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Contents

Abstract

This paper aims to estimate a long-term equilibrium price level for the Hungarian housing market by identifying key underlying macroeconomic factors. For this, in line with the empirical literature, a vector error correction model is employed. The housing market price level is mapped by the newly established MNB housing price index. The results establish one stable cointegrating relationship between the housing prices and its long-term driving factors: average new housing loans, disposable income and housing stock. Credit channel plays a decisive role in determining equilibrium level of housing prices. Housing prices exhibit overshooting to various shocks potentially due to the protracted supply side adjustment. Due to the short sample size the estimated price gap might be underestimated in magnitude; nevertheless the fairly slow price adjustment coefficient ensures a persistent gap. Therefore, the sign of the estimated price gap is informative for policy makers from a macroprudential perspective.

Keywords: housing prices, VECM, error correction, housing loans, cyclical position
JEL classification: E44, R21, R31

Összefoglaló

Tanulmányunk a magyarországi lakásárak makrogazdasági fundamentumok által meghatározott hosszú távú egyensúlyi szintjét becsli meg egy vektor hibakorrekciós modell segítségével. A lakásárak szintjét az MNB által 2016-tól publikált árindexszel mérjük. Egyetlen stabil kointegráló kapcsolatot azonosítottunk a lakásárak és az azt meghatározó tényezők között, amelyek az újonnan kihelyezett lakáshitelek átlagos összege, a háztartások rendelkezésre álló jövedelme, valamint a lakásállomány. Azt találtuk, hogy a hitelezési csatorna érdemi szerepet játszik az egyensúlyi árszint meghatározásában. Becslésünk szerint az erős kínálat oldali alkalmazkodás a lakásárak ideiglenes túllendülését okozza különböző sokkok esetén. Nem találtuk jelét annak, hogy a válságot megelőzően jelentős mértékű lakás-árbuborék alakult volna ki. Ugyanakkor a rendelkezésre álló rövid idősorokból adódóan a lakásárrés mértékét alulbecsülhetjük. A lakásárak rövid távú alakulására az egyensúlyi szinthez való viszonylag elhúzódó visszatérés jellemző. Ez perzisztens lakásárrést eredményez, vagyis az árrés aktuális előjele hasznos információval szolgál az MNB makroprudenciális beavatkozásainak finomhangolásához.

1 Introduction

Development of housing prices influences many aspects of the Hungarian economy. First, since vast majority of the households' accumulated wealth are in dwellings, house price fluctuation cause changes in wealth for homeowners who may react by adjusting their level of consumption. Through this channel housing prices have an effect on the real economy. Second, by stimulating housing investments, dwellings construction activity increases if house prices are soaring relative to costs of building, hence influencing the business cycle. Via credit markets these effects can be amplified in the presence of market frictions, since developments in housing prices may also affect households access to mortgage loans for house purchases and vice versa.

The identification of housing price determinants, particularly the role of mortgage loans is primarily important in terms of financial stability, since it may lead to overindebtedness and impact the expected loss thus also affecting the capital requirement of the banking system through the collaterals of housing loans. If the housing prices are too high, higher volumes of mortgage loans can be disbursed, however their repayment is exposed to higher risks, because after the temporary overvaluation, a more serious decrease in the housing prices may be expected, causing the depreciation of mortgage collaterals. Therefore, in the absence of macroprudential interventions, systemic risks may arise undermining the financial stability. Consequently, the housing price cycle can amplify the financial cycle increasing both the intensity and the probability of a potential financial crisis.

This paper focuses on a quantitative approach to assess the cyclical position of housing prices. In accordance with the empirical literature the chosen methodology is a vector error correction model as such an econometric model is capable of jointly estimating existing short and long-run interactions between the variables within a consistent framework. A long-term relationship, the *housing price equation* has been identified among the considered variables corresponding to theory. New housing loans, disposable income for households and housing stock proved to have long-term impact on the real housing prices**.** Additional exogenous variables, the effective nominal interest rate and number of dwellings transactions are also incorporated to provide control for house price expectations and short-term changes in the cost of financing. The inclusion of these variables also influences the estimated housing price equation indirectly through the credit market. Cost of financing does not enter the long-run relationship directly, since on the one hand it shows a mean reverting pattern over the estimation sample and on the other hand other endogenous variables, namely income and new housing loans, partly pick up its effect.

The paper contributes to the empirical literature in two important aspects. First, to our knowledge, no housing price model is available for the Hungarian market in which credit constraints are modelled in determining short and long-run housing price level. Second, by considering possible supply side effects in line with the theory, it is concluded that a rise in housing stock has a significant and negative long-run impact on housing prices. A positive demand shock results in steadily increasing housing prices but after a while supply side adjustment makes it gradually decrease to its long-term equilibrium level. Hence, overshooting of house prices can be observed.

The paper gives a brief survey of theoretical and empirical literature in Section 2. In section 3 stylized facts are presented about the Hungarian housing market to put the paper into perspective. Section 4 serves a detailed description on the modelling methodology and the underlying data. In Section 5 results of vector error correction estimations are shown and discussed extensively, while the robustness of the model is also checked. Finally, section 6 concludes.

2 Theory of the housing prices

To estimate equilibrium housing price level supported by economic fundamentals the first step should be the identification of the relevant macroeconomic variables. To achieve this, a theoretical framework free of market frictions is described to outline the underlying dynamics which define the relevant market movements. As the real housing market is not free of such frictions, the real housing prices observed are generally different from those set by the fundamentals. Still, market frictions should only be felt temporarily and the prices would converge to the fundamental level if economic circumstances remain unchanged.

2.1 ECONOMIC THEORY

The theoretical framework presented here draws on four underlying interactions (see for example Poterba 1984, Meen 1990, DiPasquale and Wheaton 1992, Meen 2001, Cameron et al. 2006)**.** The first such interaction is that the rental fee of the apartments in period t is determined by the fix short-term supply of residential real estate and the demand for housing services:

$$H_t = POP_t * f\left(Y_t, R_t, D_t\right) \tag{1}$$

We assume that the supply of housing services equals to the fix stock of homogeneous dwellings available (*H*). The demand for housing services decreases with the reduction in real rental fee (*R*), while it increases with household's (*Y*) real income. *D* indicates the other factors influencing the demand curve. In a dynamic setting, the expected future development of rental fees and income may also affect the current demand. Given a representative household, the aggregate demand is calculated by multiplying the individual demand with the number of households. More generally, the number of households would not solely depend on the population, but also on the age composition, as well as on the opportunities and preferences of long-term cohabitation of various relatives.

A second important consideration is that no arbitrage opportunities may arise between the rental fee and the price of apartments in well-functioning markets.

$$R_t = P_t * U_t \tag{2}$$

The real rental fee paid for apartments should just cover the various costs incurred by the owner. Such costs should be expressed in proportion to the real price of the apartment (*P*). The third main implication of the theoretical framework is the so-called user cost of housing.

$$U_t = r_t + \delta - \frac{E\left(P_{t+1}\right) - P_t}{P_t} + \lambda_t \tag{3}$$

The real taxed return on investment (*r*) resulting from residential real property investments is the cost of renouncing of the profit from alternative investment opportunities that may be chosen instead of apartment ownership. During the supply of housing services, the apartment is subject to depreciation also including the real estate tax (δ). The costs of ownership of the apartment also include the expected appreciation in the price of the apartment. Finally, according to the literature, the presence of credit constraints is also an important factor. These factors lead to an outcome where there is less home ownership than desired in the economy as the savings of the buyers does not always cover the total purchase price. Credit constraints (λ_t) therefore result in a housing stock lower than required. In this simple theoretical framework, the welfare loss of real property owners stemming from suboptimal consumption structure is included in the user cost of housing.

The last point summarizes the changes in housing stock fixed in the short run. This may also be considered as the long-term supply curve of housing services:

$$H_{t+1} = g\left(E\left(P_{t+1}\right), C_t, S_t\right) - \delta H_t \quad (4)$$

The existing housing stock decreases in proportion with the depreciation. The construction of new dwellings takes time, therefore the number of new apartments constructed in period t ($g \geq 0$) is primarily dependent upon the actual costs of construction (C) (also including the price of the land) and the expected price appreciation of the apartments in the following period. The former decreases, while the latter increases the volume of dwelling constructions. The construction of apartments is an irreversible process and the apartments already constructed are difficult to exploit for other purposes, therefore in case of higher uncertainty the construction firms tend to wait until they have a more accurate picture of future housing prices. S includes other factors influencing the supply of new dwellings.

Models explaining the development of housing prices therefore emphasize the role of the following variables:[1]

- **Housing stock:** It decreases the housing prices in the long run (Oikarinen 2009, Oikarinen 2012, Poterba 1984).

- **Households' income:** It increases the housing prices in the long run.

- **User cost of housing** (main elements: net profit of alternative investments, depreciation, maintenance expenses, housing price expectations): It decreases the housing prices in the long run. Often depreciation and the maintenance expenses are assumed to be constant over time due to lack of sufficient data, but they can be measured directly in certain cases (Oikarinen 2012). In general, adaptive expectations are applied in relation to the development of housing prices, i.e. they are measured with the observed housing price development (Dümmler and Kienle 2010, Oikarinen 2012, Kivistö 2012). Another strategy is that lagged price appreciation in the model may pick up the effect of price expectations through the model dynamics (Anundsen and Jansen 2013, Iacoviello 2005). In this respect the use of real or nominal interest rate is justified and net profit of alternative investments can be used for capturing speculative (mostly cash based) house purchases.

- **Credit constraints:** It increases the housing prices in the long run. The credit market frictions are mostly approximated by credit stock variables (Brissimis and Vlassopoulos 2009, Fitzpatrik and McQuinn 2007, Hofmann 2003, Oikarinen 2009), but the housing debt maturity (Oikarinen 2012) or the loan-to-value ratio (Duca et al. 2011) can also be used. The inclusion of the credit aggregate captures the effect of changes in cost of financing on housing prices, but also contains information about housing price or income expectation - the more uncertain households are about the prospects, the less likely they are to borrow.

- **Costs of building new apartments:** It increases the housing prices in the long run (eg. Adams and Füss 2009, Fitzpatrik and McQuinn 2007).

2.2 HOUSING PRICE ADJUSTMENT TO ITS EQUILIBRIUM LEVEL

Adjustment of housing prices to an exogenous shock takes time even if the market functions well. According to the presented theoretical framework, for example, a permanent shock to income will affect the housing prices as follows: If the supply is inelastic in the short run, the higher demand for accommodation may increase rental fees (equation (1)) and the housing prices (equation (2)), as well. If the increase of housing prices is expected to be permanent, the number of dwellings constructed also increases (equation (4)). The continuously expanding housing stock starts to decrease the rental fees (equation (1)) and the housing prices (equation (2)), resulting in the fall of construction activities, as well. The new long-term equilibrium housing prices will be higher than the original one, but overshooting is expected in the short run.

[1] For each empirical variable, it was indicated how the long-term growth of the variable would affect the housing prices in the long run underpinned by the empirical results.

The adjustment of housing prices to the changing economic fundamentals are hindered by multiple market frictions. Apartment rental and to greater extent, apartment purchase involves significant transaction costs. Such costs include, for example, the costs of moving, the duties to be paid after the apartment purchased and related attorney's fees, as well as, minor adjustments to the apartment according to individual preferences. Significant transaction costs may also be due to the time and money spent on searching, because it is about a significant expense and the quality of apartments is not always easy to judge either. The search-related costs are partly due to the geographical distances, resulting in the formation of regional submarkets that are able to affect each other's prices in a slower pace. The construction of new apartments is also subject to significant transactional costs. Appropriate construction sites, subcontractors, investors and, finally, customers should be found. Furthermore, the full process is subject to extensive government regulation and compliance implies administrative costs.

In Hungary, the underdevelopment of the apartment rental market may also be particularly important, because it makes the determination of apartment rental fees difficult and deteriorates the consistency between rental fees and the housing prices. The protracted adjustment of housing prices may also be due to price stickiness. The rental fees and the prices of apartments sold had already been recorded in the parties' agreements during construction, therefore the actual economic circumstances may not change the previously negotiated prices any more.

Due to the prolonged adjustment of supply and the market frictions, the housing price observed often deviates from its long-run equilibrium value. Based on the actual value of economic fundamentals, however, it can be estimated to what extent the actual prices imply over- of undervaluation of apartments. Such differences do not persist in a stable economic environment, because they arise due to the sluggish market adjustment only. The speed of adjustment may also be important in terms of planning any possible policy interventions, and should also be quantified.

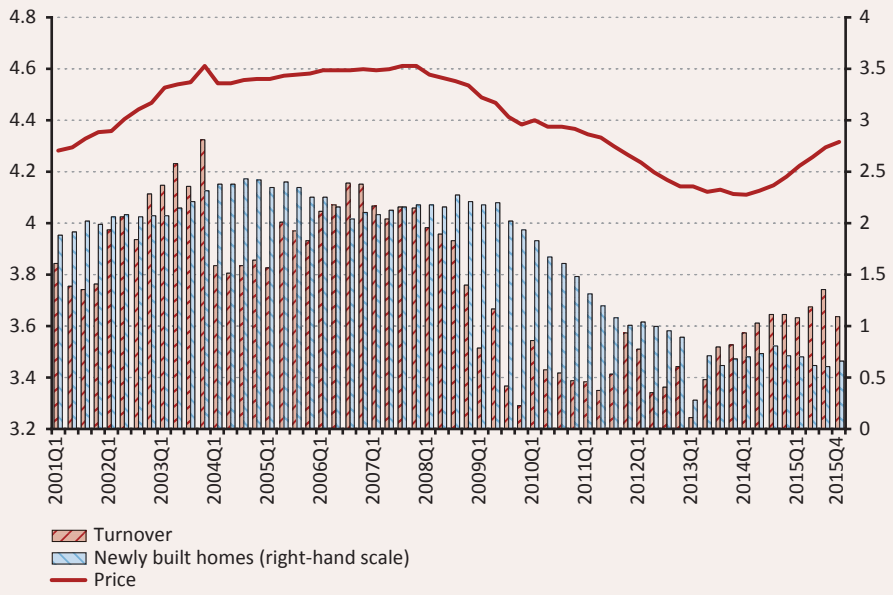
3 Stylized facts of the Hungarian housing market

Before estimating the over- or undervaluation of the prices in the Hungarian housing market it is important to put the analysis into historical context. For this reason, an overview is provided of the past 15 years' housing price development and a description of the major events influencing the key economic fundamentals.

3.1 THE HUNGARIAN HOUSING PRICES, SALES VOLUME AND THE NEW DWELLINGS BUILT

A newly constructed indicator for measuring the housing price level in Hungary is the housing price index published by MNB containing data from 1992.[2] The MNB real housing price index was steadily increasing between 1998 and 2007 almost doubling by the end of 2007 (Figure 1). The growth of real prices significantly slowed down after 2003, while from the beginning of 2008 a slightly decreasing trend could be noticed. Both the nominal and real housing prices indexes showed a clear decreasing trend from the beginning of the crisis until 2014. The value of the real index fell back to the level, which was typical around the millennium. From 2014, a dynamic price increase started, real prices rose by 25% within two years while nominal price index exceeded its pre-crisis level by late 2015.

Figure 1
Development of housing prices, the number of dwellings built and transactions



Note: All data are in logs and seasonally adjusted. Source: Hungarian Central Statistical Office, MNB.

[2] Earlier the quarterly FHB housing price index was commonly used (see FHB 2010). Both the MNB and FHB housing price indicator is a hedonic price index. Most important difference between the calculation of FHB and MNB price index is that the in latter almost all available housing transactions are included. Another difference occurs in the construction of index namely that MNB spatially disaggregated sub-indices are separately estimated and aggregated to form the nationwide index (see Banai et al. 2017).

The dynamics of new dwellings built followed the development of the real price index with some lag indicating the growing demand for housing (Figure 1). At the same time, transaction volume can be regarded as a better leading indicator for housing prices as it captures changes in demand in the short run. As opposed to the time series of the number of new dwellings built or dwelling permits issued the growing housing prices were accompanied by increasing sales volume after 2013.[3]

3.2 MAIN EVENTS INFLUENCING THE HOUSING PRICES IN HUNGARY

The dynamic housing price increase around the millennium could be due to several factors. In regards to demand-side factors, it is important to note that Hungary already underwent the most critical period of the transitional crisis and households' real income and savings had already been increasing significantly. Additionally, the uncertainty caused by the transitional period decreased, which encouraged the realisation of postponed house purchases.

Mortgage lending started to play a significant role both in the housing and the credit market from 2001. The households' credit demand increased due to the macroeconomic stabilisation and real convergence, their actual and expected income position improved (Endrész 2014), and – due to the fact that the inflation rate fell below 10 percent by the early 2000s – the nominal interest rates entered a downward trend facilitated by ongoing financial deepening.

From 2001, households could apply for significant amounts of state interest-rate subsidies for new mortgage loans. Various subsidy schemes were widely available and easily accessible to a high number of households. These subsidies played a fundamental role in jumpstarting the outstanding volume of housing loans (Farkas et al. 2006). By the end of 2003, the terms of subsidies were significantly tightened, causing a temporary fall-back in the demand for housing loans.

Regarding supply-side factors, it is important to highlight that socialism left behind a bad quality housing stock, which did not improve or expand significantly in the 90s. The dynamic increase of housing prices starting from 1998 was followed by a quick growth in the number of new homes constructed, but this could not counteract the rising housing prices due to the relatively high housing stock available (Vadas 2007). Overall, the number of new homes built per year more than doubled between 1998 and 2004.

Therefore, the dynamic housing price increase observed from 1998 and ending in 2003 was accompanied by the significant change in many fundamentals. This shows that the deviation of housing prices from the equilibrium level may only be established with much uncertainty for this period.

The most important trend in the following period ended with the crisis and is characterised by moderately growing housing prices spurred by the expansion of FX-denominated mortgage loans. By the end of the period, the growing importance of lending can be characterized by the fact that outstanding mortgage stock of the households in proportion to GDP grew by 150% from the end of 2003, with the vast majority of new housing loans being FX-denominated. The significant increase of FX-denominated housing loans was due to both supply-side and demand-side factors. On the supply side, increased bank competition led to the banks embarking on non-price competition, increasing their risk appetite which led to conditions of housing loan application becoming less strict (Nagy and Szabó 2008). Although, the decrease in effective interest rate of HUF-denominated non-subsidized housing loans continued, the interest rate of FX-denominated loans was significantly lower. In the favourable money market environment, the Hungarian financial intermediary system was provided with abundant funding from their respective parent banks until late 2008. The increase in the demand for housing loans was further encouraged by the fact that the actual and expected real income of the households continued to grow. Although, this growth came to a halt due to the series of fiscal austerity measures from mid-2006, the lending impetus did not significantly decrease.

[3] A level shit occurred to the sales volume in 2004 Q1 owing to the "sudden" phase out of generous interest-rate subsidy scheme at the end 2003.

The significant loosening of credit constraints encouraged the increase in the real housing prices, which was mostly counterbalanced by the high number of new dwelling constructions and gradually deteriorating income expectation after 2006. Between 2004 and 2008, the number of new apartments was around 40 thousand per year, which is the highest home construction volume since the start of the transition period, which led to real housing price growth deceleration compared to earlier periods.

After the outbreak of the 2008 crisis rapidly deteriorating macroeconomic conditions resulted in the severe balance sheet adjustment pressures which ultimately led to the decrease in demand for housing services thus falling housing prices. The households' income position has considerably worsened while their debt service burdens also increased significantly, which was mainly due to the weakening HUF and the unilateral interest rate increases adopted to mitigate expected banking losses. Average instalments of a debtor with a CHF-denominated housing loan almost doubled between the summer of 2007 and late 2014.

Furthermore, the banking losses generated by non-performing loans decreased banks' willingness to take risks significantly which translated into significantly tightening lending conditions (Homolya 2012). The tightening of borrowing conditions for households, a significant hike in real interest rate at the beginning of the crisis, as well as the expected fall of housing prices increased the user cost of housing, also contributing to the reduction of real housing prices. Due to the significantly decreasing housing prices, the profitability of home constructions deteriorated and the number of new dwellings constructed annually fell under 10 thousand by 2013.

The increase of nominal and real housing prices from 2014 was followed by the economic fundamentals improving due to the recovery from the crisis. In this period, the income position and prospects of the households started to improve, the debt service burdens lowered and strict credit conditions were easing. Compared to the beginning of the crisis, real interest rates on mortgage loans saw a marked decrease. The demand for apartments is also driven by the expectation of further price appreciation as well as emergence of buyers on the housing market who postponed their home purchases due to the uncertainty caused by the crisis.

4 Model specification and data

4.1 ESTIMATION METHODOLOGY APPLIED

To quantify the housing prices determined by the underlying economic fundamentals, a vector error correction model (VECM) was chosen. This framework is widely used for empirical estimations related to the housing market as there exists a cointegrating relationship between the housing prices and related macroeconomic variables. The following econometric model was used to capture the long and short-run coefficients of the system:

$$\Delta X_t = \alpha_0 + \Pi X_{t-1} + \sum_{n=1}^{k-1} c_n \Delta X_{t-n} + \Lambda \Delta X_t^* \tag{5}$$

where X_t is the vector of the endogenous variables and X_t is the vector of exogenous variables. The lag length k is the optimal lag length for the unrestricted VAR using the Schwartz information criteria. This criterion was chosen as it yields the most parsimonious lag length in line with the relatively short estimation sample. Π captures the error correction term which is the product of the vector of loading parameters (α) and the vector of the long run coefficients. This parameter is of key interest as it captures the level of house prices that is supported by economic fundamentals.

The model is estimated using the Johansen methodology. Compared to alternative estimation procedures the Johansen method estimates both the short-run and long-run parameters simultaneously. Furthermore, this method checks the presence of cointegration by calculating the rank of the matrix of endogenous variables. This yields cointegration results that are independent of normalisation choice. It opens up the possibility of estimating the model with restrictions to the long run coefficients and the speed of adjustment parameters as well.

*The estimation period ranges from 2001 Q1 and 2015 Q4***.** This sample was chosen because lending has an overwhelming importance in determining house prices and extensive provision of mortgage loans launched in 2001.[4]

Although VECM framework allows the identification of more than one cointegrating relation, it is expected that there is only one stable cointegrating relationship among the endogenous variables. The assumption of two cointegration relationships among the relevant variables is mostly made when the main focus is on the systematic exploration of the interaction between housing prices and credit. Such studies identify a lending equation besides the housing price equation. The coexistence of these two cointegrating relationships can be understood in a way that the lending activity and housing prices are interdependent in the long run and when disequilibria in either house prices or lending occurs it may be corrected through changes in both variables at the same time.

We considered estimating a single system of VECM with two cointegrating vectors but due to the relatively small size of the sample and structural breaks[5] in the time series - particularly the lending activity - establishing

[4] Between 2001 and 2015 the average share of transactions involving housing loans out of total sales volume was almost 40 percent with considerable variation. Compared to similar data on countries with developed mortgage lending the proportion in Hungary is considerably lower.

[5] The mains structural changes are as followings: (1) Due to the financial deepening, the borrowing conditions were loosened significantly from 2001 also with the expansion of FX-denominated mortgage loans, which may be partly captured by the continuously decreasing cost of financing, but it may not be controlled entirely for this effect (Endrész 2014). (2) Amount of new housing loans shrunk to a marginal level in shortly after the crises had broken out. (3) The interest rate subsidization schemes effective between 2001 and 2003 influenced the borrowing decisions significantly.

a model with two cointegration vectors in which the estimated coefficients have the expected sign and magnitude provided us with mixed results. However, only estimating the housing price equation is in line with the intention of assessing cyclical position of the Hungarian housing prices.

The robustness of the estimated results is checked via alternative housing stock and loan variables as well as a recursive dynamic OLS (DOLS). A full-blown a parsimonious short run model is also estimated to check significance of endogenous variables in the short run. Finally, impulse response analysis is also conducted.

4.2 DATA

All data used in the analysis are seasonally adjusted, expressed in natural logarithm with the exception of real interest rate and user cost of housing. The consumption deflator was used to adjust for inflation. The source of the data is MNB unless indicated otherwise. Variable plots can be found in the appendix (see Figure A1-A3 in the appendix).

The *MNB real housing price index* (P) measures the average real housing prices in Hungary, which is a hedonic housing price indicator (Banai et al. 2017). The change of the average price that is calculated from the sales prices observed are adjusted for the change in the composition of the dwellings' relevant properties (location, age, site area, technological specifications, etc.) if available.

The *real income* (Y) variable is the households' actual real disposable income, which includes the cash transfers received from the government in addition to the net wages and salaries. Actual income was included in the model as opposed to a constructed permanent income variable because in the presence of credit market imperfections, the use of the actual income may better capture credit constraints. The households' real income also picks up demographic effects.

The *housing stock* (S) is the real value of housing stock available at the end of the period determined by a law of motion of housing capital accumulation,

$$H_{t+1} = IH_t + \left(1-\delta\right)H_t \tag{6}$$

where a constant, 2 percent depreciation rate was assumed following Dümmler and Kienle (2010). Annually available real household investment data (IH_t)provided by the Hungarian Central Statistical Office (HCSO) were converted to quarterly frequency.[6] Supply-side effects on housing prices are to be captured by total housing stock in Hungary. In the absence of quarterly available housing investment variable, the effect of supply side adjustment on prices is not directly modelled.

The *average real housing loans granted* (per mortgage contract) (L) captures the household credit constraints.[7] The increase of the loan variable indicates the loosening of lending conditions, which may encourage the increase of housing prices. The basic data - loans for buying new and resale dwellings[8] - is available from 2001 on a semi-annual basis which was transformed to quarterly frequency.[9]

User cost of housing (UC) is measured by the mean of effective annual percentage rates of new housing loans in the previous four quarters minus the mean of house price growth rate in the last four quarters. That is, house price expectations are to be captured by lagged housing price appreciation. Due to lack of sufficient data, real

[6] The data is from the The conversion was made by Denton method using the number of dwellings built quarterly time series as indicator variable with sum matching (See Eviews 9 User Guide I more detailed). Time series properties of resulting series of different frequency conversion procedure when transforming semi-annual to quarterly data does not sensitive to the choice of interpolation method.

[7] The housing credit stock often applied in the empirical literature as a measure of credit constraint, but in Hungary housing prices and debt dynamics is not closely related owing to frequent structural changes and policy interventions in lending.

[8] These two homogenous housing loan categories altogether made up 70 percent of the total housing loans provided during 2001 Q1 – 2015 Q4.

[9] Again, Denton method was applied using quarterly MNB real housing price index time series as indicator variable with average matching. The source of data is the HCSO.

average maintenance cost and depreciation rate are left out. In accordance with the house price modelling consideration presented in the theoretical section, user cost of housing is alternatively measured with either nominal or real effective annual percentage rate of new housing loans - nominal (I) and real interest rate (R).

Sales volume (sale) is for tracking short term changes in demand for housing services. We use total number of dwellings transaction of households for measuring sales volume. Since credit constraints faced by households are expected to influence sales volume indirectly dwellings transaction is likely to incorporate elements of credit constraints.

In the empirical literature effect of *demographic changes* on housing prices is controlled for by correcting relevant variables (income, housing stock or loans) either with number of total population or number of households.[10] However, a steadily growing number of households can be observed in Hungary over the estimation period, but it is counterbalanced by a downward trend in the number of total population over the same time span. In addition, population decrease implies less, while growing household number translates to more housing units, although decreasing average household size implies that less average floor area is needed at the same time. Considering these two contrasting demographic developments, neither of these two demographic effects are controlled for in the baseline model.

[10] Relevant demographic variables can directly enter the estimation as regressors.

5 Results

5.1 THE LONG-RUN RELATIONSHIP DETERMINING EQUILIBRIUM HOUSING PRICES

Before estimating the long run parameters of the model, it is imperative to test the variables for the presence of unit root behaviour. This was done using both the ADF and the KPSS test as the null hypothesis of the two tests is different minimising the possibility of a type II error. The results of these tests are shown in Table A1 in the appendix. All the series seem to be I(1).

In line with the theoretical consideration the VECM contains the following variables: real housing price (P), average real new housing loans (L), real disposable income for households (Y), housing stock (S) as endogenous, sales volume (sale) and nominal interest rate (I) as exogenous variables.[11]

The unconditional VAR estimates of the model showed that two lags are needed for the estimation in order to have non-autocorrelated error terms. The Johansen procedure was used to determine the rank of the matrix. Since the model includes I(1) exogenous variables in the estimation the critical values of Pesaran et al. (2000) were used to determine the number of cointegrating vectors. Both the trace test and the maximum eigenvalue test, shown in Table 1, identifies one cointegration equation at the 10 percent level.[12]

Table 1
Result of cointegration tests

	Trace test			Maximum Eigenvalue test		
No. of CE(s)	**Statistic**	**10% level**	**5% level**	**Statistic**	**10% level**	**5% level**
None	65.93	63.57	68.06	31.44	31.30	33.87
At most 1	34.49	42.67	46.44	17.58	25.21	27.75
At most 2	16.92	25.63	28.42	10.16	18.78	21.07
At most 3	6.76	12.27	14.35	6.76	12.27	14.35

Note: The critical values are taken from Pesaran et al. (2000). The number of I(1) exogeneous variables is two.

Neither nominal/real interest rate nor user cost of housing enter the estimated long-run house price equation. Real interest rate and user cost of housing often driven by inflation and housing price dynamics show a mean reverting pattern, thus forward-looking households with long planning period would not react to changes in these variables (Oikarinen 2012). Moreover, user cost effect on housing prices may picked up by the credit and income variable (Anundsen and Jansen 2013).[13] The loan variable may also contain information about the income, interest rate and price appreciation expectations as well. The insignificant long run parameter of

[11] Several alternative variables were considered including in short-term dynamics of the model: output gap, long-run unemployment rate, unemployment rate, number of dwelling construction permit issued, real housing debt stock, alternative investment net profit with respect to lagged housing price appreciation (speculative house purchase). Most of them turned out to be insignificant when sales volume and/or nominal interest rate were included at the same time.

[12] Even without the inclusion of any exogenous variables the maximum eigenvalue test finds one cointegrating relation among the endogenous variables.

[13] Until 2009 mortgage loans were predominantly provided with flexible interest rates in Hungary. Therefore, a change in interest rates almost immediately feed into the disposable household income, and it is likely to take up the effect of interest rates on demand for housing rendering interest rate insignificant in the model.

real and nominal interest rate reinforces that interest rate may not be directly incorporated in housing price equation (Hofmann 2003).[14]

Turning to the coefficients of variables involved in the cointegrating relation (Table 2), the long-term coefficient of real income is around 1.25, which corresponds to the estimation results of the international literature which uses time series data (Fitzpartik and McQuinn 2007, Gerlach and Peng 2007, Gimeno and Martinez-Carrascal 2010, Oikarinen 2012).[15] This means that if the real disposable income increases by 1 percent, the real housing prices increase by 1.25 percent in the long term. Income variable picking up the demographic impacts on housing prices but it is not likely to have great impact on coefficient value. Another effect modifying coefficient value is that the income variable may also contain effects of changes in the cost of financing.

Table 2
Long-run parameters

Restrictions:	$\alpha_L=\alpha_Y=0$
Probability of identification	0.648
Number of lags	1
L	-0.243**
	(0.102)
Y	-1.266***
	(0.272)
S	2.997***
	(0.789)
α	-0.141***
	(0.033)
Exogenous variables:	
ΔSale	Yes
ΔI	Yes

Note: Standard errors are shown in brackets. The number of stars indicates at which significance level the coefficients are different from zero (: 10 percent, **: 5 percent, ***: 1 percent). In the table, the signs of coefficients are the opposite of what usually reported, because MNB real housing price index was normalised on 1 in the cointegrating vector.*

The long-term elasticity of the housing stock with respect to house prices is -3, i.e. real housing price index decreased by such percentage in the long term due to the one percentage increase in the housing stock. Supply side has a significant and substantial effect on the housing prices in the long run, house price growth rate is moderated by growing housing investments activity, in line with the theory. However, empirically the housing stock is found to have a positive impact on housing prices because increasing housing stock indicates the tendency of growing demand for dwellings (Gimeno and Martinez-Carrascal 2010). Due to small increments of housing investment relative to housing stock, housing prices are sensitive to changes in the persistent housing stock times series. This value corresponds to empirical results ranging from 3 to 4 using similarly constructed housing stock variables (Oikarinen 2012, Anundsen and Jansen 2013, Farkas 2011 on Hungarian panel data).

[14] In case of two cointegration long-run relations interest rate parameter in house price equation is often restricted to be zero as an identification restriction. However, we cannot reject that two cointegrating vectors exist after examining many specifications of endogenous variables with different identifying restrictions.

[15] In the empirical studies on panel data the income elasticity of housing prices is between 0.5 and 1 depending on the definition of income or covered time span, while studies on time series data amounts to an average of 1.25 with a significant standard deviation (Cameron et al. 2006). It can also be said that generally, the elasticities have higher absolute value in case of smaller economies or the emerging Central-Eastern European economies than in case of larger size developed economies (Égert and Mihajlek 2007). The baseline estimation is not directly comparable with the result of estimations conducted on the Hungarian panel data (values around 1) (Farkas 2011, Kiss and Vadas 2005).

The variable average real new housing loans aims to capture the borrowing limits experienced by the households. If changes in credit conditions are controlled for the stability of estimation can significantly be improved (for the consumption equation, see Aron et. al 2010). This empirical consideration corresponds to theoretical insights in the housing market and highlights the importance of the inclusion of credit variable in the housing price equation. Moreover, it is also likely that the reason why none of the variables measuring user cost of housing enter the long-run equation is that the credit variable captures effects of these variables at least partially.

The new housing loans is significant in the long-term relationship with the expected sign and the coefficient value of 0.24. Although not directly comparable, it does not correspond with the loan coefficient estimates in the literature, since it is considerably smaller. In general household mortgage loan stock is used for this purpose in the empirical literature – designed to capture similar effects (Oikarinen 2009, Anundsen and Jansen 2013, Gimeno and Martinez-Carrascal 2010, Fitzpatrick and McQuinn 2007). Low absolute value of elasticity is related to the fact that relatively underdeveloped financial intermediary system in Hungary may be responsible for the relatively low rate of housing purchases financed with debt compared to countries with developed financial system. Frequent regime changes in lending manifested in a very volatile amount of new housing loans which may also contribute to low absolute value of elasticity in question. The link between housing prices and lending is less direct which is also evidenced by the low rate of debt financed housing purchases.

It should be mentioned that the income and loan variables were assumed to be weakly exogenous, which implies that neither the loan variable nor the income variable reacts to disequilibrium in house prices. The chi-square statistics used for testing the validity of such restrictions provides further evidence that the selected variables are weakly exogenous by yielding a p-value of 0.6.

To sum up, in the estimated long-run housing price equation, the endogenous variables affect the housing prices in line with both the theory and empirical findings. None of the variables measuring user cost of housing enter the cointegrating relation.

5.2 SHORT-RUN DYNAMICS

The VECM short-run dynamics includes price adjustment towards its estimated long-run equilibrium value and effects of endogenous and exogenous variables in the short-run (see Table A4 the appendix).

Short-run dynamics has an important role in determining equilibrium housing prices. VECM allows short-run dynamics to be data-driven, which can be conducive to represent the sluggish nature of housing price adjustment. By letting short-run model dynamics capture housing price expectation results in significant short-term lagged endogenous variables as opposed to modelling expectation explicitly via the user cost variable.

Based on the results of the empirical literature, the adjustment (‘loading’) parameter of housing prices is usually between -0.07 and -0.25 in models identifying one or two cointegrating relations (e.g. Gimeno and Martinez-Carrascal 2010, Fitzpatrik and McQueen 2007, Oikarinen 2009, 2012). The loading parameter estimated for the 2001-2015 period is -0.14, which is in line with the empirical literature even if flow-type loan variables were employed instead of stock-type which is more stable than the former implying slower adjustment speed. This results suggest that if housing prices are higher than their long-term equilibrium by 10 percent, housing prices will fall by 1.41 percent in the next quarter. This correction is done through housing (dis)investment decisions made by the households.

Sales volume is included in the short-term only. It is often a leading indicator of housing prices, that is, it reacts more rapidly to changes in demand for housing services than prices do (Oikarinen 2012). Besides credit constraints it may embody information speculative housing purchases. It is estimated that if sales volume growth increases by 10 percent then housing price growth increases by 0.5 percent in the same period. It should be noted that despite having a relatively small coefficient due to its volatile movement it affects development of equilibrium housing prices.

Nominal interest rate is also present as an exogenous variable in the short-run. It only has an indirect and significant effect on housing price via the weakly exogenous lending equation with the expected sign. It decreases the growth of lending activity in the short run by 1.2 percent when interest rate of new loans increases by 10 percent.

Besides the exogenous variables, lagged differenced housing prices and housing stock turn out to have significant effect on house price growth in the short run. Here, positive short-term coefficient of housing stock indicates growing demand for housing.

5.3 DEVIATION FROM THE LONG-TERM EQUILIBRIUM LEVEL OF HOUSING PRICES

Looking at the co-movement between the equilibrium price level, housing prices, and the resulting house price gap, four time periods can be identified with respect to under and overvaluation of housing prices (Figure 2). Development of the house price gap enables us to check whether the preliminary knowledge detailed in the stylized facts section can be confirmed by observed housing price deviations from equilibrium prices in magnitude and direction.

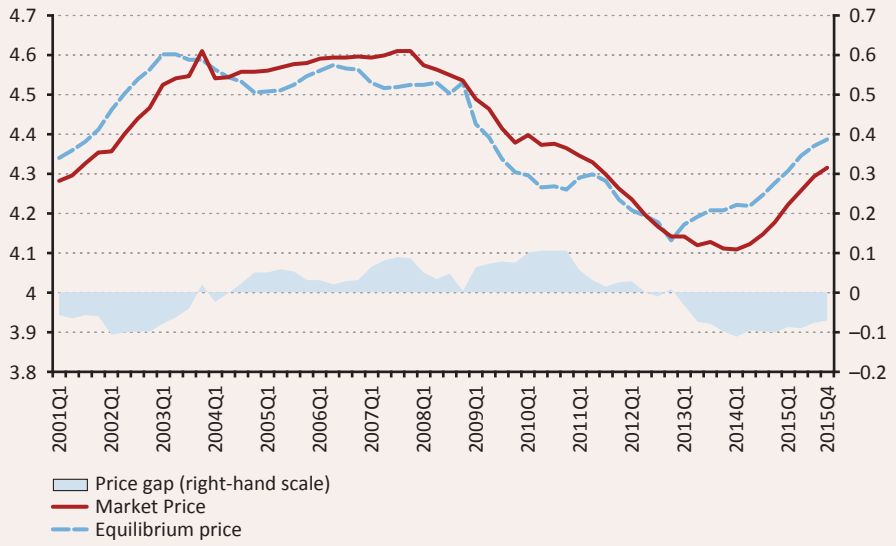
In the first period the price gap remained negative and altogether stable as the observed house prices were increasing with the pace of the equilibrium price level. This period was characterised by extensive interest rate subsidisation of housing loans for both new and existing dwellings, which made the cost of financing become cheap and widely available thus increasing the equilibrium price level significantly mostly via the credit channel. This dynamic was also supported by the significant increase in real income and income expectation.

After 2003 there was a reversal in the equilibrium price dynamics which was due to the sudden phase out of the generous interest subsidisation scheme. This led to a temporary significant decrease in loan outflows and a sudden emergence of positive price gap. From 2004 Q4, house prices were mostly dominated by market forces. This period was characterised by a positive price gap. Equilibrium prices were driven by the expansion of FX-denominated mortgage loans in the light of loose borrowing conditions and stable income growth and expectations. Record high level of construction dwellings was gradually feeding into a steadily increasing housing stock which partly offset the effect of lending on housing prices. Between 2004 and 2008 sustained positive gap highlighted the importance of competitive credit conditions of FX denominated mortgage loans in the form of delayed capital repayment which the loan variable used is not able to capture. From the second half of 2006 due to ongoing fiscal austerity measures, contribution of income to sustain such a high equilibrium prices eroded which increased the positive gap, because households considered the effects of fiscal cutbacks on income position to be temporary, thus credit expansion continued after 2006.

The fundamentals already indicated the stagnation of the equilibrium price level from 2007. Shortly after the outbreak of the 2008 crisis, the equilibrium price level sharply decreased because of the series of negative shocks affecting the fundamentals. Credit conditions became drastically stricter, cost of financing increased considerably, sales volume and dwellings constructions fell back significantly. Housing prices reacted much slower to the rapidly deteriorating economic conditions due to severely constrained access to credit market and lingering balance sheet adjustment[16] in the housing market showing symptoms of considerable dysfunctionality. As a result, housing prices remained overvalued until 2013.

[16] The negative shocks caused a debt overhang problem to which the households reacted to a great extent by reducing their level of consumption.

Figure 2
Observed and estimated long-run housing prices and the house price gap



Along with the diminishing excessive debt problem alleviated also by government measures[17] the extent of overvaluation of housing prices began to decrease after 2010. The closing of the gap was also facilitated by stagnant housing stock and decreasing cost of financing from the equilibrium price level perspective. The housing price gap became negative again, as loans and particularly income started to rebound solidly while income expectations was likely to remain moderated as the aftermath of crisis. Realization of postponed housing investments translated into protracted increase in observed housing prices which narrowed price gap during 2014.

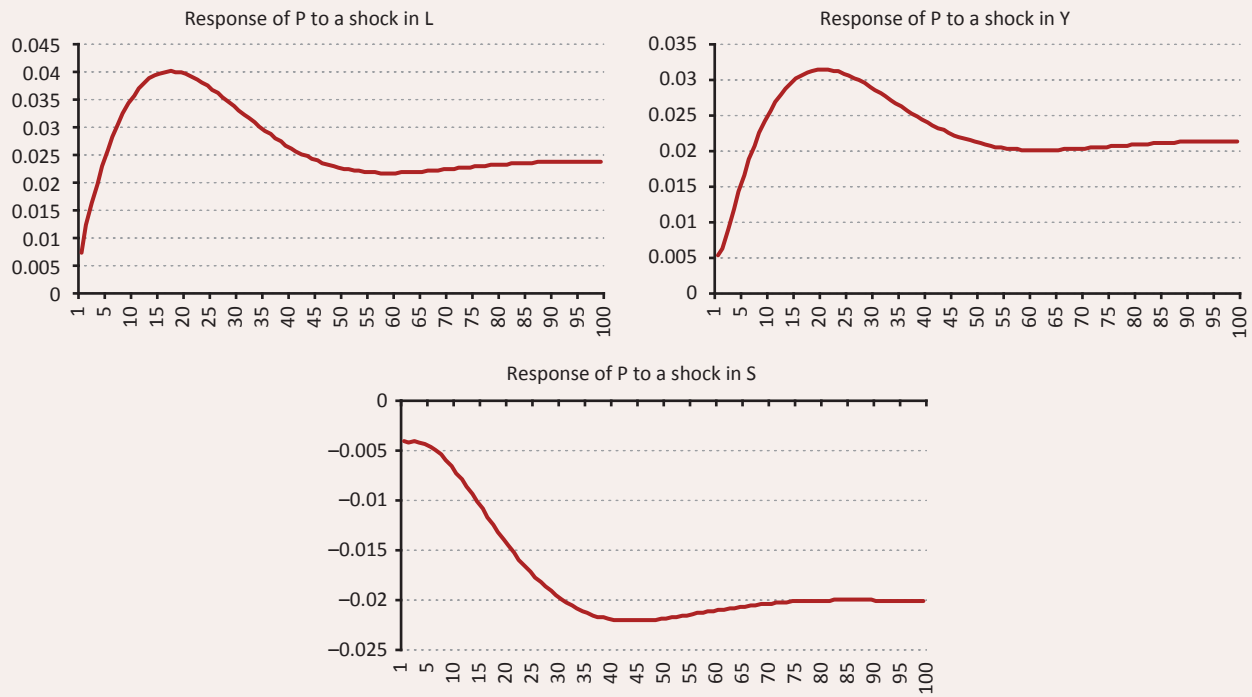
5.4 REACTION OF THE HOUSING PRICES TO DIFFERENT SHOCKS

The VECM allows for assessing the reaction of the housing prices to various shocks over time. For this purpose, the impulse response functions are used. The identification of shocks is done with the Choleski decomposition using the following ordering of endogenous variables: housing stock –> income –> new housing loans –> housing price.

In Figure 3, the reaction of prices to various shocks is shown over a 100-quarter horizon. Shock to new housing loans cannot be interpreted as a pure demand shock since it captures not just loan demand effect but to some extent loan supply effect and housing price expectations as well. Based on the impulse response functions of housing price level to various demand-type shocks, the phenomenon of overshooting of prices is reflected in the response curve in case of shock to income and new housing loans.[18] This means that the real price level increases up to the point from where the significant reaction of the supply forces price level down. This new equilibrium price level is higher than it was prior to the shock.[19] In this sense, the reaction of prices to demand shocks can be regarded as cyclical. Even without explicitly modelling supply side, overshooting of prices appears in the impulse response curves. The data used clearly indicates that not only the supply of housing reacts to changes in housing prices and there is a strong feedback effect to housing prices via housing stock in case of a demand shock.

[17] The most important policy intervention was the early repayment of FX-denominated mortgages at discounted rates at the end of 2011 which contributed to a decrease in total household debt per GDP by almost 4 percentage points.
[18] Since income or loan variable are likely to incorporate various effects such as cost of finance, income or interest rate expectations, shocks to them cannot be interpreted as pure income or loan supply shocks respectively.
[19] Vadas (2007) indirectly pointed out the overshooting effect of house prices on Hungarian data due to very sluggish supply side adjustment and large amount of housing stock.

Figure 3
Impulse responses of housing prices to one unit of shock in the endogenous variables



The price reacts to the income shock relatively quickly and substantially; around the 20th quarter price peaks and after a relatively long descend it reaches its new equilibrium level. The shape of housing price reaction to a unit innovation in the loan variable is similar to that of the income shock with a slightly larger magnitude in the long run. Response of housing prices to a positive housing supply shock immediately results in gradually decreasing curve and permanently lower housing prices in the long run.

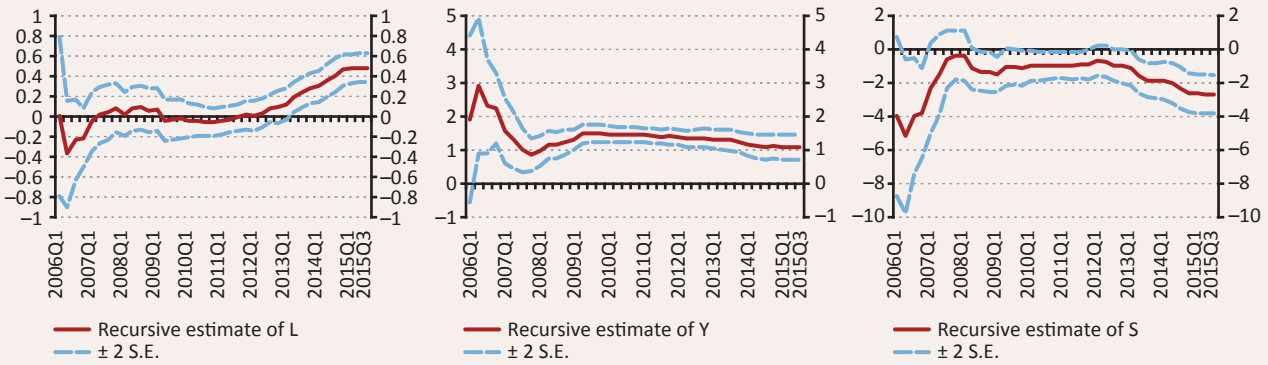
Therefore, the impulse response curves show that the real housing price reaches the long-term equilibrium level only with a significant delay due to the various shocks, which is in line with slow housing price adjustment. This observation corresponds to the widely accepted findings of Case and Schiller (1989) according to which the housing market is typically imperfect and it only adapts slowly to the changing macroeconomic conditions.

5.5 ROBUSTNESS OF THE VECM MODEL

To verify the stability of the estimated model, several tests were run on the residuals which confirms that there is neither significant autocorrelation nor heteroscedasticity present and that the null hypothesis of joint normality cannot be rejected (see Table A1 the appendix).

To check the stability of the coefficients a recursive dynamic OLS (DOLS) was run in which only parameters of long-run relationship were estimated. Given the relative short estimation period the number of lead and lag for the DOLS was set at one. This yields similar long-run coefficients to those of the VECM.

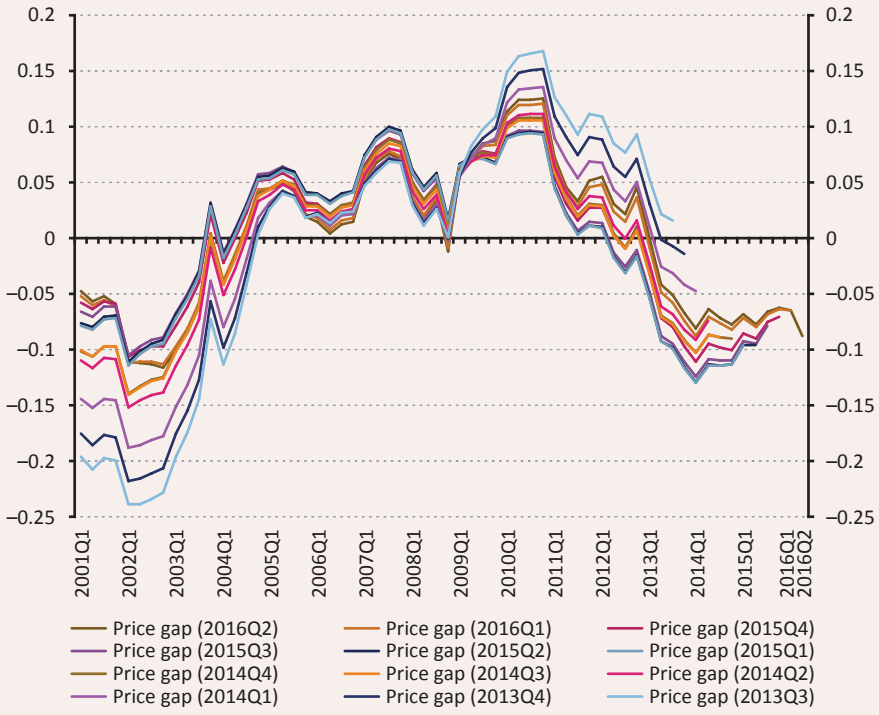
Figure 4
Recursive coefficient estimates of endogenous variables



The recursive parameter estimate of real income can be regarded to be stable in time (Figure 4). The instability of estimates of the loan variable is mostly related to structural changes in lending and to the fact that the loan variable absorbs several effects - housing price expectation cost of financing, loan supply – which may be counteracting each other. Furthermore, this coefficient only becomes significant after 2013 Q1, when the financial cycle downswing appears in the estimation.

The VECM was also re-estimated on several sample sizes to check how much the gap changes as new data is gradually added. Due to the already short sample, only about two years' worth of data was cut, as discarding more data would yield a model with unintuitive coefficients and lack of a cointegration relationship.[20] To tackle this issue, preliminary data estimates of MNB price index were included, up to 2016Q2, to get a better gap robustness check. The results are shown in Figure 5 below, from which it is visible that as more data is

Figure 5
Price gap estimates with varying sample size



[20] This finding is in line with the recursive coefficient results as the loan variable only becomes significant with the correct sign post 2013.

added the gap estimates will diverge to a lesser extent, in particular after the turning point around the end of 2013. This is related to the long run elasticity of variables, mostly the loan variable which did not prove to be stable before 2013 when the sample does not cover one whole housing price cycle (see Figure 4). Also, in the VECM estimation the constant term in the long run equation is not estimated; instead it is calculated by forcing the gap to have a zero mean on each estimation sample. This makes the price gap particularly volatile around turning points.

Another important aspect inferred from Figure 5 is that although the level of the gap is not necessarily stable at the start and end of the sample, its sign is informative for policy makers: on all the samples the positive portion of the gap is at the previously mentioned periods. When using the model in real time policy application it is suggested to fix the model parameters and only re-estimate them after the occurrence of turning points.

To get more detailed picture on the effect of long-run loan variable in the model, alternative VECM specifications were run, which include alternative loan definitions to verify the validity of the baseline estimates. These alternative models are presented in Table 3. An alternative loan category is L_2 which stand for total new housing loans instead of average new housing loans in each quarter and L_3 which, just like L, looks at the average real loan amount but for a wider spectrum mortgage loans related to housing (see Figure A4 in the appendix).[21] These alternative VECM specifications are found in column (2) and (3) of Table 3, while column (1) showing the baseline estimate. Just like the recursive DOLS case the alternative specifications highlight how sensitive the coefficients are to the loan variable. The coefficients for loans range between 0.1 and 0.4.[22] This level of variability of long-run loan parameter highlights the importance of including a variable that captures credit constraints and cost of financing at the same time.

Since demographics can shape the real estate market a specification was constructed to capture these effects by dividing income and house supply by total population. [23] This model is presented in column (4). Surprisingly, these changes do not influence the coefficients much. This is reassuring and verifies that the baseline model captures the underlying fundamentals of the Hungarian housing market.

A fully-specified user cost variable is seldom included in the long-run equation (see for example: Oikarinen, 2012). The aim of such a variable is to factor in interest rate as well as agents' explicit expectations about the house price dynamics. Naturally, if this variable is included in the estimation then the variable nominal interest rate must be omitted. Column (5) shows this model. The striking feature of this model is that the user cost of housing variable renders other endogenous variables to be insignificant both in long-run and short-run. It should be noted that it is unlikely that the user cost of housing overtly determines the long-run level of house price.

[21] In addition to loan for new dwelling and existing dwelling purchases, mortgage loan for new build and modernization and enlargement investment also included in L_3.

[22] Additionally, in the model with L_2 variable weak erogeneity assumption does not hold for loan equation. For this reason, this model is estimated without restricting the adjustment coefficient of the loan variable.

[23] Adding per household endogenous variables in the VECM will result in the lack of cointegrating relation and counterintuitive long-run parameters.

Table 3
Long and short-run parameters of the model with alternative endogenous variables

	(1)	(2)	(3)	(4)	(5)
Restrictions	$\alpha_L=\alpha_Y=0$	$\alpha_Y=0$	$\alpha_{L3}=\alpha_Y=0$	$\alpha_L=\alpha_Y=0$	
Probability of identification	0.648	0.752	0.829	0.587	
Number of lags	1	3	1	1	1
L	–0.243**			–0.315***	–0.198
	(0.102)			(0.079)	(0.127)
L_2		–0.122**			
		(0.059)			
L_3			–0.396***		
			(0.086)		
Y	–1.266***	–0.892**	–1.402***		–0.778
	(0.272)	(0.373)	(0.251)		(0.403)
Y/pop				–1.422***	
				(0.252)	
S	2.997***	1.675**	4.01***		1.127
	(0.789)	(0.747)	(0.671)		(1.304)
S/pop				3.012***	
				(0.673)	
UC					0.013***
					(0.004)
α	–0.141***	–0.173***	–0.117***	–0.159***	–0.079***
	(0.033)	(0.043)	(0.028)	(0.039)	(0.025)
Exogenous variables:					
ΔSale	Yes	Yes	Yes	Yes	Yes
ΔI	Yes	Yes	Yes	Yes	No

Note: Standard errors are shown in brackets. The number of stars indicates at which significance level the coefficients are different from zero (: 10 percent, **: 5 percent, ***: 1 percent). In the table, the signs of coefficients are the opposite of what usually reported, because MNB real housing price index was normalised on 1 in the cointegrating vector.*

The greatest variation in coefficient estimates is for the housing stock variable which ranges from 1.6 to 4, but the baseline estimate of 3 seems reasonable given that the demographic adjusted VECM yields quite similar estimates. The robustness checks verify that the baseline model estimates are robust to alternative variable specification in the cointegrating relationship.

To investigate the validity of the short-run estimates of the baseline model a general-to-specific procedure was applied to specify a parsimonious equation capturing the short-run effect of fundamentals on housing prices. This parsimonious final model is presented in Table 4 below. The residuals of this model can be regarded as stable according to the usual tests (see Table A3 in the appendix). In this estimation, contemporaneous effects are also allowed to uncover all the possible effects that can influence house price growth. The results show that besides error correction term coming from the baseline model new housing loans and income have a statistically significant contemporaneous impact on price developments while interest rate does not enter the short-run.[24] It is also found that although the adjustment parameter (α) implies somewhat slower convergence toward equilibrium than in the VECM, but the difference is small.

[24] Since the housing stock adjusts slowly, it is assumed to be fixed in the short-run.

Table 4

Short-run parsimonious model

	α	ΔP_{t-3}	ΔL	ΔY	Δsale	constant
ΔP	–0.094***	0.242***	0.154***	0.361***	0.065***	–0.002
	(0.034)	(0.088)	(0.049)	(0.136)	(0.017)	(0.002)
		R^2	0.726	Adjusted R^2		0.699
		AIC	–5.477	SIC		–5.265

Note: Standard errors are shown in brackets. The number of stars indicates at which significance level the coefficients are different from zero (: 10 percent, **: 5 percent, ***: 1 percent).*

6 Conclusion

In the analysis, we assessed the short and long-term relationship among Hungarian housing prices and the factors determining them within the framework of a vector error correction analysis. Such analysis framework is capable of estimating the long-run equilibrium price – allowing to identify the cyclical position of the housing prices and the effects of factors influencing them –, and modelling the adjustment to this long-run equilibrium price level if the actual price level departs from it.

Despite the considerable and frequent demand and supply shocks hitting the housing market, a fairly stable cointegrating relationship was identified. Housing prices are driven by average real new housing loans, real disposable income and housing stock. Estimated on the 2001 Q1 – 2015 Q4 sample, long-run coefficients have theoretically appropriate signs and have values in line with the empirical literature. The only parameter that does not adequately fit with the existing empirical literature is the loan variable because it is measured with a flow rather than a stock variable: proxy for credit constraints is provided by average real new housing loans as opposed to the commonly chosen debt stock variable. The pace of housing price adjustment to new long-term equilibrium can be said to be sluggish which is in line with the results of empirical literature.

The VECM estimation results can be considered robust compared to alternative long-run specifications - different loan and housing stock definitions - given the severe loan data problems and the short estimation sample. Not surprisingly, the loan data used proved to be the most unstable variable as it conflates both loan demand and supply effects. Its stability is also undermined by the changing role of loans financing housing purchases due to simultaneous loan supply and demand shocks and ongoing financial deepening in the early 2000s.

Looking at responses of housing price to different demand shocks the phenomenon of overshooting of prices can be observed which is in line with similar findings on Hungarian data. This is related to the identified significant supply side effect on housing prices that not only dampen price growth rate, but forces price level down after a rapid temporary price hike in case of demand shocks.

By examining the deviation of housing prices from its equilibrium level no significant deviation (more than 10 percent) is observed after or before the 2008 crisis as opposed to international evidence. Along with a moderated housing price appreciation the slight overvaluation of prices is mostly fuelled by widely available and cheap FX housing loans. As a result of drastic revaluation of FX mortgage loans, emergence of debt overhang problem necessitated balance sheet adjustment of the Hungarian households which led to an immediate fall in demand for dwellings. Together with strict credit conditions the slowly changing reservation prices of the sellers hindered adjustment of housing price level toward long-term equilibrium driven by rapid deterioration of economic fundamentals. Housing prices were slow to recover around 2013/2014 resulting in larger gap in absolute terms than before the crisis. A likely reason could be that housing price appreciation expectations stayed moderated as the consequence of the crisis.

A further direction for development may be the direct assessment of the interaction between housing prices and the lending activity, which would bear more direct relevance to macroprudential regulation. The main purpose would be the identification of the dynamic mutual relationship between the short- and long-term housing price and the lending activity, which could contribute to the understanding of the simultaneous build-up of housing price bubbles and excessive lending in a dynamic perspective.

7 References

Adams, Z., Füss, R. (2009). Macroeconomic determinants of international housing markets, *Journal of Housing Economics 19, 38-50.*

Anundsen, A.K., Jansen, E.S. (2013). Self-reinforcing effects between housing prices and credit. *Journal of Housing Economics 22, 192–212.*

Aron, J., Duca, J.V., Muellbauer, J., Murata, K., Murphy, A. (2010). Credit, housing collateral and consumption: Evidence from UK, Japan and the US. *CEPR Discussion Paper Series No. 7876.*

Banai, Á., Vágó, N., Winkler, S. (2017). Az MNB-lakásárindex módszertana. Forthcoming.

Brissimis, S. N., Vlassopoulos, T. (2009). The interaction between mortgage financing and housing prices in Greece. *Journal of Real Estate Economics 39, 146–164.*

Cameron, G., Muellbauer, J., Murhpy, A. (2006). Was there a British House Price Bubble? Evidence from a Regional Panel. *CEPR Discussion Paper No. 5619.*

Case, K. E., Shiller, R. J. (1989). The Efficiency of the Market for Single-Family Homes. American Economic Review 79(1), 125-137.

DiPasquale, D., Wheaton, C. W. (1992). The Markets for Real Estate Assets and Space: A Conceptual Framework. Journal of the American Real Estate and Urban Economics Association 20(1), 181-197.

Duca, J., Muellbauer, J., Murphy, A., (2011). Shifting credit standards and the boom and bust in US home prices. Technical Report 1104, Federal Reserve Bank of Dallas.

Dümmler, T., Kienle, S., (2010). User costs of housing when households face a credit constraint - evidence for Germany. *Deutsche Bundesbank Discussion Paper No. 12/2010.*

Endrész, M., (2014). Fogyasztás és hitelezés – A magyar háztartások mérlegalkalmazkodásának vizsgálata. *Manuscript*

Égert, B., Mihaljek, D. (2007). Determinants of house prices in central and eastern Europe. *BIS Working Papers No. 236, September 2007.*

Farkas, M. (2011). Housing Demand and Demographic Trends: Evidence from Hungary. *Central European University, MA Thesis.*

Farkas, J., Hegedüs, J., Székely, G. (2006). Lakáshelyzet, lakástámogatások, 1999–2003. *In: Társadalmi riport 2004, Kolosi Tamás, Tóth István György, Vukovich György (ed.). Budapest: TÁRKI, 176–192.*

FHB (2010). Methodological guide of the FHB House Price Index. http://www.fhbindex.com/FHB-Index/downloads/Methodology/Methodology%20long%20version.pdf.

Fitzpatrick, T., McQuinn, K. (2007). House prices and mortgage credit: empirical evidence for Ireland. *The Manchester School 75, 82-103.*

Gerlach, S., Peng, W. (2005). Bank lending and property prices in Hong Kong. *Journal of Banking and Finance 29, 461-481.*

Gimeno, R., Martinez-Carrascal, C. (2010). The relationship between house prices and house purchase loans: the Spanish case. *Journal of Banking and Finance 34, 1849-1855.*

Hofmann, B. (2003). Bank lending and property prices: some international evidence. Technical Report 22, The Hong Kong Institute for Monetary Research.

Homolya, D. (2012). Hitelszerződések ár és nem árjellegű feltételei, és azok alakulása az elmúlt években Magyarországon. *Pázmány Law Working Papers 2012/28.*

Iacoviello, M. (2005). House Prices, Borrowing Constraints and Monetary Policy in the Business Cycle. *American Economic Review 95, 739-764.*

Kiss, G., Vadas, G. (2005). Monetary Transmission in Hungarian Housing Market, *Magyar Nemzeti Bank Background Studies, 2005/3.*

Kivistö, J. (2012). An assessment of housing price developments against various measures. *Bank of Finland Bulletin 3/2012.*

Kwiatkowski, D., Phillips, P. C., Schmidt, P., Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics*, *54*(1), 159-178.

Meen, G. (2001). Modelling Spatial Housing Markets: Theory, Analysis and Policy. *Kluwer Academic Publishers, Boston.*

Nagy, M., Szabó, E. V. (2008). Az amerikai másodrendű jelzáloghitel-piaci válság és hatásai a magyar bankrendszerre. *MNB-Szemle, April 2008.*

Oikarinen, E. (2009). Interaction between housing prices and household borrowing: the Finnish case. *Journal of Banking and Finance 33, 747-756.*

Oikarinen, E. (2012). Empirical evidence on the reaction speeds of housing prices and sales to demand shocks. *Journal of Housing Economics, 21(1), 41-54.*

Pesaran, M. H., Shin, Y., Smith, R. J. (2000): Structural Analysis of Vector Error Correction Models With Exogenous I(1) Variables. Journal of Econometrics, 97(2), 293–343.

Poterba, J. M. (1984). Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach. The Quarterly Journal of Economics, 99(4), 729-752.

Tsatsaronis, K., Zhu H. (2004). What drives housing price dynamics: cross-country evidence. *BIS Quarterly Review, March 2004.*

Vadas, G. (2007): Wealth portfolio of Hungarian households – Urban legends and facts. MNB Occasional Papers 68.

8 Appendix

Table A1
Tests for the order of integration

	ADF lags	ADF p-value	KPSS statistic
Levels			
P	3	0.193	0.548**
L	1	0.224	0.372*
L_2	3	0.313	0.549**
L_3	1	0.218	0.367*
Y	0	0.004***	0.567**
Y/pop	0	0.004***	0.679**
S	5	0.134	0.868***
S/pop	10	0.053*	0.899***
UC	5	0.348	0.622**
First differences			
ΔP	2	0.392	0.269
ΔL	0	0.048**	0.239
ΔL_2	1	0.002***	0.212
ΔL_3	0	0,010***	0.174
ΔY	1	0.024**	0.393*
ΔY/pop	1	0.022**	0.388*
ΔS	4	0.649	0.823***
ΔS/pop	3	0.405	0.832***
ΔUC	4	0.060*	0.374*

*Note: Unit root tests are carried out using the KPSS and ADF tests for all the endogenous variables in levels as well as first differences. The number of stars indicates at what level of significance (1%: ***, 5%: **, 10%: *) we can refuse the null hypothesis. The null hypothesis of the KPSS test is that the time series is stationary, whilst for the ADF test is that the process follows a unit root process. The unit root tests are carried out in a sample between the 2001 Q1 and 2015 Q4. Although for the sample size specified Y and S didn't seem to be I(1), upon closer inspection the source of problem is identified: for income, when looking at a slightly longer sample size the ADF test finds a unit root; for housing stock the result is probably due to the fact that the series is constructed with interpolation which introduces strong persistence. With these caveats in mind it is assumed that each variable is I(1).*

Table A2
Residual diagnostics of the VECM

	p-value
Autocorrelation	
LM(1)	0.486
LM(4)	0.277
Normality	
Joint Jarque-Bera	0.681
Heteroskedasticity	
White test with cross terms	0.357

Table A3
Residual diagnostics of the short-run model

	p-value
Autocorrelation	
LM(1)	0.343
LM(4)	0.313
Normality	
Joint Jacque-Bera	0.111
Heteroskedasticity	
BPG test	0.929

Table A4
Estimated short-run parameters of the VECM

	ΔP	ΔL	ΔY	ΔS
α	–0.141***	–	–	–0.002***
	(0.033)			(0.001)
ΔP_{t-1}	0.315***	0.379	0.211*	0.001
	(0.119)	(0.243)	(0.112)	(0.002)
ΔL_{t-1}	0.089	0.665***	0.027	0.002**
	(0.056)	(0.113)	(0.052)	(0.001)
ΔY_{t-1}	–0.236	–0.254	–0.16	–0.006*
	(0.161)	(0.329)	(0.152)	(0.003)
ΔS_{t-1}	2.044**	–0.364	1.514	1.001***
	(0.943)	(1.923)	(0.889)	(0.018)
C	–0.005	0.001	0.002	–0.001
	(0.003)	(0.007)	(0.003)	(0.001)
ΔSale	0.051**	–0.012	0.033*	0.001*
	(0.021)	(0.043)	(0.019)	(0.000)
Δi	–0.021	–0.121*	–0.057*	0.001
	(0.032)	(0.065)	(0.030)	(0.001)
R^2	0.705	0.639	0.354	0.988
Adjusted R^2	0.657	0.580	0.248	0.985
AIC	–5.300	–3.874	–5.418	–13.240
SIC	–4.980	–3.554	–5.098	–12.921

Note: A dummy variable was also included in the model which took a value of 1 in 2003 Q4, -1 in 2004 Q1 and 0 elsewhere. This is included for capturing transitory changes occurred in housing price level due to the announcement of sudden phase out the generous interest rate subsidisation schemes which considerably affected the timing of transactions clearly observable in turnover series in Figure 1. Huge variations in transaction series during the concerning period coupled with prices hike underpins this interpretation.

Figure A1
Log of real housing prices and average real new housing loans

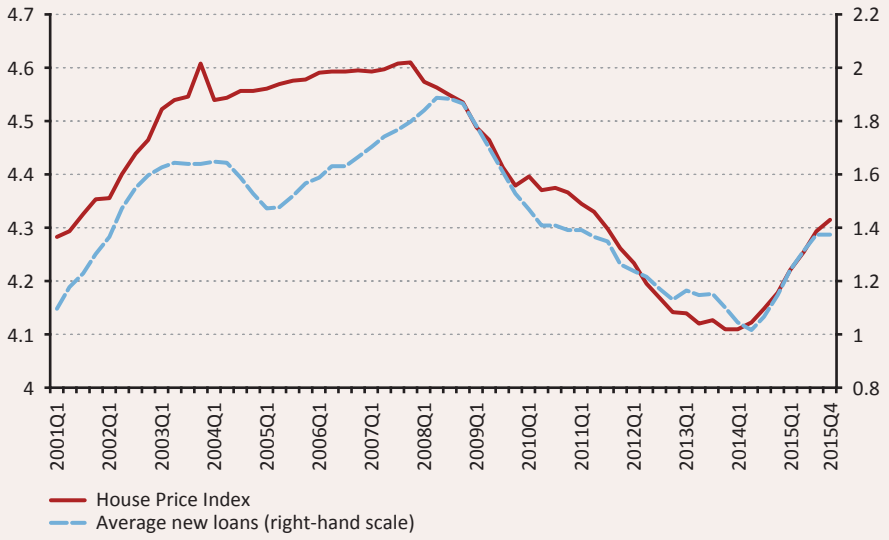


Figure A2
Log of real housing stock and real disposable income for households

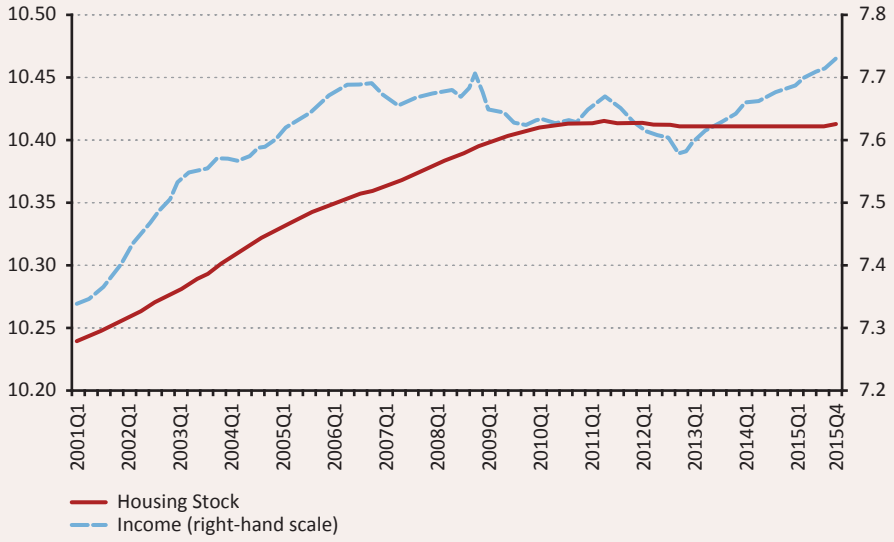


Figure A3
Log of nominal interest rate and sales volume

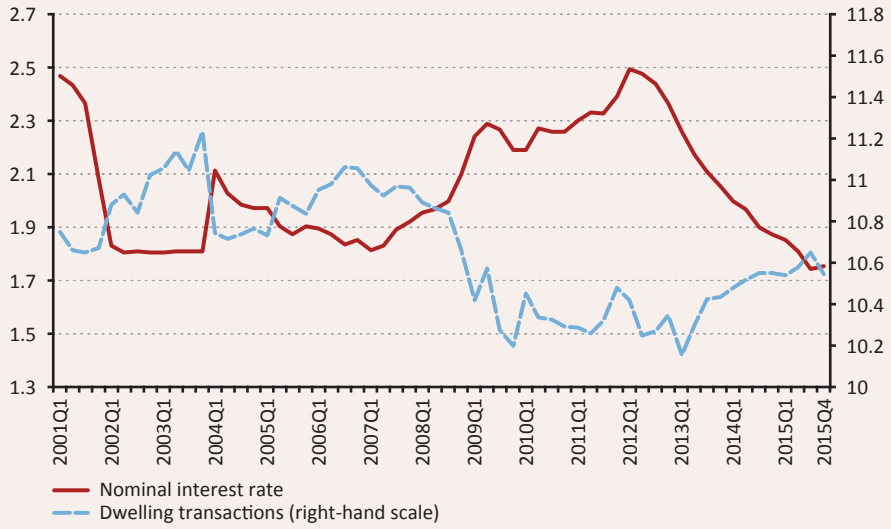
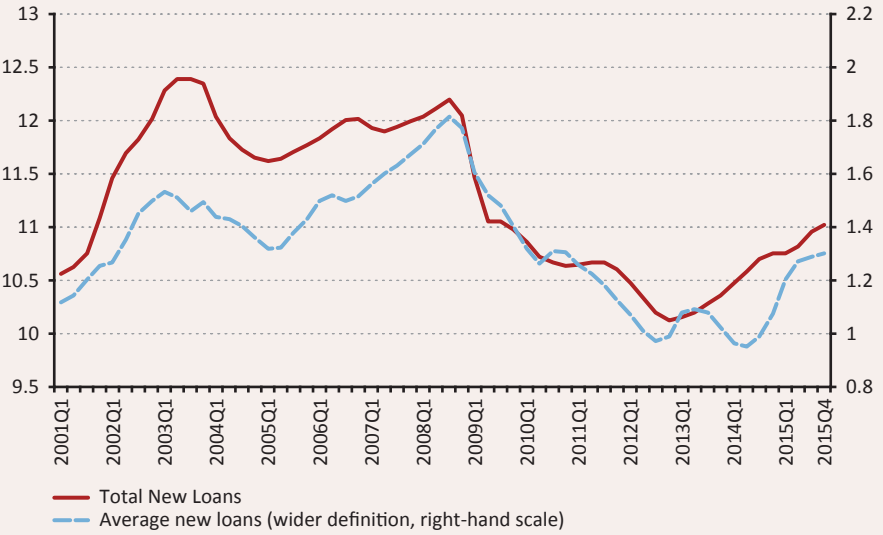


Figure A4
Log of total new housing loans and modified average new housing loans



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