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MODELLING HOUSING MARKET AND HOUSING PRICE DYNAMICS IN CROATIA*

Abstract:

Since the beginning of this century, the Croatian housing market has passed through various stages of development. Roughly, trends in this housing market could be observed through three different phases. The first period encompasses the first eight years of this century and is characterized by stable and positive movements of supply and demand indicators. The year 2008 represents the turning point towards negative trends on the Croatian housing market. This was the beginning of a crisis which lasted seven years. During this period, the demand for housing units has fallen dramatically and supply of new housing units has grown at low rates. As a result of such market developments, housing prices have decreased. Negative trends persist until 2015, when stable increase of supply indicators is perceived. Thereafter, demand side of the market starts to recover, along with housing prices which begin to rise.

This research represents an attempt to identify the factors that have influenced the mentioned developments on the Croatian housing market. The significance of factors which are included in analysis is tested within the multiple regression framework. Special emphasis is placed on modelling housing prices dynamics. The results indicate that there are certain specificities of the Croatian housing market. For example, demand cannot be explained well by standard housing demand determinants. The low significance of the standard factors is even more pronounced in modelling supply side of the market. When observing the significance of housing prices in the supply and demand equations, the results show that lagged prices in both equations are statistically significant. Therefore, it can be concluded that expectations on housing market in Croatia are adaptive. Finally, supply and demand elasticities are observed as their comparison can potentially help in explaining cyclic movements in the housing market.

Keywords:

Housing Supply, Housing Demand, Housing Prices, Multiple Regression Analysis, Croatian Housing Market

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JEL Classification: R21, R31, R32

1 Introduction

This century has been characterized by turbulent developments in various real estate markets across the world. The pattern of rise, and then strong decline of real estate market indicators is especially present in the segment of housing. Some housing markets have passed through serious crisis. Mainly, negative trends in housing markets were closely connected with recessions which affected overall economic activity in particular countries. Such development was also present in Croatia. Roughly, trends in Croatian housing market could be observed through three different phases. First phase lasted eight years (2000-2008). That was the period of strong expansion of construction, housing and real estate market in general. Demand for housing units has steadily increasing, and that was probably driven by favorable lending conditions of banks. The rise of supply indicators was also present in this period. Construction volume index, as well as number of newly built residential units continuously grew during this expansion. The year 2008 represents the turning point towards negative trends on the Croatian housing market. This was the beginning of a second phase of development. During this period, general economic conditions in Croatia worsened and spillover effects of recession occurred in housing market. Firstly, the demand for housing units has fallen dramatically. Supply side of the market was adjusting slower to new market conditions. As a result of such market developments, housing prices have decreased, but that decrease was relatively small in regard to demand movements. Housing market crisis lasted seven years. Increase of supply indicators is perceived in 2015. That was the beginning of the third phase of development. Thereafter, demand side of the market starts to recover, along with housing prices which begin to rise.

This research represents an attempt to identify the factors that have influenced the mentioned developments on the Croatian housing market. The starting point for this investigation represents DiPasquale and Wheaton (1992, 1996) model. Within this pretty simple analytical framework it is possible to analyze effects of the different shocks from the broader economic environment on the housing market. Following this approach, modelling demand and supply side of the national housing market is conducted through estimating housing price and construction equations. Special emphasis is placed on modelling housing prices dynamics. Therefore, DiPasquale and Wheaton (1994) dynamic stock-flow model represents the background for this analysis. According to other existing theories and research papers in the field of housing economics, the set of possible determinants of price and construction in Croatia is selected. The significance of factors which are included in analysis is tested within the multiple regression framework. Data are obtained from national statistic sources, mainly Croatian Bureau of Statistics and Croatian National Bank. Some of the data were available on monthly basis, while other were published quarterly. Stock-flow model in this paper is estimated using quarterly data.

The organization of this paper is as follows. In section 2 theoretical background for conducting this research is provided. Section 3 describes data and methodology. The empirical results and discussion are presented in section 4. The final section is conclusion in which are summarized main findings, research limitations and recommendations for further investigation in this field.

2 Theoretical background and literature review

Real estate market represent one of the crucial segment of national economy. Therefore, observing their interdependence with the overall macroeconomic system in particular countries is quite common in research practice. The importance of the real estate market in an economy as a whole is visible through the shares of the construction and real estate sectors[1] in a national accounts measures. According to the Eurostat (2019) data, the share of construction and real estate activities in total gross value added ranged between 16-18% in EU 28 countries from the beginning of this century. That proportion is slightly lower when observing Croatia, but it remains evident that shares of mentioned activities in a total gross value added are quite non-negligible (Table 1).

Table 1: The percentage of the construction and real estate activities in a total gross value added

GEO/TIME	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
EU 28	16,40%	16,34%	16,53%	16,60%	16,65%	16,92%	17,24%	17,42%	17,55%	17,23%
Croatia	14,57%	14,90%	15,12%	16,15%	16,47%	16,71%	17,01%	17,77%	17,63%	17,55%

GEO/TIME	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU 28	16,83%	16,85%	16,87%	16,79%	16,76%	16,72%	16,62%	16,58%	16,71%
Croatia	16,47%	16,25%	15,79%	15,79%	15,80%	15,67%	15,31%	15,05%	15,05%

Source: author's calculation based on Eurostat (2109) data

The presented data imply that mentioned sectors are of a high importance in economy structures. Moreover, in the available literature from the field of real estate economics it is clearly emphasized the existence of a strong interconnectedness between real estate markets and macroeconomic systems in particular, as well as in different groups of countries.

The issue of bi-directional relationship between real estate market and macroeconomy has become topical at the beginning of this century. Actually, it is driven by the cognition that real estate is a more important component of the total wealth than financial assets in many countries. Goodhart and Hoffman (2007) state that September 11 2001, as well as burst of the stock market bubble in USA represent breakpoints towards redirecting of funds from stocks to other asset forms, especially housing real estate. After that, housing wealth becomes an increasingly important component of total wealth. Otrok and Terrones (2005) emphasize importance of the housing market as a specific segment of real estate market, pointing out that housing units represent the main component of total households' assets in industrialized countries, while their main liabilities are mortgage loans. Therefore, there are several channels through which fluctuations on housing market might have impact on economic activity, but also *vice versa*. Research interest in the field of housing economics is equally focused on the effects that fluctuations on housing market have on the broader economic system, as well as on investigating the impact of macroeconomic movements on real estate market indicators. In the latter, the analyzing of housing prices determinants is dominant. Knowledge of the extent to which

[1] In Statistical classification of economic activites in the European Community (NACE Rev.2) construction activities are observed under the section F, and real estate activities under the section L.

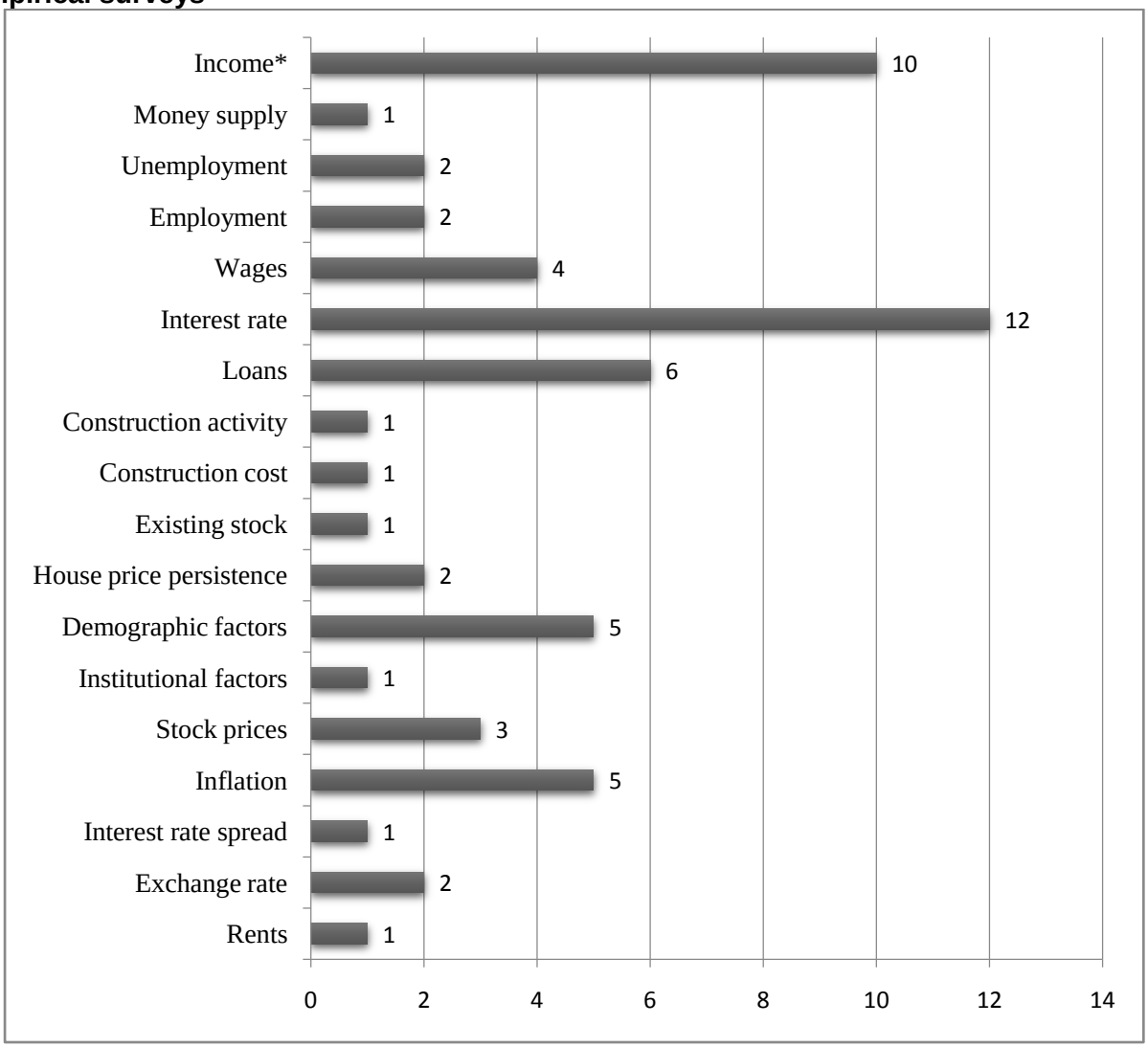
macroeconomic variables cause housing prices is of great importance for economic policy makers, as they can use it to identify certain problems and take concrete action. In the absence of such research and cognition (which is especially the case in transition countries), it is possible only to speculate on the reasons for housing price fluctuations, as well as on the potential effects of developments in the housing market on the overall economic activity (Posedel and Vizek, 2009).

As well as any other market, the housing market can also be explained in terms of demand and supply. Many authors, for example McQuinn and O'Reilly (2008) emphasize that unique set of factors that shape supply and demand for housing doesn't exist. Moreover, a list of such factors is inexhaustible and it varies in different countries. The most common factors that shape housing demand are current and expected housing prices, different measures of disposable income, loans availability, mortgage interest rates and demographic factors. On the supply side the cost of housing, the amount of available building land, zoning and planning restrictions and construction costs are pointed out as a standard determinants (McQuinn and O'Reilly 2008). Hlaváček and Komárek (2009) present even broader list of factors that affect housing supply and demand, including labor market factors, rents, financial markets developments and foreign demand. In any case, the change in any factor that has impact on supply or demand for housing shifts supply and demand curve and indirectly affects housing prices. For that reason, a large number of existing research is dominantly focused on investigating housing prices determinants.

Some of the research paper which dealt with identifying housing prices determinants in Croatia (as a particular country, or as a part of a group of transition countries) are Tica (2004), Égert and Mihaljek (2007), Lovrinčević and Vizek (2008), Posedel and Vizek (2009), Vizek (2010) and Dumičić, Čeh Časni and Žmuk (2011). All of them modelled housing prices of new and/or existing housing units using housing demand and supply factors. For example, Tica (2004) observed the number of houshods, GDP and/or average real net wages, average mortgage interest rates and existing housing stock on a market as possible determinants of housing prices. Dumičić, Čeh Časni and Žmuk (2011) focused only on demografic variables, concretely the rate of new marriages and net wages. The broadest list of possible determinants is included in work of Égert and Mihaljek (2007). Acorrding to them, house prices are a function of household income, real mortgage interest rate, financial wealth, demographic as well as labor market factors, the expected rate of return on housing, other demand shifters and real costs of construction which include the price of land, construction workers' wages and material costs.

Some of mentioned, as well as some other chosen research in which housing price determinants were investigated, are summarized in Table 2 in appendix. In Table 2 are presented housing price determinants which have proven to be statistically significant in fifteen selected research papers. The simplified representation of the specified table is shown by the graph below (Graph 1). Graph 1 shows the frequency of statistical significance of observed housing price determinants. It is visible that most common variables in explaining housing prices are interest rate, income and loans. Interest rate is the key variable in explaining the dynamics of house prices. In almost all observed scientific papers is proven statistically significant impact of interest rates on the house prices. In large number of research disposable income is also assesed as highly significant factor that affects housing prices. Loans have a statistically significant effect on the house prices in six observed research papers.

Graph 1: Frequency of statistical significance of the house prices determinants in selected empirical surveys



Source: author's own adjustment based on Table 2 in Appendix

**Note: The income variable includes several income measures. In particular, the variables of national income, income per capita, household disposable income and industrial production as approximation of GDP are covered.*

Beside mentioned several researches which deal with house price dynamics in Croatia, there is also a small number of them in which interdependence between housing market and macroeconomy (or some segment of economic system) is investigated (for example Dumičić, Čeh Časni and Šprajaček (2012), Slišković (2018), Slišković, Nakić and Sekur (2019)). The motivaton for this research stems from the fact that supply side of the housing market is disregarded in domestic literature, as literature is mainly focused on prices and their determinants from the demand equation. For that reason, in this research both supply and demand side of housing market will be modelled using determinants which are considered as standard. Moreover, this century was period in which housing market in Croatia experienced great swings. Crisis in this market took place simultaneously with the decline of GDP, rising unemployment, tightening lending conditions and generally negative economic developments. Therefore, this research

represents an attempt to explain housing demanad and supply developments with movements in macroeconomic and banking variables.

The background for this research is integrated model of real estate market which is developed by DiPasquale and Wheaton. In their original work (1992, 1996), these authors develop diagrammatic model of real estate market as a integration of property and capital market. The similar concept also describes Fisher (1992). Such model can serve as a pretty simple analytical frame within which is possible to analyze different effects which arise in one, and then spillover to other segments of market. Moreover, it allows to explain how various exogenous shocks (for example change in GDP, interest rates, loans or construction costs) affect equilibrium on integrated property and capital market. Since original model didn't include dynamics, DiPasquale and Wheaton developed dynamic stock-flow model in their later work (1994). In that research the highest emphasis is put on describing housing price adjustments. Dynamic stock-flow model represents starting point for empirical analysis in this paper. On the one hand, it will be tested how rapidly house prices adjust to equilibrium. On the other hand, this research covers the question of a measure in which house price developments can explain movements on the supply side of housing market. Finally, comparison of price elasticities of demand and supply theoretically helps to explain cyclical movements on the market. Wheaton (1999) points out that oscillations on real estate market occur when elasticity of supply is greater than elasticity of demand, assuming that market agents are irrational. This research will show whether the expectations in the housing market in Croatia are adaptive, and whether the oscillations in this century can be explained by the relationship between supply and demand elasticities.

3 Data and methodology

As it is already mentioned in previous chapter, in this research a version of dynamic stock-flow model is estimated. So, the background for selection of variables is DiPasquale-Wheaton (1994) model which is expanded and adjusted according to specificities of Croatian economy and available data.

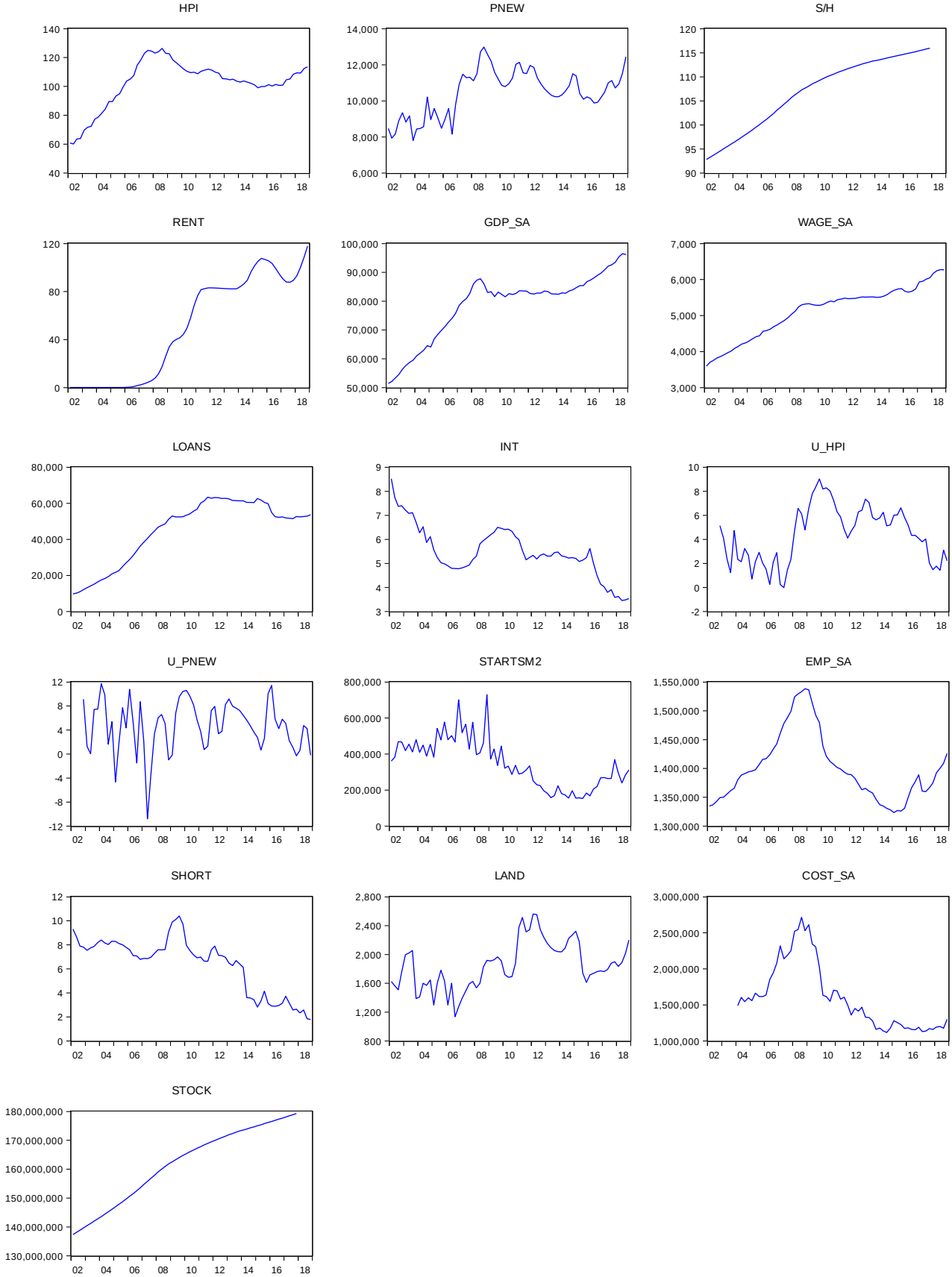
All time series of data required for the model estimation are obtained from official and publicly available domestic statistical sources. One part of the data was collected from the first releases and statistical reports of the Croatian Bureau of Statistics (CBS) and the second from the statistics published by the Croatian National Bank (CNB). Most of collected data were originally published on a quarterly or on a monthly basis. Exception is a small number of time series published semi-annually. Model founded in this research is estimated using quarterly data. Therefore, all data originally published at the semi-annual level were translated into quarterly using the quadratic interpolation method in EViews. Monthly data are mainly translated to quarterly by average method. In the case of variable STARTSM2, quarterly levels were obtained by aggregating the monthly data. Variables STOCK and HOUSING were published only in Census, so they had to be constructed by author using different approximations. All used variables are listed and briefly described in Table 3, and the graphical representation of data series is given in Figure 1. Mainly, collected data cover the period from the first quarter of 2002 to the last quarter of 2018.

Table 3: Variables used in dynamic stock-flow model estimation

Variable	Description	Source	Publication frequency
HPI	House price index (Ø 2015. = 100), based on real estate prices in Croatian kunas	CNB	Quarterly
PNEW	Price of m^2 of newly built and sold dwellings (in Croatian kunas)	CBS	Quarterly + semi-annualy
S/H	Housing stock per houshold	CBS + author	Census
RENT	Rent as component of CPI (base index, 2015m1=100)	CBS	Monthly
GDP_SA	Gross domestic product, current prices, seasonally adjusted (in millions of Croatian kunas)	CBS	Quarterly
WAGE_SA	Average net wages, seasonally adjusted. Proxy variable for disposable household's income	CBS	Monthly
LOANS	Total bank housing loans in million HRK	CNB	Monthly
INT	Interest rate on long-term kuna loans to households indexed to foreign currency	CNB	Monthly
U_HPI	User cost of housing, includes HPI change as a measure of house price appreciation	CNB+CBS +author	Quarterly
U_PNEW	User cost of capital, includes PNEW change as a measure of house price appreciation	CNB+CBS +author	Quarterly
STARTSM2	Useful area (in m2) of the dwellings for which the building permits were issued.	CBS	Monthly
EMP_SA	The number of employed persons, seasonally adjusted	CBS	Monthly
SHORT	Short-term interest rates on kuna loans to non-financial corporations not indexed to foreign currency	CNB	Monthly
LAND	Cost of building land as a component of PNEW, in Croatian kunas	CBS	Quarterly + semi-annualy
COST_SA	Value of building material, complete units and structures and propulsion material used	CBS	Quarterly
STOCK	Housing stock on the market (in m^2)	CBS +author	Census

Source: author

Figure 1: Variables in stock-flow model of Croatian housing market



Source: CNB (2019), CBS (2019), author's own adjustment

The dynamic stock-flow model encompasses two equations. In the first of these, the demand for housing is estimated, and in the second construction, i.e. the flow of new housing supply to the market. In modelling demand side of the Croatian housing market, it is assumed that demand for housing (which is approximated by number of households) is a function of rents, income, prices and user cost of housing:

$$H = f(RENT, INCOME, LOANS, PRICE, U) \quad (1)$$

This analysis includes two modalities of variables income, price and user cost of capital. The price variable is expressed as a house price index which reflects price developments on the whole housing market (HPI) or as a price of newly built and sold dwellings, which reflect price movements on a specific market segment. User cost of capital incorporates interest rate on housing loans, as well as house price appreciation. As it is assumed that expectations of housing market agents are adaptive, expected future house price appreciation is calculated as an average change of house prices in previous three periods:

$$I_t = 1/2 * ((P_{t-1} - P_{t-2})/P_{t-2} + (P_{t-2} - P_{t-3})/P_{t-3}) \quad (2)$$

According to this, user cost of housing is defined as a difference between interest rate and house price appreciation. In other words, user cost of housing is one kind of inflation adjusted interest rate on housing loans. Depending on price measure which is used in calculation, the variable U is expressed in two modalities:

$$U = \begin{Bmatrix} U\_HPI \\ U\_PNEW \end{Bmatrix}$$

Finally, variable income is expressed as a national income (GDP_SA) or household's disposable income (WAGE_SA). To avoid multicollinearity, these two measures are not used simultaneously as explanatory variables in demand estimation. Moreover, variable LOANS will also be used in demand equation as one kind of exogenous shock. It will not be used simultaneously with income variables, which also represent exogenous shocks in stock-flow model.

Assuming that equilibrium on the housing market exists and that the prices adjust slowly, demand equation can be rearranged in the way that price becomes dependent variable (see DiPasquale and Wheaton, 1994 for details). Therefore, demand equation becomes housing prices equation. In this research, it will be estimated in the following form:

$$PRICE_t = \frac{\tau}{\beta_4}\left(\frac{S_t}{H_t} - \beta_1\{RENT_t - \beta_2\begin{Bmatrix} WAGE\_SA_t \\ GDP\_SA_t \\ LOANS_t \end{Bmatrix} - \beta_3 U_t\right) + (1-\tau)PRICE_{t-k} \quad (3)$$

Given the assumption of gradually adjusting prices, the number of lags k=2 is chosen in estimating house price equation.

The supply equation has the following form:

$$STARTSM2_t = \alpha_1 + \alpha_2\begin{Bmatrix} BDP\_SA_t \\ EMP\_SA_t \end{Bmatrix} + \alpha_3 PRICE_t + \alpha_4 SHORT_t + \alpha_5 LAND_t + \alpha_6 COST\_SA_t - \alpha STOCK_{t-k} \quad (4)$$

In estimation of supply equation, two mentioned measures of prices are used. Moreover, it is additionally tested whether the new supply on housing market reacts on the change of current or

lagged housing prices. The variable STOCK in supply estimation is lagged, given the assumption that stock slowly adjusts to its long run level. The number of lags is chosen to be k=4.

4 Results of empirical analysis

In order to avoid spurious regressions, the first step in analysis is testing whether time series are stationary. In order to examine the order of integration Augumented Dickey-Fuller (ADF) unit root tests were carried out and results are shown in Table 4. According to results, I(1) variables are differenced and included in models in the form of first differences.

Table 4: Results of ADF unit root tests

Variable	Level			First difference			Decision
	Intercept	Trend and intercept	None	Intercept	Trend and intercept	None	
HPI	0.0874	0.3371	0.8354	0.1103	0.2608	0.0183	I(1)
PNEW	0.2962	0.4250	0.8378	0.0000	0.0000	0.0000	I(1)
RENT	0.9542	0.3420	0.9598	0.0128	0.0516	0.0064	I(1)
WAGE_SA	0.5204	0.7045	0.9993	0.0000	0.0002	0.0004	I(1)
U_HPI	0.3089	0.6281	0.2210	0.0000	0.0000	0.0000	I(1)
U_PNEW	0.0152	0.0632	0.1398	0.0000	0.0003	0.0000	I(0)
S/H	0.0755	0.4153	0.5693	0.9058	0.6345	0.2446	I(0)
GDP_SA	0.1728	0.4727	0.9945	0.0001	0.0002	0.0088	I(1)
LOANS	0.1176	0.9766	0.8862	0.0037	0.0010	0.0198	I(1)
STARTSM2	0.7121	0.7858	0.3119	0.0010	0.0065	0.0000	I(0)*
SHORT	0.9032	0.7899	0.0896	0.0000	0.0000	0.0000	I(1)
STOCK	0.0939	0.4090	0.6038	0.8974	0.6269	0.2838	I(0)*
LAND	0.1725	0.2435	0.6757	0.0000	0.0000	0.0000	I(1)
COST_SA	0.5224	0.3552	0.5172	0.0138	0.0607	0.0008	I(1)
EMP_SA	0.4028	0.6766	0.8197	0.0060	0.0319	0.0004	I(1)

Source: Author's calculation
Note: The values in table are MacKinnon (1996) one-sided p-values.
** In case of contradictory results the decision is made on the basis of an additional tests (Phillips-Perron's unit root test, KPSS unit root test and / or graphical analysis of the observed time series).*

The demand analysis covers the period from the beginning of 2002 until the end of 2017. As some time series used in supply equation had shorter time dimension, analysis of supply has been conducted in the period 2004-2017. In order to test robustness of results, both models are estimated with HPI and PNEW as two different measures of housing prices. All equations are estimated using OLS. Moreover, in all estimations diagnostic tests were conducted in order to examine autocorrelation of residuals and homoscedasticity of variance. If test indicated heteroscedasticity, estimate if made using White correction of standard errors and covariance.

All demand models are estimated in two variants: with and without intercept. The theoretical model doesn't include intercept (see equation 3), but in empirical analysis it is common to

estimate model with constant, unless there are strong reasons for its omitting. The results of estimation of demand (i.e. price determination) equation are presented in Tables 5 and 6. When HPI is used as a measure of housing prices, the results of estimation (Table 5) tell a clear and consistent story. It is visible that all used explanatory variables are assessed as statistically significant, and the coefficient of determination indicates that the model fits the data solidly. Results suggest that the change in prices depends negatively on housing stock per household[1]. According to theory, such relationship was anticipated. The change in variables which represent exogenous shocks affect change in HPI positively, which is also in accordance with theoretical stock-flow model, but it is pretty surprising that mentioned effect is estimated to be negligible small. The lagged prices are statistically significant. That result clearly shows that expectations about house prices are adaptive. The value of estimated parameter in models with intercept is 0,24 (or 0,22 in model 3) and it is interpreted as speed of price adjustment to the equilibrium price. One should be cautious when interpreting this parameter. For example, if the value of the estimated parameter equals 0,24, that is interpreted as the rate of change of price adjustment equals 76%[2] in the period of two quarters.

Beside these expected results, there are some atypical which indicate certain specificities of Croatian housing market. Firstly, the change in rent should have positive effects on the change in housing prices, but that is not the case in Croatia. Obtained estimates also show positive impact of change in user cost on the change in prices. This is not in line with the predictions of the stock-flow model. Furthermore, it was expected that user cost will have statistically significant and negative effect on housing prices, as interest rate (from which user cost is derived) is one of the determinants which is frequently used for explaining house price developments in different countries. Therefore, mentioned results in Table 5 indicate atypical relationship between house prices and interest rates.

Table 5: The estimation results of demand equations (HPI prices)

Dependent variable: DHPI						
Explanatory variables ↓	**Model 1**	**Model1a**	**Model 2**	**Model 2a**	**Model 3**	**Model 3a**
C	13,75***	-	12,28***	-	12,49***	-
S/H	-0,12***	0,00	-0,11***	0,00	-0,11***	0,00**
DRENT	-0,16***	-0,15**	-0,11*	-0,07	-0,21***	-0,24***
DWAGE_SA	0,01*	0,01**	-	-	-	-
DGDP_SA	-	-	0,00**	0,00***	-	-
DLOANS	-	-	-	-	0,00	0,00***
DU_HPI	0,49***	0,45***	0,47***	0,43***	0,50***	0,48***
DHPI(-2)	0,24**	0,42***	0,24***	0,40***	0,22**	0,33***
R^2	0,69	0,60	0,71	0,64	0,69	0,63

Source: author's calculation

Note: Asterisks indicate a rejection of the null hypothesis (β=0) at a significance level of 1% (* *), 5% (* *) and 10% (*)*

Estimation of demand models in which prices are measured by PNEW variable gives poor results (Table 6). In the first row, there is not a good fit in observed models. Furthermore, estimated

[1] Parameter is statistically insignificant in estimations of models without constant.

[2] Parameter τ represents a speed of price adjustment. Parameter with lagged prices is (1- τ) (see equation 3).

parameters are mainly insignificant. This overall result can be explained by the fact that housing demand is obviously stronger determined by developments of the prices on the overall housing market. Demand for newly built dwelling is just one part of the total housing demad, and PNEW measures prices on the one specific market segment. For that reason, the price of new dwellings cannot be factor that has strong impact on overall demand for housing. Despite the fact that these models results with poor estimates, some obtained results are supported by theory. Furthermore, it seems that effect of change in wages and GDP is more pronounced in models with prices of newly built and sold dwellings, then in HPI determination models.

Table 6: The estimation results of demand equations (PNEW prices)

Dependent variable: DPNEW						
Explanatory variables ↓	**Model 1**	**Model1a**	**Model 2**	**Model 2a**	**Model 3**	**Model 3a**
C	-162,11	-	-643,55	-	-337,14	-
S/H	-1,13	-2,59*	3,34	-2,46*	1,57	-1,46
DRENT	27,75	27,92	52,94**	51,78**	12,36	14,15
DWAGE_SA	4,63**	4,54*	-	-	-	-
DGDP_SA	-	-	0,23***	0,21***	-	-
DLOANS	-	-	-	-	1,31	0,09
U_PNEW	24,20	23,85	21,70	20,58	1,04	25,01
DPNEW(-2)	0,01	0,00	0,04	0,03	0,15	0,02
R2	0,12	0,12	0,16	0,16	0,07	0,07

Source: author's calculation
Note: Asterisks indicate a rejection of the null hypothesis (β=0) at a significance level of 1% (* *), 5% (* *) and 10% (*)*

In modelling supply side of the Croatian hosuing market, construction is approximated with STARTSM2 and it is assumed that is a function of house prices (current or lagged), cost shifters and housing stock. Additionally, the change in GDP and change in employment are included as explanatory variables. Estimation of construction equation shows that model is similarly adjusted to data as HPI determination model. Specifically, the coefficient of determination shows that about 68% of variance in the dependent variable is explained in all models. The general conclusion which arises from estimates of all models (Tables 7 and 8) is that new construction depends on a change in short-term interest rates, change in a cost of land and on a stock of housing. However, only the stock of housing is statistically significant in all estimated models and has expected, negative sign. The lagged stock coefficient is interpreted as the annual rate with which the stock adjusts to its long run desired level through new construction. The value of estimated parameter is really small (-0,01) but that was expected due to the facts that stock adjustment is a very slow process and that new construction is a small portion of the total stock at any point in time. The obtained result is in line with DiPasquale and Wheaton's (1994) estimates.

The presented results show that most of the explanatory variables, which are considered as standard supply determinants in theory, are not statistically significant in supply estimations. Some of the statistically significant parameters have the non-expected sign. For example, the theory predicts that cost shifters should have negative effect on new construction. Results in Tables 7 and 8 show that the change in short-term interest rate and change in cost of land are statistically significant, but the sign of estimated parameters is positive, which is not in line with

thoeretical expectations and economic logic. Particularly surprising results are related to the housing prices variables. Although it was expected that prices will strongly determinate new construction process, the presented results prove that such assumption is not entirely accurate in the Croatian case. The change in house prices positively affects new construction just in small number of estimated models. One more atypical result relates to an effect of macroeconomic movements on a flow of new housing supply. It is visible that the change in GDP does not have statistically significant effect on a construction. The change in employment is statistically significant only in models which observe prices of newly bulit and sold dwellings as a measure of house prices.

Table 7: The estimation results of construction equations (HPI prices)

Dependent variable: STARTSM2						
Explanatory variables ↓	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
C	1706819***	1708222***	1691189***	1684244***	1735963***	1740987***
DHPI	12696,31*	-	11447,20	-	9688,64	-
DHPI(-1)	-	12247,53**	-	11078,59*	-	9073,50
DSHORT	46590,48*	37502,39*	48536,98*	41015,03**	40946,02*	34306,54*
DLAND	131,67**	130,90*	131,15**	130,09*	128,22**	128,21*
DCOST_SA	-0,15	-0,13	-0,16	-0,15	-0,20	-0,18
STOCK(-4)	-0,01***	-0,01***	-0,01***	-0,01***	-0,01***	-0,01***
DBDP_SA	-	-	7,41	9,27	-	-
DEMP_SA	-	-	-	-	1,38	1,29
R2	0,68	0,68	0,68	0,68	0,69	0,69

Source: author's calculation

Note: Asterisks indicate a rejection of the null hypothesis (β=0) at a significance level of 1% (* *), 5% (* *) and 10% (*)*

Table 8: The estimation results of construction equations (PNEW prices)

Dependent variable: STARTSM2						
Explanatory variables ↓	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
C	1849302***	1864584***	1807076***	1797631***	1837638***	1859053***
DPNEW	57,74	-	52,53	-	56,74**	-
DPNEW(-1)	-	-2,79	-	0,85	-	-11,53
DSHORT	42231,67*	39417,33*	45721,18*	44409,41*	36224,95*	34345,09
DLAND	12,55	140,51**	22,17	137,11**	6,35	132,90**
DCOST_SA	-0,13	-0,07	-0,15	-0,12	-0,24**	-0,19
STOCK(-4)	-0,01***	-0,01***	-0,01***	-0,01***	-0,01***	-0,01***
DBDP_SA	-	-	10,40	15,31	-	-
DEMP_SA	-	-	-		2,15*	2,33**
R2	0,68	0,65	0,68	0,66	0,70	0,68

Source: author's calculation

Note: Asterisks indicate a rejection of the null hypothesis (β=0) at a significance level of 1% (* *), 5% (* *) and 10% (*)*

Statistical significance of house prices in estimation of demand and supply equations indicates how market agents form expectations. If lagged prices in estimations are assesed as statistically

significant, it can be concluded that expectations are adaptive. Results presented in Tables 5 and 6 confirm adaptive expectations on the demand side of Croatian housing market when housing prices are measured by HPI. However, this cannot be argued if prices of newly built and sold dwellings are observed. Adaptive expectations on the supply side of the housing market could also be confirmed in the case when HPI is used as a measure of housing prices. Wheaton (1999) points out that myopic behaviour promotes oscillations. When expectations are myopic, it is likely that oscillations will occur when „supply is more elastic than demand, development lags are long and asset durability is low" (Wheaton, 1999). According to that, elasticities of supply and demand are compared in the last part of this research. That seeks to explain the imbalance that exists in the Croatian housing market.

The elasticity coefficients can be calculated only in models where prices are statistically significant. Otherwise, it is considered that prices don't have impact on demad or new construction, so elasticity coefficient is equal to zero. DiPasquale and Wheaton (1994) calculate the price elasticity of demand as:

$$\beta_4 * P * H/S$$

where P represents average housing prices and S/H average stock per household in observed period. The coefficient can be calculated if lagged prices and stock per houshold are statistically significant in estimations. β_4 is calcuated as the ratio of one minus the estimated coefficient for lagged price over the coefficient for S_t/H_t. Price elasticity of construction is calculated as:

$$\alpha_4 * P/C$$

α_4 represents estimated coefficient for housing prices and C represents average new construction during observed period. Price elasticities of supply and demand which are calculated from estimations presented in Tables 5-8 are shown below (Table 9).

Table 9: Price elasticity coefficients in demand and construction estimates

Estimated equation ↓											
	Demand			Construction				Demand			Construction	
	Model	Price elasticity		Model	Price elasticity			Model	Price elasticity		Model	Price elasticity
HPI	1	**-5,03**		1	**3,05**		**PNEW**	1	**0**		1	**0**
	1a	**0**		2	**2,94**			1a	**0**		2	**0**
	2	**-5,60**		3	**0**			2	**0**		3	**0**
	2a	**0**		4	**2,66**			2a	**0**		4	**0**
	3	**-5,79**		5	**0**			3	**0**		5	**0,01**
	3a	**0**		6	**0**			3a	**0**		6	**0**

Source: author's calculation

According to the presented caluculations, it is difficult to give unambiguous answer to the question of what causes instability in the Croatian housing market. It is clear that demand does not respond to price changes when prices of newly built and sold dwellings are observed. Almost the same can be argued for the supply of the new housing space. The comparison of the price elasticity of supply and demand is only possible in the case where the house prices are measured by HPI. However, this raises the question of the values being compared. The simplest approach is to compare the average elasticity calculated on the basis of three models in which the elasticity

coefficients are different from zero. In that case, the average amount of demand elasticity (5,47) is higher than the average elasticity of the construction (2,89), which does not confirm the Wheaton hypothesis. In other words, it cannot be confirmed that the ratio of price elasticities of demand and supply fosters the imbalance in the observed market. This can be considered as another specificity of the housing market in Croatia.

5 Conclusion

This century was turbulent for housing markets across the world, as well as in Croatia. The last ten years have been marked by a cyclical movements in Croatian housing market and construction sector. The crisis has begun in 2008 and lasted for seven years. This was the period of dramatic fall of housing demand, while supply descended, but at much slower pace. Awakening of the housing market begins in 2015. From that year onwards, the growth of supply and demand for housing is stable and the market slowly but surely starts its new rise. Therefore, the main goal of this paper was to examine factors which led to mentioned developments. The analysis was conducted within simple methodological frame, concretely dynamic stock-flow model of the housing market.

Several conclusions can be drawn from the analysis carried out. Firstly, the house price index which includes prices of all housing units (new and existing) is more important factor which affects housing demand and supply than price measure which observe only new housing units. This is especially pronounced in modelling demand side of the housing market. The estimations of house prices equations clearly show that house prices slowly adjust to its equilibrium level. As lagged prices in estimations are assesed as statistically significant, it can be concluded that price expectations on housing market are adaptive. But, it has to be once more emphasized that myopic behavior on demand side of the market is confirmed only when demand equations include house price index as a measure of house prices. The results show that changes in macroeconomic variables, which are considered as exogenous shocks in stock-flow model, don't have strong effects on demand and supply on housing market. In demand estimations the changes of GDP and employment were mainly assessed as statistically significant determinants, but their effect was negligible small in several estimated models. Inclusion of these effects in supply models results with quite disappointing estimations. It can be concluded that macroeconomic movements don't affect construction activity at all, which can be considered as atypical result.

Besides latter mentioned, there are some other unexpected results which indicate certain specificities of the Croatian housing market. Estimation of house prices equations indicates atypical relationship between house prices and interest rates. Concretely, results show that the effect of the change in user cost of housing on the change in house prices is positive. The estimated rent coefficient is negative, which is also not in line with theoretical expectations and economic logic. Atypical results are even more pronounced in construction estimations.The results of the analysis show that most of the explanatory variables, which are considered as standard supply determinants in theory, are not statistically significant in supply estimations. Moreover, some of the statistically significant parameters have the non-expected sign, for example cost of land and short-term interest rates.

It should be emphasized that there were some research limitations which should be taken into account while interpreting given results. In the first row, the greatest weakness of housing market research is quality of available data. In Croatian statistics, many housing market variables suffer from the problem of missing (or unavailable) long series of data needed for quality analysis. Therefore, the researcher has to deal with unadequate data and use different techniques for data manipulation, like interpolation and approximation. Every data manipulation potentially results with the loss of information contained in the original data. This also relates to the differencing of time series data. As time series used in this research are quite short, the need of using ADF unit root test, as well as obtained test results, are questionable. Finally, there are certainly more variables which are ommitted in this analysis. Some of them are difficult to observe, like different expectations on housing market or propensity to own a housing unit. As one of the Croatian specificity is historically high propensity to own a housing unit, it would be very interesting for future research to try to observe, measure, and than include such and similar specificities in modelling domestic housing market.

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Appendix

Table 2: Statistically significant house prices determinants in selected empirical researh

Author(s)→ / **House price determinants ↓**	Kalra, Mihaljek & Duenwald (2000)	Sutton (2002)	Apergis (2003)	Tsatsaronis & Zhu (2004)	Abelson et al. (2005)	Egert & Mihaljek (2007)	Lovrinčević & Vizek (2008)	McQuinn & O'Reilly (2008)	Hlaváček & Komárek (2009)	Posedel & Vizek (2009)	Adams & Füss (2010)	Vizek (2010)	Dumičić, Čeh Časni & Žmuk (2011)	Ojetunde (2012)	Nikolić (2015)
National income		*					*			*		*		*	
Income per capita	*					*									
Households' disposable income					*			*							
Industrial production											*				
Monney supply											*				
Unemployment					*				*						
Employment			*								*				
Wages						*			*				*		*
Interest rates	*	*		*	*	*	*	*		*	*	*		*	*
Loans			*	*		*	*		*			*			
Construction activity												*			
Construction costs											*				
Existing stock					*										
House price persistence										*		*			
Demographic factors						*	*		*				*		*
Institutional factors						*									
Stock prices		*			*	*									
Inflation			*	*	*		*							*	
Interest rate spread				*											
Exchange rate	*													*	
Rents	*														

Source: author