Residential Property Prices in Central, Eastern and Southeastern European Countries:

The Role of Fundamentals and Transition-Specific Factors

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The large movements in residential property prices in emerging markets observed over the past decade have raised interest in housing market developments. Within a cointegration framework applied to an unbalanced panel, we assess the relationship between residential property price developments, economic fundamentals and transition-specific factors in Central, Eastern and Southeastern European (CESEE) EU countries from 1999 to 2011.[2] Our results show that demand-side fundamentals (disposable income, population, interest rates) and transition-specific factors related to housing demand (such as funding through remittances and credit growth) as well as construction costs on the supply side have been particularly important in residential property price movements. Nevertheless, these factors cannot fully explain residential property price movements, i.e. we find evidence that house prices moved above the level indicated by those factors in the years preceding the crisis. The sharp correction of residential property prices that took place following the outbreak of the financial crisis reversed these overshoots and brought house prices back to – and in some countries even below – the level indicated by the explanatory factors. This suggests that residential property prices are likely to rebound somewhat when economic conditions improve.

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Since 1999, residential property prices (henceforth simply referred to as house prices) in many Central, Eastern and Southeastern European (CESEE) EU countries have gone through a dramatic rise and a slump, often causing devastating effects on the real side as well as on the financial side of many economies in the region. A feature of many housing booms is the emergence of seemingly plausible fundamental explanations to describe the upward movement in house prices. Looking back, the appreciation of house prices in many CESEE countries was to some extent driven by fundamentals, such as rising disposable income and better access to credit, but in light of the sharp declines in some countries it is evident that these house price increases were not sustainable, which raises several questions. What are the factors underlying the observed developments and can they be explained by transition-specific factors, such as pronounced credit growth? To what extent have house prices decoupled from economic fundamentals?

These questions are of particular relevance as history has shown that property price developments were often the reason for severe financial and economic crises (e.g. in the second half of the 1980s and early 1990s in Finland, Norway and

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[2] *In this study we focus on Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.*

Sweden, or in 2007 in the U.S.A.). Most recently, the slump in house prices had major implications, causing fluctuations in employment, economic growth and financial stability particularly in the Baltic countries, but also in Western European countries such as Ireland and Spain. Thus, policymakers and central bankers have a key interest in an assessment of potential risks originating from excessive house price developments. Therefore, different methods have been applied to evaluate signs of house price misalignments. This includes simply defining a benchmark for excessive developments based on historical data, comparing the affordability of house prices, or relating house prices to alternatives to owner-occupied housing.

In this paper we establish a relationship between house prices, housing market fundamentals and transition-specific factors with a particular focus on financial market developments to derive signs of price misalignments. The fundamentals are identified from the stock-flow model, which underlies many empirical studies of house prices. The empirical literature on housing market dynamics in CESEE countries is still limited compared with studies on advanced and other emerging economies (e.g. Glindro et al., 2008 and Beidas-Strom et al., 2009), although some recent papers have investigated and provided empirical facts on the particular characteristics and determinants of residential property markets in CESEE countries (e.g. Égert and Mihaljek, 2007; Ciarlone, 2012; and Hildebrandt et al., 2012).

We follow the existing empirical work and analyze the fundamentals of house prices within a panel data cointegration framework. We contribute to the literature by (1) accounting for demand- and supply-side factors related to house price movements with a particular focus on the role of foreign banks, credit and tax incentives for the external financing of house purchases, (2) analyzing the current state of the misalignment of house prices in the CESEE region and (3) briefly looking at the short-run dynamics of house prices.

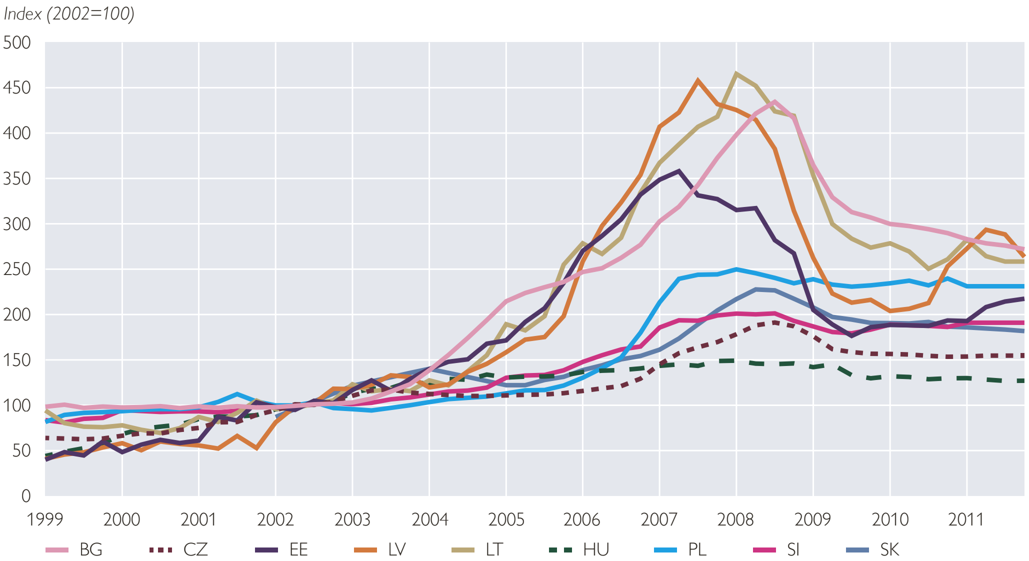
This paper is organized as follows. Section 1 sets the scene by reviewing house price developments in CESEE countries in recent years. In section 2, we outline the theoretical framework and discuss the linkages between house price developments and fundamentals. Section 3 discusses the empirical strategy, followed by the description of the data in section 4. Our main results and robustness checks are presented in sections 5 and 6. Section 7 concludes.

1 The Rise and Fall of House Prices in Most CESEE Countries

House prices in most CESEE countries went through an upsurge in the early 2000s, which came to a halt at the outbreak of the global financial and economic crisis in 2007. Since then, nominal house prices have fallen in the Czech Republic, Slovenia, Slovakia, Poland and particularly in the Baltics and Bulgaria (chart 1). The declines were a by-product of unbalanced macroeconomic developments impacting the demand and supply conditions in the housing market (see Hildebrandt et al., 2012). In Hungary house prices were on a steady upward movement until the end of 2007 and have fallen slightly since then. Only in Latvia and Estonia have house prices resumed their positive growth since 2010, but this development is likely to be due to a shift toward high-end properties bought by foreigners. Besides residential housing, the crisis also hit the commercial property market, exposing, inter alia, overcapacities of offices or shopping areas.

Chart 1

Nominal House Prices

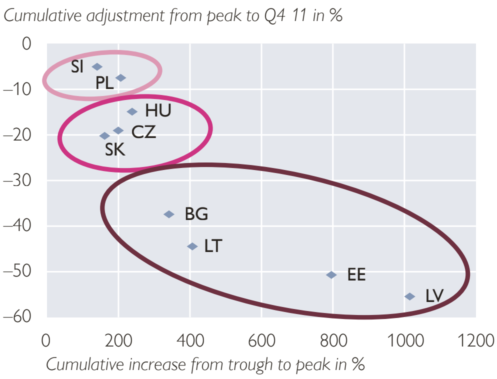


Sources: See sources provided in table A1.

Note: Romania is not included in the chart because the time series was too short.

Chart 2

House Price Cycles from 1999 to 2011



Sources: See sources provided in table A1.

Note: Based on quarterly data. Romania is not included in the chart because the time series was too short.

Looking at the period 1999 – 2011, the CESEE countries with the highest cumulated growth of house prices were also those countries where the largest declines took place, although the declines only reversed part of the cumulated growth. For example in Latvia, house prices increased more than tenfold from 1999 to mid-2007. The downward movement that ensued brought house prices back to their 2005 level. Chart 2 shows the relationship between the cumulative growth and decline of house prices before and after the individual house price peak in each CESEE country. We can distinguish between three groups of countries: first, those which experienced large corrections in house prices, i.e. the Baltic countries and Bulgaria, second, countries that saw relatively less pronounced price developments (the Czech Republic, Slovakia and Hungary), and third, countries that experienced a surge in house prices but have not seen a significant fall in prices so far (Poland and Slovenia). The Baltic countries and Bulgaria experienced a cumulative adjustment between –55% (Latvia) and –37% (Bulgaria). The adjustment following the house price peak was somewhat less pronounced but still high in Slovakia, Hungary and the Czech Republic (between –20% and –15%). Poland and Slovenia show the least pronounced house price adjustments, with a fall in house prices of between –8% and –5% from the time when prices reached their peak to the end of 2011.

In general, some of the house price appreciation is related to distorted house prices at the beginning of transition. The socialist system in the CESEE countries was based on low housing costs, centralized production and state or enterprise control over housing allocation (Tsenkova, 2011). The privatization and restitution of residential property after the collapse of the socialist system in the early 1990s fueled the expansion of homeownership but took place at prices far below market prices (Dübel et al., 2006). Hence, the rapid house price growth in CESEE countries may also have reflected the normalization toward market prices.[3]

2 The Impact of Demand and Supply on House Prices

The stock-flow model as presented by Meen (2001) and applied e.g. by Steiner E. (2010), which has been used in a vast range of empirical house price studies, considers the main fundamental factors related to housing demand (real permanent income, house prices, demographics and the user cost of homeownership[4]) and housing supply (the existing housing stock, investment, construction costs and house prices). It models both, the stock of housing and the flow of residential investment, from a demand and supply perspective. In the context of this paper, the model serves to show the fundamental factors related to demand and supply.

The demand for housing stock is derived from the life-cycle framework underlying the stock-flow model. Accordingly, an agent's demand for housing *(hs_d)* depends on the house price *(p)*, the user cost of homeownership *(uc)* and the permanent household income *(y)* (equation 1).

$$hs_{d,t} = f\big(\underset{-}{p_t}, \underset{-}{uc_t}, \underset{+}{y_t}\big) \tag{1}$$

Higher prices and user cost of homeownership lead to lower demand, while rising income and expectations thereof usually raise the demand for living and recreation space, i.e. the housing stock, which in turn drives up house prices.[5] User cost of homeownership is often proxied by the after-tax interest rate as outlined in DiPasquale and Wheaton (1994), but the application of market rates is also often considered.

Turning to the supply side of the housing market, the flow of residential investment for new homes *(inv)* depends on construction costs *(cc)* (e.g. labor costs, material costs, the cost of finance) and house prices *(p)* (equation 2).

[3] *Égert and Mihaljek (2007) provide anecdotal evidence of initial undershooting in CESEE. Cubeddu et al. (2012) find evidence of a correction of initial undershooting for Chile during the 2000s.*

[4] *The user cost of homeownership, as defined by Poterba (1984), includes maintenance costs, financing costs (i.e. interest expenditures adjusted for tax reliefs), the depreciation of house prices and the expected capital gain of homeownership.*

[5] *Purchase affordability of housing has to be considered as well. Typical measures of affordability relate house prices e.g. to wages or income. It has to be added that if house prices rise more than disposable income, demand for housing and thus house prices can be expected to decline. In CESEE countries, the affordability of houses declined in the run-up to the house price peak before improving thereafter. However, other factors, such as high indebtedness of households, additionally weigh on affordability (Hildebrandt et al., 2012).*

$$inv_t = f\left(\underset{-}{cc_t}\,,\ \underset{+}{p_t}\right) \tag{2}$$

Higher house prices will support residential investment, while higher construction costs will weigh on investment. The housing stock increases if residential investment in a given period is higher than the depreciation and *vice versa*. Formally, this writes:

$$hs_{s,t}=inv_t+(1-d)hs_{t-1} \tag{3}$$

If markets cleared quickly, demand would equal supply at all times $(hs^*=hs_d=hs_s)$. However, due to market imperfections[6] this only applies in the very long run; in the short run house prices are likely to deviate from the equilibrium level. Following the stock-flow model, sustainable house price developments should reflect the development of the demand- and supply-side fundamentals. These considerations serve as a theoretical benchmark for our empirical setting outlined in section 3 and provide guidance on the expected signs of the coefficients. In addition to the fundamentals identified by the stock-flow model, the dynamics of house prices and their link to economic activity depend on many local factors, e.g. as discussed by Beidas-Strom et al. (2009), Égert and Mihaljek (2007), and Hildebrandt et al. (2012),[7] who discuss detailed data and stylized facts on CESEE residential property market characteristics. Therefore, we test for additional factors, such as external demand for housing, credit (in particular foreign currency credit) and the role of foreign banks, which relate to transition-specific characteristics of CESEE.

3 Empirical Methodology

While the qualitative discussion in section 2 gives insight into the demand for and the supply of housing affecting house prices, this section presents the empirical specification related to the stock-flow model. We first relate house prices to the demand-side fundamentals: household disposable income and the user cost of homeownership. We add the size of the population to model aggregate demand since we analyze country-wide developments. Second, we add transition-specific demand-side variables and, third, supply-side factors. We estimate our empirical model by applying a cointegration framework, which is warranted by the statistical properties of the data, in particular stationarity and the indication of cointegration. Therefore, we start by analyzing the time series properties of the data. The results of the panel unit root tests show that all variables are integrated of order one except for the interest rate, which is stationary in levels. Then the test put forward in Kao (1999) confirms cointegration relationships among the variables being I(1). Therefore, we can establish an error correction framework to

6 *On the supply side, the lack of transparency, long institutional procedures and simply the time to start and finish building projects determine the gradual adjustment of supply. On the demand side, lack of market transparency, particularly in emerging markets with underdeveloped market structures making the search for homes a time-consuming process, set the environment for a gradual adjustment of demand (DiPasquale and Wheaton, 1994).*

7 *Global factors, such as declining real interest rates and global business cycles may also play an increasing role in housing market cycles as argued by Girouard et al. (2006). Their indirect impact on demand and supply shifters is considered in this section.*

analyze (1) the long-run determinants of house prices for the panel of ten CESEE countries (results shown in table 1) and (2) to calculate equilibrium house prices for each country, which can be compared to the actual house prices in each country (results shown in chart 3). Finally, we briefly touch upon the short-run dynamics provided in annex C.

More specifically, the empirical strategy we pursue in our analysis follows the framework proposed by Kao and Chiang (2000) to address the endogeneity problem which arises when relating I(1) variables with each other. More specifically, we estimate the parameters of the model, impose common dynamics across countries using the panel dynamic OLS (PDOLS) estimator and allow for country-fixed effects. Formally, the specification of the PDOLS estimator writes as follows

$$y_{it} = X_{it}'\beta + \sum_{s=-q}^{S} \Delta X_{it+s}'\delta_{i,s} + \lambda_i + \varepsilon_{it} \qquad (4)$$

where y_{it} is the log of real house prices for country $i = 1,... N$ (cross-section units) at time $t = 1,...T$ (time index), q indicates the number of lags and S the number of leads, X_{it} is a matrix of demand-side fundamentals (the log of real gross household disposable income, the real interest rate[8] and the log of population), other transition-specific and supply-side variables, Δ indicates first differences, β and δ represent the slope coefficients of the explanatory variables and λ is the vector of country-fixed effects. ε_{it} is an error term. The intuition behind the PDOLS estimator is that leads, lags and the contemporaneous value of the first difference of the regressors account for possible endogeneity and, hence, addresses the econometric hurdles that arise when estimating models with I(1) variables in levels.

The misalignment of house prices $\widehat{ec}_{it}$ is derived as the unexplained part of house prices, i.e. the part of the house prices which cannot be explained by demand-side fundamentals, transition-specific and supply-side factors.[9] That is

$$\widehat{ec}_{it} = y_{it} - X_{it}'\hat{\beta} - \lambda_i \qquad (5)$$

The short-run specification is estimated country by country to allow for country-specific coefficients reflecting that differences in institutional settings foster different dynamics. Formally, this writes

$$\Delta y_{it} = \phi_i \left(\widehat{ec}_{it}\right) + \sum_{j=0}^{J} \Delta X_{it-j}'\gamma_{ij} + \mu_{it} \qquad (6)$$

where γ_{ij} represent the country-specific slope coefficients. The first differences of the explanatory variables enter the equation with J lags. The country-specific error-correcting speed of adjustment term is indicated by ϕ_i. A negative sign of ϕ_i

[8] *To take into account the importance of loans in foreign currency, the interest rate we apply is a weighted interest rate according to the share of loans in domestic and foreign currency.*

[9] *The inferred misalignment indicator only represents the misalignment of observed house prices from the chosen explanatory variables. Since we do not strictly estimate the demand equation as dictated by the model, the misalignment indicator might also include any effect from omitted variables.*

suggests that the system is mean reverting to its long-run equilibrium derived from equation (4). μ_{it} is an error term.

Based on the estimation strategy outlined above, we (1) estimate the benchmark long-run model including the demand-side fundamentals (income, user cost of homeownership and population), (2) add one-by-one additional transition-specific and supply-side variables and (3) identify an "extended model" reflecting fundamentals, transition-specific and supply-side factors selected on the basis of the correct sign, the largest size of the coefficient and the highest significance. Then we derive the misalignment as outlined by equation (5) using the benchmark and the extended model. Finally, we add the lagged error-correction term in the short-run benchmark specification (equation 6), which signifies the gradual adjustment process in housing markets (see annex C). Only trending time series enter the equation in logs, which is not the case for real interest rates.[10] To summarize, given that we are working with a relatively homogeneous group of transition economies, there are good reasons to believe in common coefficients, where the country-fixed effects allow for different levels of house prices across countries in the long run despite common coefficients.

To better motivate the choice of the PDOLS estimator, we briefly discuss its properties by comparing it to a similar estimator, the pooled mean group (PMG) estimator. Our empirical framework bears many similarities to the PMG estimator as proposed by Pesaran et al. (1999), such as that it also assumes homogeneous long-run dynamics and heterogeneous short-run dynamics. A number of recent studies analyzing house price dynamics in the long run have employed the PMG estimator (e.g. Kholodilin et al., 2007). The main difference between the PMG estimator and the PDOLS estimator is that the elasticities are inferred from country-by-country estimations of long-run equations. Applying this estimator to our data, we find that in some cases the estimated elasticities have the opposite sign of what we expected, e.g. for some countries higher household income leads to lower house prices and higher interest rates lead to higher house prices. Since we cannot reconcile these findings with economic theory, we use the PDOLS estimator. Section 6 outlines the robustness checks applied to strengthen the validity of our results. In addition, compared to the PMG estimator, the PDOLS estimator allows for fixed effects in the sense that some of the regressors are systematically correlated with an unobserved country-specific fixed effect. We are not aware of any tests that could support or reject the assumptions of fixed effects in the framework of the PDOLS estimator. To provide us with some idea of the plausibility of fixed effects, we test for random effects in an ordinary panel data model. Using the Hausmann test, we reject the null of random effects in the panel data. Admittedly, this is not a formal test of the PDOLS estimator, but it provides some indication that fixed effects are not completely ruled out.

[10] *We deviate from the stock-flow model in two dimensions. First, the housing stock is not included due to missing data. Second, due to negative real interest rates in some countries the real interest rate enters the model in levels and not in logarithms, thereby violating the efficiency conditions of the stock-flow model. Nevertheless, it has been the practice in many applications to overlook these two shortcomings and we follow the same approach.*

4 Data

The data we have collected for the ten CESEE countries in some cases start as early as 1999, allowing us to exploit the cross-country and time dimension of the data, which is important considering that short time series might fail to reflect broad movements of house prices (Maeso-Fernandez et al., 2004). Compiling lengthy, comparable cross-country house price time series implies difficulties caused by the heterogeneity of the market within and across countries and its lack of transparency. Data quality largely depends on the distribution of reported transactions, i.e. whether they refer to new or existing buildings. It also depends on the type of dwelling or the location. Another crucial issue is whether prices refer to transaction or selling prices (Hildebrandt et al., 2012). While the ECB and the BIS provide various house price series, cross-country comparability is not ensured for all time series due to different methods of collecting data across countries.[11] In general, the various indices of house prices (e.g. for the capital city and the whole country) show very similar dynamics for the ten CESEE countries, though at different price levels. We apply quarterly, seasonally-adjusted price indices reflecting real house price developments in the whole country as collected by Hildebrandt et al. (2012). Most empirical studies apply real house prices (e.g. Égert and Mihaljek, 2007; Andrews, 2010; and Ciarlone, 2012). Their application facilitates the cross-country comparability of the data taking account of cross-country inflation differentials over time.

Data on house price indices for the whole country are mostly available only from the early 2000s, while other house price time series, e.g. for the capital city or house price level data for the whole country, are in many cases available at least from 1999 onward. These different time series often show similar dynamics for each country, which we exploit to extrapolate the time series for the whole country using the available growth rates of other house price data. Annex A provides more detailed information on the different house price time series. Information on the variables used as proxies for the fundamentals and the respective transition-specific variables entering the estimation equation is available in annex A (table A3). Some proxies are used in the final estimation equations shown in table 1, whereas others are applied for robustness checks as outlined in section 6 and indicated in table A3.

As we are also interested in the impact of credit financing conditions on house price developments, we collect time series to proxy the impact of foreign capital inflows, credit and interest rates, accounting for domestic and foreign currency lending to households. In addition, we calculate the cost of financing considering tax deductibility of interest rates to account for the impact of such policy measures on housing demand and thus house prices. There are good reasons to believe that the after-tax interest rate is a better proxy for the user cost of homeownership than the before-tax interest rate (Poterba, 1984). For some of the countries the inflation-adjusted after-tax interest rate is calculated, which we will use in some of the estimations below; however it is not available for all countries of the sample in sufficient length (e.g. Lithuania and Bulgaria). Details on the calculation of the after-tax interest rate are provided in annex B.

[11] *Eurostat has published a handbook on how to compile residential property price indices, while the BIS provides a collection of various house price time series on its website.*

5 Results

5.1 Long-Run Estimations

Table 1 presents the estimation results of the long-run specification. Our main benchmark model relates the log of real house prices to the demand-specific fundamentals, namely the log of real household disposable income, the real interest rate, and the log of the population between the age of 16 and 64. In the first four columns we compare the pooled estimator, the PMG estimator, the traditional fixed-effect estimator and the PDOLS estimator applied to the benchmark specification. For all models, all slope coefficients have the expected sign and are significant. The coefficient of real disposable income in the pooled regression is somewhat low, but this is likely due to the simple nature of the pooled regression and the endogeneity problem discussed by Kao et al. (1999). The advantage of the PDOLS estimator is that it allows for fixed effects instead of conducting country-by-country estimations and it additionally handles possible endogeneity. Applying the PDOLS estimator yields more plausible coefficient

Table 1

Estimation Results of the Long–Run Specification

		OLS pooled (1)	PMG (2)	FE (3)	PDOLS (4)	PDOLS (5)	PDOLS (6)	PDOLS (7)
Demand–side fundamentals	Interest rate, weighted	–0.066 ***	–0.04 ***	–0.0299 ***	–0.025 ***		–0.02 ***	–0.019 ***
		(–0.004)	(–0.007)	(–0.0027)	(–0.005)		(–0.006)	(–0.004)
	Household income	0.07 ***	2.371 ***	1.275 ***	1.544 ***	1.526 ***	1.38 ***	1.068 ***
		(–0.01)	(–0.134)	(–0.0629)	(–0.097)	(–0.108)	(–0.116)	(–0.119)
	Population, aged 15 to 64	0.16 ***	79.223 ***	4.8751 ***	6.508 ***	8.356 ***	12.257 ***	1.654
		(–0.018)	(–10.395)	(–0.7073)	(–1.138)	(–1.386)	(–1.719)	(–1.134)
	Interest rate, weighted, after tax					–0.017 ***		
						(–0.005)		
Transition–specific demand–side factors	External demand						0.254 ***	
							(–0.062)	
	Household loans							0.189 ***
								(–0.022)
	Foreign currency loans to households							
	Foreign liabilities							
Supply–side factors	Construction costs							
	Gross value added, construction sector							
	Residential investment							
	Building permits							
	Constant	–2.634 ***		–73.339 ***	–98.245 ***	–126.396 ***	–168.115 ***	–25.629
		(–0.269)		(–10.718)	(–17.302)	(–21.06)	(–23.602)	(–17.173)
	Adjusted R–squared	0.4697		0.8733	0.9009	0.9108	0.8975	0.934
	Observations	432	415	432	406	310	308	388
	Fixed effects	no	no	yes	yes	yes	yes	yes
	Cointegration test	n.a.	n.a.	–2.118 ***	4.410 ***	–2.772 ***	–2.542 ***	–1.982 **

Source: Authors' calculations.

*Note: Dependent variable: log house prices. *: significant at the 10% level, **: significant at the 5% level, ***: significant at the 1% level. Standard errors in parentheses. Cointegration test refers to the Kao (1999) panel data cointegration test.*

Table 1 continued

Estimation Results of the Long–Run Specification

		PDOLS (8)	PDOLS (9)	PDOLS (10)	PDOLS (11)	PDOLS (12)	PDOLS (13)	PDOLS (14)
Demand–side fundamentals	Interest rate, weighted	–0.027 ***	–0.022 ***	–0.015 ***	–0.028 ***	–0.042 ***	–0.024 ***	–0.005
		(–0.005)	(–0.006)	(–0.005)	(–0.005)	(–0.008)	(–0.004)	(–0.006)
	Household income	1.566 ***	1.647 ***	1.102 ***	1.61 ***	1.402 ***	0.853 ***	0.638 ***
		(–0.112)	(–0.147)	(–0.128)	(–0.104)	(–0.141)	(–0.096)	(–0.178)
	Population, aged 15 to 64	8.605 ***	8.703 ***	4.354 ***	8.899 ***	7.621 ***	5.601 ***	9.2 ***
		(–1.257)	(–1.888)	(–1.219)	(–1.321)	(–1.731)	(–0.972)	(–2.109)
	Interest rate, weighted, after tax							
Transition–specific demand–side factors	External demand							0.153 **
								(–0.067)
	Household loans							0.179 **
								(–0.069)
	Foreign currency loans to households	0.029 **						
		(–0.012)						
	Foreign liabilities		0.075 **					
			(–0.037)					
Supply–side factors	Construction costs			0.707 ***				0.49 **
				(–0.134)				(–0.195)
	Gross value added, construction sector				0.335 ***			
					(–0.08)			
	Residential investment					0.029		
						(–0.055)		
	Building permits						0.289 ***	
							(–0.023)	
	Constant	–130.042 ***	–131.904 ***	–69.161 *	–135.1 ***	–115.141 ***	–85.916 ***	–161.159 **
		(–19.101)	(–28.632)	(–18.197)	(–20.124)	(–26.31)	(–14.75)	(–35.985)
	Adjusted R–squared	0.921	0.913	0.9345	0.9045	0.9109	0.9337	0.956
	Observations	384	273	373	406	258	392	271
	Fixed effects	yes	yes	yes	yes	yes	yes	yes
	Cointegration test	–1.982 **	–3.042 ***	–6.361 ***	–2.294 **	–1.340 *	–6.692 ***	–2.175 **

Source: Authors' calculations.

*Note: Dependent variable log house prices. *: significant at the 10% level, **: significant at the 5% level, ***: significant at the 1% level. Standard errors in parentheses. Cointegration test refers to the Kao (1999) panel data cointegration test.*

estimates (equation 4 to 14). The last row of the table shows the Kao panel data cointegration test statistics, which for all models is consistent with cointegration.[12]

The results for the demand-specific fundamentals are as follows. The coefficient of disposable household income is greater than 1 in most equations, implying that a 1% to 1.6% rise in household disposable income translates into a 1% increase in house prices in the long run. While empirical research usually finds the elasticity of house prices with respect to income to be close to unity (ECB, 2003), Égert and Mihaljek (2007) report first evidence of higher income elasticities in transition economies than in advanced economies. This is supported by our findings and could be explained by two features. First, households raised their expectations of rising future income in view of improved living standards related to the catching-up process in the CESEE countries and EU accession. In turn, higher income expectations could have led to increased household demand for residential

[12] *In annex C we present the short-run specification of the benchmark model.*

property.[13] Second, housing transactions during the initial phase of privatization following the socialist era took place at prices below market prices. A normalization of house prices is likely to have supported the finding that households spend an increasing share of their income on housing. However, the size of the coefficient diminishes in the extended model, indicating that other explanatory factors than the main fundamentals are of importance too.

The coefficients of the real interest rate and the population have the expected negative signs in all our models. Higher interest rates raise the costs of external financing, thereby dampening demand for house purchases and thus house prices. However, caution is warranted in the interpretation of the results as the interest rate alone might not be sufficient to describe the share of loan servicing costs, i.e. noninterest fees and structural breaks in general financing conditions are not covered. We also see in the third row of table 1 that a growing population increases the demand for living space and supports house price growth.

In model 5 we substitute the real interest rate with the real after-tax interest rate. It shows similar estimation results as the real interest rate. In general we would have preferred to use the after-tax interest rate since this is a better proxy for the user cost of homeownership, but since we were not able to collect the information for all countries we used the real interest rate throughout this exercise for reasons of comparability.[14]

A *transition-specific feature* of the region under analysis is the importance of remittances driven by expatriates moving back to the CESEE countries and by citizens living and working (temporarily) abroad and buying second homes, i.e. *external demand*. In model 6 we add remittances as an explanatory transition-specific variable, which turns out to have the expected positive impact on house prices. Remittances often serve as external financing for house purchases or renovations in the CESEE countries, as qualitatively discussed by Égert and Mihaljek (2007).

Considering the rise in the share of credit-financed housing in CESEE countries during the past 15 years, the interplay between housing loans and housing markets deserves particular attention.[15] Especially the *liberalization of financial markets and the reduction of credit constraints* in CESEE countries, which took place against the background of foreign banks penetrating the markets and fierce competition lowering the financing costs of homeownership, can be assumed to have raised the sensitivity of house prices to interest rates (ECB, 2003). Therefore, we add financial variables to model the relationship between credit financing and house price movements in columns 7 to 9 of table 1.

The estimation presented in column 7 shows that total lending to households indeed supported the housing market. Foreign currency loans to households also turn out to have the expected positive significant sign (column 8). However, the

[13] *Due to contraints related to data on income expectations, we can only capture expected future income indirectly via housing loans in the empirical estimations.*

[14] *Another reason for bringing the after-tax interest rate into the analysis is that housing policies aimed at increasing the user cost of homeownership (and transaction costs) tend to dampen speculative behavior in the market while maintaining long-term incentives for owner-occupied housing investment, such as (counter-cyclical) taxes on capital gains of real estate transactions (OECD, 2003). These taxes were often missing in boom phases, as they did in the transition economies of CESEE.*

[15] *The stock of outstanding housing loans increased from 7% of GDP in 2004 to 20% in 2011 (unweighted average).*

coefficient is smaller in magnitude, which shows it was the generally improved borrowing conditions that supported demand for housing and thus house price growth. Égert and Mihaljek (2007) talk about a "self-reinforcing cycle" between credit growth and house price growth as already highlighted in OECD (2003). Declining interest rates foster the external financing of housing, pushing up house prices. In turn, rising house prices do not only require households to take up higher volumes of housing loans, but also allow them to take out higher loans due to the expectation that the underlying collateral would appreciate.[16] Thus, it is rather difficult to establish the causal direction of the relationship between credit and house prices (ECB, 2003). We also see that foreign liabilities of domestic banks, serving as a proxy for parent bank funding of foreign subsidiaries, have moved in parallel with house prices. The results shown in column 9 suggest that the inflow of funding from foreign parent banks indeed supported the housing market in the run-up to the crisis. Likewise, it has also amplified the downturn in housing markets since the outbreak of the crisis.

In models 10 to 13 of table 1 we add, one-by-one, different *supply-side variables*. The results are somewhat mixed. In model 10, real construction cost is added; the coefficient is significant and the sign is positive, as expected. While higher construction costs (of new homes) might just be passed on to the buyer and thus raise house prices, rising construction costs might also indirectly impact house prices via demand. When construction costs increase it becomes more attractive to buy an already existing house, which in turn would foster demand for the existing housing stock and thus house price growth in this market segment.

On the other hand, value added in the construction sector and residential investment can be expected to increase the supply of properties and thus weigh on house prices. The coefficients of value added and residential investments have positive signs (model 12), which are inconsistent with the demand equation, but consistent with the supply equation. This shows that the supply effects dominate the demand effects. An additional explanation with respect to value added in the construction sector is that construction value added covers any kind of construction, including civil engineering works. This factor could explain why value added shows the opposite sign than expected. Regarding residential investment, theory assumes that residential investment only takes the form of investment in new construction. In the CESEE countries, a high share of residential investment goes into the renovation of existing properties, which would not increase the stock but only improve it (which could also be the case for value added in construction). Given that our house price indices are not quality adjusted, an improvement of the existing housing stock is likely to support house prices.[17] The number of granted building permits is also seen to have a positive effect on house prices (model 13). As with the other supply-side variables, this finding shows that the supply effect dominates the demand effects, since an increase in house prices

[16] *In addition, (expectations of) house price appreciation loosening borrowing constraints may affect consumer spending through wealth effects. Empirical evidence on this relationship has been provided e.g. by Benito et al. (2006) and Ciarlone (2012).*

[17] *Residential investment and household income co-move to a high extent and caution is warranted since the results might be affected by possible multicollinearity. The same accounts for household income and household loans. However, estimating the respective equations (7 and 12) without household income does not significantly affect the results of the coefficients in terms of their significance, only their size turns out to be slightly bigger.*

has led to increased investments and, hence, to an increase in the number of building permits. It also has to be considered that restrictions on urban land use or the availability of land for housing construction together with poor property records or poor space planning in general restrict the housing market in CESEE countries.[18]

In the last column of table 1 we combine the significant variables with the expected sign into our extended model. All variables in the extended model still have the expected sign, although the significance of the interest rate has disappeared and the size of the coefficient of income changes has been reduced a lot. On the one hand, these changes are likely to reflect the complexity of the model and the relatively small number of observations. It should also be mentioned that some variables are not available for Slovakia and Bulgaria, which implies that the model is not estimated for these countries. On the other hand, a theoretical implication is that other variables than the fundamentals are of high importance in determining house prices (e.g. credit). Nevertheless, caution is warranted when comparing the two misalignment indicators inferred from the benchmark model and the extended model.

5.2 Misalignment between Housing Prices and the Equilibrium Level

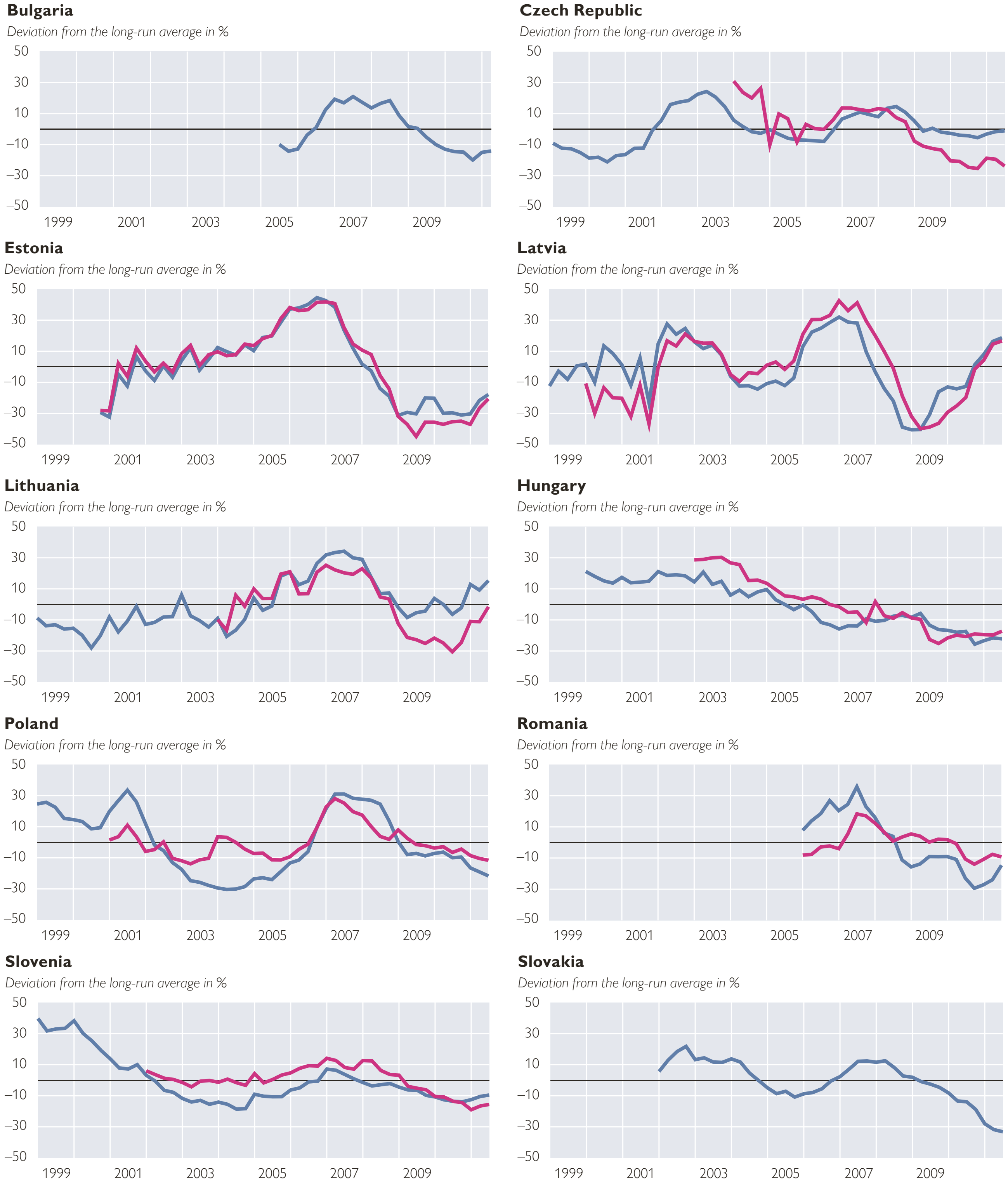
The *country-specific misalignment indicators* inferred from the benchmark and extended model of the long-run specification are shown in chart 3. The misalignment shows the part of house price movements which cannot be explained by the demand and supply fundamentals and additional transition-specific demand-side factors. Section 3 (equation 5) outlines the notion of misalignment in more detail.

On the one hand, house price growth in most countries until 2007–2008 was higher than macroeconomic developments would have justified, as the misalignment indicators show, i.e. the values above the zero line – the equilibrium – in chart 3. On the other hand, the fall in house prices seen afterwards was also much faster than warranted by the model in a number of countries (indicated by downward trending lines below the zero line). By the end of 2011 most of the excessive house price growth had been offset by an equally strong decline, e.g. in Estonia. In Poland the adjustment reflects the improvement of fundamentals rather than the adjustment of house prices. More recently, imbalances started to accumulate in Lithuania due to underlying factors; in particular, the affordability of houses declined, reflecting the still weak growth of disposable income. The relatively strong fall in house prices (see chart 2) in Slovakia brought the valuation of houses into deep negative territory, according to the model, which seems surprising. This should be seen against the backdrop of relatively strong income growth in recent years combined with a relatively flat movement of house prices in Slovakia. According to the extended model, houses in the Czech Republic and Lithuania are more undervalued than shown in the benchmark model, reflecting that the additional explanatory variables in the extended model have improved relative to house prices. In addition, in Lithuania houses were overvalued according to the benchmark model, but according to the extended model, house prices at end-2011 were broadly in line with the underlying values, showing the importance of

[18] *Although indicators of the EBRD or the World Bank could serve as crude proxy for the quality of (local) administration, the limited variation of these indices over time impedes their application in this empirical setting.*

Chart 3

House Price Misalignments in CESEE Countries



Source: Authors' calculations.

Note: The solid blue line denotes the misalignment based on the benchmark model, the red line indicates the misalignment based on the extended model. The solid horizontal black line indicates the equilibrium. No misalignment measure based on the extended model for Bulgaria and Slovakia was calculated due to missing data.

accounting for the transition-specific variables, i.e. credit and remittances. In general, some caution is warranted when interpreting these figures, since the misalignment refers to the misalignment of house prices that cannot be explained by variables other than those entering the respective models. For example macro-prudential regulation could also have an impact.[19] Moreover, the equilibrium level is subject to uncertainty and may not give a comprehensive picture of the level of misalignment.

6 Robustness Checks

In order to check the robustness of our results shown in the previous section, we (1) interchange the dependent variable with another house price index series and (2) test the model by using alternative proxies for the explanatory variables. First, uncertainties related to the heterogeneity of house price data collection methods outlined in section 4 lead us to test the robustness of the results applying house price indices for the capital city instead of those for the whole country. Table 2 shows the original results from table 1 together with the results testing the other house price index series for the baseline and the extended model. The results turn out to be similar, although the significance of the coefficients is lower for the extended model (14') applying house price indices for the capital city.

Table 2

Robustness Check Testing Different House Price Data Series

Estimation results of the long-run specification

		PDOLS (4)	PDOLS (4')	PDOLS (14)	PDOLS (14')
	Dependent house price variable	(whole country)	(capital city)	(whole country)	(capital city)
Demand-side fundamentals	Interest rate, weighted	–0.025 ***	–0.033 ***	–0.005	–0.002
		(–0.005)	(–0.004)	(–0.006)	(–0.005)
	Household income	1.544 ***	1.387 ***	0.638 ***	0.982 ***
		(–0.097)	(–0.073)	(–0.178)	(–0.178)
	Population, aged 15 to 64	6.508 ***	10.397 ***	9.2 ***	1.622
		(–1.138)	(–1.256)	(–2.109)	(–2.114)
Transition-specific demand-side factors	External demand			0.153 **	0.027
				(–0.067)	(–0.067)
	Household loans			0.179 **	0.044
				(–0.069)	(–0.069)
Supply-side factors	Construction costs			0.49 **	0.474 **
				(–0.195)	(–0.195)
	Constant	–98.245 ***	–157.448 ***	–161.159 **	–27.29
		(–17.302)	(–19.095)	(–35.985)	(–36.07)
	Adjusted R-squared	0.9009	0.895	0.956	0.997
	Observations	406	373	271	271
	Fixed effects	yes	yes	yes	yes

Source: Authors' calculations.

Note: The house price index for the capital city is based on transaction prices (asking prices for Slovakia, Poland and Romania) of new and existing homes in the capital city (Bulgaria: large cities).

[19] *We put less emphasis on macroprudential policy measures, although the importance of these policies has become greater, particularly after the outbreak of the crisis, in the wake of which numerous measures have been taken to curb the negative repercussions of the housing market volatility observed in recent years. For a comprehensive discussion we refer to Vandenbussche et al. (2012), who find that some macroprudential policies implemented in CESEE countries in recent years tend to reduce house price volatility.*

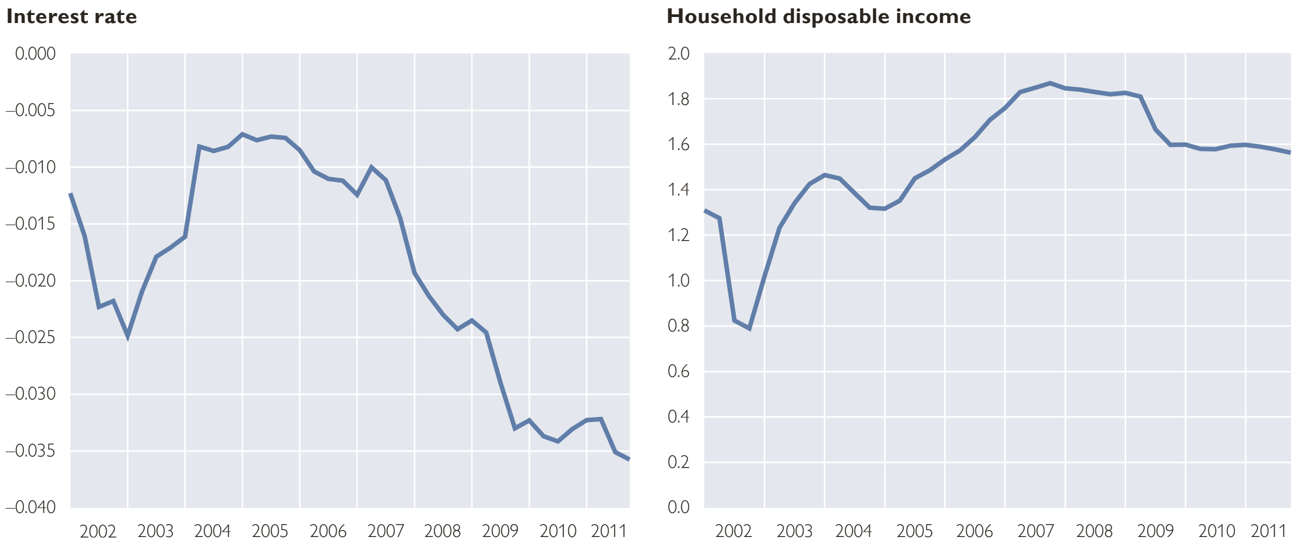
Second, we apply different proxy variables to test the robustness of the explanatory variables. For example, we apply real gross household disposable income as a fundamental demand-side factor shown in table 1, because it is very closely related to the decision of households to buy property. In turn, we exchange this explanatory variable for real GDP per capita, an alternative proxy variable. The coefficient of real GDP also turns out to have the expected positive sign with a relatively similar size of the coefficient, which supports the robustness of our results. The same procedure is applied to selected other demand and supply fundamentals and transition-specific demand variables.[20] Overall, the results applying the different proxies as explanatory variables show that the signs of the coefficients and their size are similar to those reported in table 1.

In addition, we have cross-checked whether the estimations of the benchmark model differ if we split the sample into two subsamples: those countries which experienced an outright boom-bust (Bulgaria and the Baltics) and the other remaining countries. We find that the elasticities are numerically bigger for the boom-bust countries compared to the benchmark model presented in the paper. As expected we also find smaller numerical elasticities for the other countries. The conclusions regarding the misalignment of house prices remain broadly unchanged.

To see whether house price elasticities have changed since the onset of the crisis, we run a series of recursive estimations. The coefficients of disposable income and the interest rate derived from this exercise are shown in chart 4. The chart shows the coefficient estimates for the sample ending in the quarter indicated on the horizontal axis. We see that interestingly, house prices have

Chart 4

Coefficients of Recursive Estimates of the Benchmark Model



Source: Authors' calculations.

Note: The charts show the coefficient estimates for the sample ending in the quarter indicated on the horizontal axis. The PDOLS estimator was applied to the benchmark model.

[20] *Annex A, table A3, shows descriptive information on the alternative proxies applied. The results for the various proxies used for robustness checks are available upon request.*

become more sensitive to changes in the interest rate since the beginning of 2006, while we do not observe any significant structural breaks around the time of EU accession. In the right-hand panel of the chart we report the coefficients of disposable income. House prices became more sensitive to changes in income in the run-up to the crisis. Our interpretation of this finding is that the boom years in the region bolstered demand, and growth contributed to improving the income prospects of many households. This could have led households to purchase properties on the margin of what they could afford due to expectations of rising future income.[21]

7 Conclusions

House prices in CESEE countries went through a significant rise in the years before the crisis, with nominal house prices increasing up to tenfold in some countries. The upward movement came to a halt at the outbreak of the crisis, and house prices declined rapidly in the countries where house prices had increased most strongly. In this paper, we assess these developments and relate them to fundamentals and transition-specific factors that characterize the CESEE countries. For financial stability reasons we are particularly interested in those factors that are related to banking sector developments. We apply the stock-flow model to motivate the choice of fundamental factors, which are mainly related to demand for housing: gross disposable income, interest rates and population. These explanatory variables enter our benchmark specification. In addition, we add further demand-side factors related to external demand for housing (remittances) and credit financing of house purchases (loans to households, foreign currency loans to households, foreign liabilities of banks and after-tax interest rates). We also account for the supply side by analyzing the role of construction costs, gross value added, residential investment and the number of building permits for house price changes. The estimation results are based on a panel data cointegration framework, which allows us to also consider the misalignment of observed house prices with the development of the fundamental factors.

Despite the sensitivity of the results to the estimation specifications, we find a relatively strong relationship between house prices and fundamentals, as suggested for transition economies by former research. In particular, the disposable income of households turns out to be a major factor related to house prices. In the initial phase of our sample, i.e., after the privatization of housing, prices were below market prices. Subsequently, house prices normalized and households began to spend an increasing share of their income on housing. Since the early 2000s, the complete overhaul of the banking sectors in CESEE countries increased the borrowing opportunities at lower interest rates. This supported demand for housing too, as indicated by the results. According to our estimation results it was, however, not necessarily the access to foreign currency loans in itself that supported the housing market, but rather the generally improved borrowing conditions. The results also suggest that the inflow of funding from foreign parent banks to local subsidiaries pushed house prices further up in the run-up to the crisis.

[21] *We restrict our attention to estimations in which we assume the coefficients to be fixed, while the evidence presented in chart 5 suggests that the coefficients might be time varying. This avenue is left for future research.*

Because of their severe macroeconomic effects house price movements will remain of key interest to policymakers. Our findings concerning the influence of borrowing conditions on house prices illustrate this fact in a quite obvious way. Furthermore, the negative correlation of after-tax interest rates and house prices makes the deductibility of housing credit expenditures and repayments an instrument for policymakers to influence housing market developments.

We also find evidence that the surge in house prices was associated with a decoupling from the development of fundamentals in almost all CESEE countries covered in our sample. The correction after 2008 has removed these misalignments and, in fact, in 2011 house prices in most countries were below the level suggested by the fundamentals. This indicates that house prices are likely to rebound somewhat once fundamentals and credit conditions improve.

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Annex A

Annex A provides detailed information on the quarterly house price data and explanatory variables.

Table A1

National Indices of Real House Prices (2005=100)

Country	Geographical area	Type of dwellings	Statistical concept	Unit	Treatment	Minimum	Maximum	Mean	Number of observations	Time span of original time series	Extrapolated time span	Source
						of the real house price index						
Bulgaria	big cities (27 district centers)	existing apartments	transaction price per square meter	log, index	deflation using CPI	34.4	118.6	64.1	60	Q1 97–Q4 11, quarterly data	–	ECB (NSO)
Czech Republic	whole country	existing apartments	transaction price per square meter	log, index	deflation using CPI	58.2	104.2	80.3	56	Q1 04–Q4 11, quarterly data	Q1 98–Q4 03	CZSO
Estonia	whole country	existing and new apartments	transaction price per square meter	log, index	deflation using CPI	14.3	106.3	45.3	68	Q3 03–Q4 11, quarterly data	Q2 94–Q2 03	ECB (NSO)
Hungary	whole country	n.a.	transaction price per square meter	log, index	deflation using CPI	38.8	110.6	86.9	56	Q1 98–Q4 11, quarterly data	–	FHB Banking Group
Latvia	whole country	existing and new apartments	transaction price per square meter	log, index	deflation using CPI	13.7	104.5	45.5	52	Q1 00–Q4 11, quarterly data	Q1 99–Q4 99	ECB (NSO)
Lithuania	whole country	existing and new apartments	transaction price per square meter	log, index	deflation using CPI	21.0	108.0	47.2	68	Q4 98–Q4 11, quarterly data	Q1 94–Q3 98	ECB (NSO)
Poland	big cities	existing apartments	transaction price per square meter	log, index	index calculated from price level data, deflation using CPI	44.0	114.3	70.6	53	Q4 02–Q4 11, quarterly data	Q4 98–Q3 02	ECB (NSO)
Romania	capital city	existing and new dwellings	asking price per square meter	log, index	extrapolation with the trend growth rate, deflation using CPI	64.9	141.2	106.0	24	Q4 06–Q4 11, quarterly data	Q1 06–Q3 06	REAS
Slovakia	whole country	existing and new dwellings	asking price per square meter	log, index	index calculated from price level data, interpolation for 2002 – 2004 based on annual data, deflation using CPI	75.6	114.0	93.4	40	Q1 02–Q4 11, quarterly data	–	Národná banka Slovenska
Slovenia	whole country	existing dwellings	transaction price per square meter	log, index	deflation using CPI	33.3	101.4	68.5	67	Q1 03–Q4 11, quarterly data	Q2 95 Q4 02	ECB (NSO)

Source: Authors' calculations.

Table A2

Real House Price Data Used for Extrapolating the National House Price Indices

Country	Geographical area	Type of dwellings	Statistical concept	Unit	Treatment	Correlation coefficient with the house price index for the whole country	Time span	Source
Czech Republic	capital city	existing apartments	transaction price per square meter	log, index	deflation using CPI	0.997	Q1 98–Q4 11, quarterly data	CZSO
Estonia	whole country	existing and new dwellings	transaction price per square meter	log, national currency	deflation using CPI, index calculated from price level data	0.998	Q2 94–Q4 11, quarterly data	BIS, NSO
Latvia	capital city	existing and new apartments	asking prices per square meter	log, national currency	deflation using CPI, averages based on monthly data, index calculated from price level data	0.939	Q1 99–Q4 11, quarterly data	NCB
Lithuania	whole country	existing apartments	transaction or asking price per square meter	log, national currency	deflation using CPI, index calculated from price level data	0.818	Q1 94–Q4 11, quarterly data	Oberhaus
Poland	whole country	existing and new apartments	transaction price per square meter	log, national currency	deflation using CPI, index calculated from price level data	0.668	Q4 98–Q4 11, quarterly data	NSO
Romania	extrapolation of the data using the trend growth rate of the house price index for the whole country shown in table A1							
Slovenia	capital city	existing and new apartments	n.a.	log, national currency	deflation using CPI, index calculated from price level data	0.987	Q2 95–Q4 11, quarterly data	Slonep

Source: Authors' calculations.

Note: For Bulgaria, Hungary and Slovakia, there are no house price time series available that are longer than those for the whole country.

Table A3

Explanatory Variables

Variable	Description	Unit	Treatment	Minimum	Maximum	Mean	Number of observations	Source
Demand side, fundamental factors								
Interest rate, weighted	weighted real interest rate	%	deflation using CPI, compilation of the weighted interest rate based on interest rates on domestic currency loans to households for house purchase and on interest rates on foreign currency loans (up to 2006: loans to households; 2006–2011: loans to households for house purchase); weighted according to the share of foreign currency loans to total household loans; quarterly data	–48.5	25.7	4.7	569	OeNB, NCBs, ECB, IMF
Interest rate	*real bank lending rate*	%	*deflation using CPI, IFS Code (60P), government bond yield for PL (Code 60P) as no data are available*	*–51.0*	*25.7*	*4.9*	*575*	*IMF (IFS)*
Household income	real gross disposable income per capita	log, in nc	deflation using CPI, seasonal adjustment, quarterly data	–2.1	5.1	0.6	567	Eurostat
Real GDP	*real gross domestic product per capita*	*log, in nc*	*deflated, seasonal adjustment, quarterly data*	*6.1*	*13.3*	*8.6*	*643*	*Eurostat*
Population, aged 15 to 64	population aged 15 to 64 years	log, number of persons	linear interpolation of annual data	13.7	17.1	15.3	730	Eurostat
Population, aged 25 to 44	*population aged 25 to 44 years*	*log, number of persons*	*linear interpolation of annual data*	*12.8*	*16.2*	*14.4*	*459*	*Eurostat*
Demand side, additional transition-specific factors								
External demand	private remittances as a share of GDP	log, %	seasonal adjustment, quarterly data	–1.3	2.2	0.6	359	Eurostat
Household loans	loans to households and NPISH as a share of GDP, end of period	log, %	foreign currency component adjusted for exchange rate movements (at January 2008 exchange rates), quarterly data	0.6	5.4	3.6	587	OeNB, ECB, NCBs
Domestic currency loans to households	*loans denominated in domestic currency to households as share of GDP, end of period*	*log, %*	*quarterly data*	*–2.6*	*5.2*	*3.1*	*592*	*OeNB, ECB, NCBs*
Foreign currency loans to households	household loans denominated in foreign currency to households as a share of GDP, end of period	log, %	adjusted for exchange rate movements (at January 2008 exchange rates), quarterly data	–6.7	5.2	1.3	565	OeNB, ECB, NCBs
Foreign currency housing loans	*housing loans denominated in foreign currency to households as share of GDP, end of period*	*log, %*	*adjusted for exchange rate movements (at January 2008 exchange rates), quarterly data*	*–9.0*	*5.0*	*1.6*	*257*	*OeNB, ECB, NCBs*
Foreign liabilities	foreign liabilities of commercial banks as a share of GDP	log, %	based on immediate-borrower basis, quarterly data	1.8	8.3	4.2	341	IMF (IFS)
Suppy-side factors								
Construction costs	real construction costs for residential buildings	log, index (2007=100)	deflated, seasonally adjusted, quarterly data	3.1	4.9	4.4	495	Eurostat (Haver Analytics)
Wages in construction	*real wages in construction*	*log, index (2007=100)*	*deflated, seasonally adjusted, quarterly data*	*2.8*	*5.3*	*4.4*	*480*	*Eurostat*
Gross value added, construction	real gross value added in construction as a share of GDP	log, %	deflated, seasonally adjusted, quarterly data	–0.1	6.3	1.9	680	Eurostat
Residential investment	real gross fixed capital formation (housing) as a share of GDP	log, %	deflated, seasonally adjusted, quarterly data	–0.5	5.4	2.1	360	Eurostat
Building permits	new building permits	log, index (2007=100)	seasonally adjusted, quarterly data	1.8	5.2	3.9	485	Eurostat (Haver Analytics)

Source: Authors' calculations.
Note: The variables in italics are used as alternative proxy variables for robustness checks. The summary statistics are shown in logarithms to allow for the cross-country comparability of the data.

Annex B

Construction of the After-Tax Interest to Represent Financing Conditions and Tax Deductibility

Taxation and regulatory policies influence not only prices and ownership rates but also macroeconomic developments. Tax incentives stimulate ownership (Springler and Wagner, 2010). This results in a higher level of house prices and may also result in a greater cyclical volatility of house prices. Even though tax incentives do not cause volatility in house prices by themselves, they interact with and magnify the shocks that impinge on house prices (variations in disposable incomes, demographic changes, etc.; see van den Noord, 2003).

To be able to analyze the correlation between price developments and prevailing taxation rules it makes sense to construct time series to represent tax deductibility and to estimate the financing cost of housing investment to the extent by which they are affected by the personal income tax system. To quantify governments' involvement in housing markets for the CESEE countries, we expand the model by Fukao and Hanazaki (1986). They assume a typical price of one unit of housing P (it is six times the disposable income of an average production worker (APW)). By incorporating marginal tax rates we get the after-tax nominal interest rates $i_a(t)$. As the duration of tax relief is limited, the $i_a(t)$ are time dependent.

As the following relationship holds

$$\int_0^\infty i_f P e^{-(i-\pi)t} dt = \int_0^\infty i_a(t) P e^{-(i-\pi)t} dt \qquad (7)$$

(with the inflation rate π and the unit of housing P), we obtain the nominal after-tax interest rate i_f. For further information see van den Noord (2005). The theoretical model suggests that price volatility would be largest when tax breaks for owner-occupied homes are largest. Pearson's correlation coefficient between the after-tax interest rates and house price changes against 2004 is –0.324 (authors' calculation).

For calculating the after-tax interest rate, information on tax interest deductibility, tax credits and imputed income from housing is taken into account.[22] Wealth taxes and capital gains taxes are not included. The formulas applied for incorporating the rules within the specific country are available upon request.

The relevant information on countries' tax regulation and tax deductibility was taken from the European Tax Handbooks (IBFD, 2001 to 2010). Furthermore, for data on marginal rates of income tax plus employees' social security contributions and personal income tax we use OECD Series (OECD, a, b). To derive the unit of housing we needed data on disposable income. We took data (OECD, a) of the net income after taxes of a married couple with two children and one earner. Disposable income is gross wage earnings minus total payments to general government plus cash transfer from general government for two children.

[22] *Property real estate taxes are not included in the calculation. Property taxation plays a minor role when comparing taxation differences among countries.*

Annex C

The Short-Run Dynamics of House Prices in CESEE Countries

The model estimated in the main text is a long-run specification of house prices and is essentially the first step of the Engle-Granger (1984) procedure. For illustrative purposes we show the estimation results of the short-run specification, i.e. equation 6, below (table C1). We focus on the benchmark model only because the number of observations drops significantly for the extended model. In the model, we include only the contemporaneous changes on the right-hand side, due to poorer fit when we include more lags. Several features are worth mentioning. First, the negative sign of the country-specific coefficient of the error-correction term indicates that there is indeed evidence of a correction back to the long-run equilibrium, although the coefficient is insignificant in most countries. The low values of the slope-coefficients indicate that this adjustment is very slow, though. It is only slightly faster and significant in Estonia, Bulgaria, and faster, but insignificant in Latvia, where the speed of adjustment takes a pace of about one-tenth of the disequilibrium per quarter. The insignificance of the error-correction term might just reflect the fact that the time series applied in the estimations are relatively short, although one would have expected a significant negative coefficient given that we find evidence of cointegration. In addition, it is likely that the strong house price increases and the following adjustment reflected the catching-up process of the economies and that this effect more than offset the error-correction mechanism.

Second, in all countries changes in disposable income have a significant positive impact on the change in house prices. The largest coefficient estimates are found for the Baltic countries. Despite the fact that Bulgaria – just like the Baltic

Table C1

Estimation Results of the Short-Run Specification Based on the Baseline Model Specification

	Bulgaria (1)	Czech Republic (2)	Estonia (3)	Latvia (4)	Lithuania (5)	Hungary (6)	Poland (7)	Romania (8)	Slovakia (9)	Slovenia (10)
error-correction$_{t-1}$	–0.104 *	–0.067 *	–0.186 **	–0.186 *	–0.137 *	0.012 *	–0.047 *	0.05 *	–0.069 *	–0.052 *
	(–0.055)	(–0.043)	(–0.087)	(–0.127)	(–0.071)	(–0.04)	(–0.033)	(–0.104)	(–0.046)	(–0.035)
Δhouse price$_{t-1}$	0.537 ***	0.363 ***	–0.063 ***	0.006 ***	0.067 ***	0.033 ***	0.169 ***	0.149 ***	0.668 ***	0.09 ***
	(–0.142)	(–0.123)	(–0.153)	(–0.165)	(–0.124)	(–0.089)	(–0.093)	(–0.191)	(–0.087)	(–0.137)
Δinterest rate, weighted$_t$	–0.013 ***	–0.005 ***	–0.026 ***	–0.021 ***	–0.016 ***	–0.005 ***	0.003 ***	–0.003 ***	–0.009 ***	–0.011 ***
	(–0.004)	(–0.005)	(–0.01)	(–0.01)	(–0.01)	(–0.003)	(–0.006)	(–0.011)	(–0.003)	(–0.006)
Δhouse-hold income$_t$	0.619 **	0.779 **	3.649 **	1.955 **	2.372 **	1.124 **	1.068 **	0.789 **	1.148 **	1.341 **
	(–0.235)	(–0.215)	(–1.124)	(–0.512)	(–0.431)	(–0.132)	(–0.135)	(–0.232)	(–0.211)	(–0.389)
Δpopu-lation, 15–64$_t$	15.326 **	2.857 **	64.407 **	–6.477 **	–4.716 **	9.309 **	0.449 **	17.93 **	11.464 **	1.534 **
	(–6.958)	(–4.098)	(–34.242)	(–16.713)	(–5.296)	(–14.332)	(–5.763)	(–70.832)	(–8.757)	(–5.009)
adjusted R-squared	0.6215	0.3242	0.2675	0.2058	0.402	0.6775	0.5804	0.4219	0.6983	0.2003
obser-vations	23	49	43	49	49	46	49	21	37	49

Source: Authors' calculations.

*Note: Dependent variable first difference of house prices. *: significant at the 10% level, **: significant at the 5% level, ***: significant at the 1% level. Standard errors in parentheses.*

countries – also experienced very large cumulated house price growth, the coefficient of disposable income for Bulgaria is the smallest among the countries. Third, declining interest rates are associated with increasing house prices in most countries, except for Poland, where we get the unexpected sign. Finally, we see that the coefficient of the change in population is very large for many countries. We do not put too much weight on this finding since it is likely attributable to the fact that population data are available only on an annual frequency and the interpolation that we conducted might have shaped the results.