t = (1, y_{t-1}, ..., y_{t-j})'$. However, if we allow for changes in contemporaneous relationships between variables, then our transformed model becomes:

$$y_t = \Gamma_1^1 y_t + \Gamma_2^1(L) y_{t-1} + (\Gamma_1^2 y_t + \Gamma_2^2(L) y_{t-1}) I\left[z_{t-d} \geq z^*\right] + u_t . \tag{2.12}$$

In this specification, Γ_1^1 and Γ_1^2 reflect the "structural" relationship in the two regimes. Using Cholesky decomposition and the relevant recursive structure with the causal ordering of DE, the exchange rate and the interest rate differential, we are able to identify structural errors. Bearing in mind this kind of identification leads to multiple Cholesky factors, we consider alternative ordering. However, different ordering choices resulted in very small differences. We use this basic form of identification mostly due to simplicity reasons. Complicated forms of identifying restrictions, together with robustness analysis of our results, are left for future work.

To proceed to the Hansen test we need to closely specify our threshold variable, deposit euroization. As in Galbraith and Tkacz (2000), we set the threshold variable z_{t-d} to be a moving average of its past values, or $z_{k,t-d}(d,k) = 1/(k-d+1)\sum_{i=d}^{k} DE_{t-i}$ for different values of d and k. Based on a minimum residual variance and maximum likelihood, we choose d equal to 1 and k equal to 3.[10]

Table 5: Estimation of TVAR and test of nonlinearity

Country	Estimated threshold	Sup F	Bootstrapped *p*-value	Chi-square *p*-value	Corresponding DE (in %)
Belarus	-0.287	41.3653	0.174	0.000	-
Bulgaria	-0.252	46.8602	0.008***	0.000	56.1
Croatia	-0.125	51.8103	0.007***	0.000	74.4
Czech R.	-1.011	45.5666	0.054	0.000	-
Hungary	-0.718	47.8170	0.018**	0.000	18.8
Latvia	-0.086	45.3061	0.033**	0.000	81.5
Lithuania	-0.426	53.5303	0.002***	0.000	37.2
Macedonia	-0.266	37.2685	0.335	0.000	-
Poland	-0.685	40.8365	0.240	0.000	-
Romania	-0.433	41.7328	0.034**	0.000	37.0
Serbia	-0.171	43.8639	0.040**	0.000	67.7
Turkey	-0.383	59.9263	0.000***	0.000	41.9

Note: *** null hypothesis about linearity rejected at the 1% level of significance; ** hypothesis about linearity rejected at the 5% level of significance.

Source: Central banks and Eurostat databases; own calculations.

Bootstrapped *p*-values for the Hansen test and for the corresponding baseline linear model, together with the estimated coefficient for the threshold parameter, can be found in Table 5. The trimming percentage for the threshold variable is 30 percent and the number of bootstrap replications is 1000. It turns out that the chi-square test statistic is significant for all countries at the 1 percent level. However, the bootstrap test rejects linearity in a greater part of our country sample: Bulgaria, Croatia, Hungary, Latvia, Lithuania, Romania, Serbia

[10] However, the deposit euroization variable enters the VAR in its original form.

and Turkey.[11] For Bulgaria, Croatia, Lithuania and Turkey linearity is rejected at the 1 percent level, and for the other countries at the 5 percent level. It is interesting that both the Czech Republic and Poland show no sign of nonlinearity. Among post-transition countries in our sample, those two have the lowest level of unofficial euroization, both have flexible exchange rate and inflation targeting regimes and both implement policy measures to curtail FE.

The estimated threshold values for a VAR model with three lags and the threshold variable specified as a three-period moving average with one lag are given in Table 5. Since these values are in logarithms and moving averages, we report the corresponding original DE values in the last column. We observe that threshold values are country specific and vary between 18.8 percent in Hungary and 81.5 percent in Latvia.

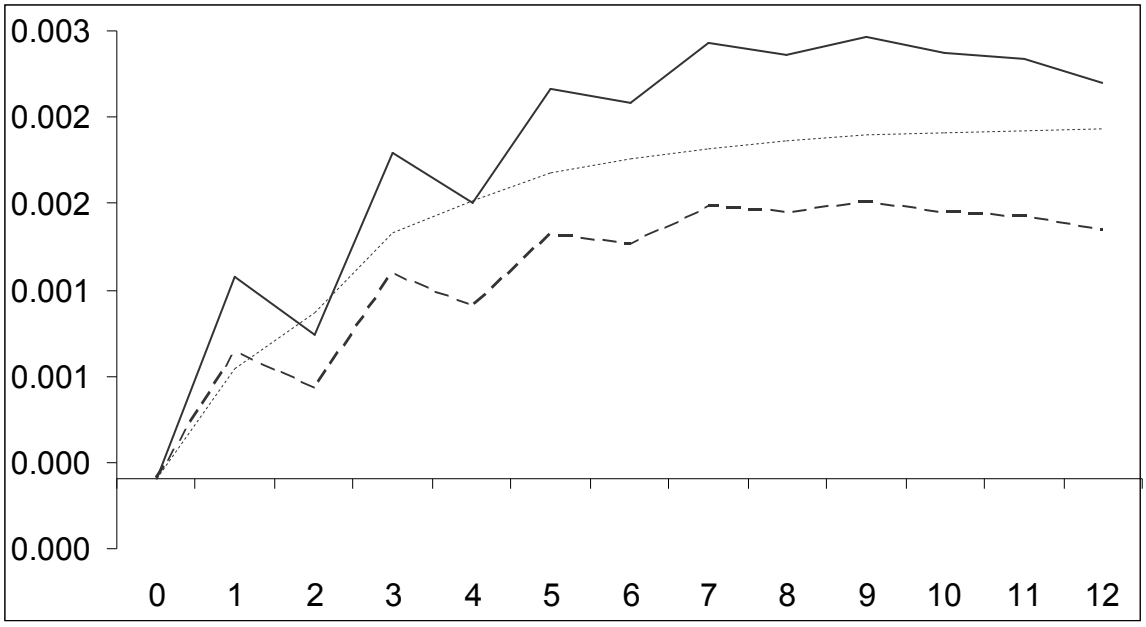
Figures 1 to 3 directly compare positive and negative shocks with the linear impulse response functions. For easier comparison of positive and negative shocks, we transform the sign in front of the simulated impulse response after a negative shock.[12] Although linear responses are misspecified when tests confirm nonlinearity, we leave them as a reference. We find clear differences between linear and nonlinear GIRFs and between positive and negative shocks in all countries. Further, since differences between regimes are almost negligible, we present GIRFs for low regime only, while high regime results can be found in Appendix D. It is important to note that regime differences are observable when there is a natural explanation for two states of the endogenous variable. If the endogenous variable is the output gap or perhaps credit growth rate, there is reasoning for the existence of a low (negative or contractionary) and a high (positive or expansionary) regime. Since DE does not have a negative and a positive state (DE is always positive), we simply use it as a threshold variable.

Before discussing the results for all countries and all shocks explored in this study, we discuss results for one country and one specific shock in order to explain this rather complicated technique. First, the x-axis measures periods, in this case months, while the y-axis measures the value of the response to the shock that is set to one standard deviation.

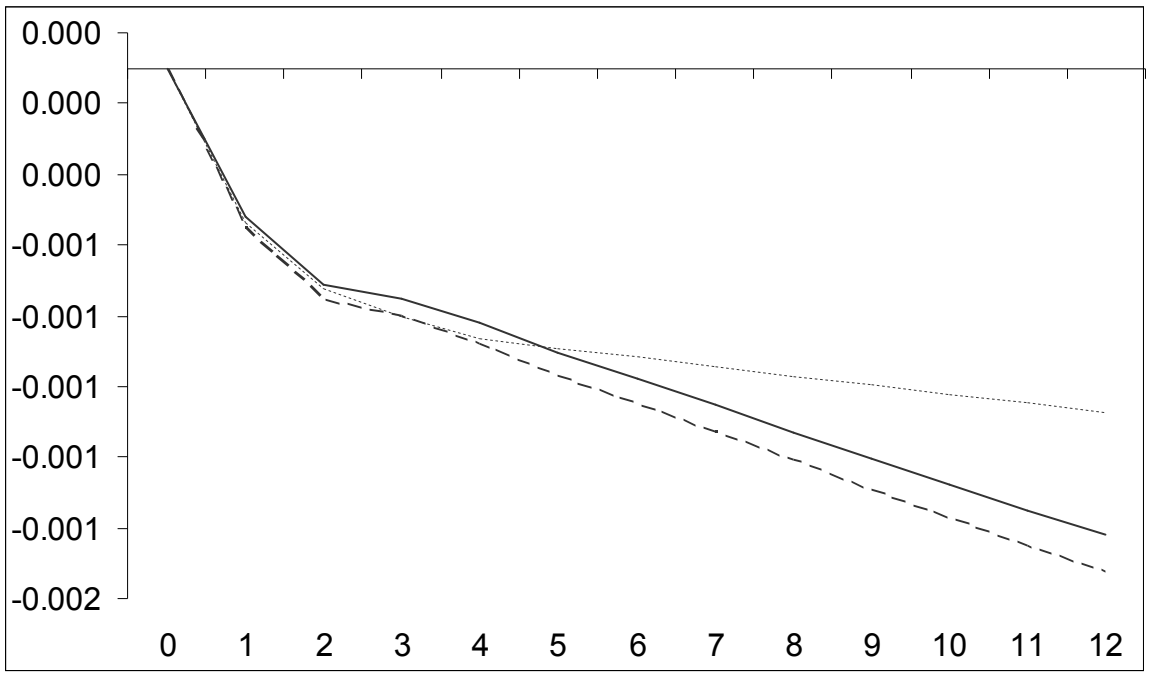
[11] For the Czech Republic and Macedonia, the linearity is rejected at the 10 percent level only.
[12] We do not present confidence intervals around impulse responses since there is no consensus on how to compute them for nonlinear models that allow regimes to switch (Kilian, 1998).

Figure 1: Effect of positive and negative (one-standard deviation) exchange rate shocks on deposit euroization

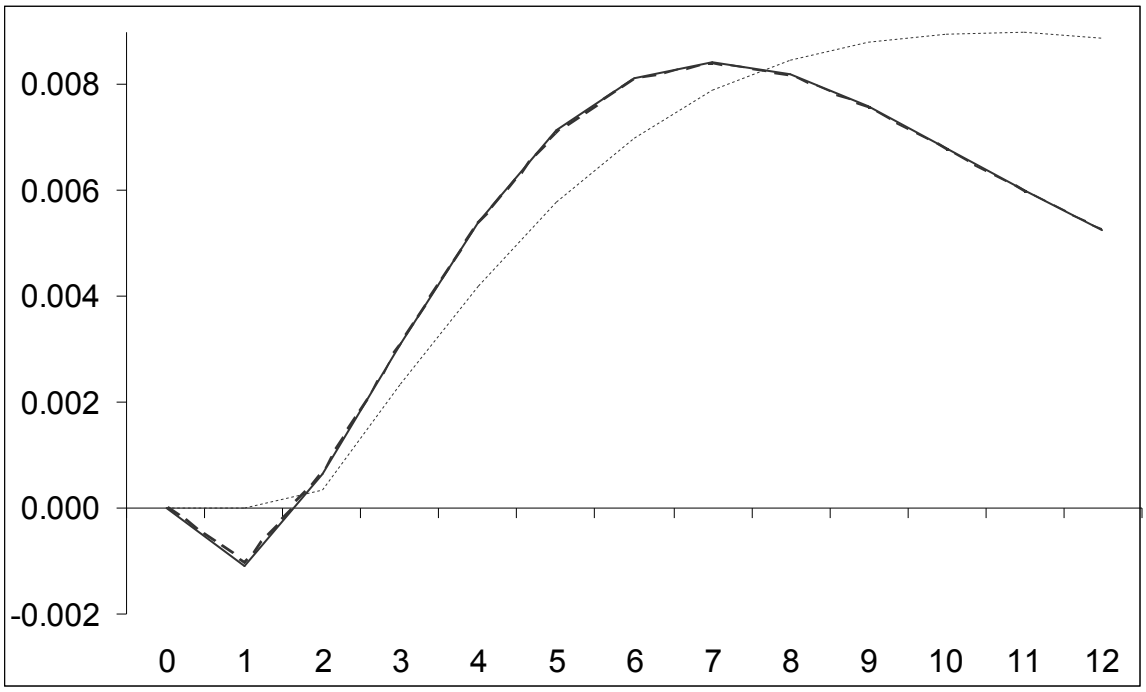
Bulgaria



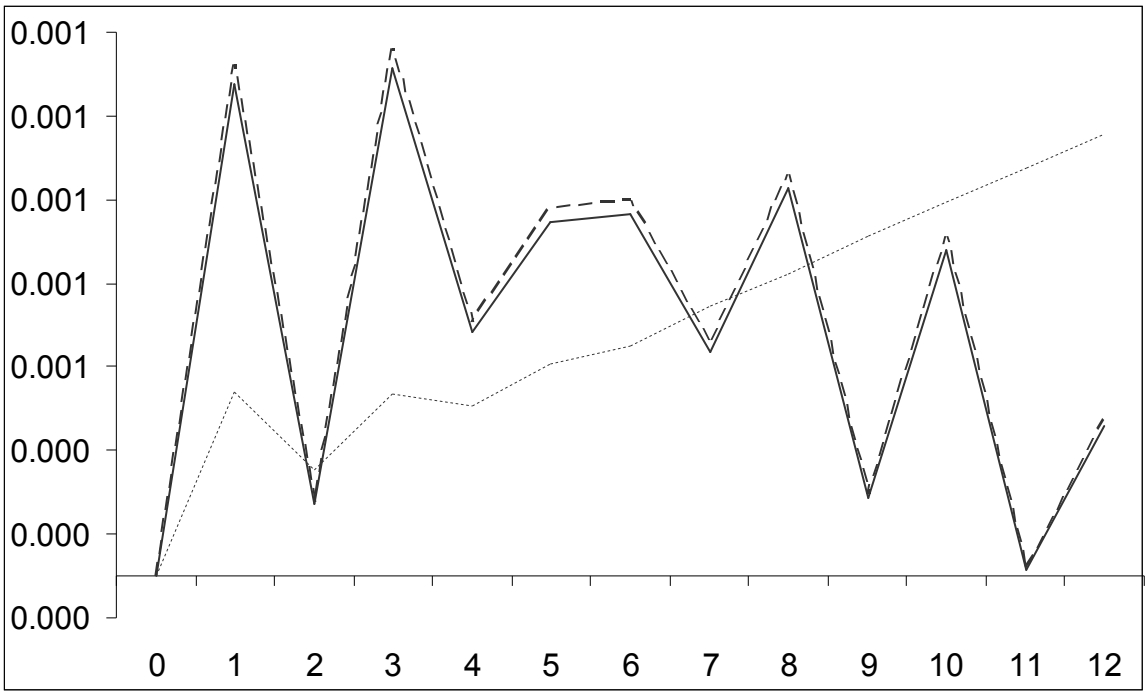
Croatia



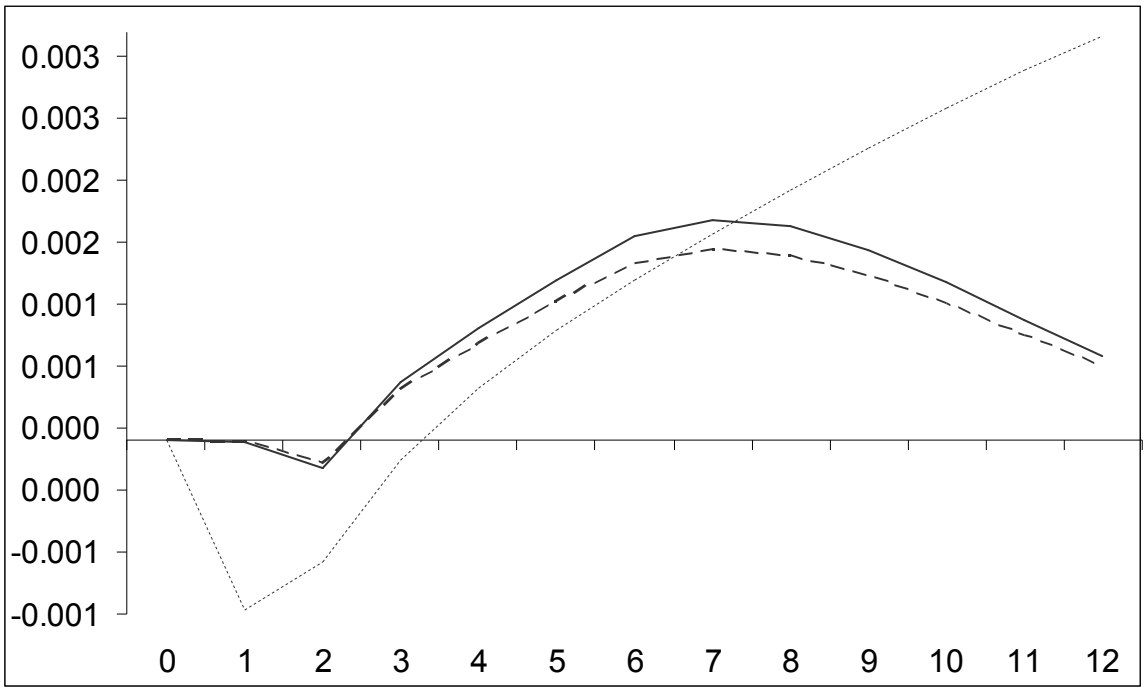
Hungary



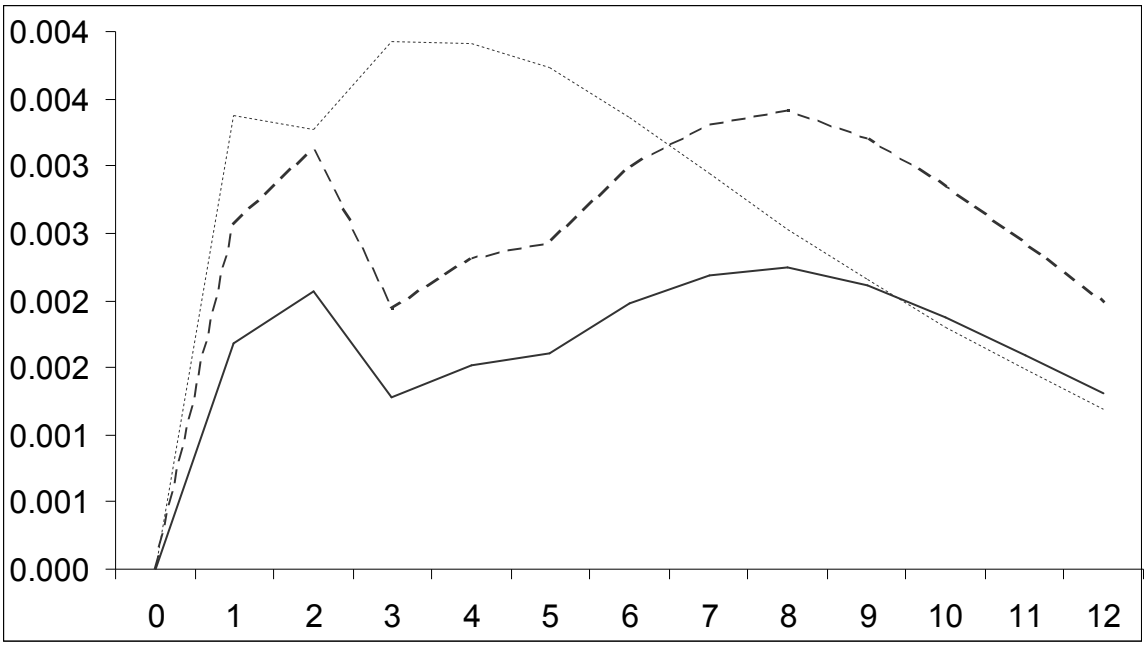
Latvia



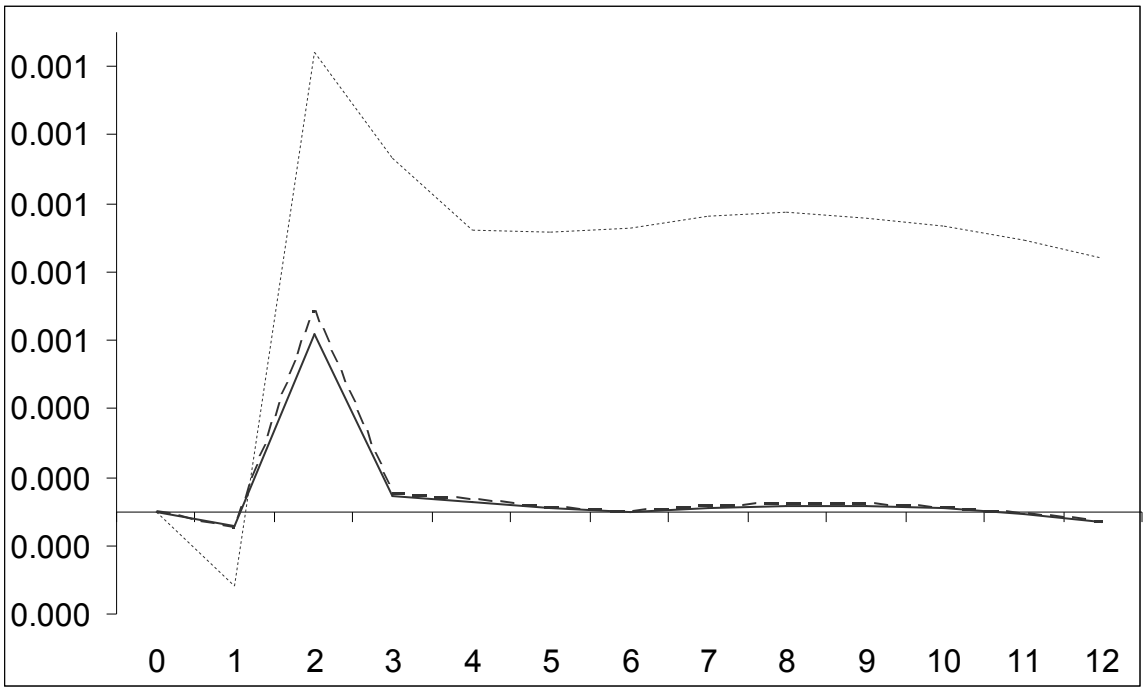
Lithuania



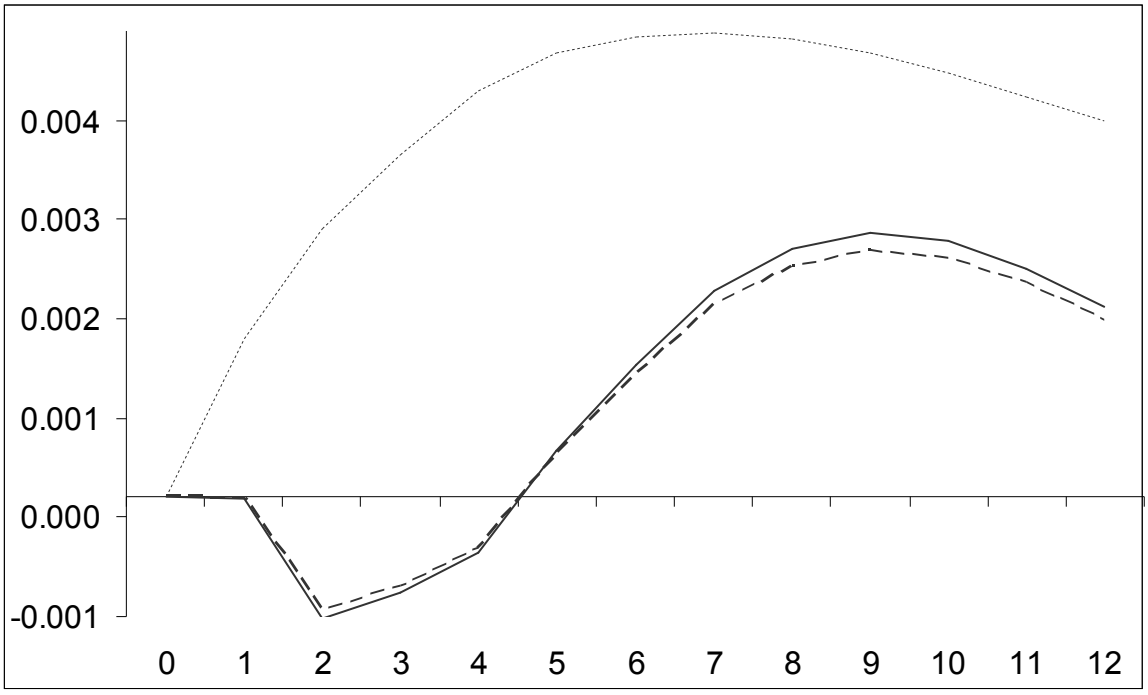
Romania



Serbia



Turkey



Note: full line represents a positive shock, broken line a negative shock and dotted line a linear response.

Source: Central banks and Eurostat databases; own calculations.

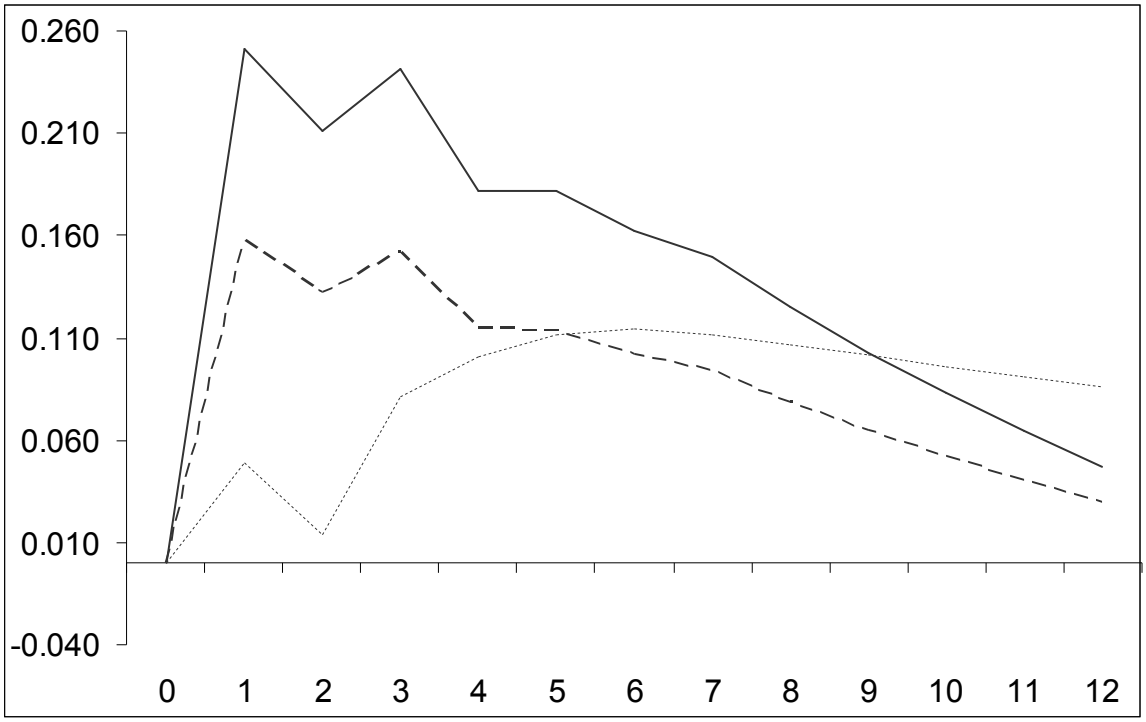
In cases where the responses to positive and negative shocks differ, this difference is measured on the y-axis. The first graph of Figure 1 presents the cumulative response of DE, both positive and negative, to a one-standard-deviation shock in the exchange rate. The graph provides evidence of nonlinearities between the effects of positive and negative exchange rate shocks on DE in Bulgaria. The response of DE to exchange rate depreciation is around 0.0009 after two months and around 0.0022 after six months. However, responses to negative exchange rate shocks differ and are around 0.0006 after two months and around 0.0014 after six months. These findings show that after two months, positive exchange rate changes (depreciations) have a 50 percent stronger impact on DE in Bulgaria than do negative exchange rate changes (appreciations). After six months, the difference becomes more pronounced since DE has 57 percent stronger responses to positive exchange rate changes than to negative ones. The remaining graphs should be interpreted in the same manner, but due to space considerations we provide an overall summary of results.

Figure 1 presents the reaction of DE to exchange rate shocks. Results for Bulgaria, Latvia and Romania are in line with economic intuition and indicate DE rises with exchange rate depreciation. Moreover, depreciation effects in Bulgaria are stronger than appreciation effects in both regimes. Lithuania and Turkey also show stronger responses to depreciation in both low and high regimes. DE in Hungary, Lithuania, Serbia and Turkey also reacts as one would expect, with a hike preceded by exchange rate depreciation. To summarize, from the countries witnessing nonlinear behavior, only in the case of Croatia we reject our hypothesis that depreciation drives up DE.

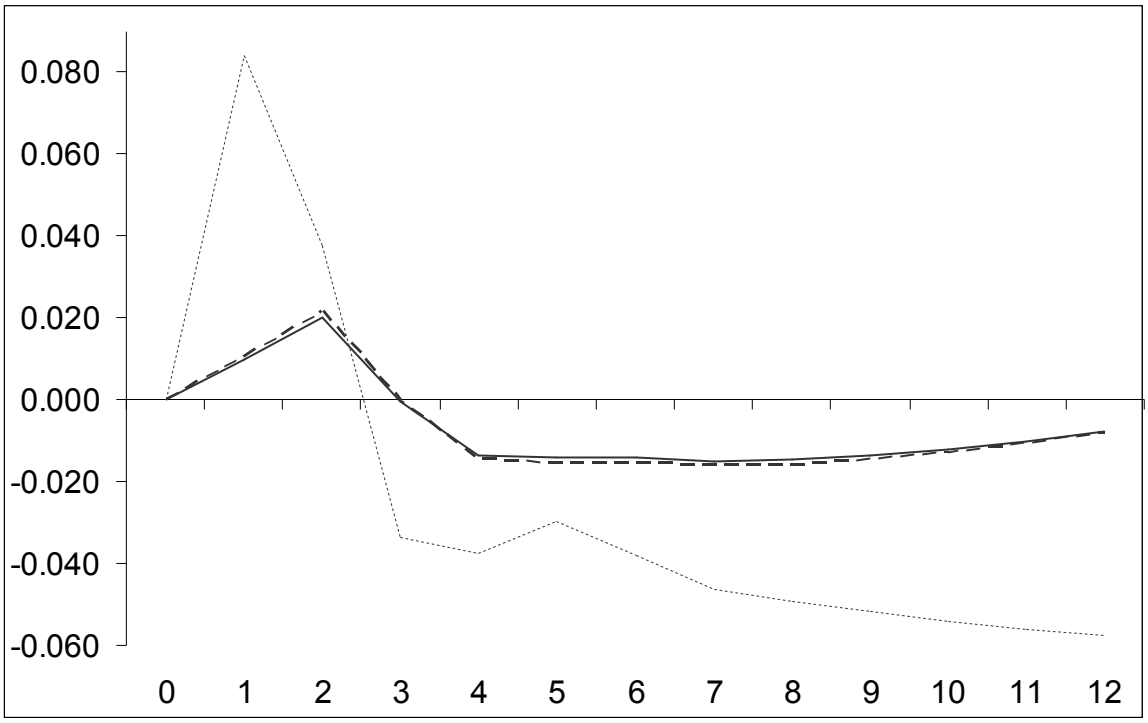
When depreciation pressures arise, central banks that experience “fear of floating” usually react with a liquidity squeeze that eventually manifests itself in a domestic interest rate increase. If this theory holds, we would observe a positive response of the interest rate differential to a positive exchange rate shock or depreciation. Interest rate differential responses to exchange rate shocks are displayed in Figure 2. We find evidence of the described effect in all countries, except in Lithuania. Linear and nonlinear responses are very similar in shape, but in six out of eight countries nonlinear responses are stronger. The only indication of regime differences is found in Romania where appreciation is much stronger in the low regime.

Figure 2: Effect of positive and negative (one-standard deviation) exchange rate shocks on interest rate differential

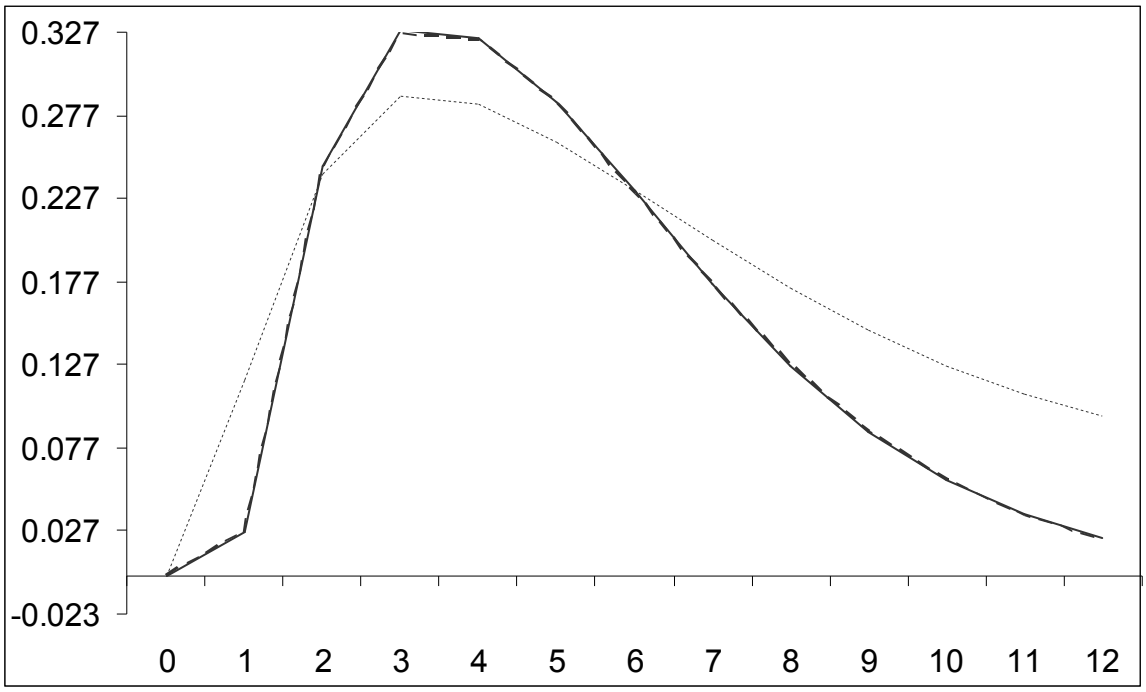
Bulgaria



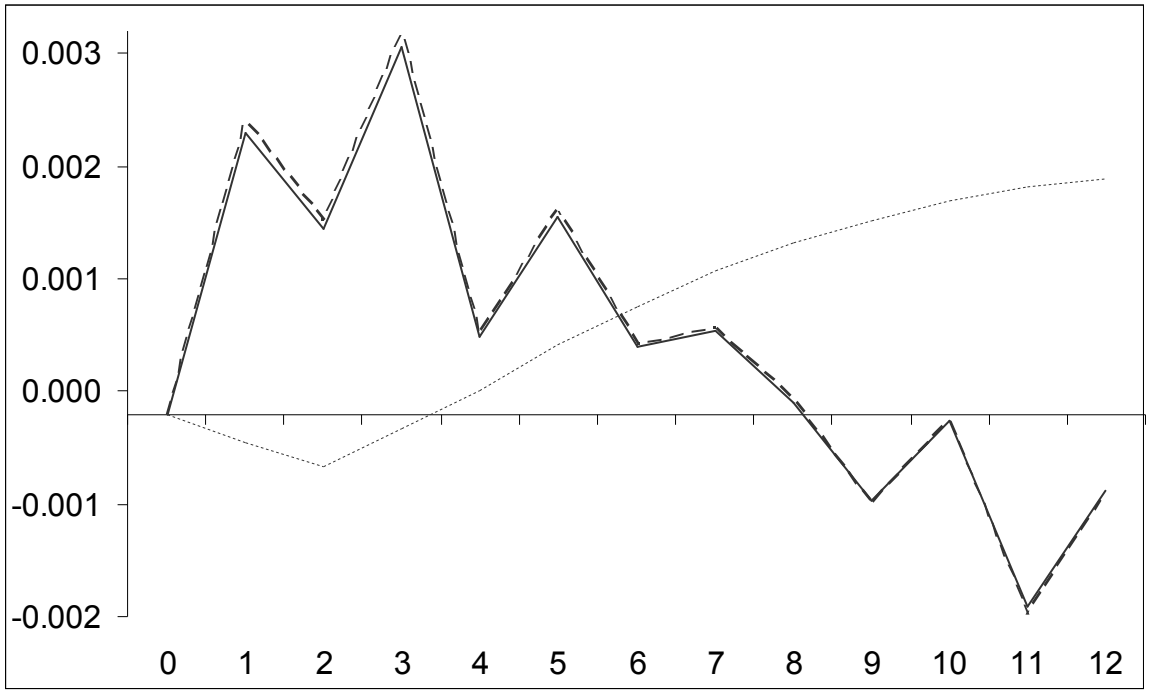
Croatia



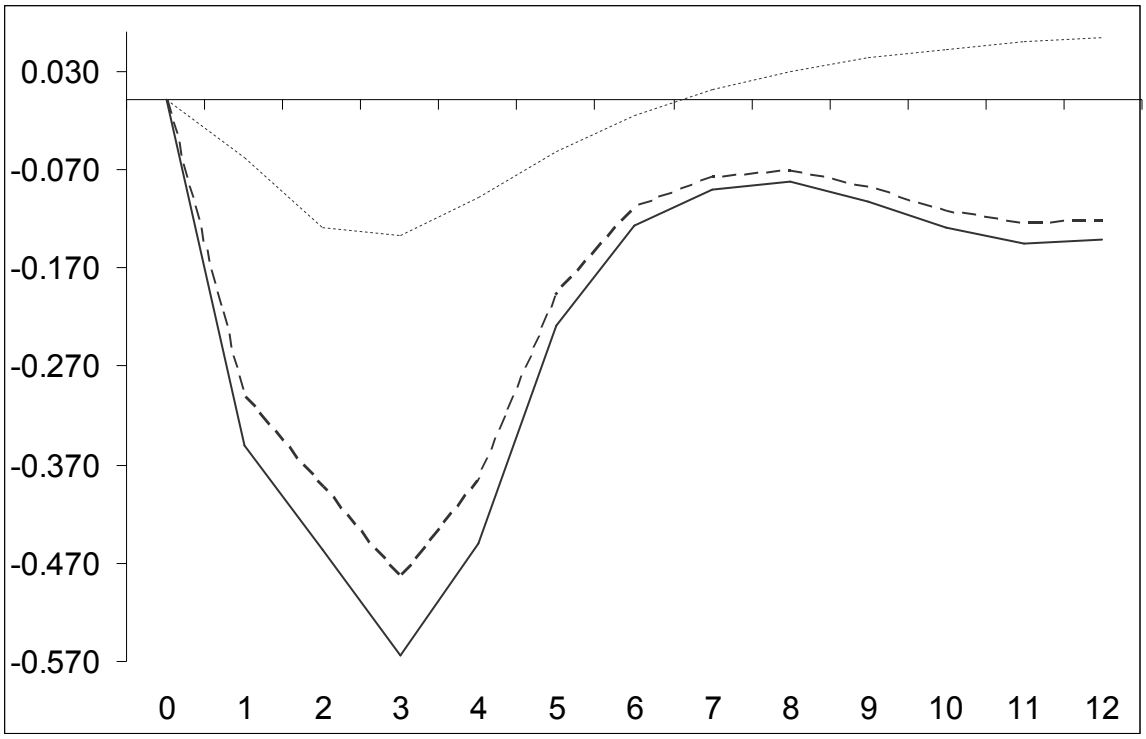
Hungary



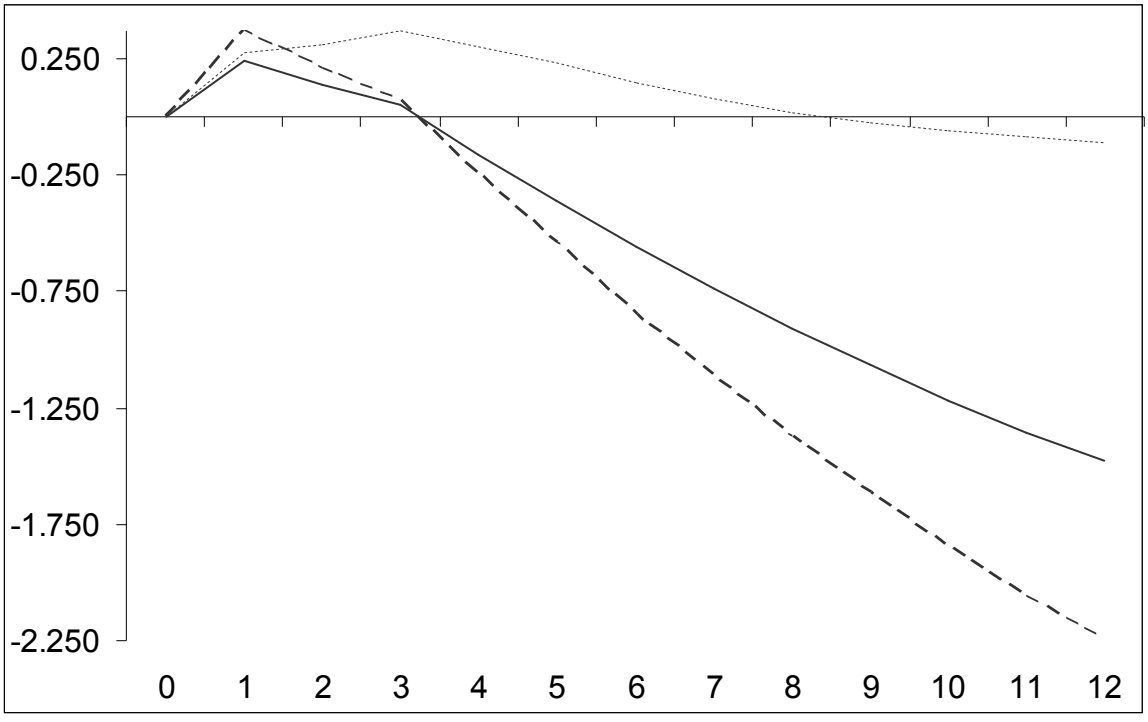
Latvia



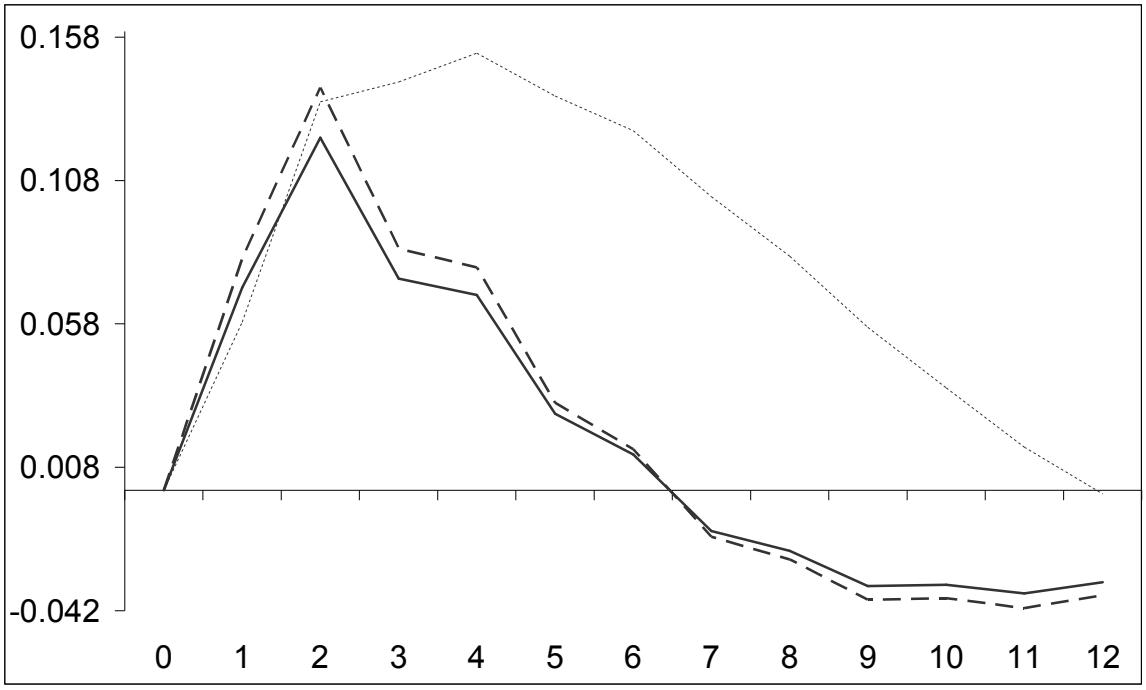
Lithuania



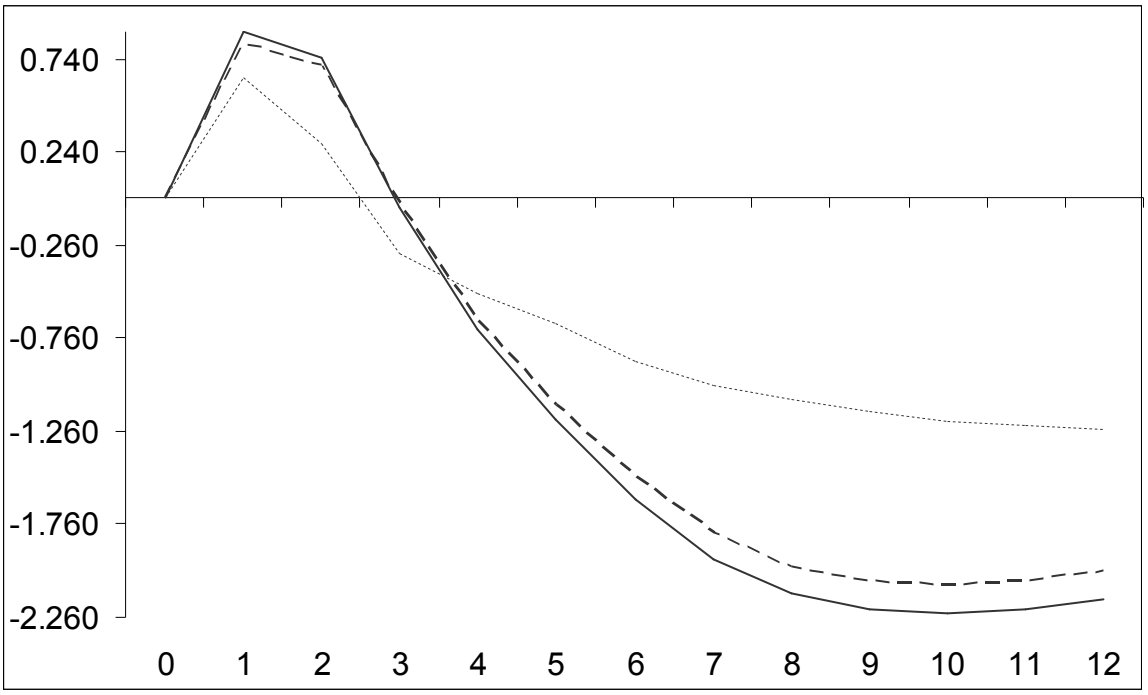
Romania



Serbia



Turkey

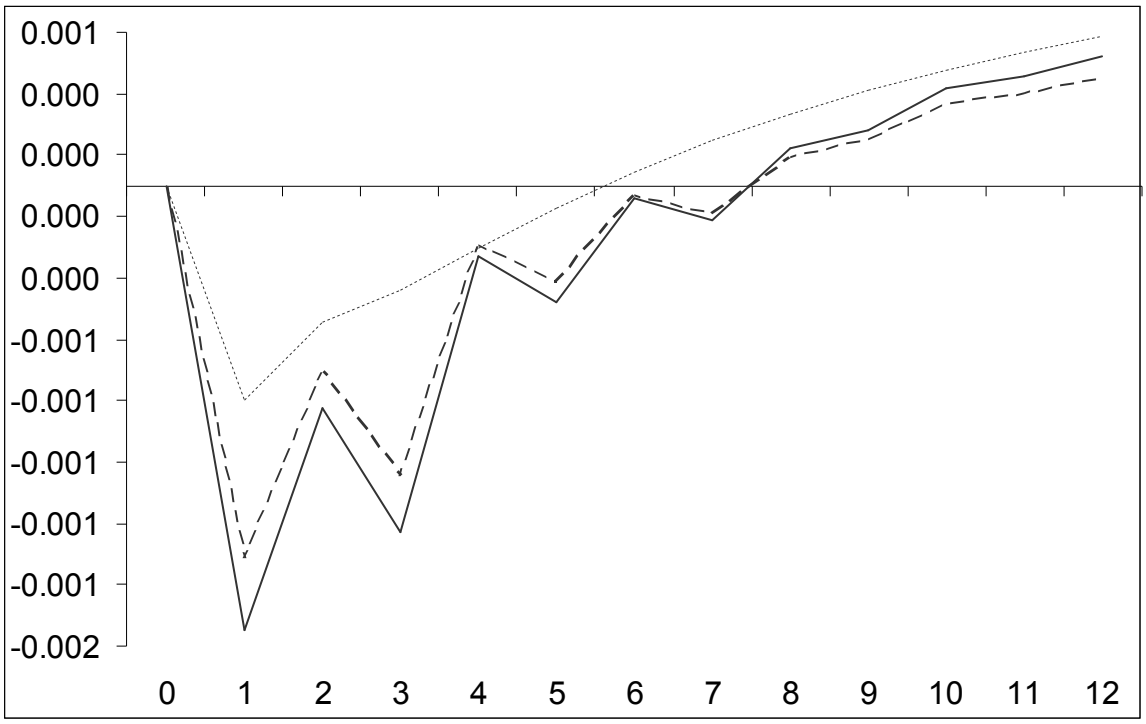


Note: full line represents a positive shock, broken line a negative shock and dotted line a linear response.

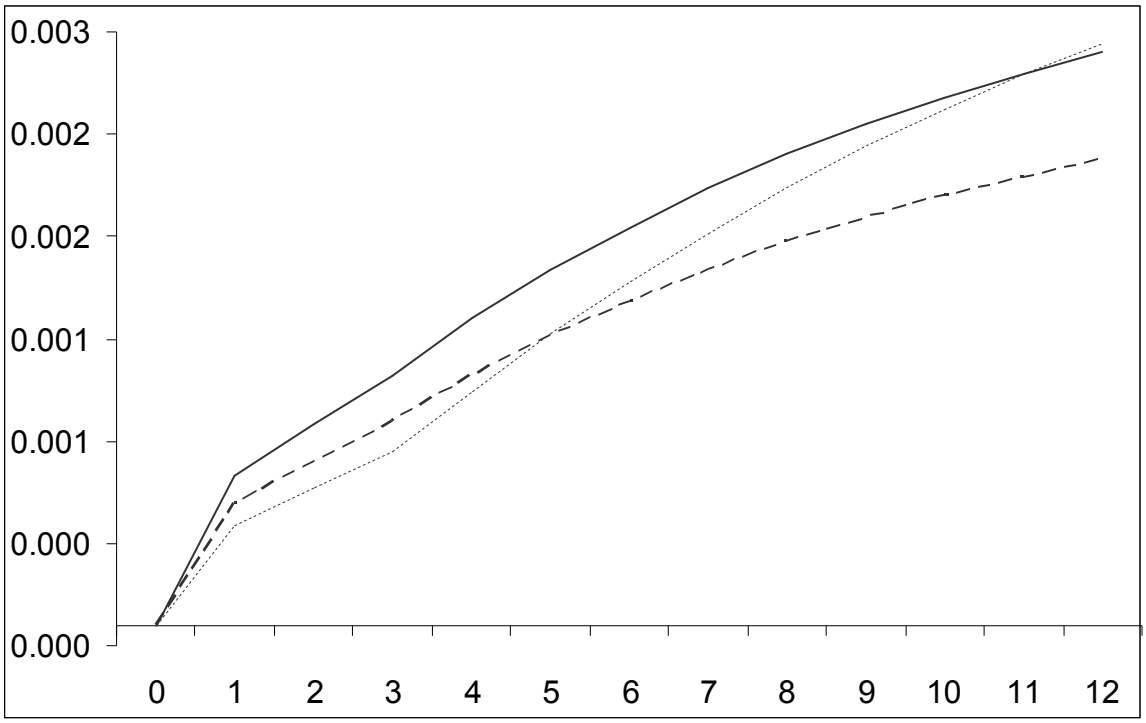
Source: Central banks and Eurostat databases; own calculations.

Figure 3: Effect of positive and negative (one-standard deviation) interest rate differential shocks on deposit euroization

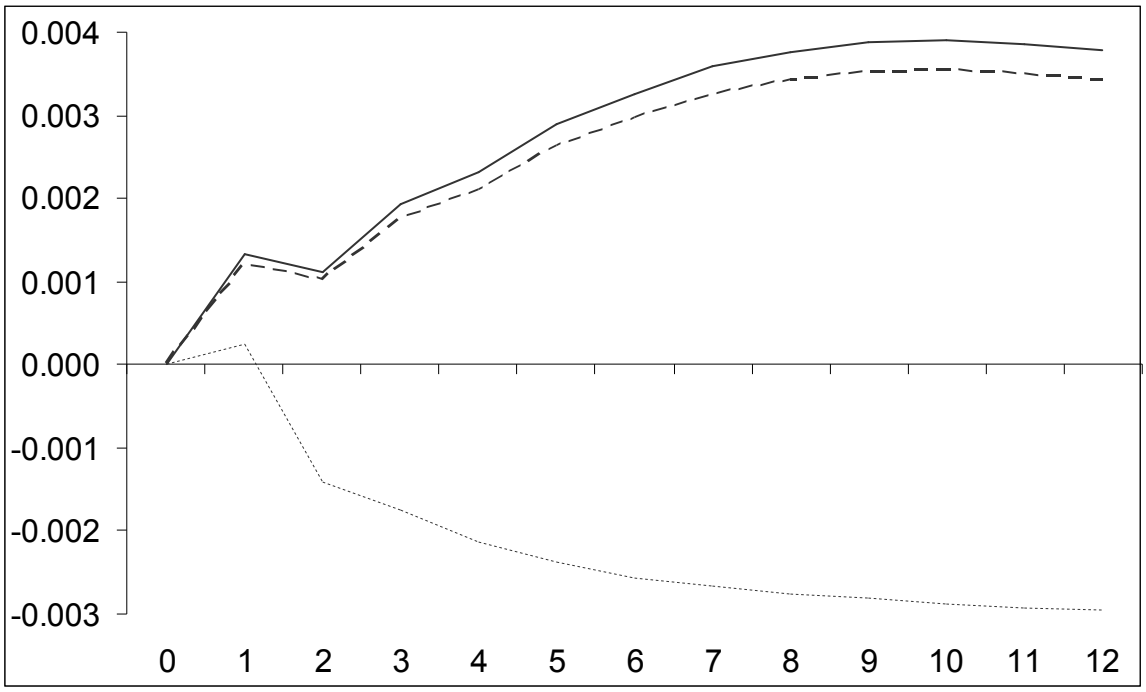
Bulgaria



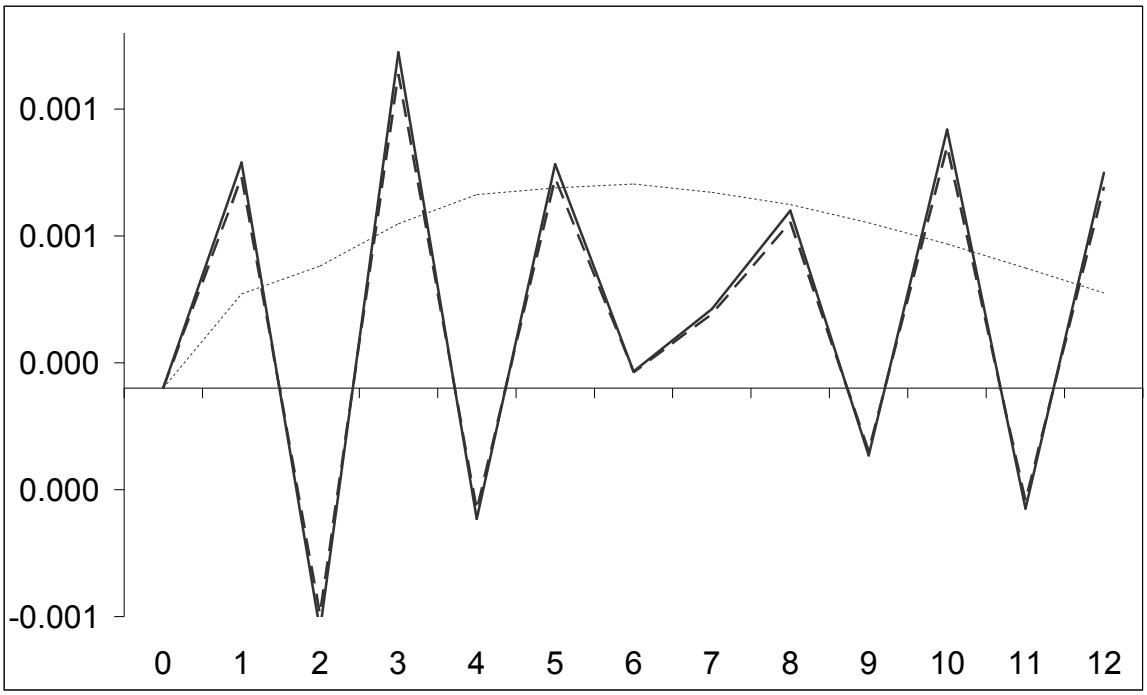
Croatia



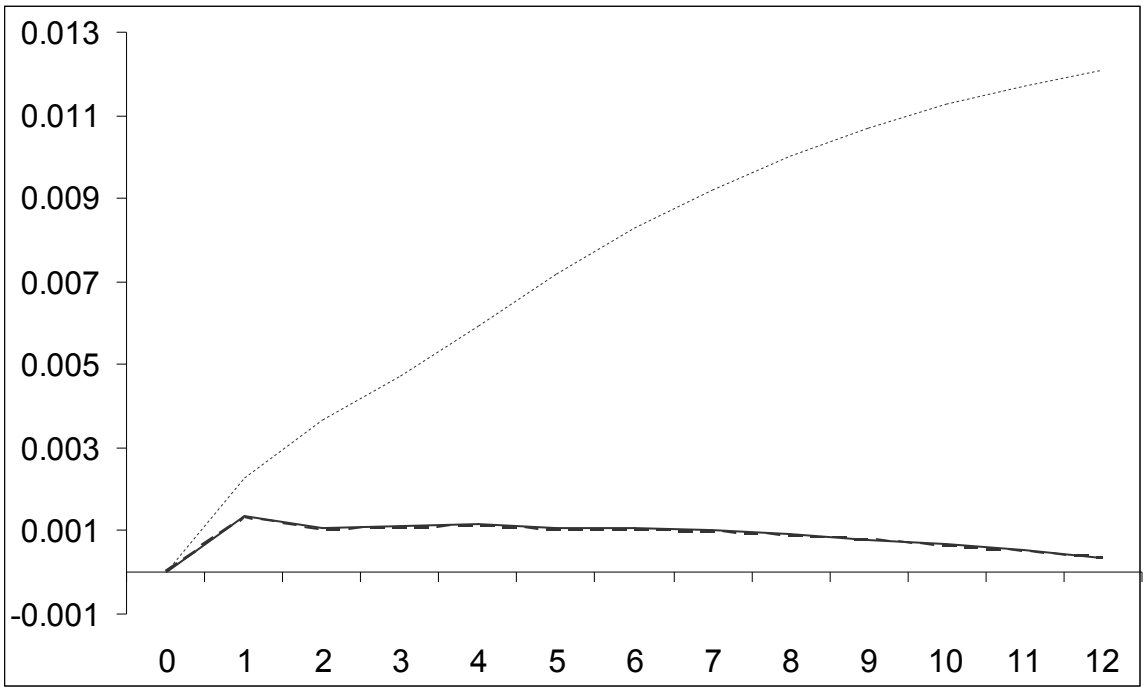
Hungary



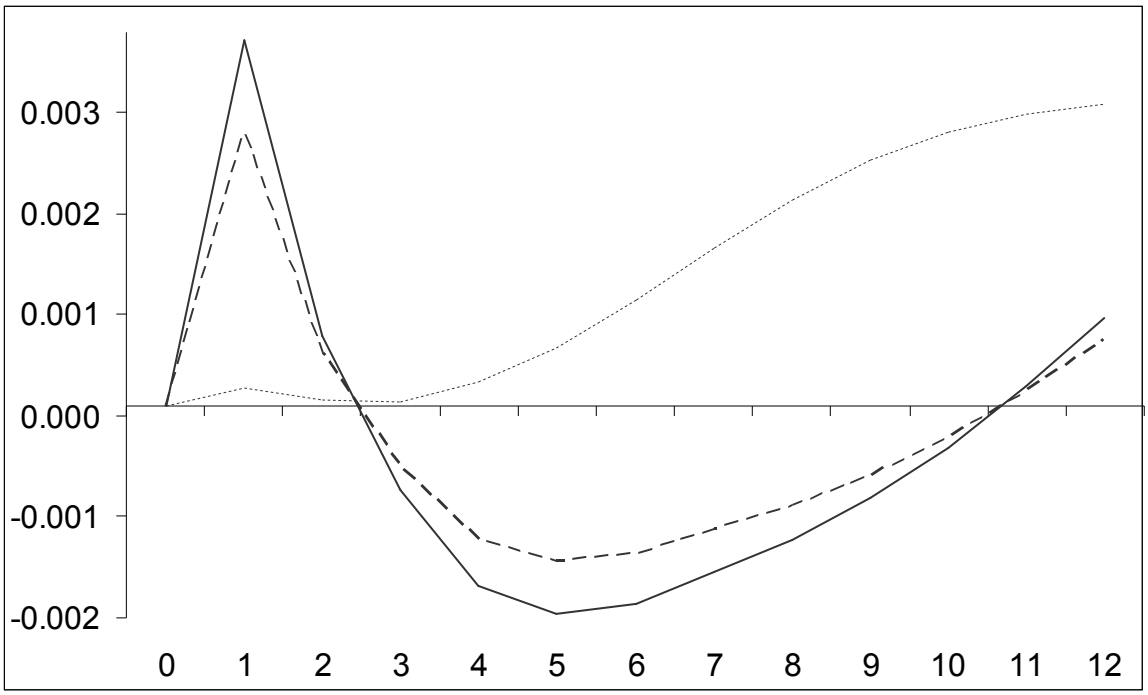
Latvia



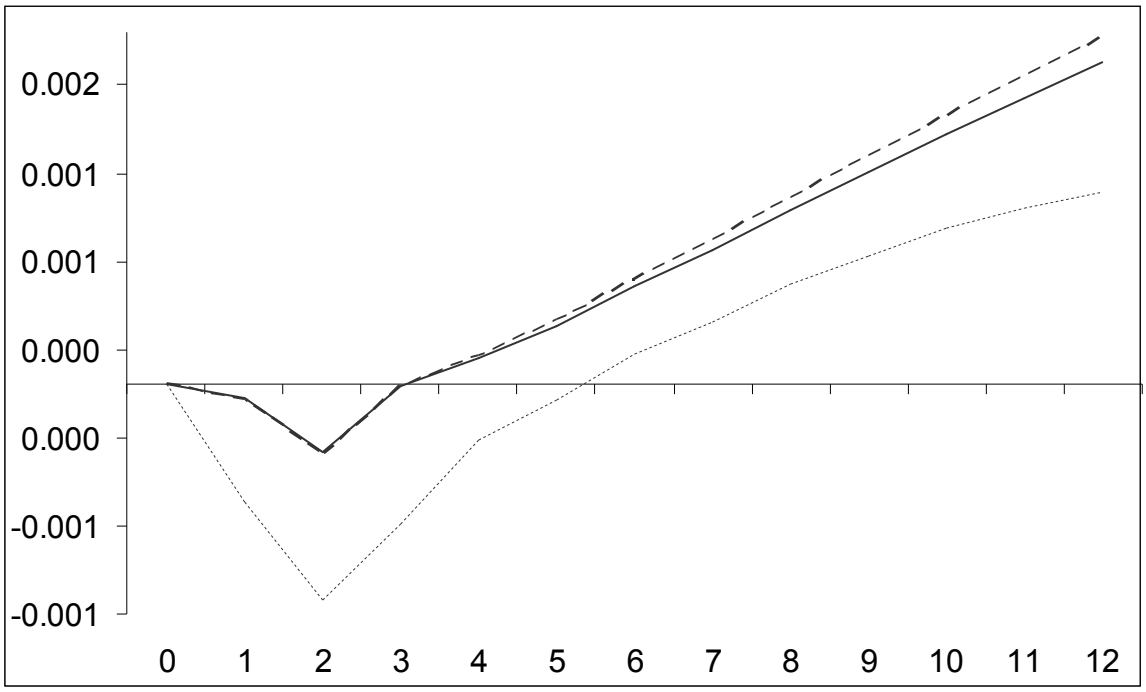
Lithuania



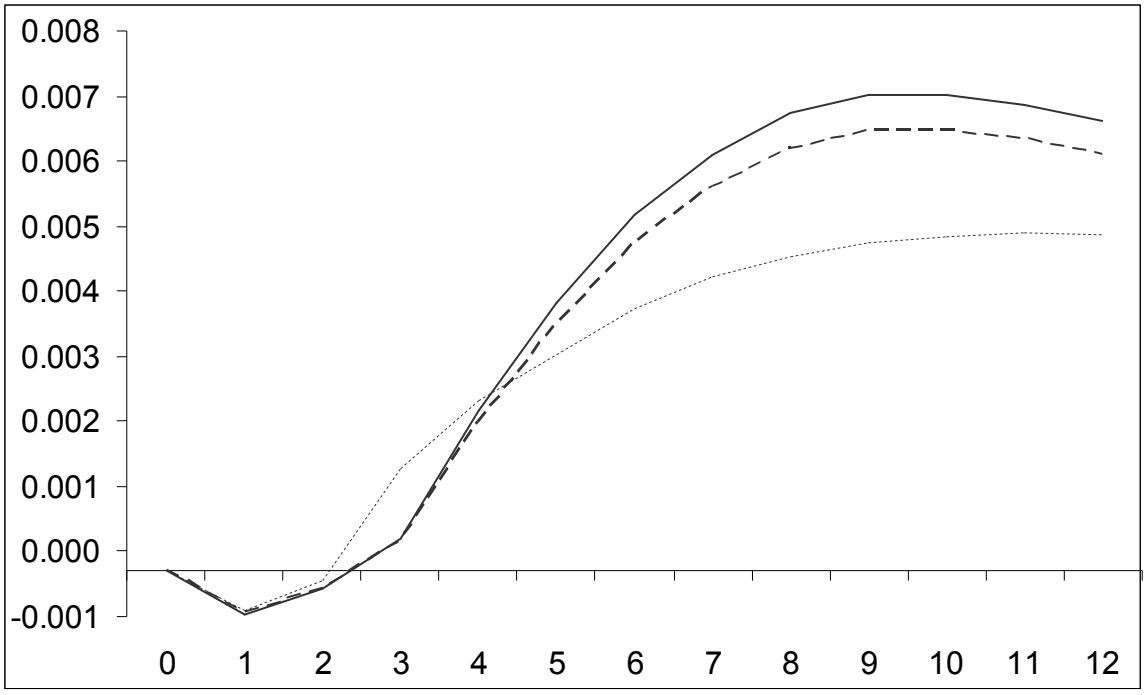
Romania



Serbia



Turkey



Note: full line represents a positive shock, broken line a negative shock and dotted line a linear response.

Source: Central banks and Eurostat databases; own calculations.

The only other case where negative exchange rate shocks appear to be stronger is Serbia, while in Bulgaria, Lithuania and Turkey we find clear evidence of stronger depreciation effects.

Figure 3 displays DE responses to shocks in the interest rate differential. Although these shocks are not our primary goal of research, a few interesting findings can be noted. As in Luca and Petrova (2008), we find that DE increases after a positive shock in the interest rate differential in six out of eight countries and in five countries positive shocks have stronger effects on DE than negative ones. Only Bulgaria manifests an opposite response, while for Latvia it is impossible to detect the direction of the responses.[13]

The above results imply that exchange rate and interest rate shocks affect deposit euroization and play an important role in DE dynamics. Differences in positive and negative shocks are evident and in line with the observed deposit euroization behavior in our post-transition economies sample.

2.6 CONCLUSION

Financial euroization in the European post-transition region has multiple causes, of which policy credibility, high inflation, low exchange rate volatility and closeness to the EU are the most important ones. In addition, a number of authors stress the influence of foreign bank financing and capital inflows as being in large part responsible for FE persistence in emerging Europe. Nevertheless, FE is not just a temporary consequence of macroeconomic instability experienced in the first period of transition, but a long-lasting phenomenon in almost all European post-transition countries.

The latest economic crisis, aggravated by large currency depreciations in some countries and massive defending of hard pegs in others, emphasized the severity of high FE. In the last few years, a need to de-euroize has grown and European as well as national policy makers are coming out with policy recommendations more frequently. Since any de-euroization policy will have success only if the determinants of FE are correctly specified, we find it necessary to start FE analysis by detecting its determinants. Results of this study

[13] We find no evidence of threshold behavior for Belarus, the Czech Republic, Macedonia and Poland.

suggest what the monetary determinants of deposit euroization are in European post-transition economies and describe the nonlinear relationships between them.

Cointegration analysis results suggest that monetary variables influence DE considerably and that some countries experience an increase in their DE levels after exchange rate depreciations occur. The only two countries in our sample with flexible exchange rates, i.e., the Czech Republic and Poland, suggest just the opposite and speak in favor of flexible exchange rate regimes. Since TVAR methodology implies that linear results are not misspecified only for the Czech Republic and Poland, for other countries one should interpret only nonlinear analysis results. Although regime switching is significant in a small number of cases, the differences in the sign of shocks are obvious and in line with the observed DE behavior. In seven out of eight countries, depreciations have a stronger effect on DE than appreciations, showing clear signs of nonlinear behavior. That interest rate differentials widen by a greater amount after depreciations is also confirmed in seven out of eight countries. Both results indicate foreign currency deposits react unfavorably to exchange rate depreciations since they increase when compared to domestic currency deposits. Although one would expect that a rise in domestic interest rates relative to euro rates would decrease DE levels, it does just the opposite. In six out of eight countries, we find evidence that DE changes more strongly after interest rate spread widening than interest rate spread narrowing.

These results form suggestions for an optimal set of policy recommendations aimed at curbing DE in post-transition Europe. The most simple "exit strategy" would be to adopt the euro, but that scenario is becoming less and less likely for some countries due to difficulties in reaching the Maastricht criteria. For countries that have already fixed their exchange rate like Latvia, Lithuania and Bulgaria, this seems to be the most possible scenario. The path these countries are supposed to follow is achieving convergence (by fiscal consolidation and structural reforms) and eventually adopting the euro as their official currency. Countries that are too far from adopting the euro and have already exhausted a great deal of regulatory measures in fighting DE like Croatia, Hungary and Romania, but to some extent also Serbia and Turkey, will probably have to rely on measures other than in the regulatory sphere because managing euroization risks is already becoming unsustainable. Their only alternative is to decrease DE by using different types of measures. Zettelmeyer, Nagy, and Jeffrey (2010) suggest that countries should go

through a reform of macroeconomic regimes and institutions in order to increase macroeconomic and institutional credibility. Experience from Latin American countries suggests that those policies are usually based on inflation targeting and floating exchange rate regimes. A contribution to that argument is made by countries like the Czech Republic and Poland that already have a tradition of such policies and as a result exhibit the lowest DE levels.

Our study finds that exchange rates and interest rate differentials have an important influence on DE in emerging Europe. Therefore, it would be justifiable to introduce insurance measures for investors saving in domestic currency. In practice, that implies allowing investors to hedge against domestic currency interest rate risk and developing and deepening domestic money and capital markets. Some kind of preferential treatment for domestic currency savings is also a possible solution for encouraging savings in local currency. One must keep in mind that these market development measures are plausible only in countries with strong institutional frameworks. This indicates that country-specific characteristics should be taken into account when designing de-euroization strategies.

3 A NEW LOOK INTO THE PREVALENCE OF BALANCE SHEET OR COMPETITIVENESS EFFECT OF EXCHANGE RATE DEPRECIATION IN A HIGHLY EUROIZED ECONOMY[14]

3.1 INTRODUCTION

One of the most dangerous threats to economies that record high levels of liability euroization (LE) is a negative balance sheet effect. The balance sheet effect occurs after enterprises that are highly indebted in foreign currency (with assets mostly denominated in local currency) experience real exchange rate depreciation that makes debt servicing more expensive (Céspedes et al., 2004). In case of exchange rate depreciation, the companies' net worth deteriorates and with increasing exchange rate risk, access to credit becomes scarce and more expensive. Therefore, the higher the LE level and the stronger the exchange rate depreciation, the negative balance sheet effect is larger. Opposite to the negative balance sheet effect stands a positive competitiveness effect that measures a positive reaction of firm's performance, which manifests itself after the exchange rate depreciates. This process decreases prices of export goods and services, resulting in a positive influence on international competitiveness of the companies in the tradable sector.

The role of these two effects rests on the price elasticities of exports and imports. If imports are highly inelastic to changes in relative prices, usually when inputs and capital goods are imported, a higher cost of inputs and capital goods can have a contractionary effect on output (Reif, 2002). Depending on the strength of each of these effects, the total exchange rate depreciation effect is either positive or negative. Either way, exchange rate movements have a significant effect on firms' performance and investment decisions. Though there are numerous studies that measure the predominance of one effect over the other (Aghion et al., 2001; Krugman, 1999), there is no consensus on the issue.

A vast body of literature presents theories favouring either competitiveness or balance sheet effects. The results are mixed, but the recommended approach for investigating that problem is straightforward. In order to detect which of the two effects dominates an economy, an empirical analysis on disaggregated data is the most suitable way to go. We apply sectoral level analysis that combines balance sheet data from Croatian non-financial

[14] This chapter of dissertation has been published as Tkalec and Verbič (2013).

corporate sectors with macroeconomic data in order to explore the influence of currency mismatches, a basic feature of LE on enterprise performance. The Croatian case is interesting, because Croatia suffers from a high degree of LE and therefore large currency mismatches. Those mismatches are pronounced particularly in the nontradable sector since this sector holds assets mostly in local currency and liabilities in foreign currency. Hence, the corporate sector in Croatia is a potential victim of balance sheet effects that can have adverse effects on business performance.

Using data from twenty Croatian economic sectors, we find evidence that economic performance, measured by investment or alternatively sales, in sectors with large foreign currency denominated debt holdings is adversely affected by exchange rate depreciation. We describe the influence of exchange rate depreciations on the performance of Croatian sectors and measure the prevalence of the two effects, i.e. the balance sheet and the competitiveness effects. Besides, we detect if the relationship between banks and enterprises is based on asymmetric information.

The main contribution of this study is in providing completely new evidence on prevalence of either balance sheet or competitiveness effect for a European transition economy. To the best of our knowledge, there is no sector-level empirical research of that kind for any emerging European country with large inherent currency mismatches. This study will therefore improve our understanding of exchange rate depreciation effects that occurred in a number of Central and Eastern European countries in the last few years.

Results of this research should help policy makers understand the effects of adverse exchange rate changes and help them in creating competitiveness policies that will not destabilize sectors exposed to large currency mismatches. Sector-based evidence will also contribute to the current debate on whether Croatia should devaluate the local currency, and to the issues related to domestic capital market development and promoting exchange rate hedge opportunities. Additionally, sectoral debt composition analysis provides insights into the relationship between banks and the corporate sector, revealing a presence of asymmetric information.

The remainder of the article is organised as follows. The next section presents an overview of the existing theoretical and empirical literature with an emphasis on studies for developing economies and research that uses data on a lower level of aggregation.

Financial euroization in Croatia is described in section three, data and methodology are described in sections four and five, while section sixp rovides the results. The last section concludes the article.

3.2 LITERATURE

The theoretical framework for exchange rate depreciation effects in countries that record high foreign currency debt is an open economy Bernanke-Gertler-Gilchrist (BGG) model (Bernanke and Gertler, 1989; Gertler et al., 2007). The BGG model includes financial markets' imperfections and allows for multiple equilibria, and unexpected and strong currency depreciations. Krugman (1999), Aghion et al. (2004) and Céspedes et al. (2004) find the BGG model useful in the research of balance sheet effects. However, as emphasized by Céspedes et al., (2004), balance sheet effect is an empirical question that should be studied country-by-country. It is thus not surprising that most studies are empirical and, due to data availability considerations, usually done using aggregate indicators. Only a limited number of articles is available at the firm level.

Examination of empirical studies reveals that a company's decision on the debt currency denomination, i.e. in which currency to take a loan, primarily rests on the fact whether the firm's cash flows are in local or foreign currency. In case of the latter, firms hedge their foreign currency risks simply by borrowing in foreign currency (Goswami and Shrikhande, 2001). Besides hedging, companies sometimes prefer to borrow in foreign currency if the loan costs are lower (Graham and Harvey, 2001).

In line with that, Cowan (2002) builds a model, in which Latin American firms with more foreign cash flow that can take advantage of low exchange rate volatility or fixed exchange rates and higher interest rate differentials in their countries, also build higher levels of debt in foreign currency. Moreover, Cowan (2002) finds that companies with higher leverage have lower levels of liability dollarization. On the other hand, Luca and Petrova (2008) and Basso et al. (2011) explore the loan supply side, banks, and credit euroization in European transition countries, and assume that banks try to match their currency positions. In case banks' foreign currency supply (funded on international financial markets and by their parent banks abroad) increases, banks grant more loans in foreign currency regardless of true corporate needs.

Contrary to the European transition economies, studies on emerging Latin American and East Asian countries are not so scarce. For instance, Bleakley and Cowan (2008) made one of the first contributions to the balance sheet effects experiment for five Latin American countries during the nineties. They reported a positive balance sheet effect that can be explained by the finding that companies match the currency denomination of taken loans to their revenues. In line with that, firms from the tradable sector have higher liability dollarization and vice versa. In the case they explored, depreciations discriminate in favour of companies with higher levels of foreign currency debt, in the sense that they increase their investment. Those countries then experience positive competitiveness effects, manifested in profitability improvements.

On the contrary, Harvey and Roper (1999) studied the Asian crisis and found support for negative balance sheet effects. High levels of foreign currency debt, encouraged by exchange rate stability expectations, deepened the financial crisis aggravated by massive currency depreciations. Negative balance sheet effects prevailed and generated a contraction in investment. In general, studies for Asian and Latin American countries provide evidence for negative balance sheet effects on investment.

A number of studies for Latin America find that corporations partially match the currency of their revenues with the currency of their liabilities, supporting the hypothesis of export sectors being more exposed to exchange rate movements (Agénor and Montiel, 2008; Benavente, Johnson, and Morande, 2003; Carranza et al., 2003; Clark and Judge, 2008; Cowan, Hansen, and Herrera, 2005; Gelos, 2003; Pratab, Lobato, and Somuano, 2003; Reif, 2002). The case of Peru, explored in Carranza et al. (2003), is especially interesting, because Peru had one of the lowest levels of liability dollarization and smallest exchange rate movements among Latin American countries. In spite of that, Peruvian companies suffered greatly after real exchange rate depreciations, with investment and sales collapsing due to strong negative balance sheet effects.

As surveyed here, (at least to our knowledge) there is no research on the balance sheet effect in European transition countries or on the relationship between banks that grant loans, the currency denomination of those loans and the performance of non-financial corporate sectors. However, we present some partial findings and results that help us to understand the drivers behind high LE in emerging Europe. Those are panel data studies

done for developing countries (Berganza et al., 2004; Calvo, Izquierdo, and Mejía, 2008), firm-level studies on credit euroization in the banking sector (Brown et al., 2009; Brown, Ongena, and Yeşin, 2011), and aggregate cross-country studies conducted in emerging Europe (Basso et al. 2011; Luca and Petrova, 2008).

Results for balance sheet effects in European transition countries can be marginally found in Calvo et al. (2008), who used panel probit methodology and empirically studied the determinants of externally driven sudden slowdowns or stops in capital inflows into both developed and developing countries. They observe that a small supply of tradable goods, large potential changes in real exchange rates and liability dollarization are most important drivers of sudden stops in capital inflows for 110 countries in their sample. Similarly, Berganza et al. (2004) confirm that negative balance sheet effects significantly increase credit costs in a panel of 27 developing countries, out of which six are from emerging Europe.

On the banking or loan supply side, Brown et al. (2009) claim that under asymmetric information, banks grant more loans in foreign currency, while Brown et al. (2011) show that credit euroization in European emerging countries is driven by foreign currency revenues more then by lower interest rates abroad. Luca and Petrova (2008) and Basso et al. (2011) depict low exchange rate volatility and access to foreign funds as credit euroization drivers. Ivanov et al. (2011) explore credit euroization in Croatia using aggregate data, and report that it is affected by banks' currency matching behaviour and that it shows strong persistence.

3.3 FINANCIAL EUROIZATION IN CROATIA

Croatia, like many other emerging economies, suffers from high and persistent unofficial euroization. As presented in Tkalec (2012), Croatia has one of the highest levels of financial euroization among European transition economies. Both deposit and liability euroization is high enough to claim that Croatia is a highly euroized economy with large mismatches in the currency structure of its balance sheets. Although Croatia joined the European Union in 2013, and is still very far from entering the eurozone, substitution of local currency with the euro has a long history.

Euroization appeared in 1980s, together with financial, exchange rate and price instabilities that dominated former Yugoslavia. Periods of high inflation and exchange rate devaluations made the value of the local currency rather volatile at that time. Fears of further deterioration of local currency coupled with lack of credibility in the domestic banking system, made investors reluctant to save or take loans in local currency. These conditions led to both asset and currency substitution where the Deutsche mark became the preferred currency. First years of the transition process only spurred euroization, as Croatia was struck by war and recession. Another round of hyperinflation episodes that occurred in 1993 reduced trust in the local currency even further, and threatened central bank credibility. The stabilization that succeeded in the next few years did not help much to bring unofficial euroization to lower levels; instead it persisted all the way to the new millennium. Besides these economic and institutional factors, Stix (2011) argues there are at least three more factors that determined high levels of unofficial euroization in Croatia. These are the closeness to the European Union, high revenues from foreign tourists and foreign currency inflows in the form of workers remittances.

Therefore, Croatia is a country that uses the euro extensively, both as a unit of account and store of value, it records very high levels of both deposit and liability euroization, and it has large currency mismatches on banks and corporate sector balance sheets. The only period in which euroization subdued is recorded at the beginning of the 21st century. For example, the variable that measures liability euroization or the share of foreign currency liabilities over total liabilities recorded very high levels until 2002, around 84 or 85 percent. However, in the years that followed, liability euroization was tamed by central bank measures. Abundant foreign funding at the time posed a threat to an unsustainable credit boom so the central bank used prudential measures to reduce foreign funding by which, regulatory cost for granting foreign currency loans increased and liability euroization decreased. The reduction in liability euroization accelerated in 2006 and 2007 mostly because the government switched its funding strategy from foreign currency or foreign currency linked bonds to pure local currency bonds of longer maturity. This process of de-euroization accompanied by central bank measures to fight foreign currency induced credit risk stopped before it seriously started (Galac and Kraft, 2012). Global financial crisis brought an increase in exchange rate volatility in 2008 and induced the central bank to defend the exchange rate towards euro by sterilizing local currency and releasing euro liquidity. Measures throughout 2008 made the regulatory cost of holding foreign currency debt to sink and eventually caused an increase in liability euroization. For

more information on the role of the central bank in financial euroization in Croatia, see Kraft and Šošić (2006) and Galac (2012). A similar liability euroization development is recognized on the sectoral level with the median value of liability euroization falling to 73 percent in 2007 and rising above 85 percent in 2009.

On the other side of the balance sheet, deposit euroization followed liability euroization and by 2008 it leveled off from 85 or 90 percent to around 65 percent. Higher interest rates on local currency deposits and appreciation of the exchange rate towards the euro were behind the observed moderation, but macroeconomic stability coupled with high GDP growth rates contributed as well. After 2008 and the occurrence of the global financial crisis, both deposit and liability euroization swiftly returned to the levels observed in 2002.

3.4 DATA

We study the balance sheet effect caused by exchange rate depreciations for different non-financial economic sectors in a European transition economy that records high levels of LE. Investments and alternatively sales are the dependent variables, while different financial, sectoral and macroeconomic variables are used as regressors in the panel data models presented later on.[15]

Our dataset consists of balance sheet data for 20 Croatian sectors over the period 2002–2009. Lack of firm-level data forced us to use data on a higher level of aggregation, but still we were able to depict sectoral characteristics in fostering foreign currency loans in Croatia. The reason we do not use firm-level data is simply that they are not available, so instead we collect aggregated balance sheet sectoral data. The analysis initially covers the seven biggest sectors: mining and quarrying, manufacturing, electricity, gas and water supply, construction and real estate, wholesale and retail (trade), hotels and restaurants, and transport and storage. Manufacturing, the biggest and most diverse sector of the seven, is not used as an aggregate, but divided into 14 different subsectors, providing a total of 20 corporate sectors. Some smaller sectors are discarded due to their negligible share in total sales.

[15] Details about the definition and sources of all variables can be found in Appendix E.

3.4.1 Descriptive statistics

Indicators summarized in Table 6, with the corresponding statistics, are the variables used in the empirical analysis. As presented in Table 6, the average investment growth rate in the period between 2002 and 2009 was 0.16 percent. The growth rate was the highest in 2005 (2.07 percent), and the lowest two years later (-0.74 percent), both in the manufacturing sector. The highest volume of sales, our alternative dependent variable, was recorded in 2008 in the wholesale and retail sector (251.31 billion HRK[16]), while the lowest was recorded in the manufacture of leather (1 billion HRK) in the first year of our sample. Although the real exchange rate index was gradually increasing in the period 2004-2008, it surged in 2009 by 0.28 (or 2,800 pips) when compared to the previous period, suggesting that the strongest real exchange rate depreciation occurred in the last year of the sample.

The variable that measures the liability euroization is our central variable, and its dynamics was very similar in all of the sectors. It moderated in the period between 2002 and 2007, and recorded its lowest level in 2007 (73 percent) in the sector of manufacturing. However, in the next two years, it increased to levels very near or above the levels at the beginning of our sample. Although the lowest level of LE is very high (73 percent), the lowest export ratio is very low, only 0.4 percent (sector of electricity, gas and water supply), and ranging to 80 percent in the sector of leather manufacturing. Already from this, it is evident that the export ratio and liability euroization in Croatia are probably not correlated, implying that firms do not match the currency structure of their assets and liabilities. The leverage indicator shows that, on average, 56 percent of assets are indebted. The smallest leverage was recorded in 2003 in the manufacture of chemicals (22 percent) and the highest in the manufacture of transport equipment in 2007 (142 percent). The data also suggest that the Croatian corporate sector had more short-term loans, i.e. 60 percent of short-term loans in total loans.

Earnings before taxation amounted to 1.64 billion HRK on average; lowest in the manufacture of leather (0.04 billion HRK), and highest in the construction sector (10.62 billion HRK). Subscribed capital, labour costs and total assets were the highest for the construction sector in 2007, and the lowest for the manufacture of rubber and leather in

[16] HRK is a conventional abbreviation for the Croatian kuna, official currency in Croatia.

2002. These three indicators had very high standard deviations, implying that they differ notably between sectors. The average interest rate on credit to enterprises fluctuated mildly in the period under consideration, from the lowest 5.86 percent in 2005 to the highest 7.67 in 2009. The deposit euroization indicator followed the same dynamics as LE, with an average of 75 percent of foreign currency deposits in total deposits, while the exchange rate volatility indicator ranged from the lowest 0.30 in 2007 to the highest 0.86 in 2004.

Table 6: Summary statistics for all variables

Variable	Mean	Standard deviation	Minimum	Maximum
Investment (in percent)	0.16	0.47	-0.74	2.07
Total sales (in billion HRK)	26.92	48.34	1.00	251.31
Real exchange rate index (in differences)	0.06	0.12	-0.06	0.28
Liability euroization	0.83	0.05	0.73	0.96
Export ratio	0.31	0.19	0.00	0.80
Leverage	0.56	0.20	0.22	1.42
Short-term liabilities	0.60	0.13	0.24	0.88
Turnover indicator	5.14	1.72	2.90	9.95
Earnings before taxation (in billion HRK)	1.64	2.37	0.04	10.62
Sectoral performance indicator	0.79	0.35	0.23	1.82
Own funding indicator	0.40	0.13	0.13	0.83
Subscribed capital (in billion HRK)	15.75	27.65	0.97	126.71
Labour costs (in billion HRK)	2.40	4.56	0.03	18.90
Total assets (in billion HRK)	41.40	63.54	2.99	320.63
Interest rate on credit (in percent)	6.75	0.67	5.86	7.67
Deposit euroization ratio	0.75	0.07	0.66	0.86
Exchange rate volatility indicator	0.60	0.19	0.30	0.86

Note: HRK – Croatian kuna; the real exchange rate index is given in first differences where a level equal to 0.0001 presents one pip, the smallest price movement that the exchange rate can make.

Source: Croatian Bureau of Statistics, Croatian National Bank and Eurostat databases; own calculations.

Our sample is representative for the Croatian economy, as the 20 sectors account for 97 percent of total sales in the period 2002–2009. Instead of having a balanced panel of 160 observations (20 sectors over the period of eight years), we build an unbalanced panel of altogether 128 observations due to missing data for some years and some sectors. Four sectors are exclusively nontradable (construction, trade, transport, and electricity, gas and water supply), two are mostly tradable (mining and quarrying, and hotels and restaurants), while nine out of 14 manufacturing sectors have a large share of exports in total sales. Two

tradable sectors make a small share of total sales (8 percent for the period 2002–2009) due to import orientation of the Croatian economy, and not because those sectors would have been underrepresented in our sample. This special characteristic will be accounted for when representing the results. Because of that, it is not surprising that we expect the balance sheet effect to surpass the potential positive competitiveness effect at the aggregate level.

3.5 THEORETICAL FRAMEWORK

3.5.1 Balance sheet effect

Mathematically, we can write our model in this form:

$$I_{it} = q_0 + q_1 RER_t + q_2' Z_{it} + \eta_i + e_{it} \tag{3.1}$$

where I_{it} is the growth rate of gross fixed capital formation (and alternatively sales) of sector i in year t, RER_t is the variation of real exchange rate in differentials in year t, Z_{it} is a set of sector-specific variables, and η_i is the sector-specific effect. The coefficient q_1 captures the overall exchange rate effect, though equation (3.1) does not disentangle between the competitiveness and balance sheet effects. Therefore, we transform equation (3.1) by using two new variables, one that captures the balance sheet and the other that captures the competitiveness effect.

As discussed in Carranza et al. (2003), the total exchange rate effect, captured by the coefficient q_1, can be written as a combination of the variables that take into account the balance sheet effect, $\beta EURO_{it}$, and the competitiveness effect, γEXP_{it}, respectively. Later on, we measure the balance sheet effect as a product of real exchange rate changes and the year-on-year growth rate of the share of foreign currency liabilities in total liabilities, while the competitiveness effect is defined as a product of real exchange rate changes and year-on-year growth rate of the share of exports in total sales. The exchange rate effect can therefore be written as:

$$q_1 = \alpha + \beta EURO_{it} + \gamma EXP_{it} \tag{3.2}$$

Plugging equation (3.2) into equation (3.1), we obtain:

$$I_{it} = q_0 + \alpha \times RER_t + \beta(EURO_{it} \times RER_t) + \gamma(EXP_{it} \times RER_t) + q_2^{'} Z_{it} + \eta_i + e_{it} \quad (3.3)$$

In this representation, β captures the balance sheet effect and is supposed to be negative, while γ captures the competitiveness effect and is expected to be positive. The α coefficient is supposed to capture the pure real exchange rate effect (when the balance sheet and the competitiveness effects are excluded), but it actually reflects the overall macroeconomic conditions. The problem is that α is a common effect for all sectors, and in order to circumvent possible identification problems, we will substitute $\alpha \times RER_t$ with different macroeconomic variables.

When we include the LE and the leverage effect, together with some sectoral balance sheet indicators and macroeconomic variables, we arrive at the benchmark model that we will be using throughout this exercise:

$$I_{it} = q_0 + \beta(EURO_{it} \times RER_t) + \gamma(EXP_{it} \times RER_t) + \delta EURO_{it} + \phi LEV_{it-1} + q_2^{'} Z_{it} + \eta_i + e_{it} \quad (3.4)$$

Besides the two interaction effects we are interested in, we try to capture the pure effect of liability euroization, $EURO_{it}$, by estimating the coefficient δ, and the lagged leverage effect, represented by the variable LEV_{it-1}, defined as a ratio of total debt over assets. However, other financial, sectoral and macroeconomic variables are added to the variables stated in equation (3.4). In the case with investment as the dependent variable, the share of short-term liabilities in total liabilities, earnings before taxation, turnover, and interest rates on credit to enterprises are added as additional explanatory variables. In the alternative case with sales, additional regressors are the share of short-term liabilities, turnover, subscribed capital, labour costs, and lagged new investment.

To estimate the baseline model presented in equation (3.4), we use econometric methods that fit regression models to panel data. All models are estimated by both fixed and random effects and then tested for correlation between individual effects and the regressors using the Hausman test. In case we reject the hypothesis of no correlation, the random effects estimator is inconsistent, but the fixed effects estimator is still consistent and thus preferred, though usually inefficient (less efficient).

Additionally, we add the lagged dependent variable in order to account for some dynamics, leading to the following equation:

$$I_{it} = \alpha I_{it-1} + \beta(EURO_{it} \times RER_t) + \gamma(EXP_{it} \times RER_t) + \\ + \delta EURO_{it} + \phi LEV_{it-1} + q_2' Z_{it} + \eta_i + e_{it} \quad (3.5)$$

Equation (3.5) is estimated using the generalized method of moments (GMM) estimator in differences developed by Arellano and Bond (1991) that solves possible endogeneity problems (arising from the correlation between regressors and the error term) and eliminates fixed effects (because time-invariant sector characteristics may be correlated with the regressors). This additional, dynamic model is also a robustness check for the results obtained by fixed or random effects estimators.

3.5.2 Debt composition

We also explore the debt composition of Croatian sectors by estimating the following equations:

$$EURO_{it} = \alpha ASSETS_{it} + \beta EXP_{it} + \gamma Z_{it} + e_{it} \quad (3.6)$$

$$SHORT_{it} = \alpha ASSETS_{it} + \beta EXP_{it} + \gamma Z_{it} + e_{it} \quad (3.7)$$

where $ASSETS_{it}$ is the log of total assets, EXP_{it} is the share of business revenues from sales abroad in total business revenues from sales, and Z_{it} is a vector of sector-specific and macroeconomic variables. To construct the dependent variables, we assume that sectors with LE or the share of short-term liabilities in total liabilities above the median value are "euro indebted" and "short-term indebted", respectively, and are given value 1, while sectors below the median are allocated value 0 (dependent variables $EURO_{it}$ and $SHORT_{it}$, respectively). Since these dependent variables are binary, we use probit model to estimate the parameters of equations (3.6) and (3.7).

3.6 RESULTS

3.6.1 Balance sheet effect results

The effects of real exchange rate depreciation on investment and sales are presented in Tables 7 and 8. Since the Hausman test suggests that fixed effects is the preferred estimator, we will focus on the results in the first (fixed effects estimates) and the third column (Arellano-Bond estimates). In the specification with investment (Table 7), the balance sheet effect is not statistically significant in either of the model specifications. The competitiveness effect, on the other hand, is positive and statistically significant in the dynamic model specification (0.028). To gain additional insight into whether the real exchange rate depreciations in Croatia have an adverse effect on enterprise performance, we now turn to the results from Table 8. When we change the dependent variable to sales, we find the balance sheet effect to be negative (from –0.21 to –0.16) and statistically significant, while the competitiveness effect is positive and much smaller than the balance sheet effect (though not significant in the linear case). Therefore, the overall effect is negative, implying that exchange rate depreciation has a negative effect on sales.

Another interesting result from these specifications is that the LE coefficient is negative (from –0.48 to –1.14) and highly statistically significant in all the models we estimated. Results suggest that foreign currency borrowing reduces both investment growth and sales. These findings are in line with Harvey and Roper (1999), Carranza et al. (2003) and Calvo et al. (2008), who claim that companies, driven by low exchange rate volatility expectations rather than by matching their currency structure, make foreign currency loans that in turn harm their business performance. Large currency mismatches in the Croatian corporate sector, created by assets in local currency and liabilities in foreign currency, have a deteriorating effect on corporate performance. Leverage is negative in the case with investment, but not statistically significant. On the other hand, it is positive (from 0.11 to 0.36) and significant in the alternative specification, i.e. with sales as a dependent variable, implying that leverage increases sales.

Short-term liabilities ratio is not statistically significant, while turnover appears positive (0.22) and statistically significant only in the linear model specification with investment as the dependent variable. This indicates that higher turnover drives investment growth and therefore affects corporate performance positively. Earnings before taxation positively affect investment growth, as their coefficients are positive and statistically significant in the linear (0.21) and in the dynamic model (0.32). Surprisingly, interest rates on credit to

Table 7: Effect of exchange rate movements and LE on investment

Dependent variable	INVESTMENT		
	Fixed effects	Random effects	Arellano-Bond
Lagged dependent variable			–0.402**
			[0.037]
Main effects			
Liability euroization	–0.574*	–1.132***	–1.137**
	[0.059]	[0.001]	[0.031]
Lagged leverage	–0.167	–0.342*	–0.826
	[0.364]	[0.075]	[0.128]
Interaction effects			
Balance sheet effect	–0.015	–0.009	0.027
	[0.676]	[0.854]	[0.576]
Competitiveness effect	0.007	0.005	0.028*
	[0.210]	[0.492]	[0.050]
Controls			
Short-term liabilities	–0.395	–1.329***	–1.146
	[0.261]	[0.000]	[0.269]
Earnings before taxation	0.214**	–0.146***	0.324**
	[0.038]	[0.000]	[0.033]
Turnover indicator	0.215**	0.267**	0.169
	[0.017]	[0.014]	[0.254]
Interest rate on credit	–0.006	–0.044	–0.029
	[0.828]	[0.207]	[0.408]
Number of observations	108	108	88
Within R-squared	0.3307	0.1834	
Between R-squared	0.3517	0.5822	
Overall R-squared	0.3838	0.5990	
Hausman test	51.45*** [0.000]		
Sargan test			12.01
			[0.678]
First order autocorrelation			–1.38
			[0.167]
Second order autocorrelation			–1.11
			[0.267]

Note: a constant is also included, but not reported; *p*-values presented in brackets; ***, ** and * represent statistical significance at 1 percent, 5 percent and 10 percent, respectively; time effects are not presented due to space considerations.

Source: Croatian Bureau of Statistics, Croatian National Bank and Eurostat databases; own calculations.

enterprises do not seem to affect investment growth (i.e. are not statistically significant), though the negative coefficient sign is in accordance with the theory. The finding that investment increases with respect to turnover and earnings, but does not seem to decrease with respect to interest rates, could be pointing to a possibility that the domestic financial system is a constraining factor for corporate investment dynamics. Besides the short-term liabilities ratio and turnover, the model with sales comprises three additional control variables: subscribed capital, lagged investment, and labour costs. In the linear specification, all three are positive and statistically significant, implying sales grow by hiring labour (0.34), issuing equity (0.27), and investing in new fixed assets (0.14, with one lag).[17] Arellano-Bond estimation results corroborate these findings, especially the ones for subscribed capital.[18]

The lagged dependent variables are significant in both model specifications; negative for investment and positive for sales, respectively. Especially the latter result (0.34) is expected and implies that growing sales from a previous period lead to higher sales in the following period, while the former result (–0.40) implies that higher investment in the previous year leads to falling investment in the subsequent year. This seemingly unusual result could reflect either the nature of the investment dynamic in the Croatian economy or the fact that the dynamic GMM estimation loses some observations at the beginning of the sample, which in turn puts more weight on the recession years at the end of the sample.[19]

[17] A large number of other balance sheet and macroeconomic variables were included in the analysis, such as indicators of performance, illiquidity, tradability, GDP growth rates, a "recession dummy" etc. However, they did not appear to be statistically significant in explaining investment or sales dynamics. Therefore, those results are not presented in the article, but are available upon request.

[18] Equations (3.4) and (3.5) were additionally estimated, using different sector-specific and macroeconomic variables as explanatory variables. When we exclude the competitiveness effect, and the interest rate variable from the specification with investment as the dependent variable, the signs and coefficients remain unchanged. Similarly, excluding the short-term debt ratio from the model specification with sales, does not affect our results either. Including different indicators of revenues, turnover, earnings, and capital obtained results very similar to those reported. This implies the results are robust.

[19] The Sargan test and the autocorrelation tests indicate that the number of lags used in the dynamic panel data estimation were appropriate.

Table 8: Effect of exchange rate movements and LE on sales

Dependent variable	SALES		
	Fixed effects	Random effects	Arellano-Bond
Lagged dependent variable			0.341***
			[0.002]
Main effects			
Liability euroization	–0.789***	–1.676***	–0.488***
	[0.000]	[0.000]	[0.001]
Lagged leverage	0.112*	0.478	0.362**
	[0.094]	[0.106]	[0.048]
Interaction effects			
Balance sheet effect	–0.208***	–0.308	–0.160***
	[0.000]	[0.162]	[0.001]
Competitiveness effect	0.000	–0.006	0.006*
	[0.980]	[0.556]	[0.062]
Controls			
Short-term liabilities	0.188	0.530	–0.129
	[0.119]	[0.317]	[0.670]
Turnover indicator	0.011	0.051*	0.000
	[0.131]	[0.097]	[0.981]
Lagged investment	0.135***	0.304*	0.033
	[0.000]	[0.060]	[0.497]
Subscribed capital	0.267**	0.093	0.767***
	[0.013]	[0.796]	[0.003]
Labour costs	0.337***	–2.007***	0.206
	[0.000]	[0.000]	[0.346]
Number of observations	108	108	88
Within R-squared	0.7984	0.0677	
Between R-squared	0.6269	0.7666	
Overall R-squared	0.6533	0.7951	
Hausman test	94.07*** [0.000]		
Sargan test			18.28
			[0.147]
First order autocorrelation			–0.70
			[0.483]
Second order autocorrelation			–1.25
			[0.213]

Note: a constant is also included, but not reported; *p*-values presented in brackets; ***, ** and * represent statistical significance at 1 percent, 5 percent and 10 percent, respectively; time effects are not presented due to space considerations.

Source: Croatian Bureau of Statistics, Croatian National Bank and Eurostat databases; own calculations.

3.6.1 Debt composition results

Since debt seems to have a high influence on Croatian economic sectors, we decided to further explore the debt composition of Croatian sectors by estimating equations (3.6) and (3.7). Besides size, approximated by total assets, and the export ratio, we include different sector-specific and macroeconomic variables that are recognized in the literature as LE or short-term debt determinants. Apart from the sectoral performance, the own funding, and the leverage indicator, following Ivanov et al. (2011) we include deposit euroization and exchange rate volatility to the model specification with "high LE" (i.e. dummy variable $EURO_{it}$) as the dependent variable. In the model specification with the "high short-term ratio" as the dependent variable (i.e. dummy variable $SHORT_{it}$), we include a recession dummy as a macroeconomic determinant[20].

Although we expected the export ratio to be significant, and assets to be only a control variable for size, the results contradicted our intuition. Nevertheless, these results are very robust, i.e. even when we include other explanatory variables and build different model specifications, the coefficient for assets is statistically significant while the exports coefficient remains to be statistically insignificant. Probit estimation results, presented in Table 9, show that size has a negative impact on foreign currency debt creation (–0.47), and a positive impact on short-term maturity debt creation (0.36), respectively. When compared to smaller firms, larger firms have less foreign currency debt in total debt, and are more likely to have higher shares of short-term loans in total loans, regardless of their exporting or non-exporting activity.

These results provide a useful insight into asymmetries of firm size, inherent in bank lending. In order to match their currency structure, banks in European transition economies grant loans in foreign currency mostly (Basso et al., 2011), and when they lend in local currency, they are more inclined to grant short-term loans (Brown et al., 2009).

[20] The recession dummy is defined as a variable that takes value 1 for a recessionary year, and value 0 otherwise. For the case of Croatia, value 1 is given for the years 2008 and 2009. The recession dummy variable is included in the model, as we believe that in a period of an economic downturn, companies find it rather difficult to borrow at longer maturities, because creditors opt for less risky loans with shorter debt maturity. Consequently, the companies' short-term to total debt ratio increases.

Table 9: Probit estimation

Variable	Liability euroization	Short-term liabilities
Total assets	–0.473*** [0.009]	0.361** [0.038]
Export ratio	–0.353 [0.871]	2.514 [0.168]
Sectoral performance indicator	–6.051*** [0.001]	5.525*** [0.001]
Leverage	–3.505 [0.142]	–2.256** [0.022]
Own funding indicator	–7.468** [0.014]	0.541 [0.648]
Deposit euroization ratio	12.090** [0.035]	–
Exchange rate volatility indicator	–4.538** [0.031]	–
Recession dummy	–	4.737** [0.015]
Number of observations	108	108
McFadden R-squared	0.6949	0.7390
Schwarz criterion	0.631	0.607
LR statistic	69.820*** [0.000]	92.865*** [0.000]

Note: a constant is also included, but not reported; *p*-values presented in brackets; ***, ** and * represent statistical significance at 1 percent, 5 percent and 10 percent, respectively.

Source: Croatian Bureau of Statistics, Croatian National Bank and Eurostat databases; own calculations.

Therefore, large firms, that can obtain loans in local currency, will have smaller liability euroization but higher shares of short-term loans in total loans, due to banking behaviour specific for European transition economies. Moreover, we confirm previous findings (Ivanov et al., 2011), and find that LE increases with deposit euroization (12.09), and decreases with exchange rate volatility (–4.54) (Luca and Petrova, 2008). The deposit euroization effect points to the fact that banks in Croatia match their currency structure, by granting more loans in foreign currency (increasing LE), when they observe a rise in deposit euroization. Therefore, higher deposit euroization in the economy, through banks'

matching behaviour, leads to higher liability euroization of the corporate sector. Increasing exchange rate volatility, on the other hand, lowers LE in the sectors characterized by a currency mismatch of assets and liabilities, since it makes the repayments on the loans in foreign currency more volatile and therefore, less appealing than the loans in local currency. As can be seen from our case, higher exchange rate volatility (or more exchange rate flexibility) leads to a reduction in LE.

Sectoral indicators, such as sectoral performance (measured by business revenues) and own funding (measured by subscribed capital), seem to be driving liability euroization down (–6.05 and –7.47). These results coincide with previous findings, as higher subscribed capital is associated with firm size (and we found that larger firms have smaller shares of foreign currency debt), and better business performance seems to be supporting local currency borrowing. In line with the specificities of European transition economies described earlier, the sectoral performance variable positively affects the debt creation of shorter maturity (5.26), since better performance spurs local currency borrowing that is more oriented to short-term loans (Brown et al., 2009). Higher leverage works in the opposite direction (–2.26), reflecting the fact that long-term loans are usually much bigger in size than the short-term loans, and that therefore long-term debt has the bigger debt share in highly-leveraged firms. The recession dummy shows that in the period of decreasing economic activity and major economic uncertainties, short-term debt increases its share in total debt (4.74). This implies that it is rather difficult to obtain long-term loans, because banks opt for less risky loans with shorter debt maturity.[21]

3.7 CONCLUSION

The article provides new sector-level evidence on the prevalence between the balance sheet and the competitiveness effect in Croatia, and contributes to the ongoing and recent de-euroization and exchange rate devaluation issues. The study confirms that exchange rate depreciation negatively influenced business performance of Croatian non-financial

[21] For the sake of robustness, we ran several regressions with different model specifications, and confirmed that the results presented here are robust. When we exclude the export ratio variable, all the coefficient signs remain unchanged, and the coefficients themselves change by negligible amounts. Alternatively, when we substitute the export ratio variable for a tradability indicator, the signs and coefficients stay unchanged. We tried also including different variables, such as indicators of illiquidity, labour, and earnings, and the signs and coefficients remained unchanged to those reported here.

economic corporations for the period 2002-2009. The balance sheet effect turns out to be negative, just as in previous studies done by Harvey and Roper (1999), Krugman (1999), Aghion et al. (2001), Carranza et al. (2003), and Céspedes et al. (2004). Taking high liability euroization, widespread currency mismatches and financial constraints into account, it is no surprise that the balance sheet effect for Croatia is significant, strong and negative. Moreover, since the competitiveness effect is positive, but much smaller than the balance sheet effect, the total exchange rate depreciation effect is negative. This is aggravated by the result that liability euroization severely affects both sales and investment.

Another concerning result is that the investment dynamics depends on sectors' turnover and earnings, and does not seem to depend on market interest rates, indicating that the financial system might not be providing appropriate financing for the business sector. In line with this, we also find that due to high illiquidity in the system, leverage is used to increase sales instead of implementing some long-run strategic goals through investment. Finally, asymmetric information between banks and firms affect the currency debt structure, ignoring the currency denomination of the firms' revenues.

In order to reduce the threat of a negative balance sheet effect, two steps should be made almost contemporaneously. First, introduce wide scale reforms aimed at increasing real sector openness that will eventually promote exports and second, de-euroize the economy. Since deposit euroization is one of the drivers of credit euroization in Croatia, savings in local currency should be stimulated (Ivanov et al., 2011). That can be done by allowing higher interest rates on savings in local currency, and by issuing inflation-indexed government bonds.

In addition, foreign currency debt creation can be penalized for non-exporting firms and encouraged for exporting firms. In case of a larger exchange rate shock, the central bank should ensure solid banking liquidity and fight speculative attacks against the local currency. Fiscal policy can also add to overall macroeconomic stability by running a healthy countercyclical fiscal policy and by obtaining funds for the public sector financial needs in due time. Some other recommendations include fighting illiquidity, increasing transparency of smaller firms, and perhaps even providing incentives to reinvest earnings.

Further research should be done in order to make firm decisions about the overall effects of exchange rate depreciation and the threats of liability euroization. More specifically, a firm-level analysis that combines business data with macroeconomic and financial sector data would provide useful insights into the drivers behind corporate currency mismatches and suggestions for de-euroization of the corporate sector. One of the possible extensions lies in the analysis of asymmetric information between banks and firms, as the results in this study reveal a dual structure of the corporate sector in Croatia. It would be of interest to explore whether there exist similar bank lending asymmetries for other European transition economies as well.

4 LONG-RUN AND SHORT-RUN DETERMINANTS OF "ORIGINAL SINNERS'" SOVEREIGN SPREADS

4.1 INTRODUCTION

Economic literature provides plenty of explanations for determinants of sovereign spreads – differences between interest rates that governments pay on their debts, and the interest rates that for example the United States or Germany pay on their debt. Sovereign spreads are a proxy for country risk premium, measure of the risk associated with a country's default on debt. This premium, or spread, is formed in order to compensate creditors for the risks of holding a risky asset until maturity. The whole idea of exploring spreads comes from the fact that sovereign spreads are higher for some countries than for the other. Emerging market economies have higher spreads than developed ones, arousing curiosity around spread determinants and channels of impact. Theory suggests that spreads depend on fundamental, macroeconomic conditions because in the long-run, spreads are affected by the size of the debt itself, total wealth, the current account and international reserves (Edwards, 1984). However, it is common that this long-run relationship breaks in the short-run, especially in turbulent times. For example, after Lehman Brothers collapsed in 2008, spreads on emerging market sovereign bonds raised swiftly, regardless the fact that their macroeconomic indicators stayed unchanged. This sort of behaviour suggests that something different is happening in the short-run, and that there are maybe some other determinants affecting spreads besides the usual suspects. This paper tries to detect why sovereign spreads deviate from the long-run equilibrium level, using market sentiment, monetary and fiscal policy as possible spread dynamics drivers.

Monetary policy and exchange rates are of special interest here, because there are opposing views on the impact they have on sovereign spreads. Although conventional open economy models suggest that real exchange rate depreciation is expansionary, recent theories on imperfect capital markets and balance sheet effects claim just the opposite (Aghion et al., 2004; Céspedes et al., 2004). For example, if a country is highly indebted in foreign currency, then debt servicing increases together with real exchange rate depreciation. Thereby causing deterioration in country's balance sheets, a fall in aggregate demand, and consequently, in economic activity too (Berganza et al., 2004). Contradicting theories cannot itself decide on the importance and validity of these effects, so additional empirical work is needed in order to decide on the relevance of each theory. We therefore build a

model that incorporates the newest theoretical and empirical findings, and empirically test the existence of a positive relationship between sovereign spreads and exchange rate depreciation, presented by the balance sheet effect. Among other things, we test if the increase in debt service caused by an unexpected real depreciation significantly raises sovereign spreads in the short-run. In this study, we find evidence of such positive balance sheet effects on sovereign spreads for European emerging countries, thus corroborating Berganza et al. (2004).

This paper uses multiple strands of literature to build a new empirical model of sovereign spread determinants. We combine three different strands of existing research to explain sovereign spread dynamics in countries that suffer from "original sin" - impossibility to issue debt in local currency (Eichengreen at el., 2003). We use the small open economy model by Céspedes et al. (2004) and Gertler et al. (2007) as our basis, to which we add two supplementary concepts. First, we borrow the collateral value concept from Kiyotaki and Moore (1997), and then add the balance sheet effect empirical findings from Berganza et al. (2004). Therefore, we construct the model so that it differs between long-run and short-run, thereby allowing both differences between countries that occur in the short-run, and theoretical universalities that comply in the long-run. This is obtained by the panel version of the error correction model, the pooled mean group (PMG) estimator developed by Pesaran et al. (1999). PMG provides a dynamic framework that allows a separation between the short-run and the long-run, enabling both short-run dynamics and equilibrium adjustment.

The main contribution of this paper is that it incorporates the balance sheet effect as a short-run sovereign spread determinant, just as observed in empirical data. Unlike previous studies, that either ignore differences between the short-run and the long-run, or the existence of balance sheet effects, our research allows for such an effect in the short-run. This is possible only because we construct a dynamic model that deviates from equilibrium in the short-run, and then gradually adjusts in the long-run. Moreover, we also assume that not all countries react the same to changes in fundamentals, and in that respect, we allow short-run heterogeneity between countries. Additionally, our data set includes the latest financial crisis data, thus taking into account sovereign spread volatility observed in the last few years. And finally, we add three countries, Croatia, Serbia, and Turkey, which were highly underrepresented in previous research.

The rest of the paper is organized as follows. Section 2 discusses previous work and sets the theoretical and empirical framework for our model. Section 3 describes the data set, while section 4 presents the empirical model and the estimation technique. Results are given in section 5, while the last section discusses possible implications, and concludes the paper.

4.2 THEORETICAL FRAMEWORK AND EMPIRICAL WORK

4.2.1 Theoretical framework

Small open economy models are a starting point for investigating emerging market borrowing, and related country risk premiums. The simplest framework is given in early works by Edwards (1984; 1986), in which the country risk premium is related to the probability of default on external liabilities. This probability is defined as a function of a number of macroeconomic and external variables, and has become the basis for studying government bond spreads. However, both Edwards (1984) and later Kim (1998) use a very constraining assumption of perfectly competitive financial markets and risk neutral lenders, assumptions becoming more and more relaxed nowadays.

A different approach is taken by Cantor and Packer (1996) who simply replace macroeconomic fundamentals with credit ratings, arguing that the inclusion of both would lead to multicollinearity. Another study by Kamin and von Kleist (1999) ignores specific macroeconomic, as well as solvency and liquidity indicators, and uses solely credit ratings to explain sovereign yields. On the other hand, Eichengreen and Mody (1998a; 1998b) and Dell'Ariccia, Schnabel, and Zettelmeyer (2002) claim that credit ratings are defined more broadly than macroeconomic variables, and in line with that there is no multicollinearity threats when using both. We follow both groups of authors, and build models with macroeconomic variables only, and models that include both credit ratings and macroeconomic fundamentals. Our results (see footnote 27) suggest that sovereign spreads do not have a statistically significant relationship with credit ratings.

As mentioned, sovereign spreads are a function of the probability of default, and related to that, a function of the probability of loss in case of default. The probability of default is represented by external debt sustainability, which is in turn measured by indicators of

liquidity and solvency. The bottom line is that in reduced-form models, one uses macroeconomic variables to reflect liquidity and solvency, and accordingly, probability of default. This is the starting point made in Edwards (1984)[22], and is represented by a linear equation:

$$spread_t = \alpha + \sum_{j=1}^{J} \beta_{jt} x_{jt} + \varepsilon_t \tag{4.1}$$

where $spread_t$ is the sovereign spread at time t, α is an intercept term, J is the number of macroeconomic variables with x_j being a set of these variables, parameters β_j are slope coefficients, and ε_t is the error term. The specification in equation (4.1) develops with the inclusion of explanatory variables – different spread determinants. Since we explore emerging markets and their sovereign spreads, we will use a small open economy that is externally indebted. Economic theory asserts that small open economies borrow from abroad when their resources do not suffice their consumption potential, and that they repay the debts when they have extra resources. The main focus of foreign investors, in this setting, is whether a country will be able to repay its debts. First, does it have enough foreign exchange to service its obligations, and second, is the government able to collect enough resources to purchase foreign exchange to repay them. Ferrucci (2003) proposes a dynamic programming setting in which he defines a welfare function U_0, that depends on future discounted consumption. He assumes that the country maximizes its consumption C_t, or utility, by using its available resources and by issuing debt. The model is presented below:

$$\begin{aligned} Max \quad & U_0 = \sum_{t=0}^{\infty} \beta^t u(C_t) \\ s.t. \quad & G_t + rD_t \le T_t + D_{t+1} - D_t \\ & Y_t = C_t + G_t \\ & T_t = f(Y_t) \\ & Y_t = (1+g) Y_{t-1} \end{aligned} \tag{4.2}$$

with β the discount factor. The maximizing problem is subject to two constraints – the government budget constraint and the accounting identity. The first constraint binds public

[22] Work by Edwards (1984) is founded on some previous studies, such as Feder and Just (1977), Eaton and Gersovitz (1980), and Sachs (1981).

spending G_t to total revenues less interest payments on existing external debt rD_t. Total revenues are defined as a sum of domestic tax revenues T_t, and newly issued external debt $D_{t+1} - D_t$. The accounting identity implies that total domestic output is composed of private and government consumption. Inserting the second constraint into the first, and rearranging we get:

$$D_{t+1} - D_t \geq Y_t - C_t - T_t + rD_t . \tag{4.3}$$

The left-hand side of expression (4.3) is the current account, or the external constraint, and it implies that newly issued external debt must be at least as large as the sum of private saving and interest payments on existing external debt. To close the model, tax revenues and domestic output need to be defined, given in last two expressions. Tax revenues are a function of output, which is exogenously defined by its lagged value and growth rate.

This dynamic model suggests that borrowers comply with the constraints in each time period, not only in the long-run. This leads us to the conclusion that governments should have enough liquid assets to repay their foreign investors in each period, and be solvent in the long-run. From specifications (4.2) and (4.3) it is evident that fiscal balance, external debt interest repayments, tax revenues, and current account are important factors in determining government solvency and liquidity. Although they are not directly included here, official foreign reserves are insurance that liabilities will be serviced even in cases when countries do not provide necessary funds to repay foreign investors.

Net present values of government and external constraints provide us with the external debt and fiscal sustainability conditions:

$$(1+r) D_t \leq \sum_{i=0}^{\infty} \frac{PS_{t+i}}{(1+r)^i} \tag{4.4}$$

$$(1+r) D_t \leq \sum_{i=0}^{\infty} \frac{C_{t+i} + T_{t+i} - Y_{t+i}}{(1+r)^i} \tag{4.5}$$

where $\mathrm{PS}_t = T_t - G_t$ is the primary fiscal balance, and $C_{t+i} + T_{t+i} - Y_{t+i}$ is future private saving. Equations (4.4) and (4.5) present sustainability conditions of fiscal policy and

external debt, more specifically, suggest that external debt today, should not exceed the net present values of future primary fiscal surpluses or future private saving (both discounted by r, the capital cost). These two conditions are central for external debt sustainability, and consequently for country risk premium assessment. Different solvency indicators can serve as reliable determinants of external debt sustainability, such as tax revenues, level of public debt, current account, external debt level, official international reserves, international trade, etc. Trade, especially export, is important because it provides foreign currency necessary to repay the external debt.

The simple setting presented above ignores other significant factors, such as terms of trade, inflation, and exchange rates. Roughly speaking, terms of trade reflect how much foreign exchange is coming into the country from exports, relative to foreign exchange coming out of the country to pay for imports. High terms of trade are a signal for investors that their loans will be repaid. Min (1998) connects fiscal policy with inflation, and claims that high inflation rates reflect fiscal imbalance. In line with that, inflation affects the fiscal sustainability condition, and leads to higher sovereign spreads. On the other hand, McDonald (1982) links inflation to the balance of payments and finds that higher inflation leads to higher probabilities of balance of payments and default crises.

Another strand of literature builds on exchange rates and balance sheet effects. Open economies that borrow in foreign currency, rather than in local, suffer from the "original sin" (Eichengreen et al., 2003). High shares of foreign currency debt in total debt, or credit euroization[23], make a country vulnerable to exchange rate changes, if exports are not high enough to cover external liabilities. The reason is that exchange rate depreciation increases foreign currency debt in local currency terms. If a country has most of its assets in local currency, and liabilities in foreign currency, it suffers from a currency mismatch (Luca and Petrova, 2008), and is a potential victim of negative balance sheet effects. Therefore, if a country's exchange rate is perceived to be overvalued and future depreciation is expected, its risk premium will increase accordingly.

A theoretical framework for including balance sheet effects into the small open economy model is motivated by Céspedes et al. (2004) and Gertler et al. (2007). In short, small net

[23] Throughout the text, we will use the term euroization instead of dollarization. Although dollarization is a universal concept, not necessarily referring to dollars, we are exploring countries that are traditionally more connected to the euro, and consequently borrow in euro, or link their debt to the euro.

worth of a country (as defined below) implies a greater demand for external resources. Due to asymmetric information between domestic issuers and foreign creditors, this foreign borrowing increases agency costs. Exchange rate depreciations affect these agency costs in an adverse manner, which manifests itself in an increasing country risk premium. Another strand of literature (Kiyotaki and Moore, 1997) is based on the collateral value, as it argues that the cost of borrowing falls with the value of the collateral. In our case, the value of the collateral is comparable to real net worth of a country. Both of these views are combined in Berganza et al. (2004), a study that focuses on detecting whether there is an inverse relationship between government bond spreads and real net worth ω_t, presented by:

$$1 + spread_t = \Psi(\omega_t),\ \Psi' < 0 \tag{4.6}$$

where real net worth is assumed to be composed of tradable and nontradable goods. Under high credit euroization, and exchange rate depreciation, ω_t decreases in foreign exchange terms, leading to a rise in $spread_t$. This is shown by equation (4.7):

$$\omega_t = X_t - D_t R_t . \tag{4.7}$$

where X_t stands for a set of net worth determinants, and R_t for the real exchange rate (as before, D_t is external debt). Berganza et al. (2004) then take a linear approximation around the mean value of net worth, denoted by $\bar{\omega}$, and obtain the following:

$$\begin{aligned} 1 + spread_t &\approx \Psi(\bar{\omega}) + \Psi'(\omega_t - \bar{\omega}) \\ &\equiv \alpha - \beta\omega_t \\ &= \alpha - \beta X_t + \beta D_t R_t \end{aligned} \tag{4.8}$$

where $\alpha = \Psi(\bar{\omega}) - \Psi'(\bar{\omega})$ is the constant term, and $\beta = -\Psi'$ is the negative derivative of Ψ at ω_t. Inserting equation (4.7) into the second row of specification (4.8) leads us to the third row. The most important part is $\beta D_t R_t$ since it represents the balance sheet effect. An increase in the real exchange rate (depreciation), leads to a rise in the risk premium when the country has a high level of debt in foreign currency, and naturally, when β is significantly positive. Theoretically, there is no reason to believe that β is positive; it can be negative or zero. That is why it is necessary to empirically test the sign and the size of β. For that, however, we need further elaboration. By subtracting the expectation of the

last expression in (4.8) from that expression without the expectation, conditional on information at $t-1$, assuming that D_t is predetermined, and after rearranging, we get:

$$spread_t = E_{t-1}spread_t + \beta D_t\left(R_t - E_{t-1}R_t\right) + \varepsilon_t \tag{4.9}$$

where $\varepsilon_t = \beta\left(X_t - E_{t-1}X_t\right)$ is the stochastic term of the explanatory variables. If we assume that this stochastic term is unobservable, we can estimate equation (4.9) in case ε_t is not correlated with $D_t\left(R_t - E_{t-1}R_t\right)$. Having in mind that debt is predetermined, we only need to assume that ε_t is not correlated with $R_t - E_{t-1}R_t$. We reformulate equation (4.9) by replacing $E_{t-1}spread_t$ with $\gamma spread_{t-1}$ [24] and $E_{t-1}R_t$ with R_{t-1}. Although we loose some information, Berganza et al. (2004) observe that these losses are negligible, since spreads and exchange rates often behave like random walks. We also simplify a little bit more, by replacing $D_t\left(R_t - R_{t-1}\right)$ with S_t, and obtain:

$$spread_t = \beta S_t + \gamma spread_{t-1} + \varepsilon_t \ . \tag{4.10}$$

S_t is defined as a product of real exchange rate depreciation and the value of external debt, or as the value of foreign currency denominated debt in local currency terms. Together with the balance sheet variable and its coefficient β, Berganza et al. (2004) use different net worth drivers, contained in X_t or in ε_t. This brings us to equation (4.1) and the model presented by Ferrucci (2003), who also uses different variables to describe the spread. Resulting from specification (4.10), we can now insert the balance sheet effect S_t into equation (4.1) and get a more complete risk premium model:

$$spread_t = \alpha + \beta S_t + \gamma spread_{t-1} + \sum_{j=1}^{J} \delta_{jt} x_{jt} + \varepsilon_t \ . \tag{4.11}$$

4.2.2 Empirical work

As surveyed here, economic theory deals with long-run spread determinants, regardless of the fact that spreads are rather volatile in the short-run. Although spreads typically follow

[24] In the original paper, Berganza et al. (2004), replace $E_{t-1}spread_t$ with the lagged GDP value because their estimation procedure does not allow for dynamics in the system. Ours does, so we leave the lagged dependent value in the equation.

the path predicted by theory, depending on external debt, international reserves, fiscal and current account balances, they also deviate in the short-run caused by some specific factors. Studies that use short-run variables for explaining spreads, and the ones that differentiate between long-run and short-run spread determinants are rather scarce and limited to recent literature. We discuss that specific strand of literature in more detail.

The usual methodological frameworks for analysing spreads are single-country and panel data studies. Both of these have pros and cons; single-country studies take care of country-specific characteristics, but suffer from difficulties with statistical inference that appear due to short data sets, a typical difficulty when dealing with emerging market countries. Panel data studies have larger data sets that lead to improvements in statistical inference, but they assume homogeneity of the slope coefficients, neglecting country-specific characteristics.

Single-country studies use time series methods for analyzing spreads. Usually debt, fiscal and current account balances are included as regressors, together with different control variables specific for the country explored. The most important time-series study for European transition economies is by Ebner (2009) who concludes that market variables, and not macroeconomic, are more important for explaining spreads in these countries. Panel data studies also combine theoretical spread drivers with some control variables, and come to similar conclusions. Dumičić and Ridzak (2011) use a panel of eight transition countries and differ between spread drivers before and after the crisis. They conclude that financial volatility factors are important spread drivers, and that countries with higher current account deficits had larger spread increases in the period after the crisis. On a similar note, von Hagen, Schuknecht, and Wolswijk (2011) explore EU countries and find that the fiscal deficit coefficients are positive, implying higher spreads for less fiscal discipline, and that those coefficients are larger in the period after the crisis. Berganza et al. (2004) run a panel of 27 emerging countries, and among other results, find evidence that higher external debt service costs caused by exchange rate depreciations lead to higher sovereign spreads. They however, do not allow for any heterogeneity between countries nor do they differ between short-run and long-run. Malone (2009) follows the work by Berganza et al. (2004), explained here in detail, but extends their work on the endogeneity problem caused by the real exchange rate variable. Malone (2009) cannot reject the hypothesis of no endogeneity and no simultaneity bias, thus corroborating the Berganza et al. (2004) model and findings.

There are only a few studies that allow for heterogeneity between countries in the short-run. Bellas, Papaioannou, and Petrova (2010) use the pooled mean group estimator for 14 emerging countries[25] and find that only financial stress indices and market volatility affect spreads in the short-run.[26] Alexopoulou, Bunda, and Ferrando (2010) use a dynamic panel error correction framework to model sovereign spreads in emerging Europe. They find that countries with low fiscal discipline suffer from more volatile spreads. Moreover, they argue that exchange rates have a positive effect on spreads in Hungary, Poland, and Slovakia. Our work differentiates from Alexopoulou et al. (2010) in three main points. First, we construct a variable that takes into account the balance sheet effect that directly measures the relationship between the exchange rate and credit euroization. Additionally, our data spans through the years of the financial crisis, and we explore three countries not previously covered, Croatia, Serbia, and Turkey. Finally, Ferrucci (2003), using the same methodology, concludes that macroeconomic fundamentals and external liquidity conditions are most important spread drivers. Ferrucci (2003) however does not include a balance sheet effect variable, nor does he consider the influence of monetary policy.

To sum up, empirical research finds that macroeconomic variables and external debt have a significant influence on government spreads. Important part of literature suggests there are also balance sheet and market behaviour variables that are important spread drivers. Moreover, panel data studies seem to be more successful in acquiring more efficient estimates, but suffer from generality when making country-by-country conclusions. Additionally, it is observed that spreads have become more volatile, and that traditional determinants are not appropriate for explaining deviations in the short-run. This problem is usually solved by introducing new short-run variables, and by using a methodology that separates short-run from long-run variables and allows for differences between countries.

4.3 DATA

As presented in equation (4.1), the dependent variable is sovereign spread, our chosen measure for country risk premium. A typical and widely used proxy for sovereign spread is the JP Morgan Euro Emerging Markets Bonds Indices (EMBI) Global. Euro EMBI Global is a spread by construction, as it is equal to the difference between returns on foreign

[25] Their sample incorporates only three European countries: Bulgaria, Poland and Turkey.
[26] A more detailed study on the relationship of spreads and financial variables can be found in Mody (2009).

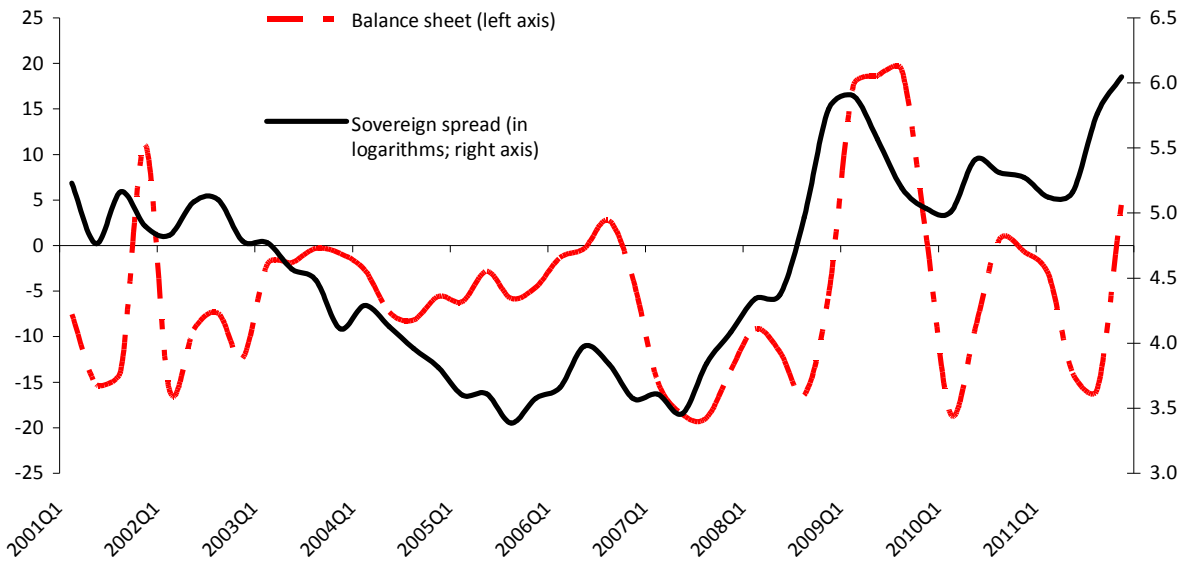
currency bonds and corresponding US Treasury bonds. It has become a standard to use such secondary market spreads in order to represent country risk premiums. For example, Dell'Ariccia et al. (2002) use EMBI Global spreads for exploring international borrowing after the Russian crisis, and a number of further work relies on the same source as well (Bellas et al., 2010; Berganza et al., 2004; Ferrucci, 2003). Their advantage is that they overcome the bias that might arise out of a choice of the basket of bonds that are representative for country risk premium. However, EMBI series are rather short, as the longest data sets are available only since 1997. We use data in quarterly frequency because some of our regressors are available on quarterly basis only. We limit our sample to nine European countries (Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Serbia, Slovak Republic, and Turkey), as EMBI spreads are not available for other countries. Data for the biggest number of countries are available from the first quarter of 2001 until the fourth quarter of 2011, which sets our panel database to 396 observations altogether. However, for some countries and periods, observations are missing, so we had to work with an unbalanced panel. Appendix F presents descriptions, sources and expected signs for all the variables we use in the empirical examination.

Consistent with existing literature, we use several long-run variables found to be important determinants of spreads. These are external debt, current account, and international reserves. All are defined as percentages of GDP, and they were tested for stationarity using different panel unit root tests.

In accordance with equation (4.11), and taking into consideration that we differentiate between the long-run and the short-run, we include the balance sheet term S_t as a short-run spread determinant. S_t is an interaction term composed of external debt and real exchange rate changes, intended to account for the rise in the service of external debt in the aftermath of an exchange rate depreciation. In line with our model and Figure 4, we would expect a positive balance sheet effect. Put differently, we would expect that besides the fact that the real exchange rate depreciation increases external debt service, it also increases the country risk premium. Figure 4 shows average sovereign spreads together with the constructed balance sheet variables for the 2001-2011 period. We can see that the balance sheet variable follows the spread turning points, and that they move more-or-less in the same direction. Especially interesting is the strong positive co-movement observed in 2008 that coincides with the beginning of the financial crisis.

Following the literature, we include another short-run variable, one that measures market behaviour, more specifically, market volatility. We define that variable as a logarithm of CBOE (Chicago Board Options Exchange) VIX (Volatility IndeX). Finally, we consider the impact of short-run fiscal policy measures, such as tax revenues dynamics.

Figure 4: Balance sheet and sovereign spread movements in the period 2001-2011



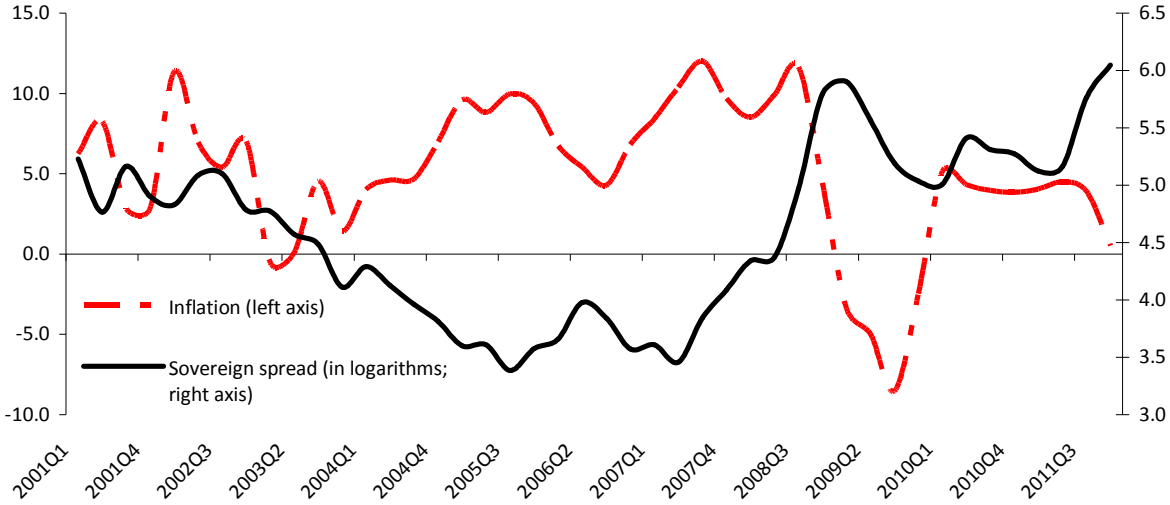
Note: Variables presented here are averages of the nine countries.

Source: J.P. Morgan Markets. (n.d.) In JP Morgan. Retrieved July 31, 2012, from.http:// http://www.jpmorgan.com/pages/jpmorgan.

We also include different control variables, such as exports. Besides the positive balance sheet effect, one would expect that the exchange rate depreciation spurs exports. Therefore, we add exports to the empirical model in order to control for such an effect, and to avoid possible omitted variable issues. For the same reason we add another short-run control variable, external debt, and an instrument variable for the balance sheet effect that is constructed as a product of external debt and inflation. The latter is necessary as it is sometimes argued that inflation actually causes spread rallies, and not the exchange rate (Min, 1998). However, already from Figure 5 we can expect that this is not the case here. Inflation and sovereign spreads sometimes move in tandem, but otherwise they seem to be diverging. Finally, all variables, except international reserves and the volatility index, are seasonally adjusted using ARIMA X12. The reason we did not apply seasonal adjustment

to these two variables, is that they do not show any signs of seasonal activity. International reserves have a smooth increasing trend in all the countries we explore, while the volatility index resembles a random walk.

Figure 5: Inflation and sovereign spread movements in the period 2001-2011



Note: Variables presented here are averages of the nine countries.

Source: J.P. Morgan Markets. (n.d.) In JP Morgan. Retrieved July 31, 2012, from.http:// http://www.jpmorgan.com/pages/jpmorgan.

Table 10: Descriptive statistics

	Mean	Median	Min	Max	St dev
Spread	4.6	4.8	3.4	6.0	0.8
External debt	265.6	230.7	156.8	447.0	100.2
Current account	-6.6	-5.8	-15.1	-2.1	3.4
International reserves	85.8	88.2	47.3	131.6	23.5
Balance sheet	-5.2	-5.7	-18.9	19.3	9.4
Volatility	3.0	3.1	2.4	4.1	0.4
Tax revenues	22.3	22.5	16.9	27.4	3.4

Note: Values presented here are for averages of the nine countries.

Source: Central banks, Chicago Board Options Exchange, Eurostat, IMF IFS and JP Morgan databases; own calculations.

Table 10 presents descriptive statistics for the variables used in our baseline model, while Table 11 shows correlation coefficients between spreads and its determinants, country-by-country. Although these are only correlations, they still suggest that the regressors are highly correlated with sovereign spreads in all countries we explore. As expected, the long-run variables show high correlation, especially external debt. However, short-run drivers are also significantly correlated with spreads. The variable of our interest, balance sheet, is significantly correlated with spreads in five out of nine countries. We expect however, that pooling data will give us more insight and preferably more consistent results.

Table 11: Correlation coefficients between spreads and its determinants

Variable	Bulgaria	Croatia	Czech Republic	Hungary	Poland	Romania	Serbia	Slovak Republic	Turkey
External debt	0.429***	0.875***	0.860***	0.849***	0.597***	0.397**	0.587***	-0.122	0.354*
	[0.007]	[0.000]	[0.000]	[0.000]	[0.000]	[0.010]	[0.001]	[0.506]	[0.055]
Current account	0.387**	0.450**	-0.216	0.762***	-0.138	0.404***	0.141	0.068	0.272
	[0.016]	[0.013]	[0.390]	[0.000]	[0.372]	[0.009]	[0.475]	[0.712]	[0.146]
International reserves	0.195	0.730***	-0.262	0.896***	0.625***	0.141	0.344*	-0.808***	-0.032
	[0.240]	[0.000]	[0.293]	[0.000]	[0.000]	[0.378]	[0.074]	[0.000]	[0.869]
Balance sheet	0.111	0.352*	-0.549**	0.273*	0.416***	0.606***	0.234	0.248	0.225
	[0.507]	[0.057]	[0.018]	[0.076]	[0.005]	[0.000]	[0.231]	[0.171]	[0.232]
Volatility	0.867***	0.869***	0.933***	0.627***	0.820***	0.863***	0.614***	0.770***	0.681***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tax revenues	0.023	0.532***	0.687***	0.513***	0.170	-0.007	0.410**	-0.665***	-0.120
	[0.889]	[0.002]	[0.002]	[0.000]	[0.269]	[0.965]	[0.030]	[0.000]	[0.528]

Note: Variables are in levels; p-values are in brackets; ***, **, and * denote significance at 1, 5, and 10 percent confidence level, respectively.

Source: Central banks, Chicago Board Options Exchange, Eurostat, IMF IFS and JP Morgan databases; own calculations.

4.4 ESTIMATION

4.4.1 Methodology

4.4.1.1 Pooled mean group estimator

Existing empirical literature offers either panel data or country-by-country estimation results, ignoring either differences between countries or universalities that arise from general theoretical concepts. This study tries to combine both, because we use a PMG estimator that enables us to explore data in a panel setting, still allowing for short-run country-specific deviations. PMG is a panel version of the error correction model, and provides an opportunity to obtain more efficient estimation results, while preserving some group-specific heterogeneity. As implied in Pesaran et al. (1999), it is appropriate to use PMG whenever there is reason to believe that countries differ on the matter in the short-run, but comply in the long-run.

A dynamic panel can be estimated using different procedures, with each one offering both advantages and limitations in comparison to alternative methods. For example, if we pool the time-series data for each group and allow only the intercepts to differ across groups, we are using a dynamic fixed effects framework. However, if the slope coefficients are actually heterogeneous, then fixed effects estimation results would be inconsistent and misleading. An alternative method is one proposed by Pesaran and Smith (1995), who suggest using the mean group (MG) estimator in which intercepts, slope coefficients and error variances are allowed to differ across groups. In this setting, the panel coefficients are given as simple averages of the coefficients obtained by estimating each group separately. This method implies no restrictions on the coefficients whatsoever, and is therefore more flexible than the suggested alternatives. Finally, Pesaran et al. (1999) suggest using PMG, a combination of previously described methods, as it uses both pooling and averaging. Just as in MG, PMG allows intercepts, short-run coefficients and error variances to differ, but analogously to fixed effects, it restricts the long-run coefficients to be equal across groups.

The original Pesaran et al. (1999) paper starts with an autoregressive distributed lag (ARDL) dynamic panel specification, with p being the number of lags for the dependent variable, and q the number of lags for the explanatory variables. The specification takes the following form:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}^{'} X_{i,t-j} + \mu_i + \varepsilon_{it} \ , \ t = 1,2,...,T \ , \ i = 1,2,...,N \qquad (4.12)$$

where λ_{ij} are coefficients of the lagged dependent variable, X_{it} is a set of regressors and δ_{ij} is a $(k \times 1)$ vector of its coefficients. Group-specific effects are represented by μ_i while ε_{it} is the error term. This model specification requires that T is large enough, rule of thumb being the possibility to estimate the model for each group separately (Pesaran et al., 1999, pp. 623). Due to the fact that T specified in equation (4.12) is rather large, there is reason to expect that some variables might not be stationary. In case the variables are integrated of order one, and consequently cointegrated, then we expect that the error term is stationary for all i. Typically, cointegrated variables react to deviations from their long-run equilibrium, and adjust in the short-run (Enders, 1995, pp. 365-366). These sorts of deviations and reactions are usually presented as error correction models, and in the original Pesaran et al. (1999) paper they take the form presented by equation (4.13), obtained by reparameterization of (4.12).

$$\Delta y_{it} = \phi_i \left(y_{i,t-1} - \theta_i' X_{it} \right) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}'^* \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{4.13}$$

where

$$\phi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij} \right),\ \theta_i = \frac{\sum_{j=0}^{q} \delta_{ij}}{1 - \sum_{k} \lambda_{ik}},\ \lambda_{ij}^* = -\sum_{m=j+1}^{p} \lambda_{im}\ ,\ j = 1, 2, ..., p-1, \text{ and } \delta_{ij}^* = -\sum_{m=j+1}^{q} \delta_{im}\ .$$

The error coefficient, or the speed of adjustment term, is presented here as ϕ_i. In case ϕ_i is statistically significant, there is evidence of a long-run relationship, while a negative ϕ_i implies that the variables return to the equilibrium after a deviation in the short-run. Equation (4.13) reveals that θ_i' is the vector of long-run coefficients, while λ_{ij}^* and $\delta_{ij}'^*$ are short-run coefficients of the lagged dependent and explanatory variables, respectively.

4.4.1.2 PMG estimation

Pesaran et al. (1999) recommend using maximum likelihood (ML) estimation method for estimating equation (4.13), as it is nonlinear in its parameters. However, prior to ML estimation, one must make a few assumptions about this specification. First, we rewrite equation (4.13) by stacking the time-series observations for each group:

$$\Delta y_i = \phi_i \left(y_{i,-1} - \theta_i X_i \right) + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{i,-j} + \sum_{j=0}^{q-1} \Delta X_{i,-j} \delta_{ij}^* + \mu_i \iota + \varepsilon_i \tag{4.14}$$

where $\iota = (1,...,1)'$ is a $(T \times 1)$ vector of ones, and the disturbance term is $\varepsilon_i = (\varepsilon_{i1},...,\varepsilon_{iT})'$. Next, Pesaran et al. (1999, pp. 624) assume that the error terms are distributed independently across groups, time, and of the regressors. The last assumption is necessary for a consistent estimate of short-run coefficients, as we allow them to differ across groups. To control for the long-run relationship, and for the adjustment to the long-run equilibrium, it is needed that the speed of adjustment term, ϕ_i, is negative. This is ensured when the model given by equation (4.12) is stable in its roots that lie outside the unit circle, or that $\sum_{j=1}^{p} \lambda_{ij} z^j = 1$. Then we can say that there is a long-run relationship between the dependent variable and regressors, with θ_i the long-run coefficients, and η_{it} a stationary process:

$$y_{it} = -\theta_i X_{it} + \eta_{it}.$$

Once we confirm there is a long-run relationship, we can rewrite its coefficients without the group-specific term:

$$\theta_i = \theta. \tag{4.15}$$

Having made these assumptions, we can rearrange equation (4.14):

$$\Delta y_i = \phi_i \xi_i (\theta) + W_i \kappa_i + \varepsilon_i \tag{4.16}$$

where

$$\xi_i (\theta) = y_{i,-1} - X_i \theta, \tag{4.17}$$

$W_i = \left(\Delta y_{i,-1},..., \Delta y_{i,-p+1}, \Delta X_i, \Delta X_{i,-1},..., \Delta X_{i,-q+1}, \iota \right)$,
and $\kappa_i = \left(\lambda_{i,1}^*,..., \lambda_{i,p-1}^*, \delta_{i,0}^{*'}, \delta_{i,1}^{*'},..., \delta_{i,q-1}^{*'}, \mu_i \right)'$.

Additional to no restrictions on the short-run coefficients, as suggested in Pesaran et al. (1999) we allow the error variances to differ across groups as well, given by $\text{var}(\varepsilon_{it}) = \sigma_i^2$. Now, the nonlinearity of the parameters θ and ϕ_i from equation (4.16) implies that we should take a likelihood approach to estimating the described panel. Just for these purposes, it is assumed that the error term is normally distributed. Together with all the assumptions, it is possible to express the likelihood of the panel as the product of each, separate, group-specific likelihoods. Taking logarithms, one gets:

$$l_T(\varphi) = -\frac{T}{2}\sum_{i=1}^{N}\ln\left(2\pi\sigma_i^2\right) - \frac{1}{2}\sum_{i=1}^{N}\frac{1}{\sigma_i^2}\left[\Delta y_i - \phi_i\xi_i(\theta)\right]' H_i\left[\Delta y_i - \phi_i\xi_i(\theta)\right] \tag{4.18}$$

where $H_i = I_T - W_i\left(W_i'W_i\right)^{-1}W_i'$, $\varphi = \left(\theta', \phi', \sigma'\right)'$, $\phi = (\phi_1, \phi_2, ..., \phi_N)'$, and $\sigma = (\sigma_1^2, \sigma_2^2, ..., \sigma_N^2)'$. In order to get consistent and asymptotically normal estimators, it is necessary to add some further assumptions that can be found in the original paper (Pesaran et al., 1999, pp. 624-625).

As implied by equation (4.18), $\varphi = \left(\theta', \phi', \sigma'\right)'$ is estimated in the following order. Maximizing equation (4.18) with respect to φ gives us estimates of the long-run coefficients, $\hat{\theta}$, and of the error correction coefficients, $\hat{\phi}_i$:

$$\hat{\theta} = -\left[\sum_{i=1}^{N}\frac{\hat{\phi}_i^2}{\hat{\sigma}_i^2}X_i'H_iX_i\right]^{-1} \times \left[\sum_{i=1}^{N}\frac{\hat{\phi}_i}{\hat{\sigma}_i^2}X_i'H_i\left(\Delta y_i - \hat{\phi}_i y_{i,-1}\right)\right], \tag{4.19}$$

$$\hat{\phi}_i = \left(\hat{\xi}_i'H_i\hat{\xi}_i\right)^{-1}\hat{\xi}_i'H_i\Delta y_i \tag{4.20}$$

where $\hat{\xi}_i' = \xi_i\left(\hat{\theta}\right) = y_{i,-1} - X_i\hat{\theta}$. Estimators in (19) and (20) are called pooled mean group estimators because they reflect both pooling, inherent in $\hat{\theta}$, and averaging across groups, inherent in $\hat{\phi}_i$ (Pesaran et al., 1999). Solving the maximization problem provides the error variance estimate as well:

$$\hat{\sigma}_i^2 = T^{-1}\left(\Delta y_i - \hat{\phi}_i\hat{\xi}_i\right)' H_i\left(\Delta y_i - \hat{\phi}_i\hat{\xi}_i\right). \tag{4.21}$$

The PMG estimators are computed using the algorithm of back-substitution or in other words, by iterating the obtained estimates. Using the initial estimate $\hat{\theta}$, one can get $\hat{\phi}$ and $\hat{\sigma}_i^2$ from equations (4.20) and (4.21), respectively. These estimates can then be replaced into equation (4.19) to get a new estimate of θ, used to get new estimates of ϕ and σ_i^2, repeated until convergence is achieved. Pesaran et al. (1999) distinguish between stationary and nonstationary regressors, but here we will focus only on the nonstationary part, because our time span is rather long and the regressors we use turn out to be integrated of order one. It is important to note that the ML estimates of long-run and short-run parameters are asymptotically distributed independently of each other, implying that once we get the long-run parameters, we can use them to consistently estimate the short-run and the error correction coefficients. Although the parameters obtained by iteration are identical to those obtained from full-information maximum likelihood, the covariance matrix is not. Nevertheless, Pesaran et al. (1999) recover the covariance matrix for all estimated parameters, because the distribution of the PMG parameters is known. The covariance matrix can be estimated by the inverse of:

$$\begin{pmatrix}
\sum_{i=1}^{N}\frac{\hat{\phi}_i^2 X_i' X_i}{\hat{\sigma}_i^2} & \frac{-\hat{\phi}_1 X_1'\hat{\xi}_1}{\hat{\sigma}_1^2} & \cdots & \frac{-\hat{\phi}_N X_N'\hat{\xi}_N}{\hat{\sigma}_N^2} & \frac{-\hat{\phi}_1 X_1' W_1}{\hat{\sigma}_1^2} & \cdots & \frac{-\hat{\phi}_N X_N' W_N}{\hat{\sigma}_N^2} \\
 & \frac{\hat{\xi}_1'\hat{\xi}_1}{\hat{\sigma}_1^2} & \cdots & 0 & \frac{\hat{\xi}_1' W_1}{\hat{\sigma}_1^2} & \cdots & 0 \\
 & & \vdots & \vdots & & \vdots & \vdots \\
 & & & \frac{\hat{\xi}_N'\hat{\xi}_N}{\hat{\sigma}_N^2} & 0 & \cdots & \frac{\hat{\xi}_N' W_N}{\hat{\sigma}_N^2} \\
 & & & & \frac{W_1' W_1}{\hat{\sigma}_1^2} & \cdots & 0 \\
 & & & & & \vdots & \vdots \\
 & & & & & & \frac{W_N' W_N}{\hat{\sigma}_N^2}
\end{pmatrix}.$$

Additionally, the MG parameters (Pesaran and Smith, 1995) are then simply unweighted means of individual coefficients, or:

$$\hat{\phi}_{MG} = \frac{\sum_{i=1}^{N}\hat{\phi}_i}{N} \text{ and } \hat{Var}\left(\hat{\phi}_{MG}\right) = \frac{\sum_{i=1}^{N}\left(\hat{\phi}_i - \hat{\phi}_{MG}\right)^2}{N-1}.$$

The homogeneity assumption in the PMG estimation or the restrictions on both long-run and short-run parameters in dynamic fixed effects can be tested using a Hausman-type test (Hausman, 1978). The null hypothesis of this test says that the poolability restrictions hold, so in case we cannot reject the null, PMG is the preferred estimator. It is important to run this test because the MG estimator is inefficient if coefficients are actually homogenous in the long-run, while the PMG estimator is efficient and consistent in that case. The same holds for the fixed effects estimators; in case the long-run restriction binds, the fixed effects estimator is inefficient.

4.4.2 Empirical specification

Following the theory suggested by Ferrucci (2003) and Berganza et al. (2004) that is presented in section "Theoretical framework", we model sovereign spreads. It has been observed that the dynamics of sovereign spreads complies with theory in the long-run, but demonstrate different dynamics in the short-run. We detect possible long-run and short-run drivers and incorporate them into a nonstationary heterogeneous panel inspired by the pooled mean group estimator of Pesaran et al. (1999). In addition to PMG, we use two alternative estimators, mean group estimator of Pesaran and Shin (1995) and a traditional dynamic fixed effects estimator. We then test the efficiency of all of these estimators and decide on the most efficient and consistent one.

The long-run relationship that we explore is similar to equation (4.1) and is given by:

$$spread_{it} = \theta_i + \sum_{j=1}^{k} \theta_{ji} LR_{jit} + u_{it} \tag{4.22}$$

where k denotes the number of long-run variables, while LR_{it} represents long-run regressors. We assume and test the hypothesis that the long-run variables together with the dependent variable are nonstationary, and cointegrated. If that is the case, then the error term u_{it} is stationary for all i. Setting maximum lags to one, and reformulating equation (4.13), we get the following ARDL equation:

$$spread_{it} = \lambda_{it} spread_{it-1} + \sum_{j=1}^{k} \delta_{1ji} LR_{jit} + \sum_{j=1}^{k} \delta_{2ji} SR_{jit-1} + \mu_i + u_{it}. \tag{4.23}$$

The error correction equation is then given by:

$$\Delta spread_{it} = \phi_i \left(spread_{it-1} - \sum_{j=1}^{k} \theta_{ji} LR_{jit} \right) + \sum_{j=1}^{k} \delta_{2ji} \Delta SR_{it} + \mu_i + \varepsilon_{it} \tag{4.24}$$

where $\phi_i = -(1-\lambda_i)$ and $\theta_{ji} = \dfrac{\delta_{1ji} + \delta_{2ji}}{1-\lambda_i}$.

Note that in equation (4.24) we call the term in differences, SR_{it}, the short-run term, regardless of the fact that it can be the differenced long-run variable or some different variable used to explain short-run dynamics. The term given in brackets represents the long-run relationship with θ_{ji}'s being the long-run elasticities. The speed of adjustment coefficient and short-run elasticities are given by ϕ_i and δ_{2ji}, respectively. Actually, the PMG estimator restricts the long-run coefficients to be equal, so we can rewrite equation (4.24) such that $\theta_{ji} = \theta_j$:

$$\Delta spread_{it} = \phi_i \left(spread_{it-1} - \sum_{j=1}^{k} \theta_j LR_{jit} \right) + \sum_{j=1}^{k} \delta_{2ji} \Delta SR_{it} + \mu_i + \varepsilon_{it}. \tag{4.25}$$

We estimate equation (4.25) using the PMG estimator, and after choosing the baseline model, we test it against two alternative estimators, the MG and the dynamic fixed effects. The reason we use PMG as our preferred estimator is in the nature of the data, economic reasoning, and econometric considerations. First, PMG is a dynamic model, and as such, it reflects the nature of sovereign spreads more realistically. The long-run coefficient homogeneity provides stability of the model, and consequently, corroborates theoretical predictions that coefficients should be identical for all countries. On the other hand, short-run heterogeneity allows for country-specific characteristics and gradual adjustment to the equilibrium, which keeps us from misleading conclusions about the dependent variable (Haque, Pesaran, and Sharma, 2000). Lastly, it has been found that pooled estimators outperform alternative heterogeneous estimators, because increasing efficiency, brought by pooling, offsets the occurrence of biases, brought by short-run heterogeneity across groups (Boyd and Smith, 2000).

4.4.3 Panel unit root tests

We assume that the long-run variables we use are nonstationary, and in line with that, we have to test these assumptions. We apply five different unit root tests on the dependent variable and the long-run variables that were eventually chosen in the baseline model. The large number of different tests we use is argued by the fact that all of these tests have disadvantages, so using more different tests will lead to robust results (Enders, 1995). We perform the following tests: Im-Pesaran-Shin (Im, Pesaran, and Shin, 2003), Fisher-type (Choi, 2001), Levin-Lin-Chu (Levin, Lin, and Chu, 2002), Breitung (Breitung, 2000; Breitung and Das, 2005), and Hadri (Hadri, 2000) tests. The first four tests test the null hypothesis that all panels contain a unit root, while the Lagrange multiplier-based Hadri test assumes that all panels are stationary under the null. These panel unit root tests are designed with options of including a trend and fixed effects. Only two tests allow for an unbalanced dataset, Im-Pesaran-Shin and Fisher-type tests, while the other tests require a balanced set of data.

Im-Pesaran-Shin test provides a test statistic based on augmented Dickey–Fuller statistics averaged across sectors. Therefore, the test is based on averages of individual unit root statistics. Fisher-type test however is more general, as it assumes that T can be different for each sector, and it allows that some sectors can contain a unit root, while some others cannot. This test combines *p*-values from each sector-specific unit root test. The Levin-Lin-Chu test fits an augmented Dickey-Fuller regression to each sector, using the AIC criterion to find the optimal lag length. The main disadvantage of this test is that it has a common autoregressive factor for all sectors, implying that it does not allow a unit root for one sector and not for the other. Levin-Lin-Chu test with panel-specific means included, is suitable for panels in which the ratio of sectors to time periods tends to zero, therefore in cases where T grows faster than N (as is the case in this study). The main advantages of the Breitung test (a robust version of the Dickey-Fuller *t*-statistic), are that it allows for contemporaneous correlated errors, and performs well with respect to size and power. Finally, the Hadri test is easy to apply, and it has performed well for panel data models with fixed effects, individual deterministic trends and heterogeneous errors across groups.

To sum up, four out of five tests are based on the null of nonstationarity (unit root), while the Hadri test has stationarity defined under the null. Levin-Lin-Chu, Breitung and Hadri tests require a balanced panel, so they were applied to a truncated version of the dataset.

4.5 ESTIMATION RESULTS

4.5.1 Panel unit root testing

Prior to estimation, we apply panel unit root tests to the dependent and long-run variables: spread, external debt, current account and international reserves.[27] Results of panel unit root testing, presented in Table 12, show that the first four tests do not reject the null hypotheses of a unit root for the spread, external debt and international reserves. For the current account, only the Breitung test rejects the null, while other three tests cannot reject the unit root hypothesis. The Hadri test with its different formulation, suggests that we can reject the null of stationarity for all long-run variables. These results imply that the long-run panel variables are not stationary, and that these variables could be cointegrated, therefore eligible for PMG specification.

4.5.2 Baseline estimation

We estimate equation (4.25)[28] using maximum likelihood as presented in Pesaran et al. (1999). We start with a parsimonious version, because the PMG technique uses a big number of parameters that decrease the degrees of freedom. The first specification, presented in column 1 of Table 13, consists only of the most important long-run spread determinants. Note that spreads are defined in logarithms, so the coefficients in the table are semi-elasticities. Results imply that there is a long-run relationship between the variables, because the speed of adjustment coefficient is statistically significant and negative. The external debt, current account and international reserves are all significant long-run variables that have the expected signs. What is found here is that the share of external debt in GDP leads to higher sovereign spreads, a result consistent with theory and empirical work (Edwards, 1984; Alexopoulou et al., 2010; Bellas et al., 2010). On the other hand, international reserves and current account balance seem to work in the opposite direction. Higher international reserves and current account surpluses tend to decrease

[27] Different variables that potentially explain the long-run were added to the model, but none turned out to be statistically significant. We tried adding variables that account for demographics (the share of citizens that are 65+ years old in total population), development (GDP per capita), primary fiscal balance, institutional framework (Worldwide governance indicators), and capital growth (as measured by gross capital formation). These robustness results are not presented here due to space considerations, but are available upon request.

[28] All models were estimated using a lag of one, though alternative specifications are possible.

sovereign spreads, as previously found in Edwards (1984) and Strahilov (2006), respectively.

Table 12: Panel unit root tests results

Test	Null hypothesis	Alternative hypothesis	p-values			
			Spread	External debt	Current account	International reserves
Im-Pesaran-Shin	All panels contain unit roots	Some panels are stationary	0.994	0.993	0.364	0.998
Fisher	All panels contain unit roots	At least one panel is stationary	0.860	0.847	0.153	0.987
Levin-Lin-Chu	All panels contain unit roots	All panels are stationary	1.000	0.108	0.156	0.843
Breitung	All panels contain unit roots	All panels are stationary	1.000	0.933	0.002	0.671
Hadri	All panels are stationary	Some panels contain unit roots	0.000	0.001	0.000	0.000

Note: The panels include nine countries; the overall sample covers the period from the first quarter of 2001 to the fourth quarter of 2011; Levin-Lin-Chu, Breitung and Hadri tests require a balanced panel and were therefore applied to a truncated version of the dataset.

Source: Central banks, Chicago Board Options Exchange, Eurostat, IMF IFS and JP Morgan databases; own calculations.

Following the balance-sheet effect point of view presented earlier in detail, we add our constructed variable to the short-run determinants, and find it to be statistically significant and positive (column 2), a result that accords with Berganza et al. (2004). Since market volatility is an important spread driver, but only in the short-run, we also add the volatility index variable (column 3). Market volatility has the expected statistically significant positive impact on sovereign spreads, just as in Ebner (2009). Finally, we add a fiscal variable, but one that affects spreads in the short-run, tax revenues, and also find it to be statistically significant. Rising tax revenues seem to push spreads down, due to the fact that higher taxes persuade investors that sovereign debts will be rapid, but only in the short-run.

All models have appropriate explanatory power, expected signs and justifiable coefficient values. Additionally, all variables are statistically significant at conventional levels and most importantly, the coefficients are robust across models. Model 4 is the broadest model

Table 13: Baseline estimates

	Model (1)	Model (2)	Model (3)	Model (4)
Speed of adjustment				
	-0.139***	-0.169***	-0.120***	-0.170***
	[0.000]	[0.000]	[0.000]	[0.000]
Long-run coefficients				
External debt	0.019***	0.020***	0.022***	0.019***
	[0.000]	[0.000]	[0.000]	[0.000]
Current account	-0.105**	-0.084**	-0.078**	-0.054*
	[0.013]	[0.013]	[0.043]	[0.058]
International reserves	-0.033***	-0.040***	-0.046***	-0.037***
	[0.000]	[0.000]	[0.000]	[0.000]
Short-run coefficients				
Δ balance sheet		0.084***	0.052**	0.065*
		[0.009]	[0.019]	[0.087]
Δ volatility index			0.754***	0.755***
			[0.000]	[0.000]
Δ tax revenues				-0.040***
				[0.006]
Number of observations	338	326	326	295
Number of countries	9	9	9	9
Log likelihood	-85.1381	-62.5343	23.0836	42.7068
Within R-squared[#]	0.6777	0.7253	0.833	0.8468
Between R-squared	0.1560	0.0147	0.1974	0.5277
Overall R-squared	0.4215	0.4777	0.6637	0.6709
Hausman test	1.67	3.81	1.83	5.49
	[0.645]	[0.283]	[0.969]	[0.704]

[#] R-squared values were obtained from models estimated by fixed effects.
Note: Estimations are performed using the PMG estimator of Pesaran et al. (1999); the reported short-run coefficients and the speed of adjustment are simple averages of country-specific coefficients; all equations include a constant term; p-values are in brackets; ***, **, and * denote significance at 1, 5, and 10 percent confidence level, respectively.

Source: Central banks, Chicago Board Options Exchange, Eurostat, IMF IFS and JP Morgan databases; own calculations.

with three long-run determinants, and three short-run drivers: market sentiment and proxies for fiscal (tax revenues) and monetary policy (balance-sheet effect). Moreover, this model

has the highest log likelihood and R-squared values that make it our preferred and baseline model.

Table 14: Speed of adjustment coefficients

	Baseline model	Estimated half-life
Bulgaria	-0.064** [0.014]	2y
Croatia	-0.128 [0.184]	-
Czech Republic	-0.258* [0.083]	6m
Hungary	-0.046* [0.062]	2y 8m
Poland	-0.095*** [0.023]	1y 4m
Romania	-0.131*** [0.005]	1y
Serbia	-0.213** [0.028]	7m
Slovak Republic	-0.201*** [0.000]	7m
Turkey	-0.397*** [0.004]	4m

Note: Estimations are performed using the PMG estimator of Pesaran et al. (1999); p-values are in brackets; ***, **, and * denote significance at 1, 5, and 10 percent confidence level, respectively; "y" stands for years, and "m" for months.

Source: Central banks, Chicago Board Options Exchange, Eurostat, IMF IFS and JP Morgan databases; own calculations.

The overall speed of adjustment is equal to -0.170, which implies that half of the adjustment occurs in eight months. However, the PMG framework allows heterogeneity between countries, so Table 14 presents country-specific speed of adjustments for the baseline model. We can see that only for the case of Croatia there is no adjustment to deviations from equilibrium, while in other countries the half-life adjustments range from -0.258 or six months for the Czech Republic to -0.046 or two years and eight months for Hungary.

Table 15: Tests on the homogeneity restriction

	Pooled mean group (PMG)	Mean group (MG)	Hausman test	Dynamic fixed effects (DFE)	Hausman test
Speed of adjustment					
	-0.170***	-0.279***		-0.656***	
	[0.000]	[0.002]		[0.000]	
Long-run coefficients					
External debt	0.019***	0.016***		0.010***	
	[0.000]	[0.002]		[0.000]	
Current account	-0.054*	-0.032	5.49	0.038***	0.04
	[0.058]	[0.511]	[0.704]	[0.000]	[0.998]
International reserves	-0.037***	-0.030		-0.018*	
	[0.000]	[0.256]		[0.070]	
Short-run coefficients					
Δ balance sheet	0.065*	0.094		0.002**	
	[0.087]	[0.155]		[0.014]	
Δ volatility index	0.755***	0.759***		0.884***	
	[0.000]	[0.000]		[0.000]	
Δ tax revenues	-0.040***	-0.038*		-0.023***	
	[0.006]	[0.063]		[0.006]	
Number of observations	295	295		295	
Number of countries	9	9		9	
Log likelihood	42.7068	64.5318		-184.0232	

Note: All equations include a constant term; p-values are in brackets; ***, **, and * denote significance at 1, 5, and 10 percent confidence level, respectively.

Source: Central banks, Chicago Board Options Exchange, Eurostat, IMF IFS and JP Morgan databases; own calculations.

As mentioned in the section "Methodology", we test the preferred PMG specification and the long-run homogeneity restriction using the Hausman test. We compare the PMG estimation to MG and to the dynamic FE, and in that way we test the long-run homogeneity assumption. Hausman test results, as indicated in Table 15, give preference to

PMG and confirm that we can impose homogenous coefficients in the long-run, while keeping heterogeneity between countries in the short-run.

Our baseline estimation results indicate that external debt, international reserves and the current account affect sovereign spreads in the long-run, and that the balance sheet effect, market volatility and tax revenues influence spread dynamics in the short-run. A one percentage point change in the share of external debt in GDP tends to increase the spread by 1.9 percent in the long-run. At the same time, one-percentage point higher shares of current account and international reserves in GDP, decrease spreads by 5.4 and 3.7 percent respectively. In the short-run, we have found that the balance sheet effect is positive and stronger than any of the long-run coefficients. It implies that a one percentage point increase in the debt service cost in local currency terms, increases spreads by 6.5 percent. One percentage point change in tax revenues decreases spreads by 4 percent, while a 100 percent change in the market volatility index, leads to a 75.5 percent jump in sovereign spreads.

4.5.3 Robustness

Following Berganza et al. (2004), we run robustness checks for our baseline model (presented in the first column of Table 16). Model 2 presents the baseline model with the annual growth rate of exports added to the short-run determinants. The reason for including exports is to test for omitted variables, i.e. to check if there is a competitiveness effect in the aftermath of exchange rate depreciation. If exports increase significantly after the exchange rate depreciates, and by that affect sovereign spreads, then the balance sheet effect could be offset. We find that exports are not statistically significant, and that the balance sheet coefficient stays almost unchanged when we add exports to the specification. This implies that we do not need to keep the exports variable.

We also add external debt to our short-run determinants, to detect is the balance sheet variable significant only due to external debt accumulation, and not due to the presence of a real balance sheet effect. Thereby, we test the assumption of predetermined debt (Berganza et al., 2004). Results in the third column suggest that the external debt variable is not statistically significant, and that the balance sheet coefficient stays almost

Table 16: Robustness checks for the baseline model

	Model (1)	Model (2)	Model (3)	Model (4)
Speed of adjustment				
	-0.170***	-0.152***	-0.207***	-0.164***
	[0.000]	[0.000]	[0.002]	[0.000]
Long-run coefficients				
External debt	0.019***	0.020***	0.018***	0.019***
	[0.000]	[0.000]	[0.000]	[0.000]
Current account	-0.054*	-0.067**	-0.007	-0.059*
	[0.058]	[0.040]	[0.694]	[0.053]
International reserves	-0.037***	-0.039***	-0.038***	-0.038***
	[0.000]	[0.000]	[0.000]	[0.000]
Short-run coefficients				
Δ balance sheet	0.065*	0.083*	0.103*	
	[0.087]	[0.087]	[0.074]	
Δ volatility index	0.755***	0.750***	0.748***	0.749***
	[0.000]	[0.000]	[0.000]	[0.000]
Δ tax revenues	-0.040***	-0.040***	-0.037**	-0.040***
	[0.006]	[0.006]	[0.025]	[0.007]
Δ export		-0.000		
		[0.864]		
Δ external debt			0.001	
			[0.707]	
Δ external debt*inflation				-0.002
				[0.148]
Number of observations	295	295	295	295
Number of countries	9	9	9	9
Log likelihood	42.7068	50.9645	50.7357	42.0037
Within R-squared[#]	0.8468	0.8665	0.8731	0.8462
Between R-squared	0.5277	0.0304	0.1514	0.0008
Overall R-squared	0.6709	0.6732	0.7768	0.6468
Hausman test	5.49	1.42	7.70	3.29
	[0.704]	[0.700]	[0.565]	[0.915]

[#] R-squared values were obtained from models estimated by fixed effects.
Note: Estimations are performed using the PMG estimator of Pesaran et al. (1999); the reported short-run coefficients and the speed of adjustment are simple averages of country-specific coefficients; all equations include a constant term; p-values are in brackets; ***, **, and * denote significance at 1, 5, and 10 percent confidence level, respectively.

Source: Central banks, Chicago Board Options Exchange, Eurostat, IMF IFS and JP Morgan databases; own calculations.

unaffected. From this we conclude that the increase in the size of external debt is not important for changes in spreads, but that spread movements are affected by increases in debt burden, caused by exchange rate movements (or balance sheet effects).

Finally, we tackle the question of the simultaneity bias.[29] As emphasized in Berganza et al. (2004), the equation we estimate may be only one of possible equations that determine the equilibrium. For example, the direction assumed here, that exchange rates affect the debt burden, might just be reversed. In that case, our balance sheet estimate is only a reduced one, and it cannot be said that it reflects a true balance sheet effect on the cost of sovereign credit. To solve this problem, we need an instrument for our constructed variable, more specifically, an instrument for the real exchange rate change, while we leave external debt in the definition, as it is assumed to be predetermined. Berganza et al. (2004) suggest using inflation because inflation and real exchange rate are correlated, and inflation is not supposed to affect spreads on external debt (for evidence on this, see Figure 5 in section "Data". We construct a new variable, "external debt*inflation", and replace the balance sheet variable with its instrument. Column 4 of Table 16 presents the estimated coefficients, and suggests that the alternative variable is not statistically significant.

4.6 CONCLUSION

This study uses different theoretical and empirical sources to build a model of sovereign spread determinants that enables us to empirically test a relationship between spreads and financial imperfections that appear in the form of "original sin", a widely spread emerging market phenomenon. We investigate a positive relationship between a country's risk premium and balance sheet effects – increasing debt servicing costs caused by exchange rate depreciation. We apply this method to nine European emerging economies for the

[29] We ran two additional robustness checks. One excluding Bulgaria (since Bulgaria introduced a currency board exchange rate regime and might not reflect such a strong balance sheet effect), and one without extreme balance sheet values (without 5% extreme values). We find that the coefficients' significance, signs, and values stay almost unchanged, once again conforming that our chosen model is preferred. These results are not presented here, but are available upon request.

2001-2011 period. We use a small open economy model and extend it with the collateral value concept of Kiyotaki and Moore (1997), and recent empirical findings on the balance sheet effect of Berganza et al. (2004). We place the model into a dynamic error correction setting introduced by Pesaran et al. (1999), and allow the short-run determinants to differ across countries, while we leave the long-run parameters to be equal for all countries. This allows more flexibility, brought by differentiation between short-run and long-run, but also provides estimation advantages, such as improved efficiency and model performance.

The results of the empirical model corroborate the differentiation between the short-run and the long-run, and suggest that there exists a strong positive relationship between spreads and balance sheet effects in the short-run. Besides the balance sheet effect, we find that market volatility and tax revenues also affect sovereign spreads in the short-run. Estimation suggests that a 100 percent rise in the volatility index leads to a 75.5 percent jump in spreads, while a one percentage point change in tax revenues reduces spreads by 4 percent. On average, half of this deviation from long-run equilibrium is corrected in eight months. In the long-run, spreads increase by 1.9 percent when the share of external debt in GDP rises by one percentage point, but tend to decrease by 5.4 and 3.7 percent when the share of current account and international reserves in GDP increases by one percentage point.

Our empirical results have serious policy implications, as they emphasize the role and strength of short-run spread determinants, next to the extensively studied long-run drivers. We find evidence that external factors, such as market volatility, and balance sheet effects caused by financial imperfections of the inability to issue debt in local currency, can be responsible for severe short-run changes in sovereign spreads. In order to avoid significant spread volatility that could result in liquidity problems of refinancing sovereign debt, countries should avoid sudden and large real exchange rate depreciations, when their foreign currency external debt is large (as previously suggested by Hausmann, Panizza, and Stein (2001), and Eichengreen et al. (2003)). Although European emerging countries did not experience larger exchange rate depreciations in the recent financial crisis, history has taught us that these events are not rare, and that countries can stand on the verge of devaluation for years before it finally comes about (Reinhart and Rogoff, 2009).

Besides external debt, further research should also include domestic debt denominated in foreign currency, as number of countries issue domestic debt that is indexed to the

exchange rate. This would ensure a comprehensive measure of euroization, and provide a more realistic picture of the balance sheet effect. However, the primary research focus should be on building a theoretical model of the relation between country's risk premium and total debt euroization. As far as we are aware, this issue has only been investigated empirically so far.

CONCLUDING REMARKS

High unofficial euroization in a great number of European transition economies complicates an effective conduct of monetary policy. As the economy would suffer in case of significant exchange rate depreciation, central banks are biased against exchange rate depreciation and manifest "fear of floating" by intervening on the foreign exchange market in order to keep the exchange rate stable. This condition of high and persistent unofficial euroization creates asymmetries in the economic system, makes countries more sensitive to external shocks, and harms investment, profitability, and economic activity in general. However, this issue has been ignored during the first 20 years of the transition process, as countries enjoyed a smooth and massive inflow of foreign currency funds. Turbulences that appeared by the end of 2008 disrupted this flow, and caused a capital flight that threatened strong exchange rate depreciations in some countries. A natural central bank response was to defend the exchange rate and prevent rising debt servicing costs, using measures that eventually affected the whole economy.

This doctoral dissertation tackles unofficial euroization in European transition economies using the balance sheet effect framework. By studying three main sectors of the economy, banking, corporate, and sovereign sector, we determine the dynamics, significance and size of the balance sheet effect and discuss its effects on the economy. In Chapter 2, we explore the banking sector by analysing deposit euroization, or the liability side of banks' balance sheets. We combine the measure of euroization, exchange rates and interest rate differentials in order to model central banks that conduct "fear of floating" monetary policy. Our theoretical setting reflects the dynamics observed in a number of European transition economies, and enables an examination of a bias against exchange rate depreciation and the consequences it has for the banking sector. In order to show that emerging Europe central banks are biased to certain exchange rate movements, i.e. they behave asymmetrically, we allow for nonlinear dynamics in the system. To create a nonlinear framework, we build a TVAR model and present the results using generalized impulse response functions that provide an appropriate setting for representation and discussion of results. This nonlinear feature of Chapter 2 is the biggest contribution to the literature, as there is no existing research of this kind, at least not to our knowledge.

Chapter 2 therefore builds an empirical model of unofficial euroization of the banking sector for 12 emerging European economies. The three-variable model empirically tests

five different hypotheses that determine how highly euroized economies and countries with less flexible exchange rate regimes react differently to exchange rate changes than countries that depict lower levels of unofficial euroization and have more flexible exchange rate regimes. Our results suggest that deposit euroization in countries that have high levels of unofficial euroization increases in the aftermath of exchange rate depreciation. The mechanism promotes itself through the balance sheet effect, as banks' liabilities in the form of deposit euroization rise together with the exchange rate. When exchange rate depreciation expectations increase, central banks intervene by defending the exchange rate, thereby squeezing local currency liquidity that results in higher domestic interest rates. This interest rate differential widening process is contained in our second hypothesis, and corroborated by our empirical results. The third hypothesis closes this loop by stating that deposit euroization increases with interest rate differential widening, a statement also confirmed by our empirical results. Additionally we find that countries with lowest levels of unofficial euroization and flexible exchange rate regimes, Czech Republic and Poland, do not show signs of nonlinear behaviour. Meanwhile, countries with higher levels of deposit euroization in banks' balance sheets and more rigid exchange rate regimes react nonlinearly to exchange rate changes. These results imply that it is highly important for countries to deal with unofficial euroization; either by joining the eurozone, or by managing euroization risks. The most obvious and most effective way would be to decrease euroization, using a myriad of possible measures. The most challenging goal would be to increase macroeconomic and institutional credibility by going through institutional reforms, a road that for example Czech Republic and Poland took in the last ten years. Some other measures would include a preferential treatment of domestic currency holdings, and developing financial products aimed at hedging foreign currency exposures.

In Chapter 3 we directly measure the balance sheet effect of 20 Croatian corporate sectors over a period of eight years and compare the balance sheet effect with the opposite, competitiveness effect. Companies that are highly indebted in foreign currency develop significant currency mismatches in case they are not export-oriented. This makes them highly vulnerable to adverse exchange rate changes, as exchange rate depreciation severely increases debt servicing costs. These costs are generated through the balance sheet effect and they can cause deteriorations in corporate investments, and lead to revenue and profitability losses. We build an empirical model that consists of investment or sales as the dependent variable, and leverage, euroization, balance sheet and competitiveness effects,

and different control variables as the independent variables. This setting allows us to directly measure the size, sign and significance of the balance sheet and competitiveness effects, and to decide on the dominance between these two effects. The importance of measuring the size of the balance sheet effect lies in the threat of freezing investment and credit crunches that can have severe consequences for the whole economy. Theory suggests that even expectations of exchange rate depreciations are enough for the negative scenario to occur, and investments and profitability to deteriorate.

We empirically test four different hypotheses in order to test if highly euroized economic sectors can be negatively affected by exchange rate depreciation. We find that sectors that build high currency mismatches by taking foreign currency denominated debt, suffer from lower business revenues in case their debt servicing costs increase driven by exchange rate depreciation. This result reflects itself in the significant and negative balance sheet effect, but in order to argue that exchange rate depreciations have unfavorable consequences we also test the size and significance of the competitiveness effect. Our results imply that the positive competitiveness effect is much smaller than the negative balance sheet effect, therefore supporting our second hypothesis and the dominance of the balance sheet effect in highly euroized economic sectors. Moreover, we find evidence that companies follow exchange rate volatility expectations, instead of matching their currency structure, when taking foreign currency denominated loans, and that this behavior leads to losses in business performance. We also find one interesting result, venue for further research, as it does not directly deal with euroization or the balance sheet effect. We find evidence in favour of the hypothesis that the lending relationship between banks and companies is based on asymmetries of firm size. Our results indicate that Croatian banks grant less foreign currency loans to bigger companies regardless of their exporting activity, resulting in smaller currency mismatches for large Croatian companies.

This is the first such study for an emerging European country, and a valuable source for policy recommendations. Besides the general remark that euroization should be lowered, another way to decrease currency mismatches in the corporate sector is by supporting exports. However, this goal is to be achieved not by exchange rate depreciation and lower relative export prices, but by using different fiscal and monetary policy instruments. In order to gain more insight into the euroization of the corporate sector, one should conduct a firm-level analysis and provide detailed, tailor-made solutions for fighting currency

mismatches. In that specific case, the question of asymmetric information between banks and firms could be tackled in a more sophisticated manner.

Chapter 4 deals with liability euroization of the sovereign sector of nine European transition economies in the period from 2001 to 2011. We build an empirical model grounded on theories of both balance sheet effects and imperfect capital markets. We add dynamics to the system by using the dynamic panel error correction modelling technique suggested by Pesaran et al. (1999). This methodological framework provides the most effective and most realistic way of measuring sovereign spreads, our dependent variable, as we allow for short-run adjustment to equilibrium and differentiation between short-run and long-run spread determinants. Similar to Chapter 3, we directly incorporate the balance sheet effect as a short-run spread determinant, as we believe that exchange rate expectations are rather volatile and have serious temporary implications. An index of market volatility is added as a short-run variable, together with tax revenues that are expected to decrease sovereign spreads in the short-run. As long-run determinants, we include typical sovereign debt determinants, such as the share of external debt in GDP, international reserves and current account balance.

Our main hypothesis is that countries with large foreign currency denominated debt holdings are subject to possible adverse short-run balance sheet effects that arise in the aftermath of exchange rate depreciations. Due to specific methodological requirements, we tested two hypotheses. First we find that sovereign spreads of European transition economies deviate in the short-run, and then gradually adjust to equilibrium in the long-run. After that we find evidence that higher balance sheet effects lead to higher sovereign spreads, corroborating our main expectations. This main finding is robust, as we verify that these balance sheet effects are a result of exchange rate fluctuations, and not just rising foreign currency denominated debt holdings. Besides the balance sheet effect, we find that fiscal policy and global variables affect spreads in the short-run. More specifically, increasing market volatility causes sovereign spreads to rise, while higher tax revenues tend to decrease sovereign spreads.

The main contribution of Chapter 4 is that it builds a completely new model of sovereign spreads for countries that suffer from “original sin”, as it combines the traditional literature on external debt with the balance sheet effect concept. We explore usually neglected short-run spread determinants, and find that they have serious implications on sovereign spreads

of emerging countries. The main recommendation arising from this study is that countries with large foreign currency denominated debt should avoid large and sudden exchange rate depreciations in order to avoid possible adverse balance sheet effects. Further research in this area should concentrate on two issues. First, domestic debt denominated in foreign currency should be included to the measure of total foreign currency debt, to get a more realistic measure of "original sin". Second, a theoretical model of country risk premium and total debt euroization should be built, in order to make more sophisticated conclusions, projections and recommendations.

The dissertation provides completely new findings surrounding unofficial euroization in European transition economies, as we are using the balance sheet effect framework, and combining different strands of existing research to get novel models and new insights. Analysing one interaction effect, the balance sheet effect, and many other control effects, we explore unofficial euroization of three main sectors of the economy. In all three parts of the dissertation we find that exchange rate depreciation has a negative effect on these three sectors, due to the presence of high unofficial euroization. Exchange rate depreciation therefore tends to further increase deposit euroization of the banking sector, it leads to smaller revenues in the corporate sector, and it increases country risk premium. These results are just warning signs that stronger exchange rate depreciations can form larger balance sheet effects that can eventually lead to declining investment, bank runs, and economic crises, scenarios previously seen in history.

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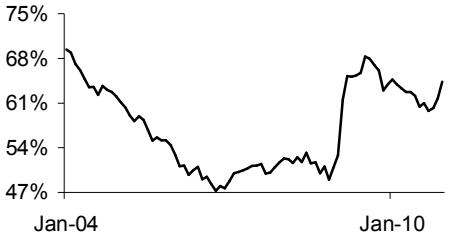
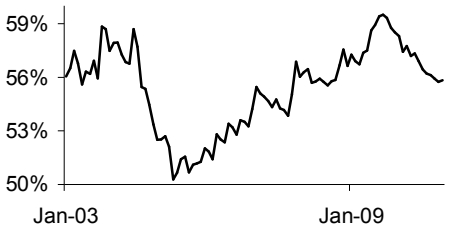
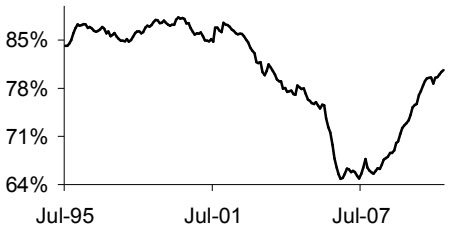
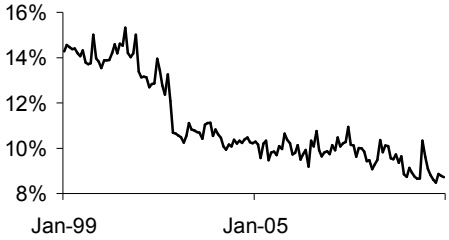
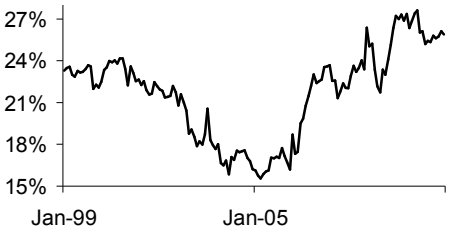
APPENDICES

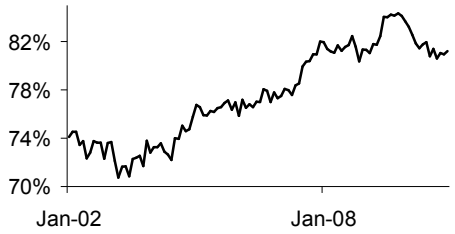
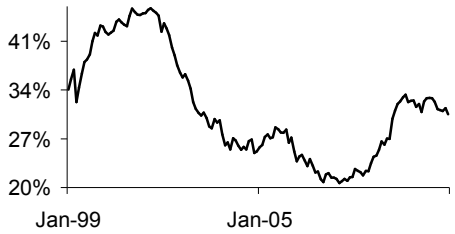
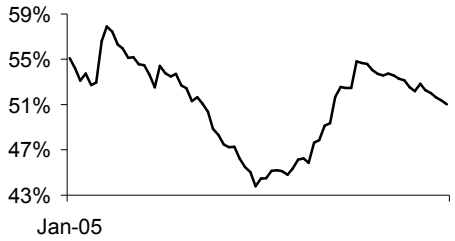
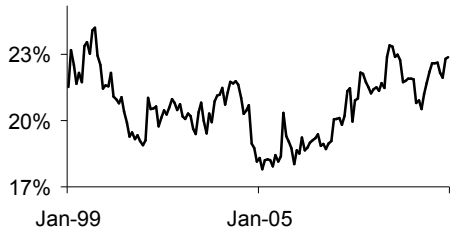
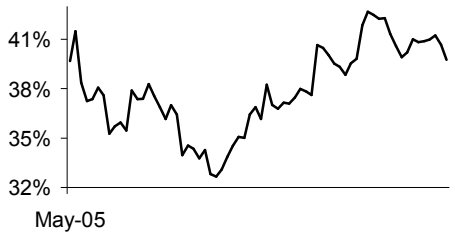
LIST OF APPENDICES

Appendix A: Deposit Euroization Levels and Exchange Rate Regimes

Country	Exchange rate regime	Average DE level in the sample period	DE development
Belarus	Pegged within horizontal bands	57.20%	
Bulgaria	Currency board	55.45%	
Croatia	Stabilized arrangement	80.00%	
Czech Republic	Free float	11.06%	
Hungary	Managed float	21.65%	

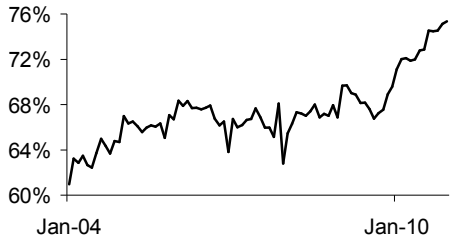
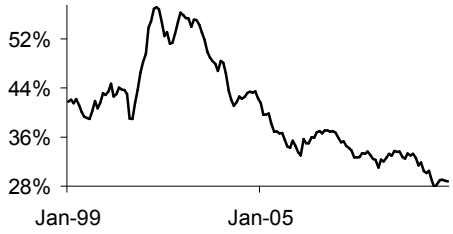
(table continues)

(continued)

Country	Exchange rate regime	Average DE level in the sample period	DE development
Latvia	Pegged to euro	77.63%	
Lithuania	Currency board	31.00%	
Macedonia	Stabilized arrangement	51.21%	
Poland	Free float	20.48%	
Romania	Managed float	37.42%	

(table continues)

(continued)

Country	Exchange rate regime	Average DE level in the sample period	DE development
Serbia	Managed float	67.41%	
Turkey	Free float	40.39%	

Source: Central banks and Eurostat databases; own calculations.

Appendix B: Data Sources and Transformations

Variable	Source	Description
Deposit euroization index	National authorities (central banks) and own calculations	Share of foreign currency deposits (where possible, we add deposits indexed to the foreign currency as well) in total deposits.
Nominal and real effective exchange rate	National authorities (central banks) and Eurostat	Average monthly nominal or real effective exchange rate of the domestic currency to the euro.
Interest rate differential	National authorities (central banks), Eurostat and own calculations	Calculated as the difference between interest rates for a respective country and the euro rate. For the euro rate and for some of the national interest rates, interbank 3-month money market interest rates are used. Where not possible, average short-term interest rates on deposits are used. The unit of measure is a percentage point.

Source: Central banks and Eurostat databases.

Appendix C: General Impulse Response Function Algorithm

This method of calculating impulse response functions for nonlinear models follows Koop et al. (1996). GIRF is defined as a response of a specific variable after a one-time shock hits the forecast of variables in the model. To measure the response of the variable we must compare it against a case in which no shocks occur. Mathematically, this formulation can be expressed as:

$$GIRF_y(m, \varepsilon_t, \Omega_{t-1}) = E\left[y_{t+m}|\varepsilon_t, \Omega_{t-1}\right] - E\left[y_{t+m}|\Omega_{t-1}\right]$$

(A.1)

with m the forecast horizon, ε_t the shock and Ω_{t-1} the initial values of the variables included in the model. The procedure assumes that the nonlinear k-dimensional model is known and requires GIRF is computed by simulating the model. The shock of one standard deviation occurs to the i-th variable (i=1,...,k) of y_t (defined earlier as $y_t = (y_{1t},...,y_{kt})'$) in period 0 with responses calculated for p periods thereafter. The algorithm is as follows:

1. Pick a history Ω_{t-1}^r (where $r = 1,...,R$) that refers to an actual value of the lagged endogenous variable at a particular date r. Since R relates to the values corresponding to the regime, the algorithm has to be carried out twice, for both lower and upper regimes.

2. Pick a sequence of k-dimensional shocks ε_{t+m}^b with $m = 0,...,p$ and $b = 1,...,B$. These shocks are generated by taking bootstrap samples from the estimated residuals of the TVAR model.

3. Using Ω_{t-1}^r and ε_{t+m}^b simulate the evolution of y_{t+m} over $p+1$ periods. The resulting baseline path is given by $y_{t+m}(\Omega_{t-1}^r, \varepsilon_{t+m}^b)$.

4. Substitute ε_{i0} for the i_0 element of ε_{t+m}^b and simulate the evolution of y_{t+m} over $p+1$ periods. In this manner you modify the path of y and by simulating over m periods you get the shocked path $y_{t+m}(\Omega_{t-1}^r, \varepsilon_{t+m}^b)$ for $m = 0,1,...,p$.

5. Repeat steps 2 to 4 B times to get B estimates of the baseline and the shocked path.

6. Take the average over the difference of the B estimates of the baseline and the shocked path. This average will give you an estimate of the expectation y for a given history Ω_{t-1}^{r}.

7. Repeat steps 1 to 6 R times, that is, over all possible histories.

8. Calculate the average GIRF for a given regime with R observations using the following equation:

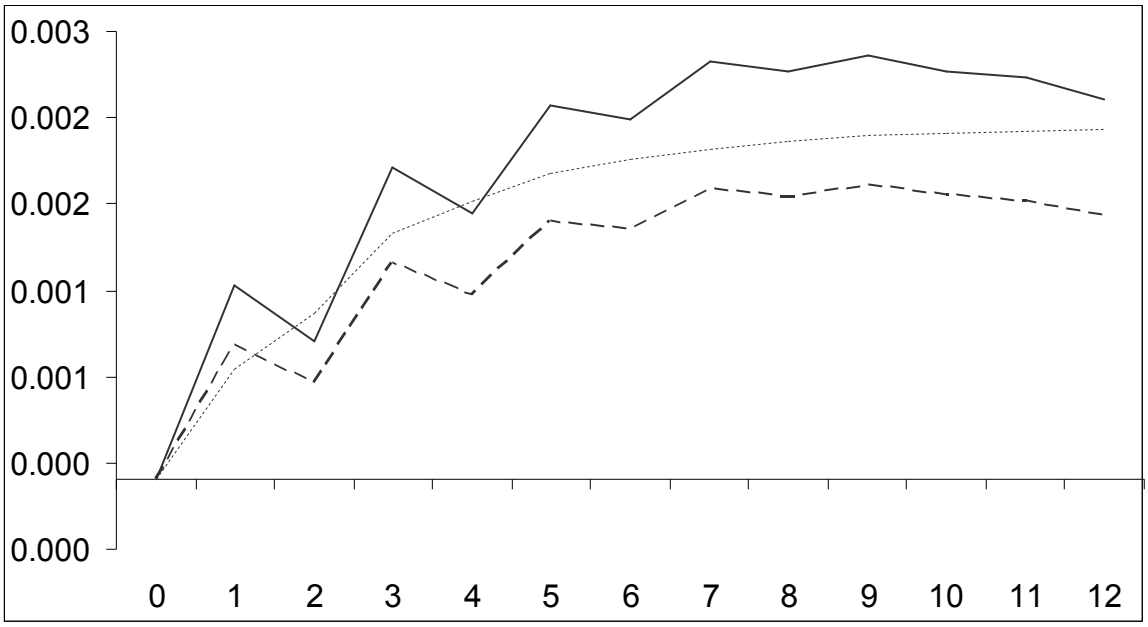
$$y_{t+m}(\varepsilon_{i0}) = \frac{\left[y_{t+m}(\varepsilon_{i0}, \Omega_{t-1}^{r}, \varepsilon_{t+m}^{b}) - y_{t+m}(\Omega_{t-1}^{r}, \varepsilon_{t+m}^{b}) \right]}{BR} \qquad \text{(A.2)}$$

As in Koop et al. (1996), B was set to 100 and R to 500.

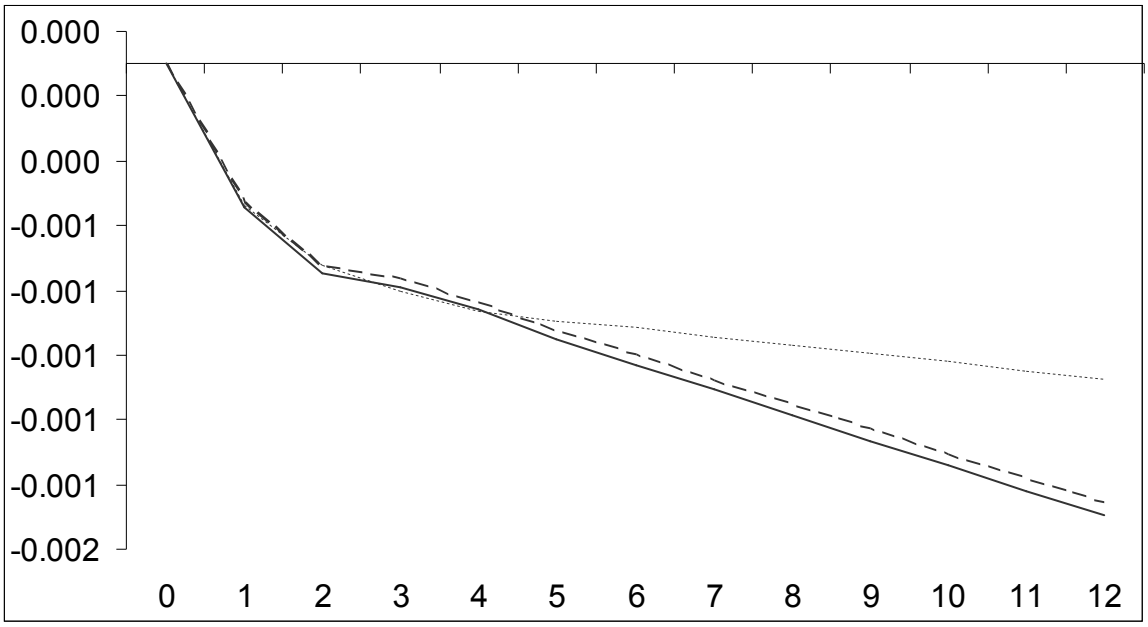
Appendix D: General Impulse Response Functions for the high regime

Effect of positive and negative (one-standard deviation) exchange rate shocks on deposit euroization

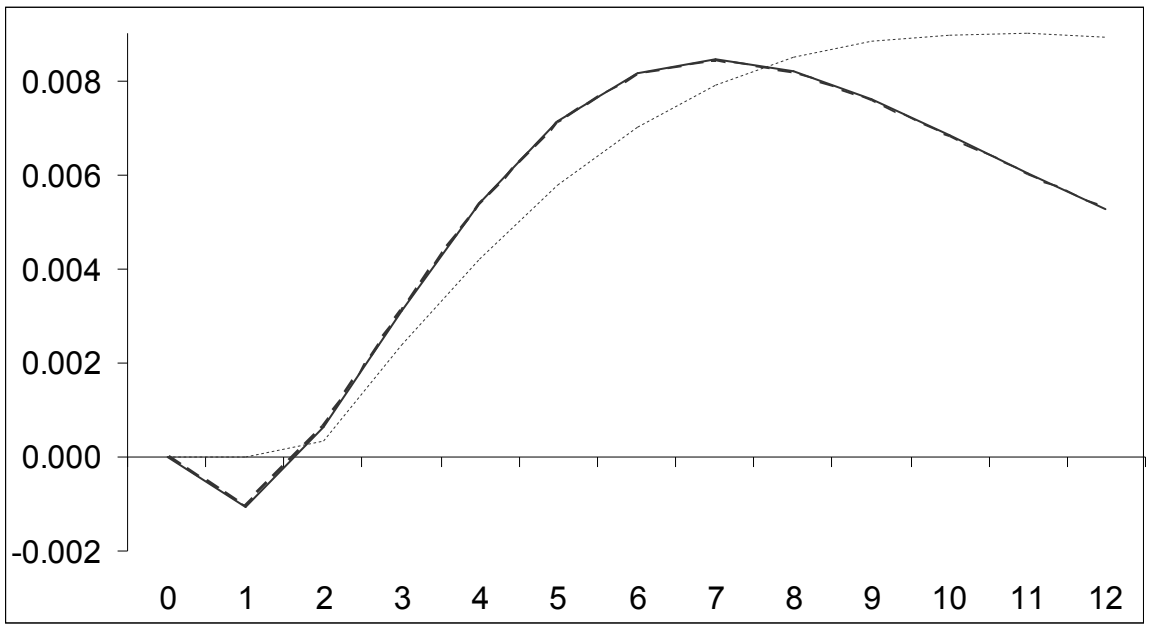
Bulgaria



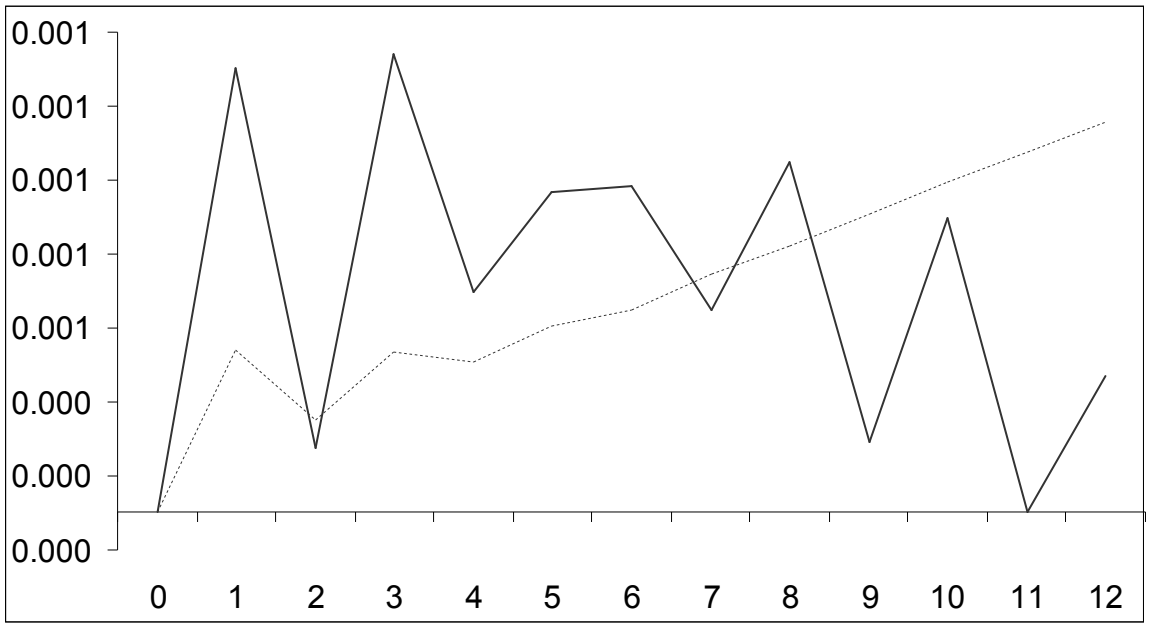
Croatia



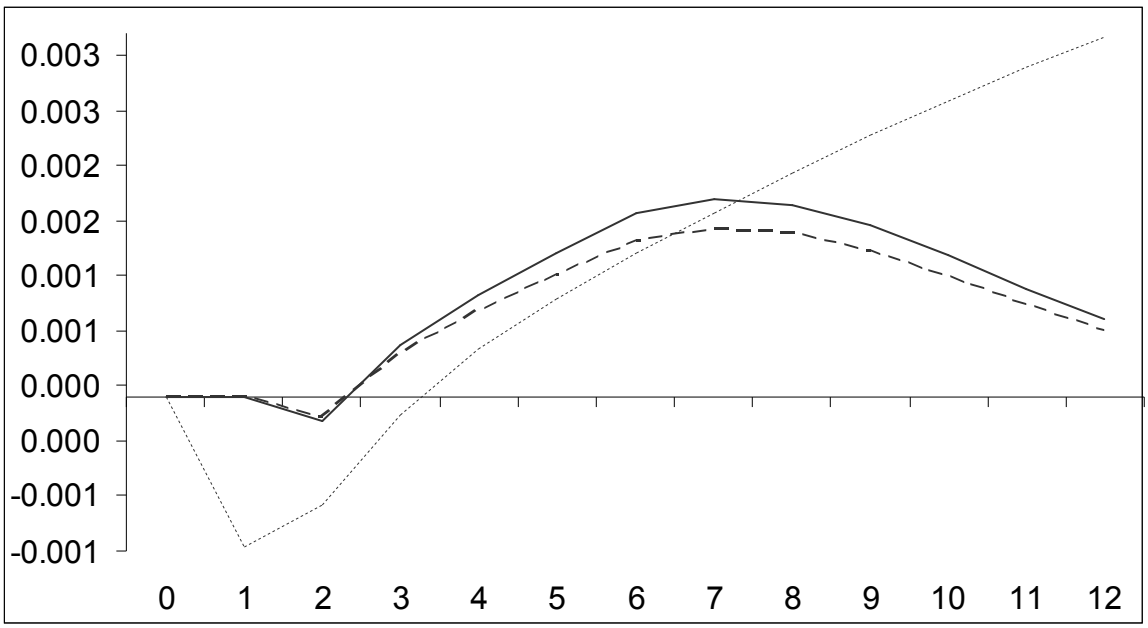
Hungary



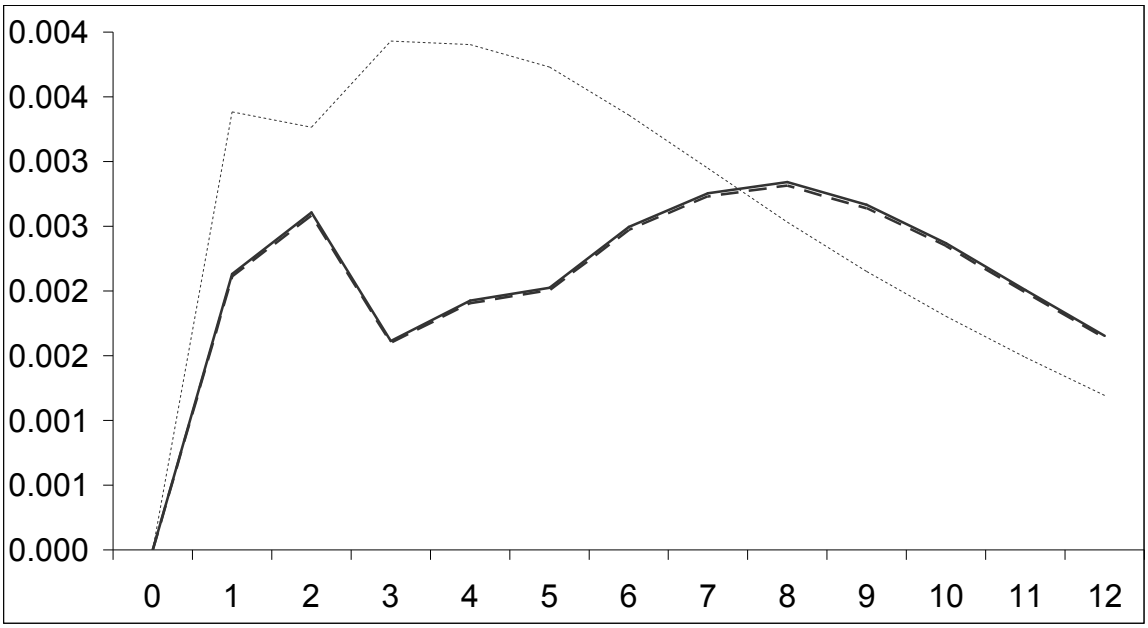
Latvia



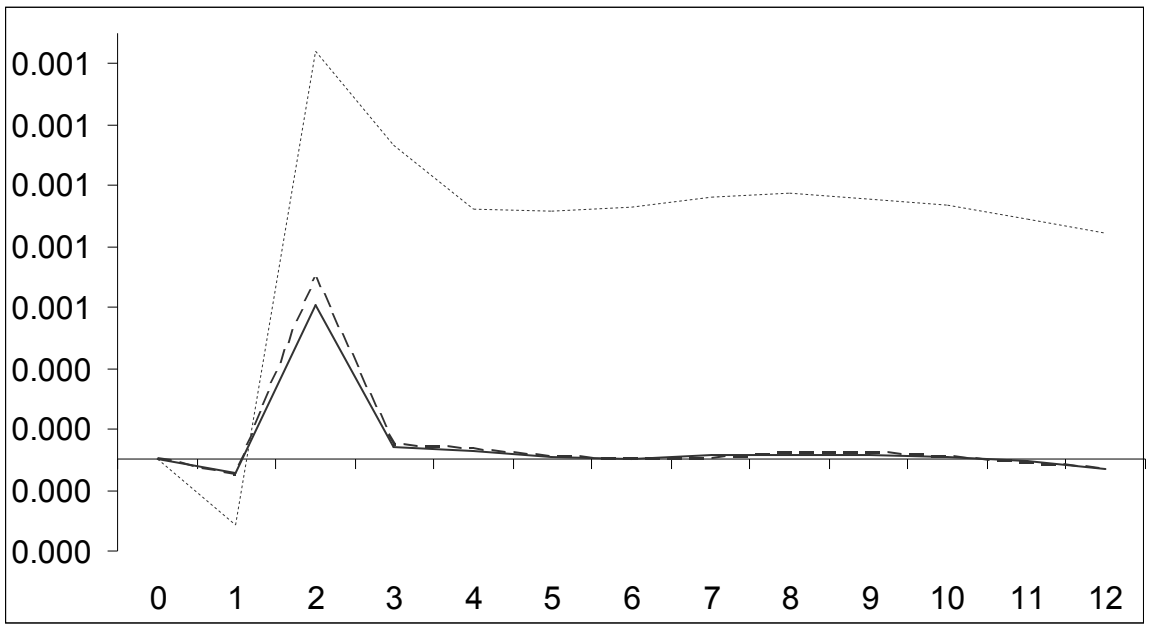
Lithuania



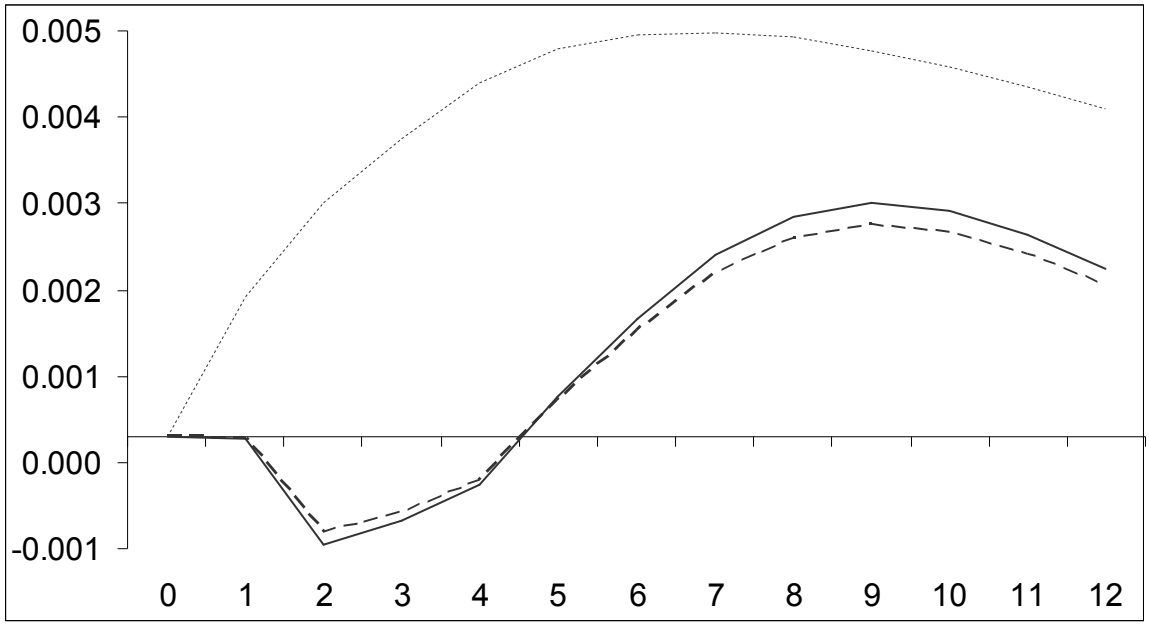
Romania



Serbia

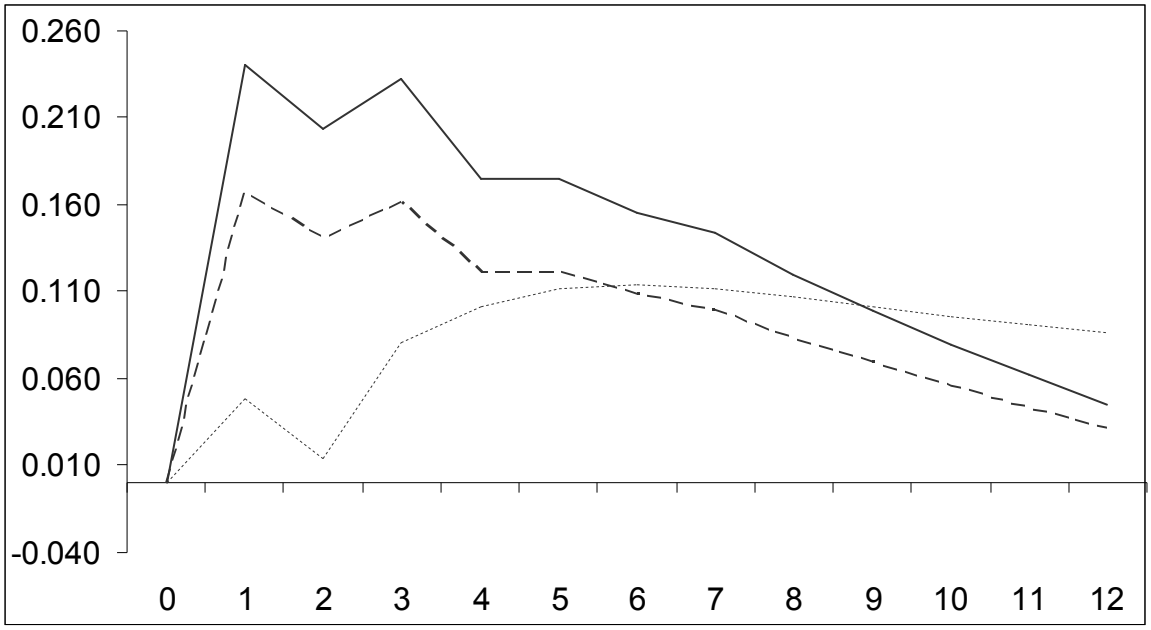


Turkey

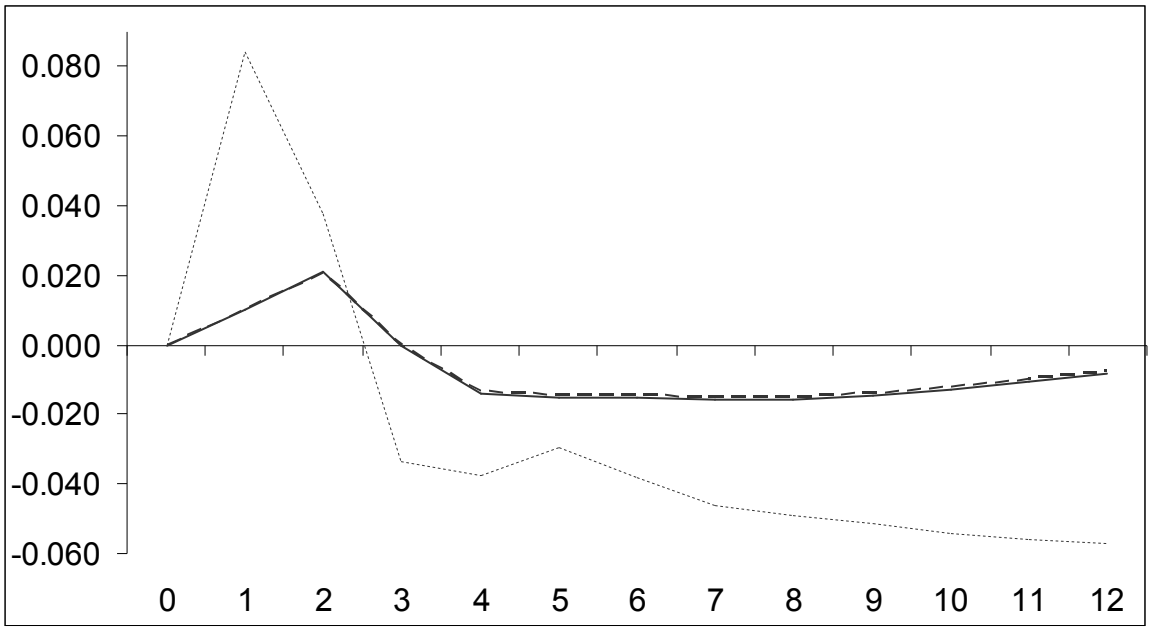


Effect of positive and negative (one-standard deviation) exchange rate shocks on interest rate differential

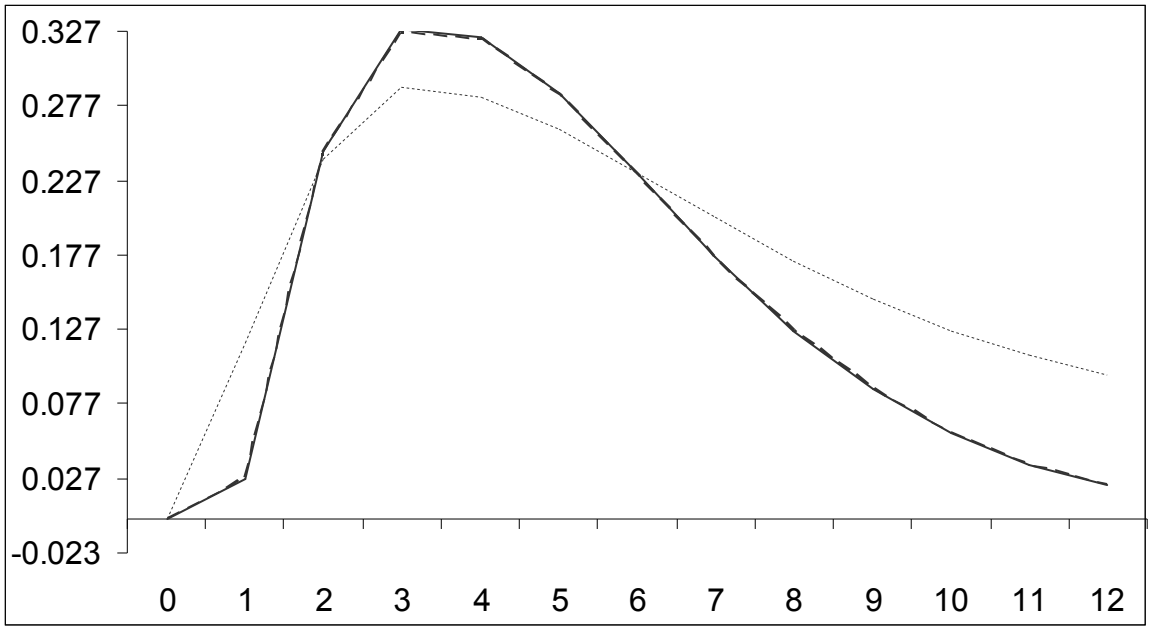
Bulgaria



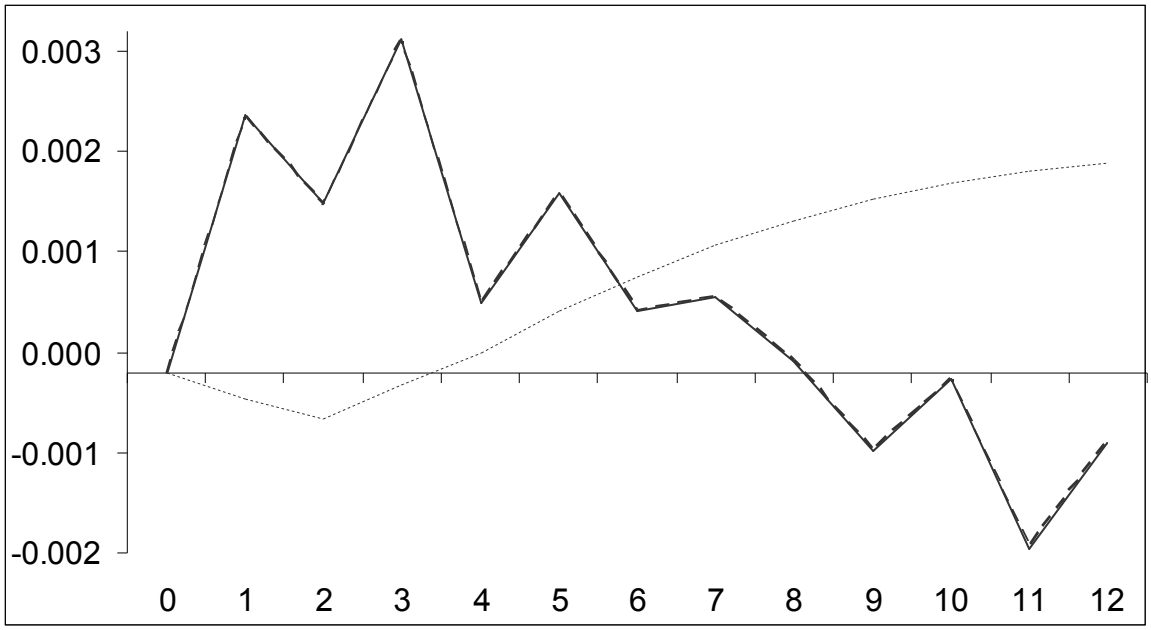
Croatia



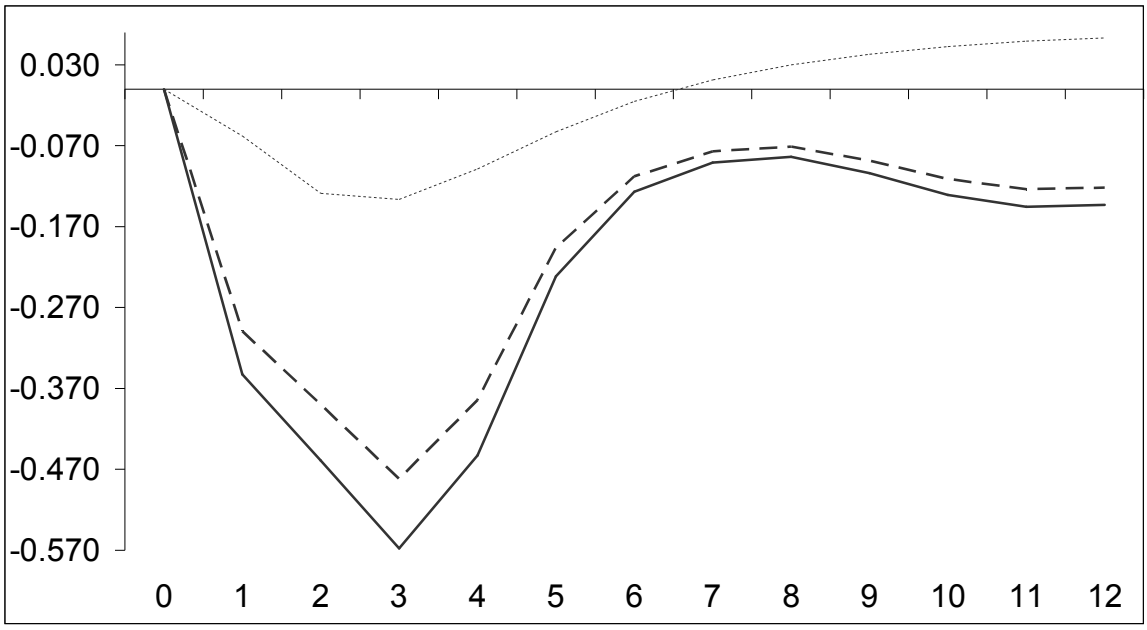
Hungary



Latvia



Lithuania



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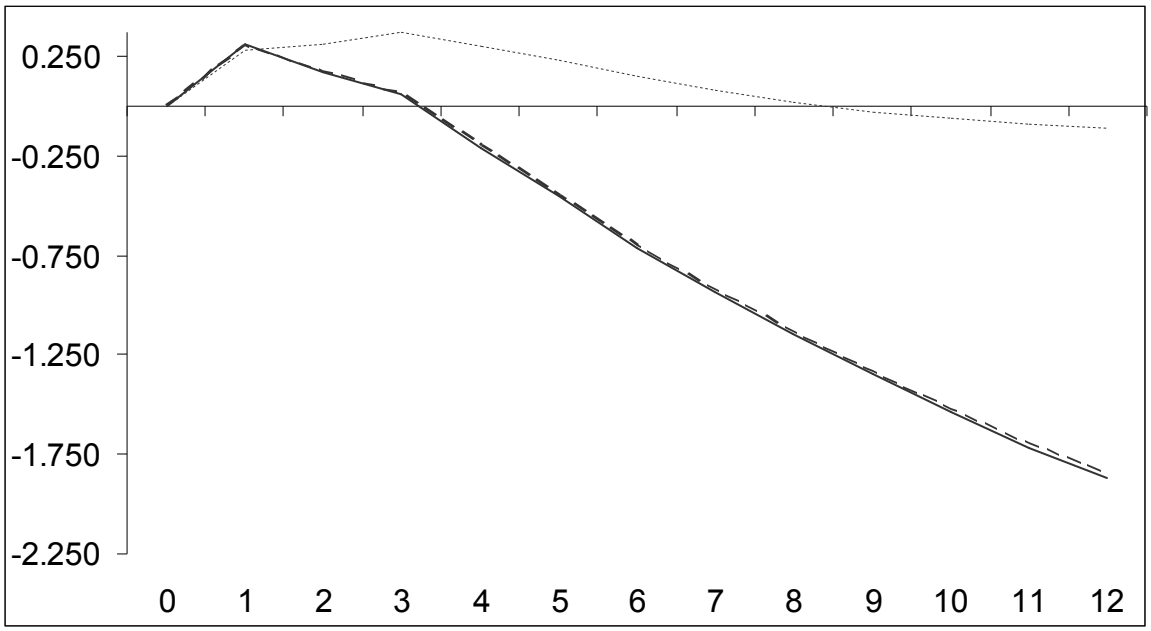

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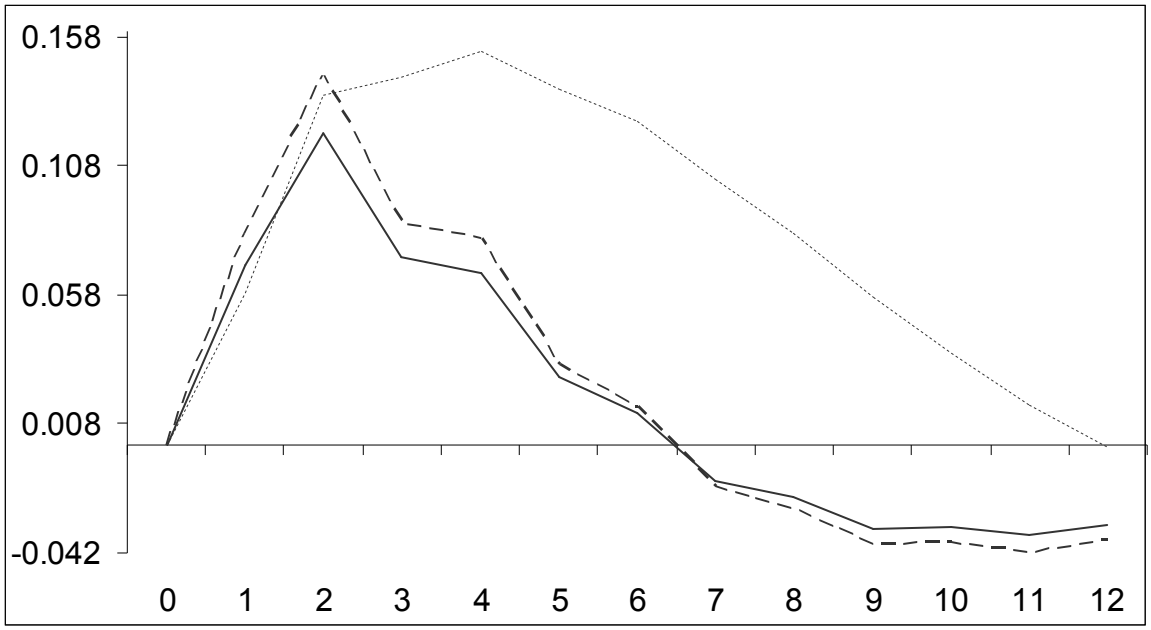
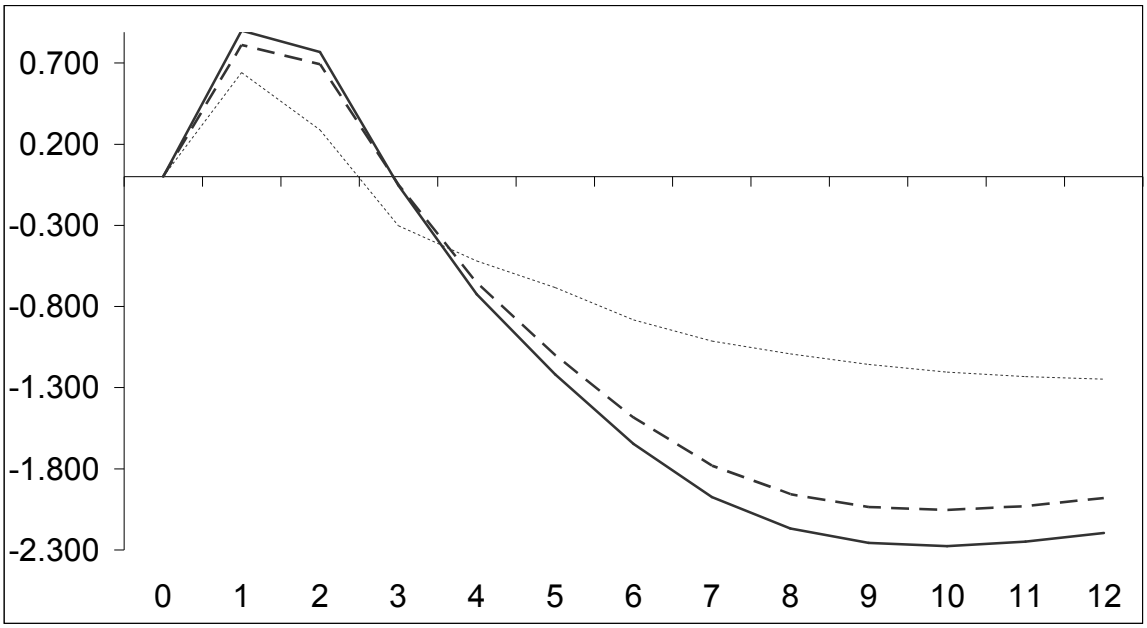
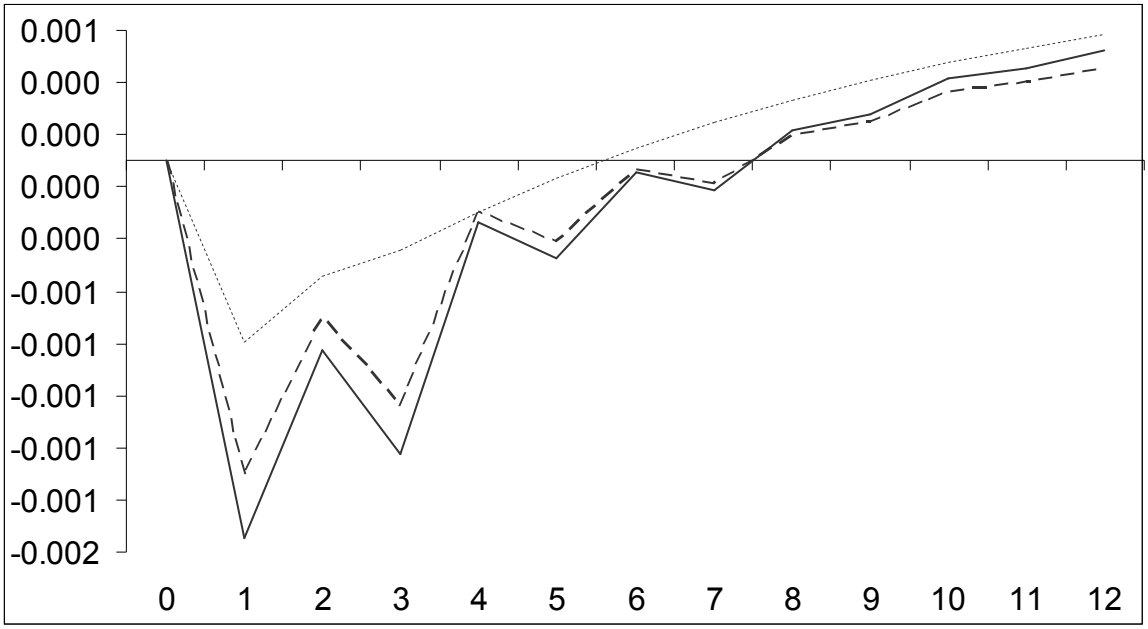


Turkey



Effect of positive and negative (one-standard deviation) interest rate differential shocks on deposit euroization

Bulgaria



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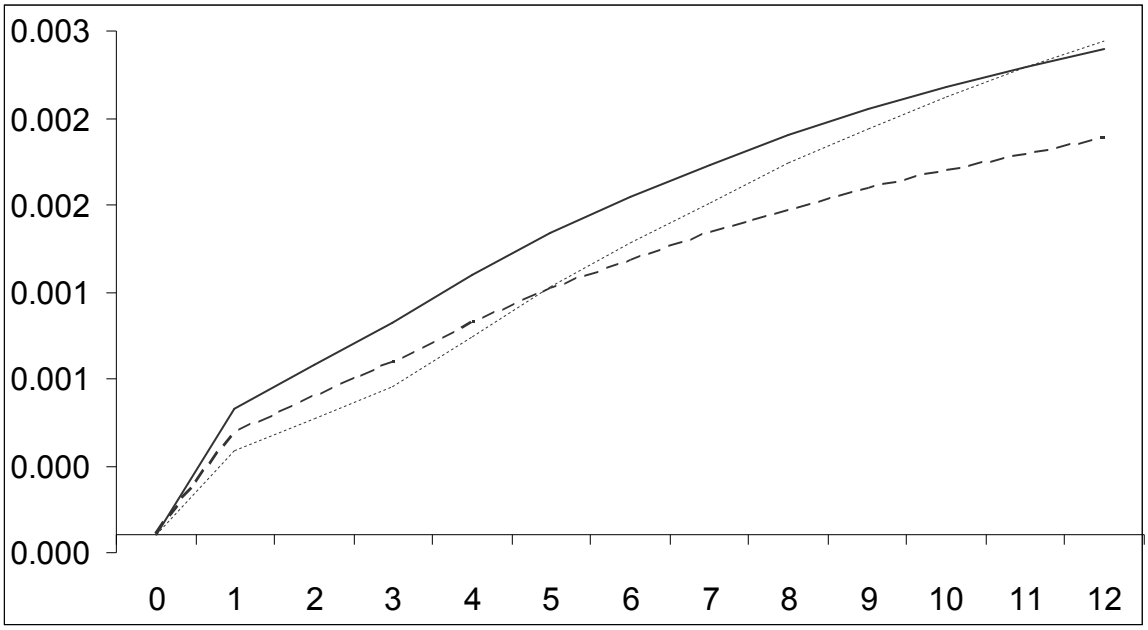
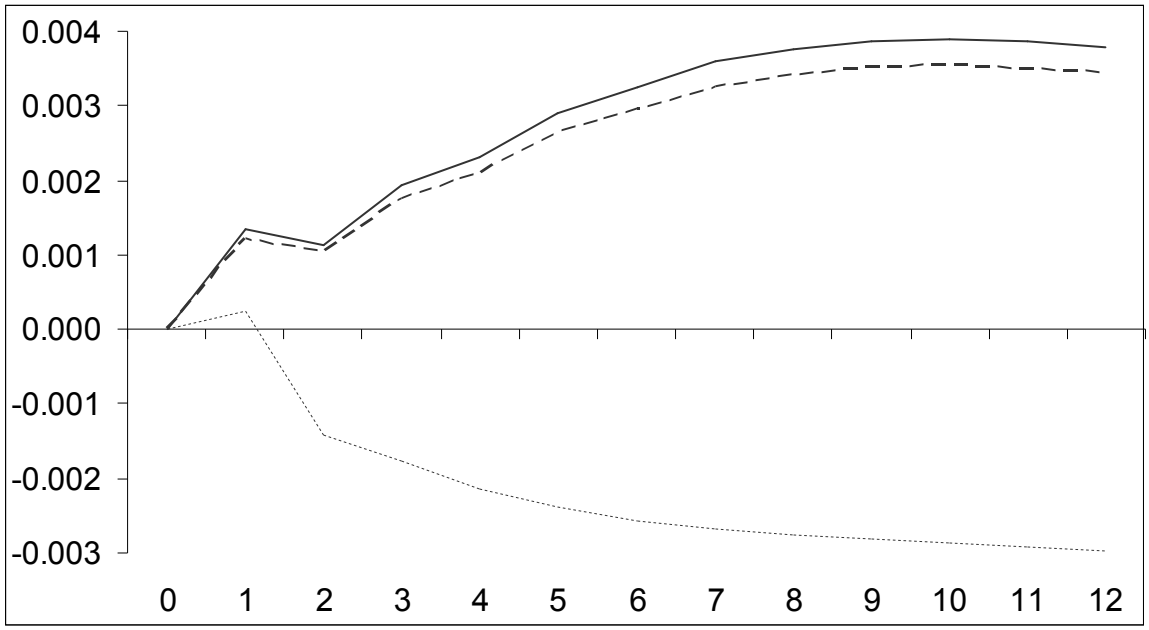
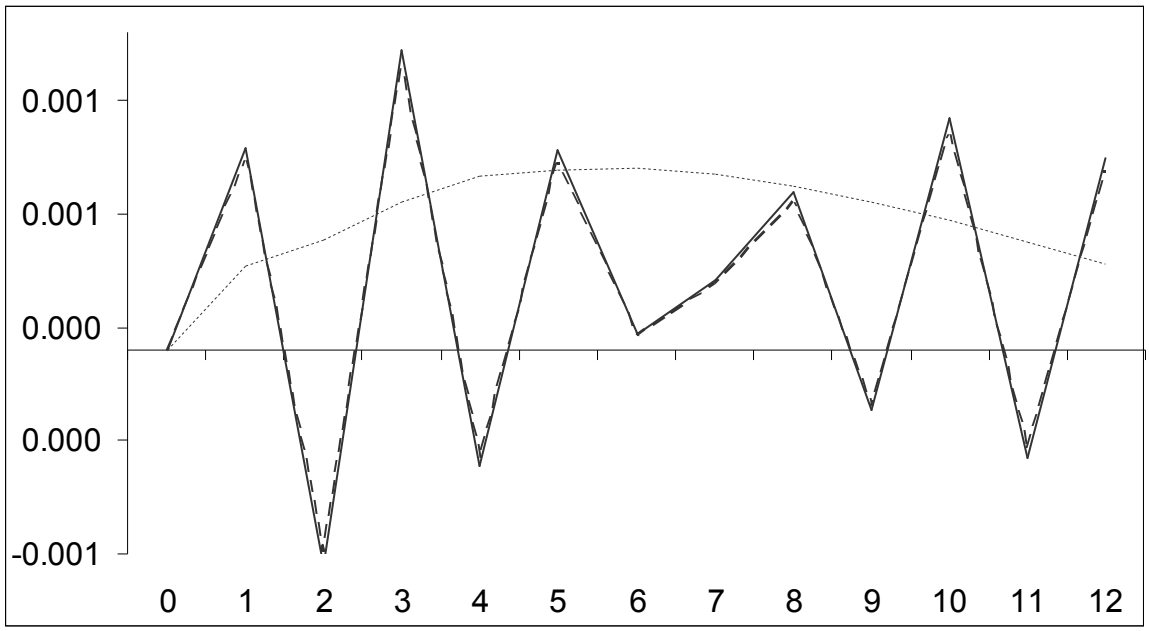


Hungary



Latvia



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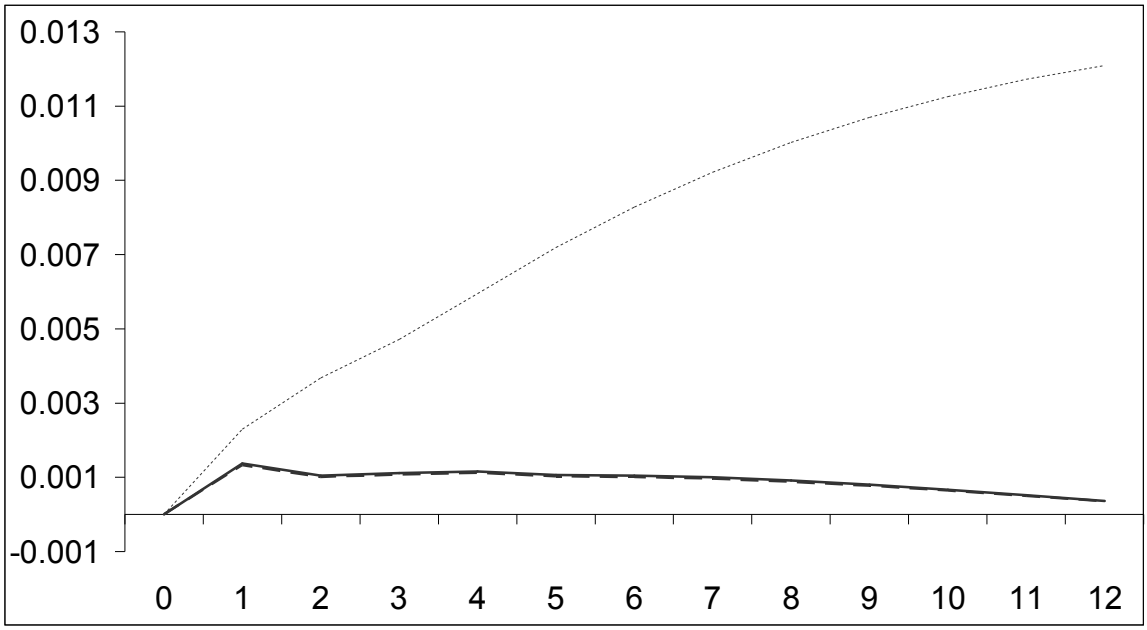

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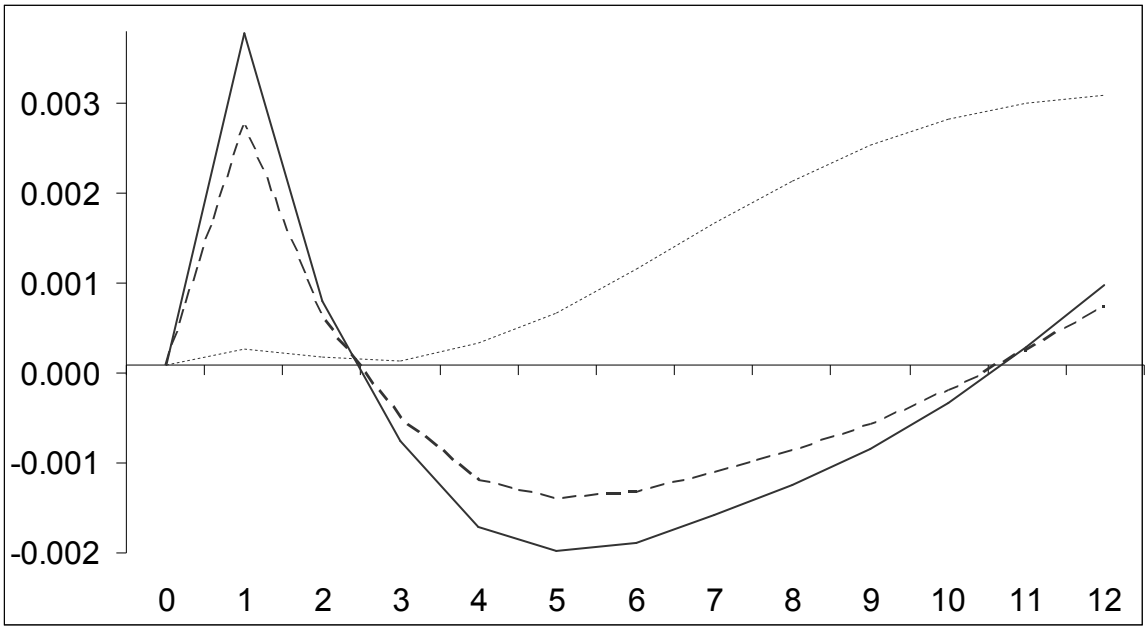
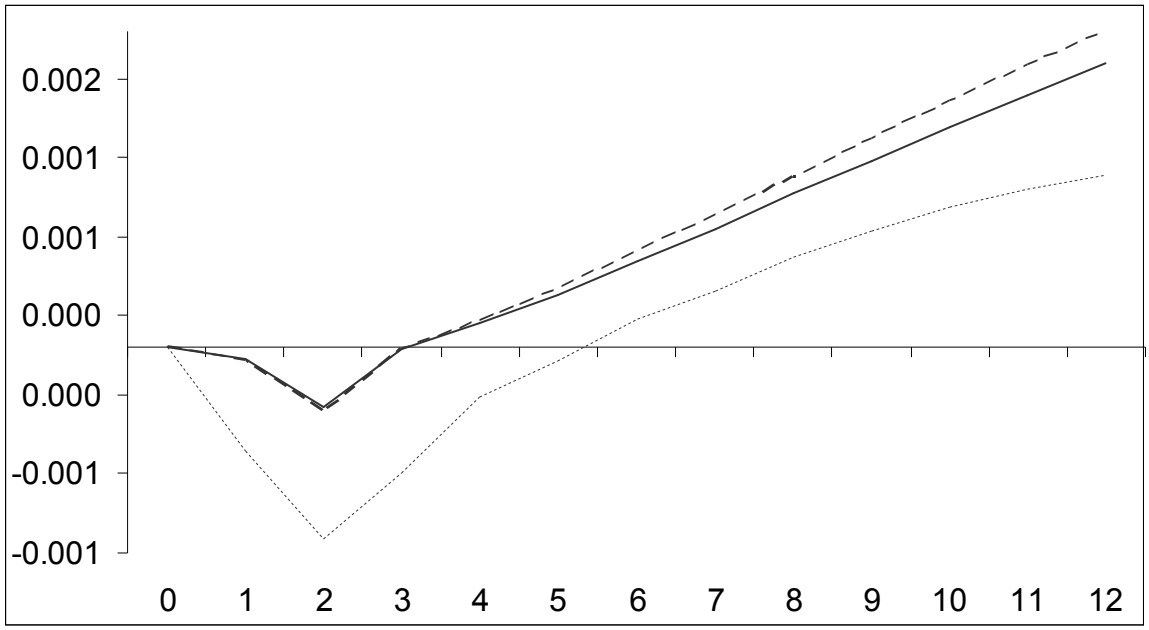
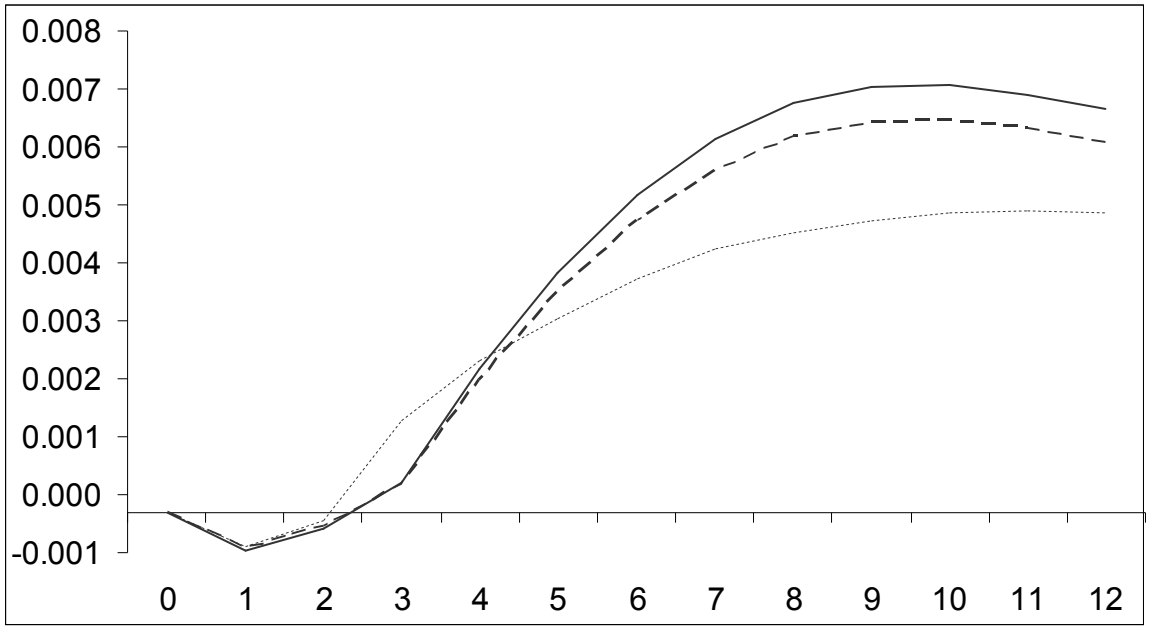


Serbia



Turkey



Note: full line represents a positive shock, broken line a negative shock and dotted line a linear response; periods are presented on the x-axis, while the size of the response can be read from the y-axis.

Source: Central banks and Eurostat databases; own calculations.

Appendix E: Description of the variables

Variable name	Variable	Description
I_{it}	Investment	Year on year growth rate of gross fixed capital formation in new fixed assets. It includes new fixed assets like buildings, equipment, installations, patents, licenses, software, etc. In the specification with sales as the dependent variable, it is used as a lagged variable. Source: Croatian Bureau of Statistics.
RER_t	Real exchange rate index	The real exchange rate is the bilateral nominal average exchange rate between the local currency and the euro adjusted for the inflation differential between Croatia and the European Monetary Union (annual average index 2005=100). The variable is expressed in first differences. Source: Croatian National Bank and Eurostat.
EXP_{it}	Export ratio	The share of business revenues from sales abroad in total business revenues from sales. Source: Croatian National Bank.
$EURO_{it}$	Liability euroization	The share of foreign currency liabilities in total liabilities. All values are expressed in local currency. Source: Croatian National Bank.
LEV_{it}	Leverage	The ratio of total debt to total assets. Source: Croatian National Bank.
$SHORT_{it}$	Short-term liabilities	The share of liabilities with maturities less than one year in total liabilities. Source: Croatian National Bank.
Turnover	Turnover indicator	The ratio of turnover to total assets (case with investment) or alternatively to total claims (case with sales). Source: Croatian National Bank.
Interest rate	Interest rate on credit	Weighted year average interest rate on credit to enterprises (average of long- and short-term credit weighted by the share of such credit in total credit to enterprises). Source: Croatian National Bank.

(table continues)

(continued)

Variable name	Variable	Description
Earnings before taxation	Earnings before taxation	The logarithm of earnings before taxation. Source: Croatian National Bank.
Capital	Subscribed capital	The logarithm of subscribed capital. Source: Croatian National Bank.
Labour	Labour costs	The logarithm of total labour costs. Source: Croatian National Bank.
$ASSETS_{it}$	Total assets	The logarithm of total assets. Source: Croatian National Bank.
Sales	Total sales	The logarithm of total business revenues from sales. Source: Croatian National Bank.
Deposit euroization	Deposit euroization ratio	The share of foreign currency deposits in total deposits. All values are expressed in local currency. Source: Croatian National Bank.
Exchange rate volatility	Exchange rate volatility indicator	Annual average of the daily exchange rate volatility, given by a ratio of standard deviation and average daily exchange rates, in four months prior to the observed period. Source: Croatian National Bank.
Performance	Sectoral performance indicator	The ratio of business revenues to lagged total assets. Source: Croatian National Bank.
Funding	Own funding indicator	Indicator of own funding, defined as ratio of capital to total assets. Source: Croatian National Bank.
Recession	Recession dummy	Dummy variable that takes value 1 for a recessionary year, and value 0 otherwise. Source: Croatian National Bank.

Source: Croatian Bureau of Statistics, Croatian National Bank and Eurostat databases.

Appendix F: Variable description

Variable	Description	Expected sign	Data source
Dependent variable			
Spread	JP Morgan Euro EMBI Global indices equal the returns for US dollar-denominated Brady bonds, loans, and Eurobonds with an outstanding face value of at least $500 million, minus returns for U.S. Treasury bonds with similar maturity. The variable is in logarithms.		JP Morgan
Long-run determinants			
External debt	Gross external debt in millions of Euros, divided by nominal GDP (2005=100) in millions of Euros, and multiplied with 100.	positive	National central banks
Current account	Current account balance in millions of Euros, divided by nominal GDP (2005=100) in millions of Euros, and multiplied with 100.	negative	Eurostat and IMF IFS
International reserves	Official international reserves at the end of the quarter in millions of Euros (excluding gold) divided by nominal GDP (2005=100) in millions of Euros, and multiplied with 100.	negative	IMF IFS
Short-run determinants			
Balance sheet	Equals the product of external debt (see above) and the year-on-year difference in the real exchange rate, where the real exchange rate is defined as the ratio of the nominal bilateral exchange rate (local currency for 1 Euro) and the GDP deflator in national currency (2005=100), divided by 100.	positive	National central banks, Eurostat and own calculation

(table continues)

(continued)

Variable	Description	Expected sign	Data source
Volatility index	CBOE volatility index of investor sentiment and market volatility, calculated as an average quarterly value. The variable is in logarithms.	positive	Chicago Board Options Exchange
Tax revenues	General government tax revenues in millions of Euros, divided by nominal GDP (2005=100) in millions of Euros, and multiplied with 100.	negative	IMF IFS and national treasuries
Export	Export in Euros, calculated as a year-on-year growth rate.	negative	Eurostat and IMF IFS
External debt	Gross external debt in millions of Euros, divided by nominal GDP (2005=100) in millions of Euros, and multiplied with 100.	positive	National central banks
External debt*inflation	Equals the product of external debt (see above), and the GDP price index year-on-year growth rate in Euros (2005=100), divided by 100.	positive	National central banks, Eurostat and own calculation

Note: The sample covers the following emerging economies: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Serbia, Slovak Republic, and Turkey.

Source: Central banks, Chicago Board Options Exchange, Eurostat, IMF IFS and JP Morgan databasess.

DALJŠI POVZETEK DISERTACIJE V SLOVENSKEM JEZIKU

Vrsto evropskih tranzicijskih držav označujejo fiksni in upravljani režim deviznega tečaja ter valutni odbori in fiksiranje tečaja. Zdi se, da je do konca zadnjega tisočletja prevladovalo fiksiranje deviznega tečaja in da je ohranjanje stabilnosti deviznega tečaja, da bi se obdržali depreciacijski pritiski, postala prednostna naloga za številne centralne banke. Ob manifestiranju določenega »fear of floating« (Calvo in Reinhart, 2002) centralne banke uporabljajo neskončno množico orodij, da bi na trgu posredovale in preprečile depreciacijo deviznega tečaja. Centralne banke ne želijo izkusiti depreciacije deviznega tečaja zaradi prisotnosti pomenljive neuradne evroizacije. Za razliko od uradne evroizacije, formalnega sprejema tuje valute kot lastne, je neuradna evroizacija prostovoljno dejanje – uporaba tuje valute kot menjalnega sredstva ali hranilca vrednosti. Če bi bila neuradna evroizacija v gospodarstvu velika, bi depreciacija deviznega tečaja povzročila pomembne težave z odplačevanjem dolga in ustvarila nestabilnosti predvsem v bančnem sistemu. Težava z neuradno evroizacijo je bila zanemarjena predvsem v času neoviranega priliva tuje valute, ko pa je tuji kapital začel uhajati iz evropskih tranzicijskih gospodarstev, se je pojavila težava z evroizacijo. Zaradi globalne finančne krizo so evropska gospodarstva v nastanku utrpela močne depreciacije deviznega tečaja v zadnjem kvartalu leta 2008 in prvem kvartalu 2009. V tem obdobju je »flight to safety« resno grozil makroekonomski stabilnosti tranzicijskih gospodarstev in razkril velike valutne neusklajenosti ter nevarnosti neuradne evroizacije.

Disertacija odgovarja na veliko vprašanj, ki so povezana z neuradno evroizacijo v evropskih tranzicijskih gospodarstvih. Uporablja koncept bilančnega učinka, da bi raziskala povezave med deviznimi tečaji, režimi deviznih tečajev, finančno evroizacijo, korporativno uspešnostjo in spremembami v *spreadu* državnih obveznic. Poleg tega so z disertacijo izmerjeni znaki bilančnega učinka z namenom ugotavljanja, ali je neuradna evroizacija krivec za negativne šoke, ki so nastali kot posledica depreciacije deviznega tečaja, v njej pa je izmerjena tudi velikost bilančnega učinka s ciljem določanja pomembnosti finančne evroizacije v evropskih tranzicijskih gospodarstvih. Raziskava prav tako komentira razlike med državami glede na finančno evroizacijo in režime deviznih tečajev in zagotavlja argumentacijo ter politične posledice za evropske tranzicijske države. Z disertacijo je bilo neposredno izmerjeno nelinearno gibanje finančne evroizacije in zagotovljeni dokazi, da ima depreciacija deviznega tečaja večji vpliv na finančno evroizacijo kot apreciacija deviznega tečaja. Poleg tega delo raziskuje tudi posledice, ki jih

imata neusklajenost valute in depreciacija deviznega tečaja na investicije in prodajo v korporativnem sektorju, pri čemer zagovarja tezo, da obstaja močen negativen bilančni učinek, ki je posledica visoke in vztrajne finančne evroizacije. Na koncu je podana raziskava neuradne evroizacije državnega dolga in posledice, ki jih ima ta na premijo za državno tveganje.

DINAMIKA EVROIZACIJE DEPOZITOV V EVROPSKIH POSTTRANZICIJSKIH DRŽAVAH: PRIMER VEKTORSKE AVTOREGRESIJE Z VKLJUČENIM PRAGOM

V tem poglavju govorimo o bančnem sektorju in njegovih deviznih obveznostih. Če je centralna banka, ki kaže »fear of floating«, izpostavljena napadom depreciacije deviznega tečaja, bo ukrepala na trgu, da bi obdržala stabilen devizni tečaj. To običajno napeljuje k relativno večji količini valute v sistemu in, vsaj kratkoročno, zagotavlja stabilnost deviznega tečaja. Po drugi strani pa vodi tudi k višjim domačim obrestnim meram in običajno višji neuradni evroizaciji. To poglavje preizkuša nelinearne učinke, ki so jih povzročile takšne monetarne politike in meri velikost učinka na finančni sektor in gospodarstvo.

Disertacija torej preizkuša naslednje predpostavke:

H1: Evroizacija depozitov v državah, ki imajo visoko raven neuradne evroizacije, se zvišuje zaradi depreciacije deviznega tečaja.

H2: Diferenciali obrestnih mer v državah, ki imajo visoko raven uradne evroizacije, se razširja po depreciaciji deviznega tečaja.

H3: Evroizacija depozitov v državah, ki imajo visoko raven neuradne evroizacije, se zviša, ko se razširi diferencial obrestnih mer.

Dodatno preizkušamo, ali raven evroizacije depozitov vpliva na velikost nelinearne reakcije in ali je režim deviznega tečaja pomemben.

H4: Države z višjo ravnijo evroizacije depozitov reagirajo nelinearno na spremembe deviznega tečaja.

H5: Države, ki imajo visoko raven neuradne evroizacije in fiksne ali manj fleksibilne režime deviznih tečajev, kažejo nelinearno reakcijo evroizacije depozitov na spremembe deviznega tečaja.

V skladu z opaženim ravnanjem centralne banke in rezultati posredovanj smo v naš model vključili spremembe deviznega tečaja, diferenciale obrestnih mer in evroizacijo depozitov. Evroizacija depozitov je določena kot delež depozitov v tuji valuti v skupnih depozitih in odraža bilančno pasivo banke, del dovzeten za možne neugodne bilančne učinke. S tem ko je izmerjen vpliv depreciacije deviznega tečaja na bančne obveznosti v tuji valuti, je posredno izmerjen tudi bilančni učinek.

S spremljanjem dela Koopa et. al (1996) in Balkea (2000) smo oblikovali model vektorske avtoregresije z vključenim pragom (angl. TVAR):

$$y_t = \Gamma_1 X_t + \Gamma_2 X_t I\left[z_{t-d} \geq z^*\right] + u_t$$

pri čemer je $X_t = (1, y_{t-1}, ..., y_{t-j})'$, gama matrice so matrice koeficienta, u_t je matrica napake, z_{t-d} je spremenljivka praga, z^* pomeni vrednost praga, medtem ko je d parameter premika. Da bi ločili režime, kazalna ima funkcija I vrednost 1, če je spremenljivka praga z_{t-d} nad izbrano vrednostjo praga z^*, drugače pa znaša 0. Formalno preizkušamo nelinearnost zgornjega modela uporabljajoč *pointwise* F statistični Hansenov preizkus (angl. pointwise F-statistic Hansen test) (Hansen, 1996):

$$F_T^* = \sup_{z \in Z} F_T^*(z)$$

$$F_T^* = T\left(\frac{\tilde{\sigma}_T^{*2} - \hat{\sigma}_T^{*2}(z)}{\hat{\sigma}_T^{*2}(z)}\right).$$

Poleg tega smo za pregled odpornosti zasnovali linearni model kot primerjalni indeks, kar pomeni, da je omogočena primerjava pridobljenih rezultatov glede na posamezno državo. Rezultati so predstavljeni v obliki posplošenih funkcij impulznega odziva (angl. generalized impulse response functions), ki razlikujejo med znakom in velikostjo in ki dovoljujejo zamenjavo režimov kot posledico šoka. Naš namen je dokazati, da visoko

evroizirana gospodarstva in tista, ki izvajajo trdnejši režim deviznega tečaja reagirajo na spremembe deviznega tečaja na drugačen način.

Disertacija dokazuje, da depreciacija deviznega tečaja zvišuje evroizacijo depozitov v evropskih tranzicijskih gospodarstvih. Depreciacija deviznega tečaja draži znesek bančnih obveznosti, denominiranih v tuji valuti, in ustvarja večjo obremenitev na eni strani bilance. V sedmih od desetih držav najdemo dokaze, ki podpirajo prvo predpostavko. Ker centralne banke reagirajo na pritiske depreciacije deviznega tečaja s krčenjem presežka likvidnosti lokalne valute in s povečanjem obresti, ni presenetljivo, da najdemo dokaze, ki podpirajo drugo predpostavko. Zanko zapira tretja hipoteza, v kateri evroizacija depozitov raste skozi t.i. mehanizem »fear of floating« , če se razširja diferencial obrestnih mer. Dokaz te trditve zopet najdemo za sedem od desetih držav. Dve državi, ki sta vedno izstopali v okviru prvih treh predpostavk, sta Češka in Poljska. To sta državi , ki imata izmed vseh držav, ki jih raziskujemo, najnižjo raven evroizacije depozitov, in državi, ki sta uvedli inflacijsko ciljanje in ki imata fleksibilne režime deviznih tečajev. Ti dve državi nista opravili našega uradnega izpita za obstoj nelinearnih reakcij evroizacije depozitov na spremembe deviznega tečaja, medtem ko ga je ostalih osem držav opravilo. Ta ugotovitev podpira predpostavko št. 4 in predpostavko št. 5 zaradi dejstva, da ima sedem od osmih držav, ki so opravile preizkus nelinearnosti, nekakšen fiksni ali upravljani režim deviznega tečaja in veliko višjo raven evroizacije depozitov kot Češka in Poljska. Splošni zaključki tega poglavja kažejo, da v bančnem sektorju visoko evroiziranih evropskih tranzicijskih gospodarstev obstajajo bilančni učinki. Poleg tega so ti učinki tudi nelinearni, torej močnejši v primeru depreciacije kot v primeru apreciacije deviznega tečaja.

Navedeni rezultati prispevajo k obstoječi literaturi na več načinov. Kot prvo zagotavljajo nove ugotovitve o determinantah, dinamikah in posledicah evroizacije depozitov v evropskih tranzicijskih gospodarstvih. Za razliko od redkih obstoječih raziskav, ki običajno upoštevajo samo makroekonomske gonilnike evroizacije depozitov, pričujoča raziskava modelira monetarne determinante in povezuje »fear of floating« z raziskavo o neuradni evroizaciji. Poglavitni prispevek raziskave pa je ta, da uporablja nelinearni pristop in empirično dokazuje, da imajo spremembe deviznega tečaja, ki vodijo v depreciacijo, večji učinek na evroizacijo depozitov kot apreciacijske spremembe deviznega tečaja. Kolikor nam je znano je ta študija prva, ki za raziskovanje finančne evroizacije uporablja metodologijo »TVAR« (op. p. vektorska avtoregresija z vključenim pragom).

Rezultati izhajajo iz predlogov za optimalen sklop priporočenih politik, ki so usmerjene v omejitev evroizacije depozitov v posttranzicijski Evropi. Najpreprostejša »izstopna strategija« bi bila sprejeti evro, toda za nekatere države je ta scenarij zaradi težav pri doseganju maastrichtskega kriterija vedno manj verjeten . Druge opcije vključujejo doseganje konvergence, ki bo na koncu bodisi privedla do uvedbe evra bodisi zmanjšala neuradno evroizacijo z uvedbo različnih ukrepov.

NOVI POGLED NA PREVLADO BILANČNEGA UČINKA ALI UČINKA KONKURENČNOSTI DEPRECIACIJE DEVIZNEGA TEČAJA V VISOKO EVROIZIRANEM GOSPODARSTVU

Pri družbah, ki imajo v skupnem dolgu visok delež dolga v tuji valuti, kar se v literaturi prepoznava kot evroizacija obveznosti, obstaja možnost, da bodo trpele za negativnim bilančnim učinkom, če je večina njihovega premoženja denominiranega v lokalni valuti. Ko pride do depreciacije deviznega tečaja, njihovi stroški servisiranja deviznega dolga proporcionalno narastejo in na ta način škodujejo likvidnosti in solventnosti družbe. Čeprav obstaja konsenz o tem, da depreciacija deviznega tečaja pripomore k izvozu, saj se v tem primeru zniža njegova relativna cena, lahko negativni bilančni učinek prevlada nad pozitivnim učinkom konkurenčnosti takrat, ko bilance družb izkazujejo veliko število deviznih obveznosti, ki so višje od deviznih prihodkov. Iz tega razloga se kot posledica depreciacije deviznega tečaja pojavljata dva nasprotujoča si učinka , namreč negativni bilančni učinek in pozitivni učinek konkurenčnosti. Konsenza o tem, kateri učinek dominira, ni, obstaja le soglasje, da bi bilo za vsako državo treba izvesti empirični pregled. (Carranza et al., 2003).

Z namenom, da bi empirično potrdili naša pričakovanja, smo oblikovali in preizkusili naslednje tri predpostavke:

H1: Ekonomska uspešnost sektorja z visokim dolgom, denominiranim v tuji valuti, je negativno prizadeta z depreciacijo deviznega tečaja.

H2: Negativni bilančni učinek dominira nad pozitivnim učinkom konkurenčnosti v sektorjih z visokim dolgom, denominiranim v tuji valuti.

H3: Družbe bolj zaradi nizkih pričakovanj nestabilnosti deviznega tečaja kot zaradi usklajevanja lastne valutne strukture najemajo posojila v tuji valuti, ki imajo na koncu imajo negativen vpliv na poslovno uspešnost.

Hipoteze preizkušamo z ocenjevanjem modela na naslednji način:

$$I_{it} = q_0 + \beta(EURO_{it} \times RER_t) + \gamma(EXP_{it} \times RER_t) + \delta EURO_{it} + \phi LEV_{it-1} + q_2' Z_{it} + \eta_i + e_{it}$$

kjer je I_{it} stopnja rasti investicij (in alternativno prodaje) sektorja i v letu t, je RER_t različica realnega deviznega tečaja, $EURO_{it}$ je evroizacija obveznosti, EXP_{it} je delež izvoza v skupni prodaji, Z_{it} je sklop sektorsko specifičnih spremenljivk, η_i pa je sektorsko specifičen učinek. Kot proučuje Carranza et al. (2003) skupni učinek deviznega tečaja se lahko zapiše kot kombinacija spremenljivk, ki upoštevajo bilančni učinek $EURO_{it} \times RER_t$ oziroma učinek konkurenčnosti $EXP_{it} \times RER_t$. Iz tega razloga zajema β bilančni učinek, ki naj bi bil negativen, medtem ko γ zajema učinek konkurenčnosti, ki naj bi bil pozitiven. Poleg dveh interakcijskih učinkov smo poskušali zajeti tudi čisti učinek evroizacije obveznosti, torej $EURO_{it}$, hkrati ocenjujoč koeficient δ in učinek vzvoda s časovnim premikom (angl. lagged leverage effect), ki ga predstavlja spremenljivka LEV_{it-1}, določena kot razmerje skupnega dolga in premoženja.

Za ocenitev osnovnega modela uporabljamo ekonometrične metode, ki prilagajajo regresijski model panelnim podatkom. Vsi modeli so ocenjeni tako s fiksnim kot s poljubnim učinkom in so kasneje preizkušeni glede na korelacijo med posameznimi učinki in regresorji z uporabo Hausmanovega preizkusa. Če zavrnemo predpostavko, da korelacije ni, ocenjevalec poljubnih učinkov ni dosleden, ocenjevalec fiksnih učinkov pa ostane naprej dosleden in mu zato dajemo prednost, čeprav je po navadi neučinkovit (manj učinkovit).

Poleg tega dodajamo odvisno spremenljivko s časovnim premikom, da bi pojasnili nekatere dinamike, kar privede do naslednje enačbe:

$$I_{it} = \alpha I_{it-1} + \beta(EURO_{it} \times RER_t) + \gamma(EXP_{it} \times RER_t) + \delta EURO_{it} + \phi LEV_{it-1} + q_2' Z_{it} + \eta_i + e_{it}$$

Ta model je ocenjen z uporabo ocenjevalca posplošene metode momentov (angl. generalised method of moments – GMM) v razlikah, ki sta ga razvila Arellano in Bond (1991) in ki rešuje možne endogene težave (ki se pojavljajo zaradi korelacije med regresorji in napako) ter odpravlja fiksne učinke (ker lastnosti časovno nespremenljivega sektorja lahko korelirajo z regresorjem). Poleg tega gre pri dinamičnem modelu tudi za pregled odpornosti pri rezultatih, pridobljenih z ocenjevalci fiksnih ali poljubnih učinkov.

Nadalje smo dodali še eno hipotezo, ki se je pojavila v procesu empiričnega raziskovanja. Ker smo opazili, da velikost, ki jo predstavlja premoženje, vpliva na ustvarjanje dolga v tuji valuti in strukturo zrelosti posojila, smo preizkusili. ali je možno, da v sistemu posojanja med bankami in družbami obstajajo asimetričnosti.

H4: Razmerje posojanja med bankami in družbami temelji na asimetričnostih v velikosti firme.

Ta hipoteza je preizkušena z ocenjevanjem naslednjih dveh modelov:

$$EURO_{it} = \alpha ASSETS_{it} + \beta EXP_{it} + \gamma Z_{it} + e_{it}$$

$$SHORT_{it} = \alpha ASSETS_{it} + \beta EXP_{it} + \gamma Z_{it} + e_{it}$$

pri čemer je $ASSETS_{it}$ logaritem skupnega premoženja in EXP_{it} delež poslovnega prihodka od prodaje v tujini v skupnih poslovnih prihodkih iz prodaje. Da bi ustvarili odvisne spremenljivke, smo domnevali, da so sektorji z evroizacijo obveznosti ali deležem kratkoročnih obveznosti v skupnem znesku obveznosti nad srednjo vrednostjo »zadolženi v evrih« oziroma »kratkoročno zadolženi« in jim je določena vrednost 1, medtem ko je sektorjem pod mediano nakazana vrednost 0 (odvisne spremenljivke $EURO_{it}$, oziroma $SHORT_{it}$). Ker sta ti spremenljivki binarni, smo za ocenjevanje parametrov modelov uporabili model probit.

Kot pričakovano smo dokazali, da ima depreciacija deviznega tečaja negativen učinek na poslovno uspešnost, zlasti merjeno po prodaji. Dokazi negativnega bilančnega učinka kažejo, da so sektorji, ki trpijo za visoko evroizacijo obveznosti, občutljivi na depreciacijo deviznega tečaja, ki na koncu vodi k izgubam učinkovitosti. Prav tako ne zavračamo druge predpostavke, saj ugotavljamo, da je negativni bilančni učinek močnejši od učinka

konkurenčnosti. Splošni učinek depreciacije deviznega tečaja je tako v visoko evroiziranem korporativnem sektorju negativen. To v empiričnem smislu podpira predhodni dokaz v primerih držav Latinske Amerike in Azije in opozarja, da visoko evroizirane države od depreciacije deviznega tečaja ne bodo imele koristi . Nadalje smo preizkusili tudi čisti učinek evroizacije obveznosti in ugotovili, da družbe, ki imajo v svojih bilancah več posojil denominiranih v tuji valuti, trpijo za nižjimi investicijami in prodajo, celo takrat, ko so gibanja deviznega tečaja izločena. Ravno tako smo našli dokaze, ki govorijo v prid četrti predpostavki, saj smo dokazali, da se ustvarjanje obveznosti v tuji valuti zmanjšuje z velikostjo firme. Poleg tega smo pokazali, da imajo večje družbe v skupnih dolgovih v povprečju tudi večji delež kratkoročnih posojil . Takšni zaključki izhajajo iz ravnanja bank, ki je značilno za evropska tranzicijska gospodarstva, kot je že bilo deloma ugotovljeno v Brownu et. al. (2009) in Bassoju et. al. (2011).

Pričujoči rezultati so pomembni ne samo za uvedbo monetarne politike v razmerju do neuradne evroizacije, ampak tudi za oblikovanje ukrepov, ki bodo spodbudili konkurenčnost, razvili dostop do domačih kapitalnih sredstev in promovirali *hedge* priložnosti deviznega tečaja. Ne glede na navedeno pa je glavni prispevek študije ta, da zagotavlja povsem nov dokaz za visoko evroizirano evropsko tranzicijsko državo o prevladi bodisi bilance bodisi učinka konkurenčnosti. Poleg tega gre za edino tovrstno empirično raziskavo na ravni sektorjev za Hrvaško ali, kolikor nam je znano, celo za katero koli evropsko tranzicijsko državo. Nazadnje, z preizkušanjem prisotnosti asimetrične informacije med bankami in družbami prispevamo k literaturi in s tem odpiramo prostor za nadaljnje raziskave.

KRATKOROČNE IN DOLGOROČNE DETERMINANTE *SPREADA* DRŽAVNIH OBVEZNIC »IZVIRNIH GREŠNIKOV«

Zadnji del disertacije se osredotoča na vlado in neuradno evroizacijo državnega dolga. Dejstvo je, da evropska tranzicijska gospodarstva trpijo za »izvirnim grehom« in posledično tudi za možnimi negativnimi bilančnimi učinki. Zato so pričakovanja deviznega tečaja v državah, ki imajo relativno velik znesek dolga, denominiran v tuji valuti, pomembna determinanta povpraševanja po državnih obveznicah in cene obstoječega dolga. Države, ki trpijo za »izvirnim grehom« so dovzetne za negativni bilančni učinek takrat, ko so izpostavljene pričakovanjem depreciacije deviznega tečaja. Negativni bilančni učinek se

v tem okolju manifestira kot pozitiven koeficient, npr. večji je bilančni učinek, večji je tudi *spread* državnih obveznic.

Raziskava se opira na različna področja literature in ustvarja nov model determinant *spreada* državnih obveznic za evropska tranzicijska gospodarstva. Začenja z majhnim odprtim gospodarstvom, ravno tako kot Céspedes, Chang in Velasc (2004) ter Gertler, Gilchrist in Natalucci (2007), nadaljuje pa z dodajanjem drugih dveh konceptov. Najprej podaja neto vrednost in koncept vrednosti zavarovanja po Kiyotakiju in Mooreu (1997). Z uporabo neto vrednosti smo lahko oblikovali učinek pričakovanj deviznega tečaja in trdili, da poslabšanje neto vrednosti, povzročeno z depreciacijo pričakovanj, spodkopava vrednost zavarovanja in potencial države, da izda obveznice ali jih izda po nižjih stroških. Nadalje smo spremljali Berganzo et. al. (2004) in podali spremenljivko, ki predstavlja bilančni učinek, in merili njen vpliv na *spread* državnih obveznic. Toda za razliko od predhodnih raziskav priznavamo, da nekatere determinante vplivajo na razmike zgolj kratkoročno. Posledično smo tako oblikovali model, da bi razlikovali med kratkoročnimi in dolgoročnimi spremenljivkami, s čimer smo sistemu omogočili, da sicer odstopa od ravnovesja, vendar se dolgoročno navsezadnje ustali (Pesaran et. al., 1999). Model smo predstavili v naslednji obliki:

$$\Delta y_{it} = \phi_i \left(y_{i,t-1} - \theta_i^{'} X_{it} \right) + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}^{'*} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it}$$

kjer je y_{it} odvisna spremenljivka ali *spread* državnih obveznic, X_{it} je vektor regresorjev, hitrost obdobja prilagoditve je $\phi_i = -\left(1 - \sum_{j=1}^{p} \lambda_{ij} \right)$, $\theta_i = \frac{\sum_{j=0}^{q} \delta_{ij}}{1 - \sum_{k} \lambda_{ik}}$, $\lambda_{ij}^{*} = -\sum_{m=j+1}^{p} \lambda_{im}$,

$j = 1, 2, ..., p-1$ in $\delta_{ij}^{*} = -\sum_{m=j+1}^{q} \delta_{im}$.

Ta specifikacija vnaša v sistem veliko dinamike, hkrati pa omogoča vsaj kratkoročno diferenciacijo med državami. Z raziskavo smo ustvarili model panelnih podatkov v devetih evropskih tranzicijskih državah in empirično preizkusili njene predpostavke. Prvi dve predpostavki izhajata iz zasnove modela in literature o »izvirnemu grehu«, ki se ujema s pričakovanji in bilančnimi učinki, o katerih razpravljata Jeanne in Wyplosz (2001).

H1: Spread *državnih obveznic v evropskih tranzicijskih gospodarstvih je mogoče oblikovati na način, ki dovoljuje kratkoročna odstopanja in dolgoročne prilagoditve ravnovesju.*

H2: V evropskih tranzicijskih gospodarstvih, ki trpijo za »izvirnim grehom«, obstajajo negativni kratkoročni bilančni učinki na spread *državnih obveznic, npr. večji bilančni učinek vodi k večjemu* spreadu *državnih obveznic. Ti bilančni učinki so med drugim rezultat sprememb deviznega tečaja, ne le večjega dolga, denominiranega v tuji valuti.*

Poleg tega smo oblikovali še dve predpostavki, ki smo ju hoteli preizkusiti v zasnovanem okolju. Natančneje, preizkusili smo ali poleg bilančnega učinka obstajajo še druge kratkoročno pomembne determinante razmika.

H3: Povečanje nestabilnosti trgov kratkoročno zvišuje spread *državnih obveznic.*

H4: Začasni ukrepi fiskalne politike kot so visoki prihodki od davkov vodijo k zmanjšanju spreada *državnih obveznic, ki pa je zgolj kratkoročno.*

Ker smo ugotovili, da je bila hitrost obdobja prilagoditve precej velika in negativna, prve predpostavke nismo zavrnili, saj smo postavili trditev da naš empirični model v resnici kratkoročno odstopa in se navsezadnje dolgoročno prilagaja ravnovesju. Našli smo dokaze, ki podpirajo drugo hipotezo, in dokazali, da višji bilančni učinki povzročajo povečanje *spreada* državnih obveznic, ki zvišujejo stroške zadolženosti. Z empiričnim modelom smo podprli tudi predpostavko št. 3 in predpostavko št. 4 in pokazali, da lahko nižja nestabilnost trga in višji prihodki od davkov vodijo k kratkoročnem zmanjšanju *spreada* državnih obveznic.

Glavni prispevek pričujoče študije je ta, da smo ustvarili model determinant *spreada* državnih obveznic, pri katerem je upoštevan pomemben, a po navadi zanemarjen bilančni učinek. Poleg tega dovoljuje kratkoročne dinamike, saj smo v empiričnem smislu opazili, da obstajajo spremenljivke, ki vplivajo na *spread* državnih obveznic le na kratek rok. Ker je »izvirni greh« spremenljivka, ki je značilna za vsako državo posebej, naj bi bilo dovoljeno, da se potencialni bilančni učinki in kratkoročna odstopanja, ki iz tega izhajajo, razlikujeta od države do države. Raziskava je med drugim tudi prispevek k literaturi, saj

vključuje podatke o najnovejši finančni krizi in upošteva države, ki prej niso bile dovolj zastopane, na primer Hrvaška, Srbija in Turčija.

Disertacija ponuja povsem nove ugotovitve, ki se nanašajo na neuradno evroizacijo in evropska tranzicijska gospodarstva, saj uporablja okvir bilančnega učinka in kombinira različna področja obstoječih raziskav z namenom oblikovanja novih modelov in za pridobitev novih vpogledov. Z analizo enega interakcijskega učinka, bilančnega učinka in veliko drugih kontrolnih učinkov smo raziskali neuradno evroizacijo treh glavnih gospodarskih sektorjev. V vseh treh delih disertacije smo pokazali, da depreciacija deviznega tečaja zaradi prisotnosti visoke neuradne evroizacije negativno vpliva na omenjene tri sektorje . Depreciacija deviznega tečaja lahko zaradi tega privede k nadaljnjem zvišanju evroizacije depozitov bančnega sektorja, vodi k manjšim prihodkom v korporativnem sektorju in zviša premijo za državno tveganje. Ti rezultati so samo opozorilni znaki, ki kažejo, da lahko močnejša depreciacija deviznega tečaja tvori večje bilančne učinke, ki lahko na koncu pripeljejo k zaustavitvi investicij, umiku depozitov iz bank in ekonomskih krizah, k scenariju, ki smo ga v zgodovini že srečali.