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Housing Price Volatility and Econometrics

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Abstract: *Econometric models have produced contradictory results and have failed to provide warning of housing market crashes. The article aims to illustrate how econometrics was unable to reliably predict the recent housing price bubble and detect the disequilibrium in the housing markets. The authors will demonstrate that two distinct but well specified econometric models, using the same data, can lead to different outcomes. The authors argue that the demand for housing is influenced by social constructs, social norms, ideologies, unrealistic expectations, symbolic patterns, and that the actual choice of housing is the outcome of complex social interactions with reference groups. Consequently, it is necessary to analyse the potential instability of social constructs, norms, expectations and the changing character of social interactions to better understand purchasing behaviour and, then, housing price volatility.*

Keywords: econometrics; housing prices; price bubbles.

Introduction

The standard mathematical models of asset price formation were based on the Efficient Market Hypothesis (Fama 1970), equilibrium systems theory (Katzner 1989) and random walk hypothesis (Samuelson 1965). According to these models, the prices of assets (such as residential real estate) incorporate all relevant publicly available information. Consequently, asset prices change randomly and it is impossible to predict future prices on the basis of past price development. These theories are a natural product of the neoliberal economic paradigm modelling markets according to the assumptions that market agents (1) behave rationally with perfect information and foresight and (2) do not interact with each other.

However, as real estate property is heterogeneous and property transactions occur infrequently, the available information on the housing market is limited (Evans 1995). Moreover, excessive volatility (price bubbles) confirms that the available information is not sufficient to adjust prices. Property prices tend to be positively auto-correlated and the assumption of the efficiency of the housing market has been questioned (Malpezzi 2005; Wheaton 1999).

Despite the fact that econometric models incorporate some housing market inefficiencies, such as the speculative element, into price estimates, they have produced contradictory results and have failed to provide any reliable warning of housing market crashes. The best illustration of this might be the inability of econometrics to reliably predict the recent housing price bubble and subsequent housing market crashes. Despite the unprecedented record growth in housing prices during the boom period leading up to 2006 (or 2007), many studies published until 2007 were inclined to conclude that at most market housing prices were not that far from the line determined by economic fundamentals (e.g. Girouard et al. 2006, ECB 2006, Stephansen & Koster 2006, Case & Wachter 2005, Himmelberga et al. 2005, Cameron et al. 2006). It must be noted that at the same time and using very similar methodological approaches some scholars reached the very opposite conclusions (e.g. Baker, Rosnick 2005, Barrel et al. 2004). The standard econometric approaches failed to reliably detect the disequilibrium in the housing markets that had drastic consequences and produced the global economic crisis.

The main goal of this article is to demonstrate the weak evaluative and predictive power of standard econometrics by presenting the estimates of two different ECM models that have comparatively strong explanatory power, use the same price time series, are well specified and meet the test standards, but arrive at substantially different results. This differences mainly stem from the fact of whether interest rates are or are not included among the fundamental factors influencing long-term housing price levels. The tests are based on data from the Czech Republic.

Methodology

To capture short-term volatility following from housing market inefficiencies, the researchers started by using alternative econometric approaches, in particular error correction models (ECM) that allow for both long-term ('equilibrium') and short-term price estimates (Hort 1998).

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The ECM can be estimated using a two-step procedure (Hort 1998, Meen 2002). In the first step, the long-run equilibrium relationship is estimated. Provided that the residuals obtained from this regression are mean-zero stationary, the short-run dynamics are explored in the second step including the residuals (the error correction term) from the cointegrating regression to capture the impact of deviations from long-run equilibrium. Asymptotically, the long-run equation may be consistently estimated by OLS.

The detailed description of the ECM will be omitted here due to limited space. It should be mentioned that the nature of economic time-series data is such that the data are non-stationary, i.e. they are characterised by a 'random walk'. Running regressions with non-stationary data could produce misleading results, i.e. results that erroneously indicate that a meaningful relationship exists among the regression variables. It is therefore necessary to test economic time series data for non-stationarity before proceeding to the estimates. It is generally assumed that the non-stationarity of most economic variables is such that differencing will create stationarity.

It is possible that even if the individual variables entered into the particular ECM are non-stationary (but integrated of order 1), a linear combination of them is stationary (integrated of order 0). Such variables are said to be cointegrated. The Augmented Dickey-Fuller test was used to determine the order of integration of the time-series, and the Johansen cointegration test and the Engle-Granger cointegration test are used to test the residuals for cointegration.

Data

The price data (the average price of flats quarterly in the Czech Republic) are provided by the Czech Statistical Office (CZSO). The source of the data is the statement for a stamp duty land tax (SDLT). For each transaction sellers have to pay a tax of 4% of the market or assessed value of the dwelling. Internal Revenue Offices enter selected data on real estate sales (i.e. transaction prices) into their databases and draw these data from SDLT forms, and the resulting data files are then submitted to the CZSO. The CZSO processes the data and provides average transaction prices and price indices. These are quarterly time series from 1998 (14 years; 58 observations) for flats, plots and detached homes (we are using only flat prices).

The measure of income (Y_{nt}^{SA}) is the logarithm of nominal net disposable household income (from the national accounts statistics provided by the CZSO) per capita after seasonal adjustment. The interest rate ($PRIBOR12M_{nt}$) is measured with a logarithm of the one-year Prague InterBank Offered Rate (PRIBOR) provided by the Czech National Bank. Unemployment (UNEMPL_t) is measured with a logarithm of the number of unemployed people in thousands. Unemployment is monitored by the CZSO and the definition of unemployed people corresponds to that of the International Labour Organization (ILO). In addition, housing supply is measured with a seasonal adjusted logarithm of completed dwellings in multi-dwelling buildings ($FDWEL_{t-6}^{SA}$). Demographic factors are captured by the share of people aged 25-34 out of the total population ($SHARE25\text{-}34_t$). This variable is supposed to take into account the fact that demand for flats tends to be particularly high in this age group (first-time buyers). The short-run dynamics model (second stage of the ECM estimate) includes the first differences in the logarithm of the number of immigrants (data provided by the CZSO). To investigate whether the deregulation of the housing finance system in the first half of the 2000s had any impact on the level of nominal flat prices, we

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used the net lending ratio (NLR_{t-4}), i.e., the ratio of net lending (balance of mortgage loans granted to households) to disposable household income, as a measure of credit availability.

Findings

In this section we present two ECMs explaining quarterly flat price variability in the Czech Republic between 1998 and 2012. The models use the same dependent variable (a logarithm of flat prices) but different sets of explanatory variables. The main difference between the two models is whether the interest rate is or is not perceived as a fundamental variable used to explain the long-term 'equilibrium' of housing price trends.

Model 1

The equation for long-term Model 1 can be formally rewritten as follows:

$$ln\ P_t = -3.298 + 1.566 * ln\ Y_{nt}^{SA} - 0.129 * ln\ PRIBOR12M_{nt} - 0.489 * ln\ UNEMPL_t - 0.078 * ln\ FDWEL_{t-6}^{SA}$$

where:

$ln\ P_t$	- logarithm of nominal flat prices in quarter t;
$ln\ Y_{nt}^{SA}$	- logarithm of nominal net disposable household income per capita in quarter t, seasonally adjusted;
$ln\ PRIBOR12M_{nt}$	- logarithm of the nominal interest rate (PRIBOR) in quarter t;
$ln\ UNEMPL_t$	- logarithm of the number of unemployed people (in thousands) in quarter t;
$ln\ FDWEL_{t-6}^{SA}$	- logarithm of completed dwellings in multi-dwelling buildings in quarter t-6, seasonally adjusted.

The model explained 98.2% of the variance in the logarithm of nominal flat prices (deterministic coefficient R^2=98.2%). The high value of the R^2 is not an annual coincidence – the model has been estimated on past time series since 2007 and it has shown very strong explanatory power each year. The unstandardized coefficients estimated using the OLS regression are stated in the equation above, all having expected signs.

The comparison of observed and (model) estimated flat prices showed that estimated 'equilibrium' flat prices were in the middle of 2011 substantially above their observed values, i.e. observed flat prices were largely below the long-term values predicted by Model 1.

The variables entered into the long-term equation of Model 1 were tested for stationarity and cointegration. An Augmented Dickey-Fuller test shows that the time series used in Model 1 have unit roots, i.e. they are non-stationary. The Engle-Granger single equation test does not support the hypothesis that the variables entered into the model are cointegrated. However, the results differ by the order of the variables, and in two cases are almost significant at the 10% significance level. The Johansen test confirmed cointegration at a 10% significance level (but not at a 5% significance level). We can conclude that the time series are with a high probability cointegrated, but empirical evidence of cointegration is somewhat weaker.

The 'short-term equation' (the second step of the ECM) for Model 1 can be formally rewritten as follows:

$\Delta ln\ P_t = 0.006 + 0.420 * \Delta ln\ P_{t-1} + 0.223 * \Delta ln\ Y_{nt-4}^{SA} - 0.196 * \Delta ln\ UNEMPL_t - 0.005 * \Delta PRIBOR12M_{rt} + 0.024 * \Delta ln\ IMMIGRANTS_{t-2} - 0.196 * RESID_{t-2}$

where:

$\Delta ln\ P_t$	- the first difference in the logarithm of nominal flat prices in quarter t;
$\Delta ln\ P_{t-1}$	- the first difference in the logarithm of nominal flat prices in quarter $t-1$;
$\Delta ln\ Y_{nt-4}^{SA}$	- the first difference in the logarithm of nominal net disposable household income per capita in quarter $t-4$, seasonally adjusted;
$\Delta ln\ UNEMPL_t$	- the first difference in the logarithm of the number of unemployed people (in thousands) in quarter t;
$\Delta PRIBOR12M_{rt}$	- the first difference in the real interest rate (PRIBOR) in quarter t;
$\Delta ln\ IMMIGRANTS_{t-2}$	- the first difference in the logarithm of immigrants in quarter $t-2$;
$RESID_{t-2}$	- the error correction term (residuals from the long-term equation) in quarter $t-2$.

The model explained 71% of the variance of the first differences of the logarithm of nominal flat prices. The unstandardized coefficients estimated using the OLS regression are stated in the equation above, all having expected signs. The variables entered into the 'short-term' equation of Model 1 were tested for stationarity. An Augmented Dickey-Fuller test shows that the time series used in the 'short-term' equation of Model 1 have unit roots, i.e. they are non-stationary.

Model 2

As it is not completely clear to what extent the interest rate could be considered a real economic fundament, we estimated the second ECM model (hereinafter Model 2). The long-term part of Model 2 has only a slightly lower explanatory power (R^2 = 95.2%) in comparison to Model 1 and it includes only net disposable household incomes and demographic factors (the share of people aged 25-34 out of the total population). The 'long-term' equation for Model 2 can be formally rewritten as follows:

$ln\ P_t = -10.345 + 1.571 * ln\ Y_{nt}^{SA} + 1.201 * ln\ SHARE25\text{-}34_t$

where:

$ln\ P_t$	- logarithm of nominal flat prices in quarter t;
$ln\ Y_{nt}^{SA}$	- logarithm of nominal net disposable household income per capita in quarter t, seasonally adjusted;
$ln\ SHARE25\text{-}34_t$	- logarithm of the share of people aged 25–34 out of the total population in quarter t.

The unstandardized coefficients estimated using the OLS regression are stated in the equation above, all having expected signs. Flat prices increase with increasing net disposable household income and the increasing share of the population aged 25-34.

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A comparison of observed and estimated (from the long-term part of Model 2) flat prices showed that unlike for Model 1 the estimated 'equilibrium' flat prices were almost at the same level as their observed values. No undervaluation of observed housing prices to market 'equilibrium' was detected in the case of the long-term part of Model 2.

The variables entered into the long-term equation of Model 2 were tested for stationarity and cointegration. The results of the Augmented Dickey-Fuller test showed that the time series used in Model 2 have unit roots, i.e. they are non-stationary. The Engle-Granger single equation test does not support the hypothesis that variables entered into the model are cointegrated. However, the Johansen test confirmed cointegration at 5% significance level. We can conclude that the time series are with high probability cointegrated, but empirical evidence of cointegration is somewhat weaker.

The 'short-term equation' of Model 2 can be formally rewritten as follows:

$$\Delta ln\ P_t = -0.004 + 0.684 * \Delta ln\ P_{t-1} + 0.297 * \Delta ln\ Y_{nt-4}^{SA} + 0.074 * \Delta ln\ NLR_{t-4} - 0.222 * RESID_{t-7}$$

where:

$\Delta ln\ P_t$	- the first difference in the logarithm of nominal flat prices in quarter *t*;
$\Delta ln\ P_{t-1}$	- the first difference in the logarithm of nominal flat prices in quarter t-1;
$\Delta ln\ Y_{nt-4}^{SA}$	- the first difference in the logarithm of nominal net disposable household income per capita in quarter *t-4*, seasonally adjusted;
$\Delta ln\ NLR_{t-4}$	- the first difference in the logarithm of the net lending ratio in quarter *t-4*;
$RESID_{t-7}$	- the error correction term (residuals from the long-term equation) in quarter *t-7*.

The model explained 68% of the variance of the first differences of the logarithm of nominal flat prices. The unstandardized coefficients estimated by the OLS regression are stated in the equation above, all having expected signs. The first differences in flat prices increases with increasing differences in flat prices in the preceding quarter, differences in the lagged net disposable household income, differences in the lagged net lending ratio and decreases with the lagged error correction term.

The variables entered into the 'short-term' equation of Model 2 were tested for stationarity. The results of the Augmented Dickey-Fuller test show that the time series used in the 'short-term' equation of Model 2 have unit roots, i.e. they are non-stationary.

We used both models (Model 1 and Model 2) to forecast the trend in flat prices for the second half of the year 2012 and for the year 2013. Most of the time the series ended in the third quarter of 2012; therefore, for the forecast we used official predictions of the variables entered into Model 1 and Model 2. The predictions of independent variables were drawn from the Macroeconomic Prediction of the Ministry of Finance of the CR from January 2013 and the Macroeconomic Prediction of the Czech National Bank from November 2012.

While Model 1 predicts a 2.7% increase in flat prices for the year 2013, Model 2 predicts for the same period a price decline of 0.4%.

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Conclusions

We used two error correction models that have comparatively strong explanatory power, use the same price time series, are well specified and meet the required test standards, but they showed different results. These differences depend on whether interest rates are or are not included among the fundamental factors influencing long-term housing price levels. While the model with the interest rate included among the fundamental values influencing 'equilibrium' housing prices showed a substantial undervaluation of recent flat prices to their long-term 'equilibrium', the second model omitting the interest rate variable showed that observed prices are almost equal to market 'equilibrium'. Both models would be accepted as relevant, as they have strong explanatory power and acceptable (comparable) results for the test values. If used to predict price trends in 2013 the models would arrive at different conclusions: while Model 1 would predict a price increase, Model 2 would predict a slight drop in price.

As Schiller (2007) has pointed out, the methods of mathematical economics that are used to assess the development of the housing market have lost their reliability. Consequently, a possible solution would be to formulate the kind of theoretical and methodological approaches that facilitate a better understanding of how (1) the preferences and expectations of actors in the housing market are formed and how (2) complex interactions between individual actors in the housing market operate.

Although the process of searching for new directions in housing market research is in its early stages, inspiration is being sought particularly in behavioural economics. Behavioural economics offers methods that certainly help to re-define the standard approaches of econometrics, but it ignores a substantial section of sociological knowledge that derives from the theories of social constructivism (Berger, Luckman 1966; Jacobs et al. 2004; Lux, Mikeszová 2012), symbolic interactionism (Blumer 1986), and social network analysis (Wasserman, Faust 1995). Modelling used in behavioural economics thus tends to overlook significant interactions and important contextual variables, and the findings thus may not necessarily be a reliable substitute for the findings produced by standard econometrics.

Standard econometric approaches mostly do not take into account the existence of social interactions and natural information barriers. Yet, it is apparent that the demand for housing is influenced by social constructs (put forth by representatives of the state, the media, and the actors in the market themselves), social norms, ideologies, unrealistic expectations, symbolic patterns (housing as a symbol of social status), and especially the actual choice (purchase) of housing is the outcome of complex social interactions with reference groups comprising family members (parents), close friends (generational patterns of behaviour), experts, developers, and real estate agents. In that case, it is necessary to analyse the potential instability of social constructs, norms, expectations and the changing character of social interactions.

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