Central European Review of Economic Issues
EKONOMICKÁ REVUE

Convergence in house prices across OECD countries: A panel data analysis

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Abstract

This study examines whether housing prices converged in OECD countries over the 1996–2015 period. The unconditional and conditional convergence hypotheses are tested via the system-GMM method using five-year span panel data of twenty OECD countries. The results reveal that there exists a significant convergence process within this country group. To test the conditional convergence hypothesis, the convergence equation is estimated also with some control variables that may reflect market activity and demand side impacts such as income level, construction, unemployment rate, permits for dwellings and share prices. The findings show that the speed of convergence is even higher when the above-mentioned variables are controlled.

Keywords

Convergence, house prices, panel data analysis, system-GMM.

JEL Classification: R31, C33

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ISSN 1212-3951 (Print), 1805-9481 (Online)
ER-CEREI, Volume 20: 5–15 (2017).
doi: 10.7327/cerei.2017.03.01

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1. Introduction

In recent years, due to rising house prices and the subsequent financial crisis, academics and policymakers have begun to analyse the interaction between house prices, the macro economy and the underlying factors behind it. Because of its effects on other sectors, studies on the housing market in developed countries have increased rapidly since the global financial crisis. Since the 1990s, many developed countries (except Japan) have witnessed a spike in house prices under the favourable macroeconomic conditions. Starting from the end of 1990 to the second quarter of 2007, real house prices rose by approximately 60% in the USA, 40% in the euro area, 55% in Canada and 135 % in the UK. Real house prices fell drastically after the great recession in 2007 but began their upward trend by the end of 2012.

In many developed countries, housing demand increased and hence house prices went up as a natural consequence of mutual dependence between financial markets, internationalisation and the ease of access to credit. Furthermore, it is expected that developments in borrowing conditions will strengthen the tendency of house prices to move together. Inclusion of house prices in the study is important in the sense that housing is a key player in explaining an individual's wealth levels (see Ludvigson et al., 2002; Catte et al., 2004; Fry et al., 2010) and a country's business cycles (see Quigley, 1999; Girouard et al., 2006; Ghent and Owyang, 2009). Housing sector activities constitute a considerable portion of GDP and household consumption in developed countries. In addition, housing constitutes the largest financial asset held by households and housing loan debts constitute the main obligations of households. As a result, large fluctuations in house prices play an important role in macroeconomic variables by influencing the spending and borrowing capacity of households.

Although housing might be used for two different purposes as a consumption good or investment good, it is a typical non-traded asset; and a significant co-movement has been observed in the rise of real house prices across developed countries. According to Vansteenkiste and Hiebert (2009), despite housing being a non-traded good that cannot be substituted easily geographically, international convergence in house prices can be explained with three channels. Co-movement in housing market fundamentals, such as income and interest rate, can be named as the first channel in explaining convergence in international house prices. Secondly, convergence in international house prices may arise because they are prone to similar financial market developments. As a result, changes in long-run domestic interest rates ease borrowing and reinforce financial integration. Finally, convergence in housing prices may originate from housing-sector-specific factors such as risk premiums on returns on housing as an asset. This co-movement in housing prices in developed countries brings about the question of whether housing prices converge across developed countries.

In this paper, we aim to answer the following questions. First, is there a stable, long-run equilibrium relationship between house prices in OECD countries? Second, what is the importance of fundamental factors of household demand and market activity, such as income level, construction, unemployment rates, permits for dwellings and share prices, in explaining the convergence of house prices in OECD countries.

The remainder of the paper is organised as follows. In the next section, a related literature review is presented, while in the third and fourth sections the methodology and data are discussed. In the fifth section, the empirical results are presented, and finally, in the sixth section conclusions are discussed.

2. Literature review

There are a large number of studies and a growing literature that have searched for both regional and national house price convergence in developed and developing countries after the 2007–2008 global finance crisis that spread from house prices. The existing literature typically relies on data on either regional/metropolitan housing markets or on data aggregated at a country level. The following studies present some findings by investigating the existence of convergence in house prices across different areas.

There is an extensive literature on the US housing market that suggests the convergence process in house prices (i.e. Holmes et al., 2011; Kim and Rous, 2012; Montanes and Olmos, 2013). Yunus and Swanson (2013) have examined the dynamic interactions among

nine US regional housing markets by estimating the multivariate cointegration model over the 1975–2010 period. Their findings indicate that the extent of convergence among the regional housing markets substantially increased over time and accelerated after the housing boom-bust during 2007. Kang (2011) has conducted a dynamic panel data analysis to investigate the effects of spatial innovation and high-tech industry innovation on metropolitan house prices. The results reveal that the high-tech industrial transmission mechanism plays an important role and increases the housing price convergence. Despite all this obvious evidence regarding house prices convergence in the US, Clark and Coggin (2009) show that favouring the existence of regional convergence is a non-trivial and complicated effort since their data ended with the second quarter of 2005. Nissan and Payne (2013) also study the convergence in house prices at regional and state levels. Their results imply that house prices converge only among nine states of the US while the remaining forty-one states do not show any findings in favour of convergence in house prices.

There is also some evidence of house price convergence across regions in Europe. Even the early studies (i.e. MacDonald and Taylor, 1993) fail to show a robust convergence path; some recent papers reveal opposite results for United Kingdom. Holmes and Grimes (2008) have analysed the long-run convergence in regional house prices in UK. Their findings point out that in the long run, house price ratios are constant among all regions. Cook (2003), Holmes (2015) and Montagnoli and Nagayasu (2015) show that within most regions of the UK, regional house prices converge. Merikas et al. (2012) ask the question whether the apparent co-movement of housing prices in the seven major euro zone economies implies convergence of their housing markets. Their findings reveal that apart from the well-known fundamentals such as GDP, interest rates and stock returns, the movement of house prices also stems from distinctive factors like demographics, the tax system and government intervention in each country. Additionally, they point out that the convergence level of house prices is determined by the given multiplicity of living standards and regulation of the property markets. Hiebert and Roma (2010) have examined house price convergence and the key factors which explain price differentials in a panel regression framework including per capita income, population, and relative distances across the four biggest euro area countries (Germany, France, Italy and Spain) compared with those in the US. While their results reveal limited findings in favour of long-run convergence in city-level house prices for the euro area and the US, income and population differentials play an important role in explaining city-level house price dispersion in these countries. Yunus (2015) has investigated the degree of convergence among the housing markets of ten major economies across North America, Europe, and Asia. The findings show that the trends and co-movements among global housing markets can be attributed to real convergence. His results also reveal an important fact that the US housing crisis caused an increase in the speed of convergence among these markets.

Gong et al. (2016) and Lin et al. (2015) have investigated regional house price convergence in China. The findings of these studies show a little evidence of overall convergence across China's regions while Mao (2016) shows that the regional house prices in China are generally not convergent. Kim (2011) has examined housing price convergence in Korea. For any type of housing price, the results show that there is little evidence of overall house price convergence.

Furthermore, in this analysis, we investigate whether there is either unconditional or conditional convergence in housing prices across OECD countries. In order to examine the conditional convergence, the housing prices are going to be linked to some market activity and household demand factors such as income, construction, unemployment, permits for dwellings, share prices. In the literature, a large number of empirical studies have propounded that house prices are closely related to a set of macroeconomic variables and market-specific conditions which are expected to influence both the demand and supply side of the housing market (i.e. Capozza et al. 2002; Egert and Mihaljek, 2007; Clark and Coggin, 2009Beltratti and Morana 2010; Glindro et al., 2011).

Studies on housing demand show that higher income levels trigger housing demand and higher demand raises house prices (i.e. Tsatsaronis and Zhu, 2004; Ciarlone, 2012). In accordance with some other studies such as Hilbers et al. (2008), Ball et al. (2010), Caldera and Johansson (2013) reveal that house prices tend to rise when households' disposable income increases. Adams and Füss (2010) also show that as economic activity increases by 1%, it raises the housing demand and thereby the house prices rise over the long run by 0.6%. The conditions in labour markets might have some impact on the housing market. Lower levels of unemployment or higher levels of population may raise the housing demand and house prices. Abelson et al. (2005) suggest that in the long run, real house prices in Australia are significantly determined and reduced by the unemployment rate. Apergis (2003) shows that positive shocks in employment raise real house prices in Greece. Barot and Yang (2002) propound that the unemployment rate is a significant determinant of house prices both for UK and Sweden. By using data for the US, Baffoe-Bonnie (1998) show that changes in

employment have significantly affected house prices on the West coast.

As a potential determinant of house prices, other types of assets which generally represent equity prices might be used as a proxy for market activity. Since the substitution and wealth effects are in opposite directions, there is not a clear relationship between stock market valuations and house prices. However, one may yet consider investing in other types of financial assets based on the relative rates of return on the alternative assets (Chen and Patel, 1998). So, by considering all the studies and suggestions above, in this study, construction, permits for dwellings and share-price data can be used to represent market activity, while income level and unemployment data can be used to proxy the market demand. The details on the variables are shown in further sections. In the following section, the methodology and data will be presented.

3. Methodology

In the economics literature, inspired by Gerschenkron (1952), the pioneers of the convergence debate have focused on the development process and investigated whether poor countries catch up the rich ones (i.e. Abramovitz, 1986; Baumol, 1986; DeLong, 1988; Barro and Sala-i-Martin, 1991, 1992; Mankiw et al., 1992, etc.). Even though their focus was on the economic growth performance of countries, the methodology and model structure used by these studies are very useful and have been adapted to many issues regarding the convergence phenomenon. Within the balanced growth path concept of the neoclassical framework, the underlying logic here is simple–if income levels of countries tend to converge, then all the factors and their prices will converge. Thus, based upon the income convergence model, the housing price convergence equation might be set up. According to Mankiw et al. (1992), Islam (1995) and many of their followers, the basic convergence model is as follows;

$$\frac{d\ln\hat{y}(t)}{dt} = \lambda\left[\ln(\hat{y}^*) - \ln\hat{y}(t)\right], \tag{1}$$

where $\hat{y}^*$ is the steady state-level of income per capita, $\hat{y}(t)$ is the actual level of income per capita at time t and λ is the adjusting parameter which includes the income convergence parameters and implies the speed of convergence process. Equation (1) can be written for two discrete time periods as below:

$$\ln\hat{y}(t_2) = \left(1-e^{-\lambda\tau}\right)\ln\hat{y}^* + e^{-\lambda\tau}\ln\hat{y}(t_1), \tag{2}$$

where $\tau = (t_2 - t_1)$. In order to obtain a relationship between the initial level and the current growth rate the $\ln\hat{y}(t_1)$ term is subtracted from both sides of the equation:

$$\begin{aligned}&\ln\hat{y}(t_2) - \ln\hat{y}(t_1) = \\ &\left(1-e^{-\lambda\tau}\right)\ln\hat{y}^* - \left(1-e^{-\lambda\tau}\right)\ln\hat{y}(t_1).\end{aligned} \tag{3}$$

Since the income per capita term, $\hat{y}(t)$ comes from $\hat{y}(t) = Y(t)/L(t)A(t)e^{gt}$, the detailed form of the income per capita equation might be written as follows:

$$\begin{aligned}\ln\hat{y}(t) &= \ln\left(\frac{Y(t)}{L(t)}\right) - \ln A(0) - gt \\ &= \ln\hat{y}(t) - \ln A(0) - gt.\end{aligned} \tag{4}$$

By solving the last one with equation (3) and expressing it in the panel data notation, the following equation will be obtained:

$$y_{it} - y_{i,t-1} = \sum_{j=1}\beta_j x_{it}^j - \left(1-e^{-\lambda\tau}\right)y_{i,t-1} + \eta_t + \mu_i + \varepsilon_{it}, \tag{5}$$

and if the terms related to initial time are collected in the right-hand side of the equation, a dynamic panel data model is obtained as below;

$$y_{it} = \gamma y_{i,t-1} + \sum_{j=1}\beta_j x_{it}^j + \eta_t + \mu_i + \varepsilon_{it}, \tag{6}$$

where $y_{it} = \ln y(t_2)$, $y_{i,t-1} = \ln y(t_1)$, $\gamma = e^{-\lambda\tau}$, x term stands for the control variables, η_t represents the country-specific effects, μ_i represents the time-specific effects and ε_{it} is the error term. Here, to be able to assert the existence of convergence, the value of the γ term should be between 0 and 1. The values bigger than 1 imply divergence. According to the basic convergence equation (i.e. equation (5)), the speed of convergence depends on the $-(1-e^{-\lambda\tau}) = -(1-\gamma)$ term which should be estimated negatively. Thus, the γ values closer to 0 imply a higher speed of convergence.

Regarding the income convergence equation, the dynamic panel data model for housing price convergence can be written as follows:

$$HP_{it} = \gamma HP_{i,t-1} + \sum_{j=1}\beta_j x_{it}^j + \eta_t + \mu_i + \varepsilon_{it}, \tag{7}$$

where the *x* term stands for the control variables.

There are two types of convergence concepts– unconditional convergence and conditional convergence. The conditional convergence considers factors that may constitute countries' characteristics regarding the dependent variable while the unconditional convergence ignores any possible factors. In this study, some control variables that may reflect the *market activity* and *demand side impacts* have been chosen for the estimations. To measure the market activity, the variables such as the construction

sector, permits for dwellings and share price data, are used. As for measuring the demand side impacts, the income level and unemployment rate data are used.

Before the mid-1990s, most of the empirical studies in the convergence literature employed cross-section data sets. But afterwards, panel data samples and improved estimation methods have been used in convergence analyses (Islam, 2003). In this respect, Islam (1995) was the pioneer who gathered the convergence concept and panel data analysis. Even though Islam (1995) controls for the endogeneity of lagged dependent variable, the analysis does not take into account the endogeneity of other explanatory variables. Therefore, the system-generalised method of moments (system-GMM) approach allowing for such a control of endogeneity of the additional explanatory variables appears to be a better method. Studies using the system-GMM approach report improved convergence speed over the fixed-effects estimation (i.e. Caselli et al., 1996).

The system-GMM estimator is the augmented version of the difference-GMM estimator developed by Arellano and Bond (1991). Arellano and Bover (1995) and Blundell and Bond (1998) have augmented the difference-GMM estimator by making an additional assumption that first differences of instrument variables are uncorrelated with the fixed effects. The difference-GMM estimator instruments differences with levels, while the system-GMM estimator instruments levels with differences (Roodman, 2009).

In order to make a panel data analysis via the system-GMM estimator, the [*xtabond2*] module which was developed by Roodman (2009) and available in *Stata* software is used. The regression outputs in Table 2 and Table 3 come with two important diagnostic tests: the Sargan/Hansen test of overidentifying restrictions and the Arellano-Bond autocorrelation test. The null hypothesis of the Sargan/Hansen Test indicates all the instruments are valid while the null hypothesis of the Arellano-Bond test indicates no serial autocorrelation (Roodman, 2009).

4. Data

The convergence analysis of the study covers the period of 1996–2015 for twenty countries.[1] The analysis could contain more countries but due to some data constraints the data set covers only the twenty OECD countries. Except for the unemployment rate, all the data are in index format and obtained from the *OECD.Stat*[2] Database. To be able to harmonise the variables, they are estimated in their natural logarithmic form. As it might be understood from equation (6) and equation (7), the dynamic panel data convergence equation measures the relationship between the previous period's value and the growth rate since the previous period. However, even the yearly data may contain business cycles and this might lead to biased results. Thus, to avoid business cycle fluctuations, the data has been transformed into four-year spans. So, the time dimension of the data is five.

The descriptive statistics on the data are shown in Table 1. As is seen from the table, due to the data limitations, the *permits for dwellings* data contain seventeen countries while all the other data contain twenty countries. The mean values and the standard deviations imply that the analysis employs a homogenous sample as is expected. Note that the housing prices for the entire period range from 3.832 to 4.927 with a standard deviation of 0.246.

Figure 1 depicts the relationship between the initial period's housing price index and the average growth rate over the period of 1996–2015. Notice that the growth rates on the vertical axis are given as

Table 1 Descriptive statistics

Variable	Number of observations	Number of groups	Mean	Std. dev.	Min.	Max
Housing prices	100	20	4.472	0.246	3.832	4.927
Construction	95	20	4.614	0.258	3.965	5.829
Share prices	100	20	4.580	0.332	3.548	5.500
Income level	100	20	4.537	0.098	4.257	4.693
Unemployment	100	20	1.871	0.419	1.115	3.192
Permits for dwellings	85	17	4.786	0.586	3.519	6.684

Notes: All data are given in their natural logarithmic form. The *Permits for dwellings* data does not exist for Italy, Japan and the United States.

[1] The countries in the analysis are: Australia, Belgium, Canada, Denmark, Finland, France, Ireland, Italy, Germany, Japan, South Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

[2] See http://stats.oecd.org/

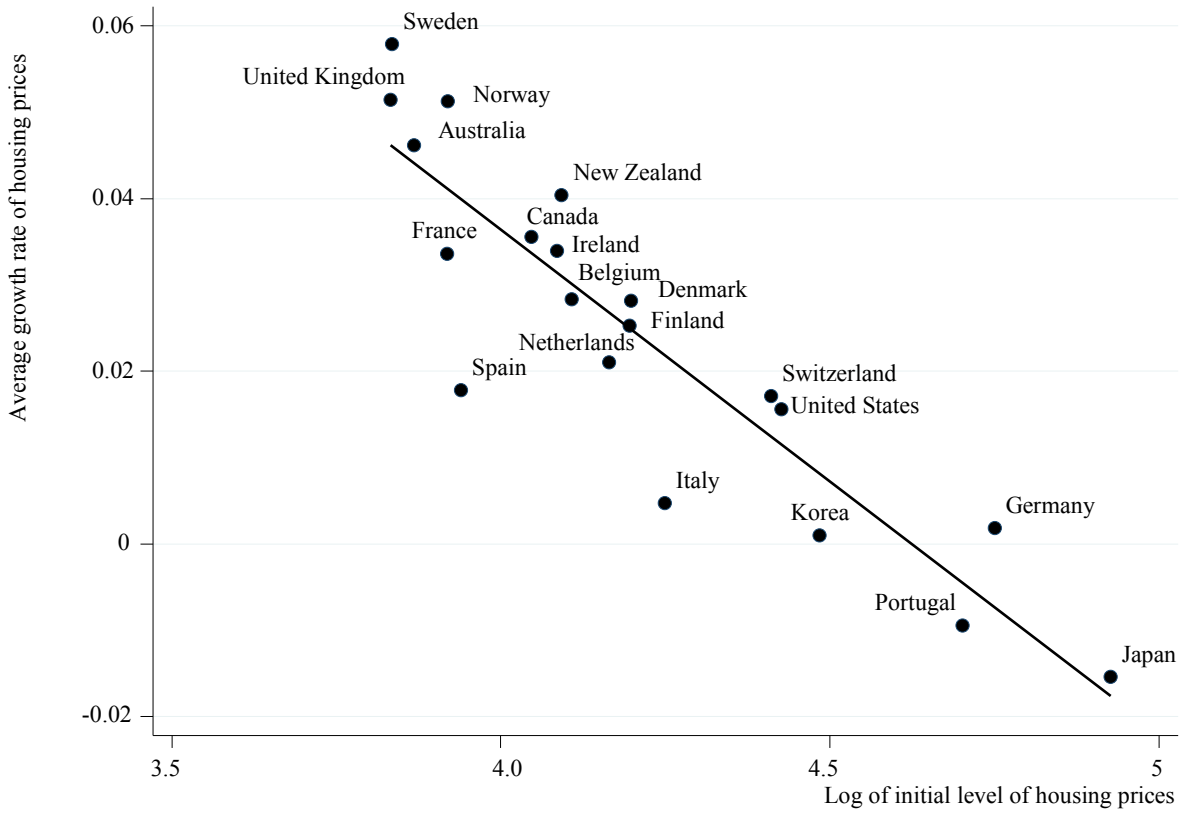

Figure 1 Housing price convergence across OECD countries
Source: OECD Stats, Analytical house price indicators

proportions, not percentages. Here, the negative trend implies an inverse relationship between the initial period's value and the average growth rate over the whole time dimension which might be considered as the first and preliminary finding of housing price convergence across these countries. To deeply investigate the existence of convergence, in the next section a dynamic econometric analysis is going to be performed.

5. Results

Table 2 and Table 3 present the estimation results obtained via the ordinary least squares (OLS) and system-GMM regressions respectively. According to the OLS regressions, the unconditional convergence estimation on column (1) implies the existence of convergence within this country group. Regressions between columns (2) and (6) present conditional convergence estimations. Firstly, it is seen that all the control variables are estimated as statistically significant with the expected sign. The results reveal that as the market activity variables, such as permits for dwellings, construction and share prices increase, housing prices rise. Here, construction and permits for dwellings might be considered as the housing supply and expected to be estimated with negative sign. However, notice that construction is also a component of total GDP and permits for dwellings is the former step for constriction. Thus, these variables can be regarded as the wealth and market power of a country; they also have a dual role on house prices. To proxy the market demand, income level and unemployment rate data are used. Notice that unemployment rate is a negative indicator for market demand. Thus, increases (decreases for the unemployment rate) in the market demand raise housing prices as expectedly. Moreover, it is observed that the speed of convergence is faster when control variables are used, except the regression with the unemployment rate. However, as has been stated in the previous section, in a dynamic panel data analysis, the OLS estimator might produce biased coefficients. To check the robustness of the OLS results, the same equations are estimated via the system-GMM method and are shown in Table 3.

Table 3 shows the system-GMM results. To cope with the possible endogeneity problems, the lagged levels of dependent variable and control variables are used as instruments. Similar with the OLS estimation, also the system-GMM estimation on column (1) indicates the existence of unconditional convergence within the country sample. As for the conditional

convergence estimations between columns (2) and (6), it is seen again that all the control variables are estimated as statistically significant with the expected sign. The results show that as the market activity variables such as permits for dwellings, construction and share prices increase, housing prices rise. As for the market-demand indicators, increases in the income level raise housing prices while increases in the unemployment rate reduce housing prices as expected. The signs of the convergence parameters and control

Table 2 OLS estimation results of housing price convergence

Dependent variable: Housing price level (HP)						
	(1)	(2)	(3)	(4)	(5)	(6)
HP in the previous period	0.492*** (0.090)	0.387*** (0.060)	0.361*** (0.041)	0.383*** (0.065)	0.647*** (0.069)	0.470*** (0.081)
Permits for dwellings		0.196*** (0.023)				
Construction			0.441*** (0.050)			
Income level				1.208*** (0.246)		
Unemployment rate					–0.429*** (0.045)	
Share prices						0.217*** (0.063)
Constant	2.334*** (0.410)	1.923*** (0.234)	0.895** (0.313)	–2.73** (1.087)	2.46*** (0.297)	1.418*** (0.404)
Time dummies	yes	yes	yes	yes	yes	yes
R-square	0.63	0.75	0.74	0.70	0.52	0.66
F-stat	29.59***	69.10***	41.61***	32.41***	52.47***	35.60***
Number of countries	20	17	20	20	20	20
Number of observations	80	68	80	80	80	80

Notes: ***, ** and * symbols imply statistically significance at the level of 1%, 5% and %10 respectively. The Permits for dwellings data does not exist for Italy, Japan and United States.

Table 3 System-GMM estimation results of housing price convergence

Dependent variable: Housing price level (HP)						
	(1)	(2)	(3)	(4)	(5)	(6)
HP in the previous period	0.558*** (0.059)	0.424*** (0.047)	0.361*** (0.045)	0.432*** (0.715)	0.404*** (0.114)	0.413*** (0.140)
Permits for dwellings		0.135*** (0.036)				
Construction			0.302*** (0.037)			
Income level				0.715*** (0.249)		
Unemployment rate					–0.220*** (0.053)	
Share prices						0.121* (0.065)
Time dummies	yes	yes	yes	yes	yes	yes
AR(2)	0.796	0.478	0.393	0.496	0.805	0.820
Hansen p value	0.232	0.144	0.152	0.171	0.446	0.375
Number of countries	20	17	20	20	20	20
Number of observation	80	68	80	80	80	80

Notes: ***, ** and * symbols imply statistical significance at the level of 1%, 5% and 10% respectively. The p-values of AR(2), the second order serial correlation test and the Hansen test of over identification imply that all the models and lags used are correctly identified. The permits for dwellings data does not exist for Italy, Japan and the United States.

variables are the same with the OLS results in Table 1 which implies both the conditional and unconditional convergence estimations implies the existence of convergence. However, the values of the coefficients obtained via the system-GMM differ slightly from the OLS coefficients. Unlike the OLS results, for all the conditional convergence estimations, the speed of convergence is faster than the unconditional convergence estimation. Remember that column (5) in the OLS estimation revealed bigger γ coefficients as against the γ coefficient of the unconditional convergence regression which implies a slowdown in the convergence speed. But according to the system-GMM results, the speed of convergence is faster when any of the control variables are used. This might be interpreted as the importance of the country-specific factors on the speed of convergence. And lastly, the Arellano-Bond and the Hansen test results show that there is no serial autocorrelation and the instruments are valid for any estimation respectively. Therefore, it might be suggested that all the system-GMM regressions are clearly identified.

To sum up, all the findings shown in Table 2 and Table 3 reveal that there is a significant convergence process across the OECD countries. Since international investors in the housing market seek higher rates of return, the growth rate of house prices is one of the main indicators for them. Thus, the existence of a convergence process which implies that in the long run house prices are going to be equal within this sample, is an important finding.

The convergence process is even faster when the relevant control variables are used. These results imply that the possible determinants of house prices are more important. Any variations in our macroeconomic control variables (determinants) such as income level, unemployment rate, permits for dwellings, construction and share prices affect house prices and correspondingly the distances between the house prices in each country, which is directly related to the convergence process. One may suggest that any positive or negative shocks on these variables might make it harder to predict the speed of convergence and this is an important point for international investors or policymakers who monitor house prices.

6. Conclusion

In this study, we investigated the existence of convergence in house prices across OECD countries over the period of 1996–2015. The housing market and its components have become more crucial day by day. In common with most other markets, the most important factor in housing market is the price. Since the term *housing* implies more than sheltering in the financialised world, house prices are scrutinised by many investors, researchers and institutions. Thus, a house deed is also a kind of financial asset which has a rate of return. In the international housing market, there are many international investors who look for higher rates of return among countries. According to the theory, if investors always pursue higher rates of return, in the long run the return of each investment tool will be equal. If we examine the validity of this assumption for the international housing market, a convergence analysis will serve the purpose.

The study is a β-convergence analysis that employed panel data using the OLS and system-GMM methods. Both the unconditional and conditional convergence hypotheses are tested. The results reveal that there is a statistically significant convergence process across the OECD countries in the analysis. In order to examine the conditional convergence hypothesis, some control variables have been used in the estimations. In accordance with many studies in the relevant literature, we decided to control some variables that represent market activity and market demand. For this purpose, construction, permits for dwellings and share prices have been used to proxy the former while income level and unemployment rate have been used to proxy the latter. The findings show that both the market activity and market demand have positive impacts on house prices. Moreover, it is observed that convergence speed is even higher when the mentioned variables are controlled. Therefore, it can be suggested that country-specific factors used in the analysis have an important role in the convergence process within this country group.

Since the findings show that some leading macroeconomic variables, such as income and unemployment rates have a significant impact on house prices and international housing price convergence, countries and policymakers should implement their independent monetary and macroeconomic policies in a stable manner. Future research may extend the scope of the analysis by using some other macroeconomic variables that may have a significant impact on house prices.

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