The impact of housing markets on banks' risk-taking behavior: evidence from CESEE

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This study empirically evaluates the impact of housing market dynamics and banks' housing market exposure on banking sector stability in Central, Eastern and Southeastern Europe (CESEE). We investigate whether there are differences between the behavior of banks located in CESEE EU Member States and the behavior of banks located in the Western Balkans. We find evidence that banks' exposure to the housing market has a significant positive impact on bank stability in both groups of countries. Furthermore, for real estate banks in CESEE EU Member States, we find that house price dynamics are positively correlated with bank stability. This outcome may possibly be related to the fact that real estate banks in these countries have better housing market expertise and, moreover, to the generally more advanced institutional environment. At the same time, we find a negative relationship between house price dynamics and bank stability for real estate banks in the Western Balkans, which might reflect the less advanced stage of institutional development in the region.

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The global financial crisis emphasized the devastating effect that the collapse of housing markets can have on the real economy and on bank stability. Therefore, investigating the relationship between housing finance, housing markets and bank risk remains important. Bank risk is closely related to the real estate market, not only because property is used as loan collateral, but also because housing finance depends on banking products. Therefore, real estate market developments can significantly influence bank performance and bank risk.

Based on previous literature (e.g. Banai and Vágó, 2018; Koetter and Poghosyan, 2010), there are two different hypotheses how house price dynamics can affect bank risk: the collateral value hypothesis and the deviation hypothesis. According to the collateral value hypothesis, an increase in house prices boosts the value of collateral pledged by borrowers and lowers credit default risk (Daglish, 2009). Therefore, the collateral hypothesis suggests a negative relationship between house prices and bank risk and a positive relationship between house prices and bank stability. The deviation hypothesis, by contrast, assumes a positive link between house prices and bank risk. According to this hypothesis, a persistent increase in house prices results in higher demand for bank financing (or mortgage) and a higher exposure of banks to bank lending for housing, accompanied by relaxed credit standards, and in excessive lending to risky borrowers, which in turn results in the stronger accumulation of risky assets and an overall higher risk-taking of banks.

Considering the important effect that real estate markets can have on bank stability, a growing body of literature investigates the link between housing markets and banks. However, the empirical literature which covers this topic with

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respect to Central, Eastern and Southeastern Europe (CESEE) is still limited. The main reasons are data limitations and the fact that housing markets in CESEE, and particularly in the Western Balkans, are still relatively new. The aim of this study is to take a closer look at the importance of housing markets and bank stability in CESEE and to understand whether banks' exposure to housing market developments plays a role in this relationship.

We focus on CESEE countries, where housing markets developed from scratch after the fall of the Iron Curtain and involved major transfers of ownership rights. We cover both CESEE countries that have already joined the EU and Western Balkan countries that aspire to join the EU.[2] In some of these countries, particularly in the non-EU countries, housing markets are still undergoing structural changes and still face institutional deficiencies, for example with regard to ownership rights. Further key features of the CESEE countries are their very high homeownership rates and almost nonexistent rental markets. Against this background, housing market analyses are of particular relevance for the authorities in this region in supporting the development of their macroprudential tools and, eventually, in ensuring financial stability in their countries. To our knowledge, there has not been any cross-country research so far on the risk-taking behavior of banks in CESEE in relation to their exposure to housing markets and housing market dynamics. Therefore, the contribution of this study is to provide empirical evidence of the impact of housing markets on the risk-taking behavior of banks in CESEE.

Based on banking data for 16 CESEE countries for the period from 2010 to 2016, we estimate the impact that bank lending for housing and housing markets have on bank stability as measured by banks' z-score. The z-score compares buffers (banks' capitalization and returns) with risk (the volatility of returns) to measure a bank's solvency risk. It is widely used and clearly shows a negative relationship to the probability of financial institutions' insolvency: A higher z-score implies a lower probability of default. We also use the ratio of nonperforming loans (NPLs) as a measure of banks' credit risk to check the robustness of our results. Our final sample comprises 176 banks[3] in 11 CESEE EU Member States and 5 Western Balkan countries. Apart from bank-specific variables, we include control variables to account for economic and institutional developments in the countries covered by our sample. In addition, we look at differences between banks located in CESEE EU Member States and banks in the Western Balkans. Based on the Generalized Method of Moments (GMM) approach as proposed by Arellano and Bond (1991), we find that the exposure of banks to housing markets has a positive impact on bank stability in both country groups. This outcome might indicate that bank lending for housing provides some stability to banks in these regions. Nevertheless, we find a mixed impact of house price dynamics on bank stability. Increasing house prices positively affect the stability of real estate banks operating in the CESEE EU Member States, while the opposite is true for the Western Balkans, where accelerating house prices seem to increase banks' risks. In our view, this outcome could be related to the more sophisticated housing market expertise of banks in the CESEE EU Member

[2] *We cover the CESEE EU Member States (CESEE-EU) Bulgaria, the Czech Republic, Estonia, Croatia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia and Slovakia, as well as the Western Balkan countries Albania, Bosnia and Herzegovina, Montenegro, North Macedonia, and Serbia. Due to data limitations, our analysis does not cover Kosovo.*

[3] *We included all banks with a market share of more than 2%.*

States and to the fact that housing markets in general function better in the CESEE EU Member States. Moreover, these countries have more sophisticated tools and better data at their disposal to assess the value of the collateral of real estate banks and better rule of law. For the Western Balkan countries, real estate banks seem to take higher risks related to house price dynamics than non-real estate banks despite rather moderate house price movements over our observation period. The negative impact of house price dynamics could possibly be linked to the fact that in the Western Balkans, the institutional setup is much weaker and banking and housing markets are less developed than in the CESEE EU Member States.

This paper is structured as follows: Section 1 provides a brief literature review, section 2 offers some stylized facts followed by the description of the data we use for our empirical analysis in section 3. Section 4 explains the empirical model we applied, section 5 discusses our main results, section 6 describes the robustness checks we carried out and section 7 concludes.

1 Literature review

The importance of housing markets for the overall economy as well as for financial stability has been well acknowledged (e.g. Borio and Drehmann, 2009; Cerutti et al., 2017; IMF, 2011). Residential property is one of the major components of households' wealth, and house price developments influence the saving and expenditure decisions of individuals. The housing sector is also strongly linked to the construction sector, which makes a significant contribution to gross value added in all CESEE countries. Furthermore, and most relevant to this study, the housing sector is strongly interlinked with financial institutions, as became obvious during the recent global financial crisis. These interlinkages are attributable to the fact that housing transactions are mostly financed by loans and that property constitutes an important type of collateral for bank lending.

Several studies have analyzed the links between housing markets and bank stability. The studies generally differ with regard to country and time coverage and methodology, and their results are often contradictory. One strand of literature comprises single-country studies. Blasko and Sinkey (2006) covered a large sample of U.S. commercial banks for the period from 1989 to 1996. Their main conclusion is that banks with a large exposure to the real estate market take higher risks and therefore have a higher probability of default. Koetter and Poghosyan (2010) focused on the German housing market and find that deviations of house prices from their fundamentals negatively influence bank stability because of overly risky lending. Rebi (2016) showed for the Albanian banking sector that banks with a higher exposure to the housing market take a higher risk than banks with less exposure. The impact was even stronger when housing market exposure interacted with house price dynamics. In a recent study, Banai and Vágó (2018) analyzed the Hungarian banking sector for the period from 1998 to 2016. The results show that higher house prices drive up bank risk. Furthermore, a higher exposure of banks to the housing market intensifies the impact of accelerating house prices on bank risk. The other strand of literature encompasses cross-country studies. For Western European banks, Gibilaro and Mattarocci (2016) analyzed the impact of housing market dynamics for the period from 2004 to 2011. Overall, the authors showed that the exposure of Western European banks to the real estate market influences banks' risk-taking behavior, making real estate banks more resilient than non-real estate banks. Moreover, house price dynamics affect real estate banks less, possibly because specialized banks know real estate markets better and have better risk management capacities. A similar study by Morgan and Zhang (2015) of 19 Asian emerging economies found evidence that the exposure to housing markets positively influences bank stability but only up to a certain threshold. Housing market exposure above this threshold jeopardizes bank stability. For U.S. and EU banks, Altunbas, Manganelli and Marqués-Ibáñez (2017) analyzed how specific bank characteristics observed before the crisis are related to bank distress during the crisis. The authors also incorporated information on real estate developments and concluded that higher real estate exposure translates into higher bank risk.

Several studies emphasize the importance of the institutional environment for the relation between housing market developments and the banking sector. The IMF (2011) highlighted that legal institutions and instruments (such as accessible land registries and bankruptcy laws) are key for the efficient functioning of housing markets, for housing finance and, eventually, for bank stability. Also, Koetter and Poghosyan (2010) argue that the impact of housing markets on bank risk is strongly connected to the functioning of the housing market and the existence of market imperfections. According to the World Bank (2018), the CESEE EU Member States rank better, on average, than the Western Balkan countries with regard to the enforcement of contracts or the registering of property.[4] As institutional factors are highly relevant for the smooth functioning of housing markets, we tested whether there is any difference in the impact of housing market dynamics between the two country groups.

2 Stylized facts

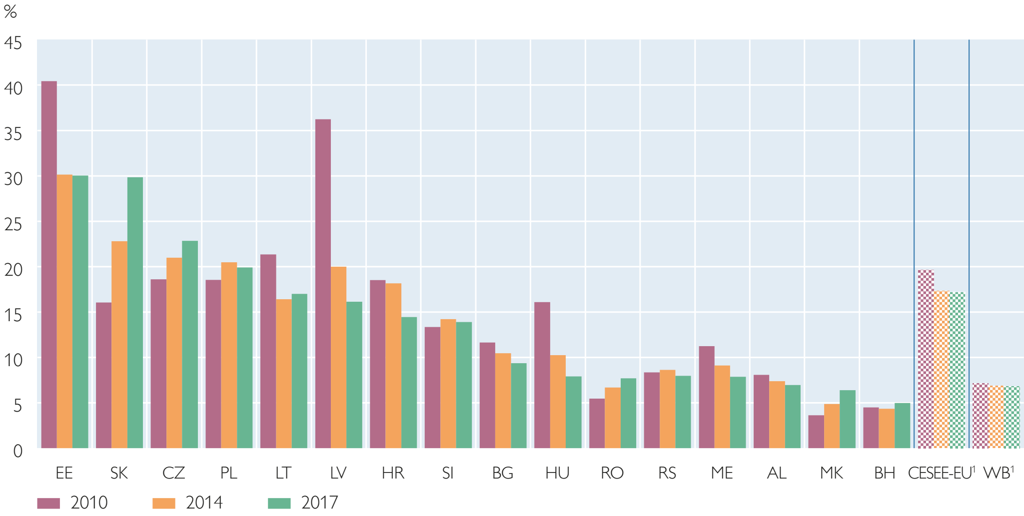
Bank lending for housing represents an important part of financial intermediation in most CESEE countries. However, there are large differences between countries with regard to the volume of housing loans in relation to the respective country's GDP. Noticeably, all Western Balkan countries report a lower ratio than the CESEE EU Member States, indicating their lower level of financial development. Furthermore, housing loan dynamics differ across countries: In some countries, such as in Estonia or Latvia, the share of housing loans in GDP moved downward between 2010 and 2017 (albeit from very elevated levels), while others recorded accelerating shares of housing loans in GDP (most notably the Czech Republic and Slovakia). In the Western Balkans, the – relatively low – ratio of housing loans to GDP remained more or less unchanged from 2010 to 2017. One important feature of bank lending for housing in our sample countries was the high share of housing loans issued in foreign currencies (predominantly in euro). This possibly had a significant impact on the credit quality of housing loans, bank performance and, moreover, on house prices. In several countries, foreign currency loans were converted into local currency loans at favorable rates at a later stage. However, these measures were mostly implemented toward the end of our observation period (except in Hungary) and therefore might only have had a limited impact on bank risk in these countries.[5]

[4] Table A1 in the annex gives an overview of institutional variables in the CESEE countries that illustrate the major differences in several areas of institutional development.

[5] For further details, see box 1, Overview of support measures for foreign currency borrowers (Beckmann, 2017, pp. 13).

Chart 1

Ratio of housing loans to GDP



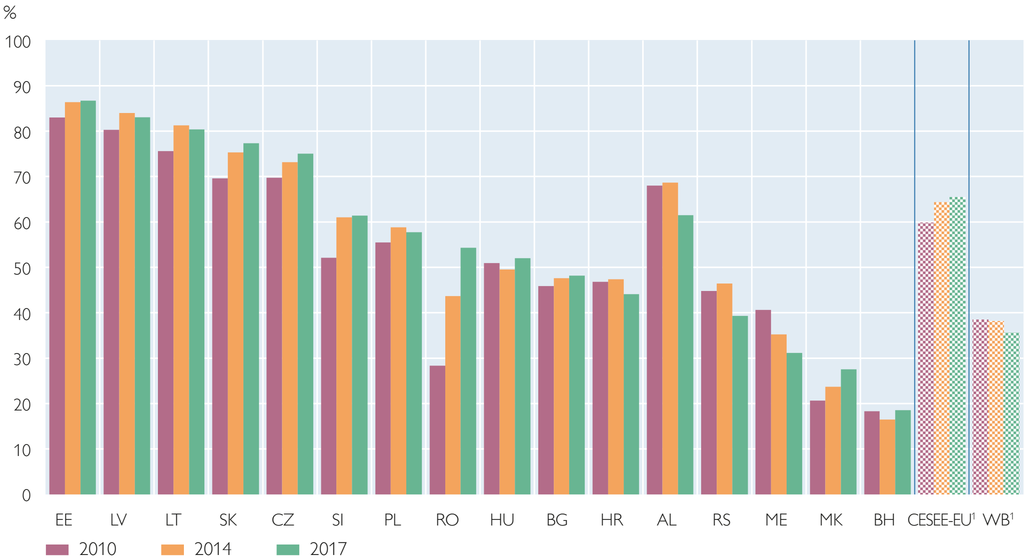
Source: ECB, national central banks.

[1] *Unweighted average.*

Note: WB = Western Balkans.

Chart 2

Share of housing loans in total loans to households



Source: ECB, national central banks.

[1] *Unweighted average.*

Note: WB = Western Balkans.

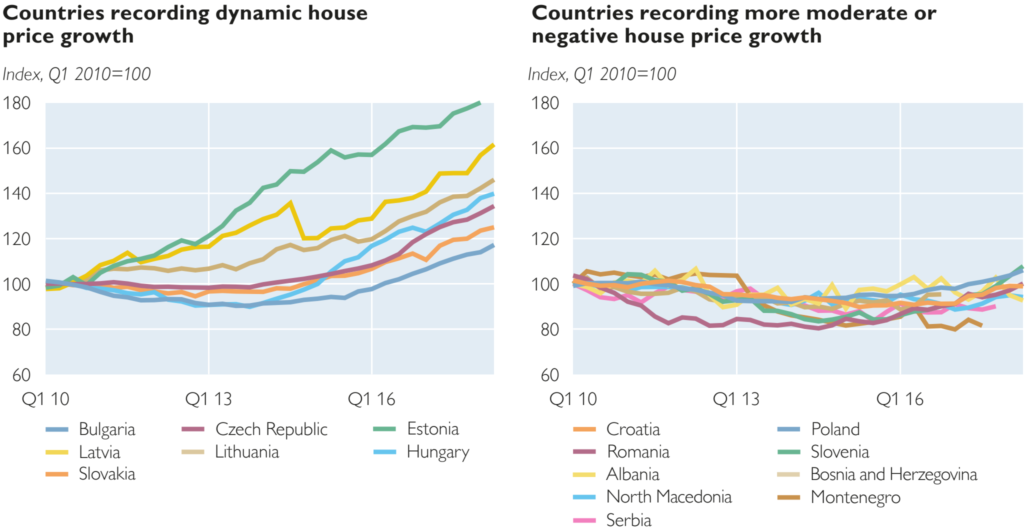
Among the different categories of loans to households (consumption loans, housing loans, loans for other purposes), housing loans dominate lending to households in most CESEE countries and reflect the exposure of banks to the housing market. Most notably, the Baltic countries but also Slovakia and the Czech Republic feature outstandingly high shares of housing loans in total loans to households. In Bulgaria and Croatia, the bulk of lending to households is used for other purposes (i.e. not for housing). The structure is somewhat comparable to some of the Western Balkan countries where a larger part of lending to households is used for consumption purposes. Interestingly, the share of housing loans in loans to households accelerated in all CESEE EU Member States (with the exception of Croatia) from 2010 to 2017. For the Western Balkans, the picture is somewhat different: The share increased only in North Macedonia and in Bosnia and Herzegovina, while it decreased in the remaining Western Balkan countries.

Chart 1 and Chart 2 deliver two important main messages: First, housing loans are an important factor of financial intermediation in many CESEE countries in our sample, and second, housing loans account for the bulk of overall lending to households, in particular in the CESEE EU Member States.

As mentioned before, housing market dynamics, as measured by changes in house prices, are an important variable for explaining banks' risk-taking behavior. In our study, we included the house price index as an explanatory variable in our regressions to evaluate the impact of house price dynamics on bank risk. Chart 3 shows a rather diverse pattern of house price dynamics in our sample countries. We see house prices accelerate strongly in the Baltic countries, Bulgaria, the Czech Republic, Hungary and Slovakia over the period from 2010 to 2017, with the recovery starting later in Bulgaria and Hungary. The pronounced recovery in the Baltic countries needs to be seen against the background that they were hit strongest during the global financial crisis. Other countries, in particular the Western Balkans

Chart 3

House price growth across the country sample



Source: BIS, Eurostat, national central banks.

and some CESEE EU Member States (Croatia, Poland, Slovenia and Romania), feature only moderate or even downward movements of house prices.

3 Data

Our analysis is based on bank data covering more than 170 banks in 16 CESEE countries. The data have been retrieved from the S&P Global Market Intelligence database. This data source offers very good coverage of the total banking sector in CESEE (on average, 90% of the total assets of banks in the region). In our sample, we use annual data on 176 banks, excluding small banks with a market share of less than 2% as these banks are often very specialized and would introduce noise into the dataset. We cover the period from 2010 to 2016.

Following the approach used by e.g. Blasko and Sinkey (2005), Morgan and Zhang (2015) or Gibilaro and Mattarocci (2016), we use the z-score as our dependent variable for measuring the financial stability of banks over time. The z-score indicates the distance of a specific bank from insolvency and is derived from combining a bank's profitability, leverage and volatility (Beck, 2008). Chiaramonte et al. (2016) show that the z-score is a reliable predictor of bank stability. Also, the World Bank (2017) noted that the z-score has several advantages. Most relevant for our exercise is the fact that the z-score, as an accounting-based indicator, can be calculated for any institution for which sophisticated data are not available, as is the case in some of the countries in our sample.

The z-score measurement relates a bank's capital level to the variability in its returns. This enables us to understand how much variability in returns can be absorbed by the bank's capital without making the bank insolvent. Variability in returns is measured as the ratio of the return on assets (ROA) to its standard deviation. To be more specific, the z-score is based on the three-year moving average of the ROA and of the ratio of equity capital to total capital (CAP) for bank i at time t divided by the three-year moving average of the standard deviation of ROA (σ).

$$z\text{-}score_{i,t} = \frac{ROA_{i,t}+CAP_{i,t}}{\sigma_{ROA}} \quad (1)$$

As explanatory variables, we include indicators that account for the bank's business model, housing market dynamics and the overall economic cycle. The bank-specific variables included in our empirical analysis are derived from the balance sheets and income statements reported in the S&P Global Market Intelligence database. We include some indicators to account for the main underlying risks related to a bank's business model, such as bank capitalization (tier 1), bank performance (return on equity – ROE), market risk measured through net interest income (NII) and loan loss provisioning (LLP) as measures of expected banks' credit risk.

Furthermore, we include an indicator of the asset structure to account for banks' exposure to the housing market. The share of housing loans in total loans is not available from the S&P Global Market Intelligence database for all banks and for each year under observation. We were able to collect most of the missing data from the individual banks' annual reports. However, for very few banks, we could not find any information on their housing market exposure; in these cases, we used the market share of loans to households of each bank as a proxy for their mortgage portfolios. Apart from individual banking data, we include house price indices (HPI) and an institutional indicator as control variables. The institutional variable included in the model is the World Bank's Registering Property (RP) index, which measures the steps, time and cost of registering property. The RP index also takes into account the quality of land administration.[6] Furthermore, we include annual GDP growth rates (real GDP growth) to control for the overall economic cycle.

Table 1 summarizes the main statistical characteristics of the variables of the final sample (1,050 observations covering 176 banks, of which 30% are considered real estate banks) used in our empirical analysis. In addition, we present some of the main descriptive statistics for real estate banks and non-real estate banks. Real estate banks are defined as banks with a share of housing loans in total loans higher than 40%, non-real estate banks are banks with a share of housing loans in total loans that is less or equal to 40%. To test whether differences between the main variables for real estate and non-real estate banks are statistically significant, we apply the F-test. The results of the F-test confirm that these two groups are statistically different almost in all indicators, which justifies the separate estimation of their behavior. If we compare the z-scores of the two groups of banks, we see that on average, real estate banks are more stable than non-real estate banks. We can draw the same conclusion when comparing the banks' NPL ratios. On average, real estate banks have a lower NPL ratio than non-real estate banks (11% versus 17%). The profitability of banks measured by their ROE is relatively low on average (5.4% for the total sample) compared to pre-crisis levels. The low profitability of banks is related to the fact that the period from 2010 to 2016 was characterized by a low interest rate environment and slow GDP growth. Real estate banks, on average, have a higher ROE than non-real estate banks. Furthermore, real estate banks are more capitalized and have a lower level of loan losses than non-real estate banks.

Table 1

Descriptive statistics: full sample (CESEE EU Member States and Western Balkan countries)

		Mean			Standard deviation			Minimum			Maximum				
Indicators	Number of observations	All banks	Real estate banks	Non-real testate banks	All banks	Real estate banks	Non-real estate banks	All banks	Real estate banks	Non-real estate banks	All banks	Real estate banks	Non-real estate banks	F-test	Probability (F-test)
z-score	702	44.75	53.92	42.59	37.75	43.05	36.10	3.40	3.57	3.40	152.95	152.95	152.54	–2.90	–0.004
		%													
NPL ratio	1050	15.94	10.85	17.27	16.65	10.90	17.61	0.02	0.19	0.02	100.00	99.84	100.00	25.70	0.000
LLP ratio	1050	1.43	1.04	1.55	1.02	0.82	1.04	0.00	0.01	0.00	4.43	3.96	4.43	39.14	0.000
Tier 1 ratio	1050	15.65	16.28	15.49	12.84	11.46	13.13	0.43	1.60	0.43	100.00	77.65	100.00	2.56	0.110
ROE	1050	5.35	7.01	4.91	6.63	6.89	6.49	–15.92	–15.74	–15.92	15.12	15.07	15.12	13.13	0.000
Housing loan ratio	1050	25.49	53.35	18.32	18.17	13.04	10.95	0.00	40.13	0.00	100.00	100.00	40.00	1,611.45	0.000
NII ratio	1050	3.05	2.83	3.12	0.85	0.85	0.84	1.46	1.46	1.47	5.13	5.10	5.13	18.47	0.000
Real GDP growth		1.85	2.16	1.77	1.73	1.75	1.72	–2.72	–2.72	–2.72	7.58	7.58	6.38		
		Index													
HPI		100.74	100.88	100.88	20.56	20.88	20.88	66.85	66.85	66.85	172.54	172.54	172.54		
RP index		72.25	71.69	74.77	9.74	9.56	10.15	48.29	48.29	48.63	92.93	92.93	92.93		

Source: Authors' calculations, Eurostat, IMF, national central banks, S&P Global Market Intelligence database, World Bank.

Note: The number of observations is different for the z-score due to the calculation method used.

[6] *For more information, refer to www.doingbusiness.org/en/methodology/registering-property.*

The low level of real GDP growth reflects the overall sluggish average economic performance over the period from 2010 to 2016. In the CESEE countries, the average HPI was only slightly above 100 (index: 2010=100) in the period from 2010 to 2016, which indicates that on average, housing markets were still in a recovery phase. The average RP index is around 72 out of a maximum of 100, which shows that the overall institutional framework is good as regards the registration of property for the whole country sample. Tables A3 and A4 in the annex provide descriptive statistics for the two country groups (i.e. CESEE EU Member States and Western Balkan countries). In general, banks in the CESEE EU Member States are characterized by a lower z-score compared to banks situated in the Western Balkan countries. In terms of credit risk (as measured by the NPL ratio), however, banks in the CESEE EU Member States, on average, display lower levels than banks in the Western Balkan countries. This indicates that for the Western Balkans, credit risk is a more important source of risk for banks' activity. Furthermore, banks in CESEE are well capitalized, with an average tier 1 of 15.6%. We also see that on average, banks in the Western Balkan countries maintain a higher level of capital than banks in the CESEE EU Member States. In terms of their exposure to the housing market, banks in the CESEE EU Member States have a higher housing loan ratio than banks in the Western Balkans. In addition, there are some differences between the CESEE EU Member States and the Western Balkan countries with regard to their institutional frameworks. According to World Bank data (World Bank, 2018), the institutional framework in the Western Balkans is weaker than the average of our country sample despite the progress seen over time.

4 Empirical model

To investigate the impact of bank lending for housing and house prices on bank stability, based on Blasko and Sinkey (2005), Morgan and Zhang (2015) and Gibilaro and Mattarocci (2016), we estimate the following model with our panel data:

$$finstab_{i,j,t} = \alpha + \beta re_{i,j,t} + \theta X_{i,j,t} + \lambda C_{j,t} + \varepsilon_{i,j,t} \quad (2)$$

where *finstab* is the measure of bank stability. As we explained in the previous section, we use the z-score as a measure of bank stability and the NPL ratio as a robustness measure of bank stability. In our equation, *re* measures the exposure of a specific bank to the housing market. For the housing loan variable, we use two measures, *Housing loan ratio* and *Dummy real estate*. *Housing loan ratio* is the ratio of housing loans to total loans for bank i at time t and in country j. *Dummy real estate* is a dummy variable based on the approach proposed by Eisenbeis and Kwast (1991) and Gibilaro and Mattarocci (2013). *Dummy real estate* takes the value of 1 if the share of housing loans in total loans is higher than 40% for bank i at time t, and 0 if the share of housing loans to total loans is less than or equal to 40%. Based on previous research (Cihák and Hesse, 2008), we include a group of control variables for bank-level characteristics as well as macroeconomic and institutional factors that could affect bank stability. The vector X contains the following bank-specific variables: bank-level capitalization (tier 1), bank profitability (ROE), net interest income (NII) and the loan loss provisions ratio (LLP). Vector C contains control variables at the country level, namely real GDP growth (GDP) and the Registering Property (RP) index. $\varepsilon_{i,j,t}$ represents the error terms, where i=1,..., N represents the bank; j=1,..., M represents the country; and t=1,..., T represents the year of observation.

To evaluate the impact housing market trends have on bank stability (in line with e.g. Gibilaro and Mattarocci, 2016), we add the year-on-year HPI change for each country. Therefore, our baseline equation is modified as follows:

$$finstab_{i,j,t} = \alpha + \beta re_{i,j,t} + \gamma_{i,t} HPI_{j,t} + \theta X_{i,j,t} + \lambda C_{j,t} + \varepsilon_{i,j,t} \quad (3)$$

If we find a positive and significant $\gamma_{i,t}$, the model shows that increasing house prices positively affect bank stability and vice versa. Also in line with Gibilaro and Mattarocci (2016), we include some interaction terms to take account of the interaction between banks' exposure to the housing market and house prices, $re_{i,j,t}HPI_{j,t}$ to be able to simultaneously investigate the impact of housing market dynamics on bank stability (see equation 4). In addition, we compare the effect of housing market dynamics on real estate banks and on non-real estate banks to see whether housing dynamics have a different effect on real estate banks:

$$finstab_{i,j,t} = \alpha + \beta re_{i,j,t} + \gamma HPI_{j,t} + \delta re_{i,j,t} HPI_{j,t} + \theta X_{i,j,t} + \lambda C_{j,t} + \varepsilon_{i,j,t} \quad (4)$$

To evaluate whether there are differences in the behavior of banks situated in the CESEE EU Member States and in the Western Balkans, we split the sample in two main groups and estimate the relation between housing markets and bank stability for each country group.

Regarding the methodology, we use a GMM approach[7] proposed by Arellano and Bond (1991), which allows for the usage of instrumental variables to account for endogeneity issues between error terms and independent variables. As instrumental variables, we used the lag value of our dependent and independent variables (Anderson and Hsiao, 1981; Arellano and Bond, 1991). The Sargan-Hansen test, or Sargan's J test, is used for overidentifying restrictions (under the null hypothesis that the overidentifying restrictions are satisfied) in order to determine the validity of the instrumental variables.

Finally, we assess the robustness of our results with respect to the bank stability indicator by considering the banks' NPL ratios, which can be interpreted is an inverse measure of bank stability, as dependent variables (Morgan and Zhang, 2015). In most cases, banks' credit risk represents the dominant source of bank risk and therefore can impede bank stability. A major drawback of using NPL ratios as an inverse measure for bank stability is their backward-looking perspective on banks' credit risk and that this measure covers only one source of bank risk.

5 Results

Table 2 presents the results for the full sample, with the z-score as the dependent variable based on the GMM approach. As instrumental variables, we used the lag values of the dependent and independent variables. The p-value of the Sargan's J

[7] *To achieve robust and unbiased results, we did some preliminary tests. First, we tested for the presence of unit roots based on the Im-Pesaran-Shin (2003) and Fisher tests (Choi, 2001), which are suitable for unbalanced panels. The test results reject the null hypothesis of a unit root, so our variables are stationary at the 5% level.*

test indicates that our model is specified correctly (Sargan, 1958; Hansen, 1982). The variables tier 1, ROE, NII, LLP as well as real GDP and the RP index represent our core variables and are included in equations (1) to (8). These variables link bank stability to its main characteristics.

As expected, we find a positive and statistically significant relation between bank stability and bank capital (tier 1) and as well as bank profitability (ROE). We find a significant positive relationship between bank stability and NII, confirming the positive impact profit from a bank's core activity has on bank stability. One of the main variables that influence bank stability is banks' credit risk as measured by LLP. As expected, the coefficient is negatively related to the z-score and is statistically significant in all equations. Regarding the macroeconomic variable, we find a positive link between real GDP and bank stability, confirming that favorable economic development has a positive impact on the resilience of a bank. The RP index has a positive coefficient, which shows that improvements of the institutional setting, in particular more regulated real estate markets and the enforcement of property rights, have a positive effect on bank stability.

We find that banks' exposure to the housing market as measured by the *Housing loan ratio* has a positive impact on bank stability in the full sample and is statistically significant in all four equations (see table 2, columns 1 to 4). The same holds for our alternative indicator of housing market exposure as measured by *Dummy real estate* (see table 1, columns 5 to 8). To see what impact housing market dynamics have on bank stability, we included changes in each country's HPI in our equation (see table 2, columns 2 and 6). For the full sample, we find a negative relationship between housing market dynamics and bank stability. However, the coefficients are insignificant in both regressions. In the rest of the estimated equations, we show the combined effect of banks' exposure to housing markets and housing market trends on bank stability. In a first step, as in Gibilaro and Mattarocci (2016), we test whether banks' sensitivity to the housing market is linearly correlated to bank lending for housing. To do so, we include two interaction terms (*Housing loan ratio*HPI* and *Dummy real estate*HPI*) to account for the interaction between our measures of exposure to the housing market and house prices. The estimated results (see table 2, columns 3 and 7) show a positive and statistically significant relationship between bank stability and the interaction terms. In a second step, we add two interaction terms (*Dummy real estate*HPI* and *Dummy non-real estate*HPI*) to estimate the effect that bank specialization has on bank stability. For the full sample, we find a positive and significant coefficient of the interaction term for real estate banks and a negative and significant coefficient for non-real estate banks (see table 2, columns 4 and 8, two last lines). This outcome shows that real estate banks appear more stable than non-real estate banks when house price dynamics are taken into account.

In addition, we estimate the link between bank stability and housing market exposure, taking into consideration the location of the respective bank. Therefore, we split the sample in two groups: banks located in the CESEE EU Member States and banks located in the Western Balkan countries. The empirical results for each group are presented in tables 3 and 4, which only show the effect of real estate exposure and housing market dynamics with respect to bank stability, while control variables, such as bank characteristics or macroeconomic variables, are not reported because they are broadly consistent with those for the full sample.

Table 2

GMM regression results for the full sample

Dependent variable: z-score	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tier 1 ratio	0.04***	0.02***	0.01***	0.02**	0.01**	0.02**	0.01**	0.003
p-value	*0.000*	*0.000*	*0.000*	*0.05*	*0.038*	*0.024*	*0.045*	*0.714*
ROE	0.02***	0.05***	0.01***	0.03***	0.03***	0.03***	0.01	0.06***
p-value	*0.007*	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	*0.174*	*0.000*
NII ratio	0.52***	0.27***	0.50***	0.48***	0.38***	0.28***	0.44***	0.28***
p-value	*0.000*	*0.001*	*0.001*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
LLP ratio	–0.43***	–0.23***	–0.60***	–0.53***	–0.60***	–0.30**	–0.51***	–0.13
p-value	*0.000*	*0.009*	*0.000*	*0.000*	*0.001*	*0.020*	*0.000*	*0.369*
Real GDP growth	0.04	0.10**	0.33***	0.07***	0.34***	0.13***	0.23*	–0.06***
p-value	*0.604*	*0.02*	*0.002*	*–0.00*	*0.000*	*0.000*	*0.09*	*0.000*
RP index	0.05***	0.02**	0.05***	0.09***	0.07***	0.02	0.06***	0.08***
p-value	*0.003*	*0.020*	*0.000*	*0.000*	*0.000*	*0.178*	*0.000*	*0.000*
Housing loan ratio	0.02***	0.02**	0.02***	0.01*				
p-value	*0.000*	*0.000*	*0.000*	*0.087*				
Dummy real estate					0.77***	0.85***	0.63***	0.28*
p-value					*0.000*	*0.000*	*0.000*	*–0.069*
HPI		–0.01				–0.002		
p-value		*0.339*				*0.911*		
Housing loan ratio*HPI			0.001***					
p-value			*0.002*					
Dummy real estate*HPI				0.10***			0.07***	0.10***
p-value				*0.000*			*0.000*	*0.000*
Dummy non-real estate*HPI				–0.08***				–0.15***
p-value				*0.005*				*0.000*
Number of observations	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
R-squared	0.56	0.79	0.98	0.88	0.66	0.9	0.73	0.71
Probability (J-statistic)	0.85	0.31	0.42	0.83	0.94	0.27	0.21	0.91

Source: Authors' calculations.

*Note: ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The constant is included but not reported.*

Table 3

GMM regression results for the CESEE EU Member States

Dependent variable: z-score	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Housing loan ratio	0.01	0.02***	0.02***	–0.01				
p-value	*0.46*	*0.000*	*0.000*	*0.15*				
Dummy real estate					0.77**	0.83***	0.66**	–0.03
p-value					*0.02*	*0.000*	*0.03*	*0.9*
HPI		–0.06***				–0.06***		
p-value		*0.01*				*0.01*		
Housing loan ratio*HPI			–0.001				–0.002	
p-value			*0.14*				*0.96*	
Dummy real estate*HPI				0.12***				0.05
p-value				*0.01*				*0.25*
Dummy non-real estate*HPI				–0.27***				–0.20***
p-value				*0.000*				*0.000*
Number of observations	634	634	634	634	634	634	634	634
R-squared	0.8	0.76	0.68	0.85	0.63	0.74	0.75	0.72
Probability (J-statistic)	0.93	0.87	0.82	0.44	0.5	0.3	0.14	0.68

Source: Authors' calculations.

*Note: ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The constant is included but not reported.*

Table 4

GMM regression results for the Western Balkan countries

Dependent variable: z-score	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Housing loan ratio	0.02***	0.01	0.01***	0.01**				
p-value	*0.001*	*0.140*	*0.000*	*0.040*				
Dummy real estate					0.02	0.52***	0.65***	0.69***
p-value					*0.970*	*0.003*	*0.000*	*0.000*
HPI		–0.03				–0.03		
p-value		*0.320*				*0.238*		
Housing loan ratio*HPI			–0.002***					
p-value			*0.000*					
Dummy real estate*HPI				–0.09**			–0.15***	–0.16***
p-value				*0.050*			*0.000*	*0.000*
Dummy non-real estate*HPI				–0.007				0.02
p-value				*0.800*				*0.450*
Number of observations	398	398	398	398	398	398	398	398
R-squared	0.51	0.46	0.57	0.53	0.94	0.65	0.58	0.58
Probability (J-statistic)	0.70	0.60	0.59	0.37	0.34	0.49	0.30	0.26

Source: Authors' calculations.

*Note: ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The constant is included but not reported.*

For the banks in the CESEE EU Member States, we find a positive coefficient for their exposure to bank lending for housing (see table 3, columns 1 and 5), which means that bank lending for housing affects bank stability positively. However, only the dummy variable for bank lending for housing shows a statistically significant outcome. We find a negative and statistically significant impact of house price dynamics on bank stability (see table 3, columns 2 and 6) for banks in the CESEE EU Member States, which suggests that housing market dynamics may negatively affect bank stability. In columns 3 and 7 of table 3, we present the results of the interaction terms accounting for bank lending for housing and house price dynamics. The estimated results show a negative but insignificant correlation between banks' exposure to bank lending for housing and their sensitivity to housing market trends. The results of the interaction terms *Dummy real estate*HPI* and *Dummy non-real estate*HPI* show that there are significant differences between real estate banks and non-real estate banks located in CESEE EU Member States. These results are similar to the results for the full sample (see table 2, columns 4 and 8). The stability of real estate banks is positively influenced by house price dynamics, and the opposite is true for the non-real estate banks. This outcome, as in Gibilaro and Mattarocci et al. (2016), shows that knowledge about and experience in the housing market matters for bank stability. This knowledge and experience are an advantage that non-real estate banks do not have.

The results for the Western Balkans show that banks' exposure to bank lending for housing positively and significantly affects bank stability (see table 4, columns 1 and 5). Furthermore, we find that house price dynamics negatively affect bank stability, but this coefficient is insignificant (see table 4, columns 2 and 6). In addition, the coefficient of the interaction term between banks' exposure to the housing market and house price dynamics is negative and significant. This result confirms that for banks in the Western Balkans, in case of higher exposure to the housing market, house price dynamics negatively affect bank stability (see table 4, columns 3 and 7).

Moreover, we test whether there are differences in the behavior of real estate banks and non-real estate banks. The estimated results presented in table 4 (columns 4 and 8) suggest that in the Western Balkans, the stability of banks specializing in real estate is negatively affected by changes in house prices, while for non-real estate banks, we cannot find a significant relationship between house price dynamics and bank stability. The negative relationship may be related to the less advanced stage of institutional development in the relatilvely new housing and banking sector in the region.

6 Robustness checks

As our results may potentially be influenced by decisions we made to set up our model, we carried out a number of robustness checks. We tested the robustness of our results by taking the NPL ratio – an inverse measure of bank stability – as our dependent variable. The NLP ratio more specifically reflects banks' credit risk. The estimated results are presented in the annex in table A5 (full sample) and in tables A6 and A7 (CESEE EU Member States and Western Balkan countries, respectively).

As in our baseline model, we estimated eight equations considering two different measures for banks' exposure to the housing market (the housing loan ratio and dummy variables to classify real estate versus non-real estate banks) and the interaction between house price developments and banks' exposure to the housing market. When looking at the impact of banks' exposure to the housing market in the full country sample, we find a positive and statistically significant relation between credit risk (as captured by the NPL ratio) and our selected housing indicators. The results suggest that banks' exposure to the housing market affects credit risk positively, i.e. the higher the exposure, the higher the NPL ratio (see table A5, columns 1 and 5), but this exposure has not damaged bank stability as measured by the z-score (see table 2, columns 1 and 5). We find that house prices negatively affect banks' credit risk (see table A5, columns 2 and 6) and in addition we find that a higher exposure of banks to the housing market might decrease banks' sensitivity to housing market dynamics (see table A5, columns 3 and 7). Furthermore for the full sample, we cannot find a significant difference between the behavior of real estate banks and that of non-real estate banks. However, the results for the behavior of real estate banks and non-real estate banks are not fully in line with the results obtained from the z-score regressions for the full sample. This difference may be attributable to the fact that credit risk represents only one of the main risks influencing bank stability.

The results for the CESEE EU Member States and the Western Balkan countries in our robustness check with NPL as the dependent variable (see tables A6 and A7) are broadly similar to the z-score results. Thus, for the CESEE EU Member States, we find that banks' exposure to the housing market has a negative impact on banks' credit risk (i.e. it lowers credit risk), a finding which is similar to the z-score results (i.e. the higher housing market exposure, the higher bank stability). Furthermore, for the CESEE EU Member States, we find that differences in banks' specialization (bank lending for housing and versus non-housing lending) in combination with house price changes has an impact on credit risk.[8] For the Western Balkan countries (see table A7), we find that exposure to the housing market has a significant positive

[8] *For real estate banks, rising house prices have a significant negative effect on credit risk, while the opposite is true for non-real estate banks.*

impact on credit risk (i.e. the higher the exposure, the higher credit risk), which is not in line with the z-score results (the higher housing market exposure, the higher bank stability). In line with the results obtained through z-score estimation, we find differences in the behavior of real estate banks and non-real estate banks. Thus, we see that an increase in house prices positively affects the credit risk of real estate banks and negatively affects the credit risk of non-real estate banks.

For robustness analysis, we assessed the sensitivity of our results to the threshold chosen to distinguish between real estate banks and non-real estate banks. Even when we lower the threshold share of housing loans in total loans to 30%, the coefficients of the entire model remain broadly unchanged.[9]

However, we are aware that factors not included in our study might play a role in the effects of housing market dynamics and banks' exposure to the housing market on bank stability. The following caveats may lay the ground for future work. A potentially relevant factor influencing bank stability is the impact of macroprudential policy measures, which are not included in our model (Altunbas et al., 2017). Furthermore, an alternative indicator for housing market dynamics would be interesting to consider. One possibility would be to include the deviation of house prices from their fundamentals, as has been discussed before (e.g. Bania and Vágó, 2018, or Koetter and Poghosyan, 2010).

Our study is constrained to bank lending for housing to households. In fact, banks' exposure to the real estate markets concerns more than their lending to households. A more comprehensive indicator would be a measure that captures banks' total exposure to the real estate market, which also includes bank lending provided for commercial real estate, for instance. In some cases, this may represent an important part of banks' exposure and the risks associated with it. This is especially relevant for the countries in our sample, where the importance of the construction sector in the entire economy is significant. However, due to data limitations, it is not possible to calculate such an indicator and include it in our study at this stage.

7 Conclusion

Housing markets and the banking sector are strongly interlinked via various channels and there is ample literature on the importance of housing market developments for the risk-taking behavior of banks. However, there is only a limited number of studies that investigate the impact of housing loans and housing market dynamics on bank stability in CESEE. This study is the first attempt to tackle this question for a large sample of CESEE countries based on individual banking data.

We find some evidence that banks' exposure to the housing market and house price dynamics can affect bank stability. However, our results are partly sensitive with regard to the sample chosen (CESEE EU Member States versus Western Balkan countries) – a finding that might be linked to differences between countries. To address the different impacts that housing markets might have on bank stability in different sets of countries, we estimated the link between the housing market and bank stability for banks located in the CESEE EU Member States and in the Western Balkan countries. For the first group, we show that housing market exposure and house price dynamics (i.e. a higher value of collateral) increase bank stability. This is possibly related to real estate banks' specialized expertise in housing markets.

[9] *Results are not presented here but are available upon request.*

Furthermore, the availability of more sophisticated data on housing markets in the CESEE EU Member States than in the Western Balkan countries might influence our results because high data quality surely supports the accurate assessment of the collateral value of houses. In addition, more prudential regulatory requirements for bank lending were implemented in the CESEE EU Member States after the financial crisis, which has supported the positive impact of bank lending for housing on bank stability. By contrast, for bank stability in the Western Balkan countries, we find some evidence that real estate banks are negatively influenced by house price dynamics, while non-real estate banks are not. This outcome might be linked to institutional deficiencies in the relatively new housing and banking sectors that are generally characteristic of the housing markets in this part of Europe.

Overall, our results point toward the importance of improving the institutional setup in CESEE as deficiencies might have negative spillover effects on other market segments – in our case, on the banking sector. Our results emphasize the importance of undertaking measures to improve the functioning of the housing market in light of the relationship between the housing market and the banking sector. Furthermore, to mitigate bank risk arising from housing market exposure, authorities will need to take into account the importance of housing finance for banking sector activity when designing their macroprudential framework.

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Annex

Table A1

Institutional indicators

Countries	Ease of doing business ranking[1]	Dealing with construction permits[1]	Registering property[1]	Resolving insolvency[1]	Enforcing contracts[1]	Getting credit[1]	Corruption perception index[2]
Czech Repulic	30.0	127.0	32.0	25.0	91.0	42.0	5.7
Estonia	12.0	8.0	6.0	44.0	11.0	42.0	7.1
Hungary	48.0	90.0	29.0	62.0	13.0	29.0	4.5
Latvia	19.0	49.0	22.0	53.0	20.0	12.0	5.8
Lithuania	16.0	12.0	3.0	70.0	4.0	42.0	5.9
Poland	27.0	41.0	38.0	22.0	55.0	29.0	6.0
Slovakia	39.0	91.0	7.0	42.0	84.0	55.0	5.0
Slovenia	37.0	100.0	36.0	10.0	122.0	105.0	6.1
CESEE EU Member States, average[3] (EU accession in 2004)	**28.5**	**64.8**	**21.6**	**41.0**	**50.0**	**44.5**	**5.8**
Bulgaria	50.0	51.0	67.0	50.0	40.0	42.0	4.3
Croatia	45.0	150.0	45.0	51.0	17.0	20.0	4.9
Romania	51.0	126.0	59.0	60.0	23.0	77.0	4.8
CESEE EU Member States, average[3] (EU accession after 2004)	**48.7**	**109.0**	**57.0**	**53.7**	**26.7**	**46.3**	**4.7**
Albania	65.0	106.0	103.0	41.0	120.0	42.0	3.8
Bosnia and Herzegovina	86.0	166.0	97.0	40.0	71.0	55.0	3.8
North Macedonia	11.0	26.0	48.0	30.0	35.0	12.0	4.4
Montenegro	42.0	78.0	76.0	37.0	42.0	12.0	4.6
Serbia	43.0	10.0	57.0	48.0	60.0	55.0	4.1
Western Balkan countries, average[3]	**49.4**	**77.2**	**76.2**	**39.2**	**65.6**	**35.2**	**4.1**

Source: World Bank Doing Business 2018, Transparency International 2018.

[1] *Ranking out of 190 countries.*

[2] *Relates to the perceived levels of public sector corruption according to experts and businesspeople. The score ranges between 10 (highly clean) and 0 (highly corrupt).*

[3] *Unweighted average.*

Table A2

Full sample: number of banks included per country

Country	Number of banks
CESEE EU Member States	
Bulgaria	22
Croatia	26
Czech Republic	20
Estonia	9
Hungary	23
Poland	31
Latvia	17
Lithuania	6
Romania	24
Slovakia	13
Slovenia	13
Western Balkan countries	
Albania	15
Bosnia and Herzegowina	20
Montenegro	11
North Macedonia	14
Serbia	29

Source: Authors' calculations, S&P Global Market Intelligence database.

Table A3

Descriptive statistics: CESEE EU Member States

Indicators	Number of observations	Mean	Standard deviation	Minimum	Maximum
z-score	356	42.2	37.0	3.4	153.0
NPL ratio	634	15.4	15.8	0.0	100.0
LLP ratio	634	1.4	1.0	0.0	4.4
Tier 1 ratio	634	15.4	6.5	0.4	51.7
ROE	634	5.9	6.6	–15.7	15.1
NII ratio	634	2.7	0.7	1.5	5.1
Housing loan ratio	634	28.7	18.6	0.0	100.0
Real GDP growth		2.0	1.8	–2.7	7.6
HPI		98.2	16.0	66.8	163.9
RP index		75.8	9.3	48.3	92.9

Source: Authors' calculations, Eurostat, IMF, national central banks, S&P Global Market Intelligence database.

Note: The number of observations differs for some variables because of missing data and according to calculation methods, especially for the z-score.

Table A4

Descriptive statistics: Western Balkan countries

Indicators	Number of observations	Mean	Standard deviation	Minimum	Maximum
z-score	243	49	39	4	153
NPL ratio	398	17	18	0	100
LLP ratio	398	1	1	0	4
Tier 1 ratio	398	16	6	4	53
ROE	398	5	7	–16	15
NII ratio	398	4	1	1	5
Housing loan ratio	398	20	16	0	82
Real GDP growth		2	2	–3	4
HPI		110	28	90	173
RP index		66	7	49	78

Source: Authors' calculations, Eurostat, IMF, national central banks, S&P Global Market Intelligence database.

Note: The number of observations differs for some variables because of missing data and according to calculation methods, especially for the z-score.

Table A5

GMM regression results for the full sample

Dependent variable: NPL ratio	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tier 1 ratio	–0.02*	–0.01	–0.02***	–0.07*	–0.02***	–0.01**	–0.03***	–0.01
p-value	*0.060*	*0.141*	*0.001*	*0.067*	*0.010*	*0.037*	*0.000*	*0.520*
ROE	–0.02***	–0.02***	–0.02***	–0.06***	–0.04***	–0.02***	–0.02**	–0.02***
p-value	*0.006*	*0.000*	*0.000*	*0.000*	*0.001*	*0.000*	*0.000*	*0.012*
NII ratio	0.10***	–0.05	–0.11***	0.02	0.03	–0.12***	–0.14**	–0.11
p-value	*0.001*	*0.498*	*0.001*	*0.905*	*0.555*	*0.002*	*0.05*	*0.244*
LLP ratio	0.63***	0.54***	0.60***	0.66***	0.64***	0.57***	0.69***	0.61***
p-value	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Real GDP growth	0.02	–0.14***	–0.11***	–0.46***	–0.17	–0.13***	0.01	–0.14***
p-value	*0.384*	*0.000*	*0.000*	*0.002*	*0.778*	*0.000*	*0.970*	*0.000*
RP index	–0.01	–0.03***	–0.05***	–0.04	–0.01	–0.03***	–0.04***	–0.03*
p-value	*0.136*	*0.000*	*0.000*	*0.448*	*0.589*	*0.000*	*0.000*	*0.060*
Housing loan ratio	0.01***	0.01**	0.01***	–0.01				
p-value	*0.000*	*0.030*	*0.000*	*0.457*				
Dummy real estate					0.475***	0.13	0.50***	0.09
p-value					*0.000*	*0.180*	*0.003*	*0.697*
HPI		–0.04***				–0.04***		
p-value		*0.000*				*0.000*		
Housing loan ratio*HPI			–0.001***					
p-value			*0.000*					
Dummy real estate*HPI				0.96**			–0.08***	–0.03
p-value				*0.039*			*0.000*	*0.805*
Dummy non-real estate*HPI				–0.18***				–0.06*
p-value				*0.000*				*0.090*
Number of observations	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050
R-squared	0.65	0.67	0.98	0.37	0.57	0.82	0.77	0.6
Probability (J-statistic)	0.63	0.61	0.47	0.78	0.4	0.36	0.98	0.29

Source: Authors' calculations.

*Note: *** , **, * denote significance at the 1%, 5% and 10% level, respectively. The constant is included but not reported.*

Table A6

GMM regression results for the CESEE EU Member States

Dependent variable: NPL ratio	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Housing loan ratio	–0.01**	–0.01***	–0.01***	0.09***				
p-value	*0.03*	*0.000*	*0.000*	*0.000*				
Dummy real estate					–0.32*	–0.30**	–0.80***	–1.51**
p-value					*0.09*	*0.03*	*0.000*	*0.03*
HPI		–0.02				–0.02*		
p-value		*0.157*				*0.1*		
Housing loan ratio*HPI			–0.001***					
p-value			*0.000*					
Dummy real estate*HPI				–0.12***			–0.04	0.14*
p-value				*0.000*			*0.269*	*0.09*
Dummy non-real estate*HPI				0.09***				–0.11***
p-value				*0.003*				*0.000*
Number of observations	634	634	634	634	634	634	634	634
R-squared	0.8	0.76	0.68	0.85	0.63	0.74	0.75	0.72
Probability (J-statistic)	0.93	0.87	0.82	0.44	0.5	0.3	0.14	0.68

Source: Authors' calculations.

*Note: ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The constant is included but not reported.*

Table A7

GMM regression results for the Western Balkan countries

Dependent variable: NPL ratio	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Housing loan ratio	0.01***	0.02***	0.01***	0.01***				
p-value	*0.001*	*0.001*	*0.01*	*0.011*				
Dummy real estate					0.60*	0.08***	0.50***	0.80***
p-value					*0.060*	*0.600*	*0.008*	*0.000*
HPI		0.01				–0.03**		
p-value		*0.822*				*0.040*		
Housing loan ratio*HPI			–0.001***					
p-value			*0.001*					
Dummy real estate*HPI				0.06***			–0.10***	0.09***
p-value				*0.010*			*0.001*	*0.000*
Dummy non-real estate*HPI				–0.07***				–0.05
p-value				*0.000*				*0.000*
Number of observations	398	398	398	398	398	398	398	398
R-squared	0.51	0.46	0.57	0.53	0.94	0.65	0.58	0.58
Probability (J-statistic)	0.7	0.6	0.59	0.37	0.34	0.49	0.3	0.26

Source: Authors' calculations.

*Note: ***, **, * denote significance at the 1%, 5% and 10% level, respectively. The constant is included but not reported.*