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Club convergence and drivers of house prices across Turkish cities

Lokman Gunduz
Department of Management, Fatih Sultan Mehmet Vakif University, Istanbul, Turkey, and
Mustafa Kemal Yilmaz
Ibn Haldun University, Istanbul, Turkey

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Abstract

Purpose – This paper aims to examine the convergence pattern of residential house prices in a panel of 55 major cities in Turkey over the period between 2010 and 2018 and to investigate the determinants of convergence club formations.

Design/methodology/approach – The authors applied the log *t*-test to identify the convergence clubs and estimated ordered logit model to determine the key drivers.

Findings – The results suggest that there are five convergence clubs and confirm the heterogeneity of the Turkish housing market. Istanbul, the commercial capital, and Mugla, an attractive tourist destination, are at the top of the housing market and followed by the cities located in the western part, particularly along the Aegean and Mediterranean coasts of Turkey. Moreover, the ordered logit model results point out that the differences in employment rate, climate, population density and having a metropolitan municipality play a significant role in determining convergence club membership.

Practical implications – Large-scale policy measures aiming to increase employment opportunities in rural cities of central and eastern provinces and providing lower land prices and property taxes in the metropolitan cities of Turkey can help mitigate some of the divergence in the house prices across cities.

Originality/value – The novelty of this study lies in employing a new data set at the city level containing 55 cities in Turkey, which is by far the largest in terms of city coverage among emerging market economies to implement the log *t*-test. It also contributes to the literature on city-specific determinants of convergence club formation in the case of an emerging economy.

Keywords Club convergence, Economic regions, House prices, Log-*t* test, Turkey

Paper type Research paper

1. Introduction

House prices have received considerable attention following the collapse of the US housing market and subsequent increase in the global liquidity leading to house price inflation, particularly in emerging markets (Bantia and Phylaktis, 2019; Martinez-Garcia and Grossman, 2020). This rejuvenated the interest in the dynamics and behaviour of house prices, and regional house price convergence is one of them.

House price convergence largely depends on the notion of ripple effect (price diffusion) hypothesis, which postulates that shocks in house prices in one region are transmitted to other regions through a variety of factors, thereby leading to convergence of house prices in the long run (Holmes *et al.*, 2017). These factors include the migration of households, the conversion of home equity (to purchase homes in lower-priced regions), use of spatial arbitrage opportunities and the interdependence of local factors that drive the local housing prices (among others, see Gupta and Miller, 2012; Holmes and Grimes, 2008; Meen, 1999). It is noteworthy that the ripple effect and long run convergence do not require a spatial link between housing markets (Shi *et al.*, 2009). The spatial house price relationship in adjacent regions is not necessarily more substantial than that of non-adjacent regions (Kim and Rous, 2012). Additionally,

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macroeconomic factors such as employment and income fundamentals may also facilitate house return integration among regions (Cotter *et al.*, 2015). Therefore, many scholars advocate the investigation of housing markets into a series of interrelated regional markets (among others, see Meen, 2001; Yunus and Swanson, 2013).

Despite its significance for policymakers, house price dynamics have been largely unexplored in emerging market economies. For example, Turkey, a G-20 member, has experienced strong and sustained real house price increases in recent years, but hardly one can find a study examining the role and existence of common factors in house price movements in Turkey. According to the annual ULI/PwC Emerging Trends in Real Estate® Europe report (2018), Istanbul, the commercial capital of Turkey, was among the top five cities in Emerging Trends Europe's prospects league back in 2012, but there is no study investigating long-run house price behaviour of Istanbul together with other major cities in Turkey. Such studies may help policymakers mitigate house price bubbles if they exist. Understanding the co-movement in house prices among the regions is also of interest as the fluctuations in one region may have a ripple effect on other areas and affect regional economic activity.

Especially in the current low interest-rate environment, domestic and international investors have increasingly started paying attention to housing for investment purposes. Examining house price convergence further offers valuable insights to those investors as it allows better real estate portfolio diversification, and it displays arbitrage opportunities. In fact, price convergence indicates much more than simple geographical diversification. Investors can form better portfolios with formed convergence clusters reflecting underlying long-term factors. In addition, arbitrage opportunities arise when one expects house prices in the lower-priced cities to catch up with those higher-priced in another city. Recently, there is a discussion among policymakers on how to take care of rampant house prices when setting monetary policy. For instance, New Zealand has now a revised charter to consider housing prices in making monetary policy decisions [1]. In any case, interest rates will not have a uniform and instantaneous impact on the house prices across the country if the house prices do not move together. Most likely, there will be regions most hit first, followed by some others in different degrees with different timings. Therefore, house price convergence is also worth studying *per se* to understand how asymmetric effects of monetary policy decisions on the regional house prices and economies occur.

Moreover, understanding how local housing markets are related to crucial socioeconomic variables at the local or national level have implications for handling regional adjustment policies. For instance, a national approach may be more appropriate than local-based policies when regional housing markets are highly integrated or vice versa (Gong *et al.*, 2016). Furthermore, Turkey is a compelling case compared to other advanced countries where demographic and economic variables mostly display convergent behaviour. Turkey has large socioeconomic and territorial imbalances across cities, including differences in climate, income, population and internal migration dynamics that play a vital role in the convergence or divergence of regional house prices.

This study contributes to the literature by investigating the convergence of house prices at the city level in Turkey. It aims to answer the following questions: (1) Is the Turkish housing market characterised by a single equilibrium where all significant cities converge (i.e. absolute convergence)?; (2) If overall convergence is not identified, are there sub-convergence groups where some cities converge and form their housing groups (i.e. convergence clubs)?; (3) If so, is there a change in the number of convergence clubs over time?; (4) What are the characteristics and drivers of those converging subgroups? The novelty of this paper lies in employing a new data set at the city level covering 55 cities and implementing log *t*-test and clustering algorithm (Phillips and Sul, 2007, 2009; PS henceforth) to investigate whether convergence and convergence clubs are present in the case of Turkish housing market between 2010 and 2018. We also examine the potential driving forces of convergence club formation.

Concisely, our findings show the existence of multiple convergence clubs in the Turkish housing market. Five convergence clubs characterise the Turkish housing market. Istanbul, together with Mugla, an attractive tourist destination, are at the top of the housing market. They are followed by the cities located in the western part, particularly along the Aegean and Mediterranean coasts of Turkey. House prices in the central and eastern part of Turkey form other convergence clubs and experience much lower house price increases. These results are in line with interregional economic disparities in Turkey. Real estate is an essential part of people's wealth and their principal saving and investment channel. We further contribute to the literature by investigating the determinants of the convergence clubs in Turkey and find that employment rate, climate, population density, and having a metropolitan municipality are key drivers of convergence clubs.

The rest of the paper is organised as follows. First, there is a brief literature review. Next, we provide the data employed in the analysis and the methodology. Then, we report empirical results of club convergence analysis and the determinants of house prices convergence clubs. The last section concludes.

2. Related literature review

The concept of convergence (sometimes known as the catch-up effect) is primarily based on the neoclassical economic growth theory and comes in mainly three forms (Islam, 2003). In applying this concept to the housing market, absolute convergence refers to a process where low-priced regions have a higher growth rate than high priced regions. The gap among these regions tends to diminish and disappear in the long run [2]. Convergence can also occur among certain regions due to having identical structural characteristics, which is called conditional convergence. Likewise, if the regions have different initial conditions or some other attributes such as climate or location, a group of regions may approach a particular equilibrium due to those common drivers and form clusters or clubs. Accordingly, the house prices in these regions can converge to each other if they are in the same clubs, but the clubs do not necessarily converge. This latter form is called "club convergence". Convergence in house prices holds not for all regions but within groups of regions having similar characteristics. Recent experiences in advanced and emerging countries point out the role of convergence clubs as a form of convergence in the housing markets (among others, see Apergis *et al.*, 2015; Churchill *et al.*, 2018; Holmes *et al.*, 2019; Montagnoli and Nagayasu, 2015).

A growing number of studies has been devoted to investigating the dynamics and behaviour of regional house prices. One particular area of interest focuses on whether or not regional house prices, defined by census region, state or metropolitan area, converge over time and how they are interrelated to each other. Regional house prices converge due to spatial linkages among themselves and the factors such as migration, equity transfer, spatial arbitrage and common determinants (Drake, 1995; Meen, 1999).

In search for testing the convergence across regional house prices, most of the studies rely upon the unit root and cointegration tests to determine the linkage between regional housing markets and the extent to which house prices diffuse from one region to another. In this regard, there is an extensive literature in advanced countries, particularly in the UK and the US markets. Among others, one can cite the studies of Drake (1995), Meen (1999), Ashworth and Parker (1997), Cook (2003, 2005), Holmes (2007), Holmes and Grimes (2008) for the UK, Tirtiroglu (1992), Macdonald and Taylor (1993), Pollahowski and Ray (1997), Clark and Coggin (2009) and Gupta and Miller (2012) for the US, Berg (2002) for Sweden, Roehner (1999) for France, Stevenson (2004) for Ireland, Luo *et al.* (2007) for Australia, Oikarinen (2009) for Finland and Larraz-Iribas *et al.* (2008) for Spain.

There is also a growing body of empirical studies on house price convergence in emerging markets by employing similar time-series techniques. For instance, Balcilar *et al.* (2013) tested the ripple effect for the South African housing market by using Bayesian and nonlinear unit root tests. Lean and Smyth (2013) used univariate and panel Lagrange multiplier unit root tests to test the convergence for Malaysian housing markets. Lee and Chien (2011) employed the unit-root test of the panel seemingly unrelated regressions augmented Dickey–Fuller test to investigate the long-run relationship of Taiwan's housing market. Chen *et al.* (2011) used the Johansen cointegration technique and Toda and Yamamoto's Granger causality test to analyse the diffusion of regional house price indices for Taiwan. Aye *et al.* (2013) addressed house price convergence and divergence across major metropolitan cities in India using a panel unit root test. There are relatively more studies on China. Among others, Zhang and Morley (2014), Mao (2016) and Zhang *et al.* (2017) investigated the extent of house price convergence across several Chinese regions by using panel unit root tests, pairwise tests and panel VAR models, respectively.

Specifically, the aforesaid studies look at the stationarity of the ratio of house prices of a specific region relative to the national house prices and investigate the notion of a causal link or long-run equilibrium. The existence of a stationary process or cointegration supports the presence of the ripple effect and the convergence.

Most recently, PS question the use of unit root tests for analysing the convergence because failing to reject the unit root null hypothesis does not necessarily imply the absence of convergence (see also Montanes and Olmos, 2013). Instead, they suggest a new methodology, known as panel club convergence (or log *t*-test) and clustering procedure. According to PS, their methodology has several advantages over previous methods. First, it does not depend on stationarity assumptions and does not suffer from small sample properties of conventional unit root and cointegration tests. Second, their approach considers possible transitional heterogeneity across regions/cities and captures both underlying deterministic and stochastic trends. Third, it uses a clustering algorithm with asymptotic properties of convergence and a regression-based test. These characteristics led their method workhorse approach in convergence analysis in several fields, including house price studies [3].

For instance, Churchill *et al.* (2018) applied this test to the Australian cities; Holmes *et al.* (2019) to the England and Wales local house markets; Blanco *et al.* (2016) to the Spanish provinces and Kim and Rous (2012) and Montanes and Olmos (2013) to the US states and metropolitan areas. Among the emerging market economies, Apergis *et al.* (2015) applied it to nine South African provinces [4]. There is only one relevant study in Turkey. Ganioglu and Seven (2019) confirm the existence of divergence in regional house prices and find seven convergence clubs by employing house price data of 26 regions of Turkey. The results from the PS approach suggest the rejection of absolute convergence and the presence of multiple convergence clubs.

In line with recent studies, this study contributes to the literature by employing the PS approach to examine the convergence of house prices at the city level in Turkey. It is by far the largest sample in terms of city coverage among emerging market economies. In addition to using house price data from 55 Turkish cities from official sources, the present study also employs another set of data from a real estate data vendor to compare the results. Last but not least we examine the evolution of convergence over time and determine essential drivers of convergence club membership when possible.

3. Data and methodology

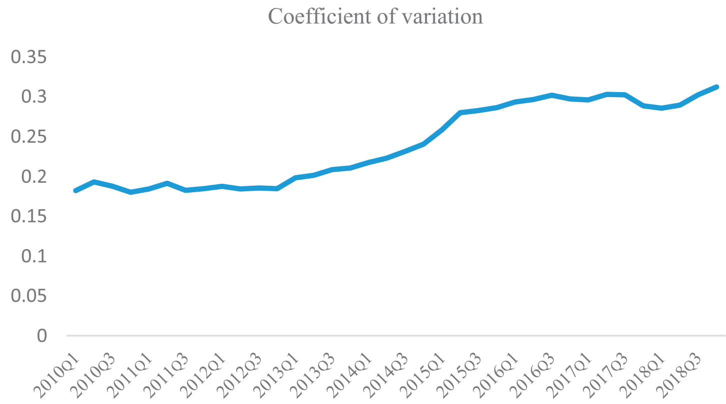
House price data have a short time span in many emerging countries. Turkey is not an exception. There are two commonly followed house price indices in Turkey – one official and the other private with significant differences in coverage and methodology. The Central Bank of the Republic of Turkey (CBRT) officially collects and disseminates house price indices since 2010 at the national and regional levels. These data are based on the valuation reports prepared countrywide by real estate appraisal companies to extend mortgage loans by the banks. One should note that all appraised residential properties are included in the scope regardless of actual sale or utilisation of the mortgage loans. On the other hand, Reidin, a private real estate information providing company, produces house price indices at the national and provincial levels based on listed residential sales offer or ask prices quoted by private developers [5]. Unfortunately, their data set at the provincial level covers many more cities but with a relatively shorter period or a few cities but with a more extensive time coverage.

In this study, we mainly rely on city-level house price data obtained from the CBRT. It is the median price (in Turkish Lira) per square meter in apartments sold. Our house price data cover 55 major cities in Turkey over the period between 2010Q1and 2018Q4. The use of city-level disaggregated data certainly provides the advantage of allowing us to pinpoint convergence across cities. It also distinguishes our study from Ganioglu and Seven (2019), which is based on 26 aggregated regions (NUTS 2) in Turkey.

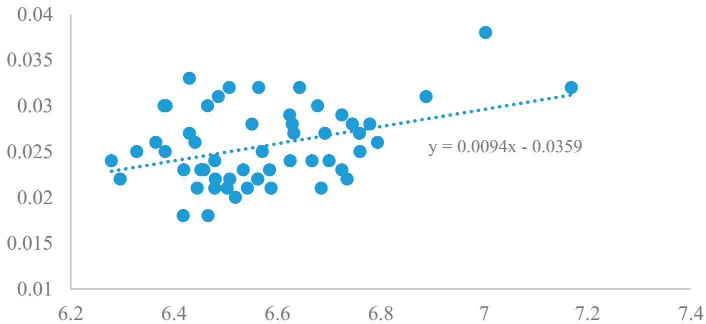
As a preliminary analysis, we start with conventional tools devised to measure convergence, known as "beta" (β) convergence and "sigma" (s) convergence tests. Beta convergence uses the cross-section regression analysis and estimates a linear relationship between the average growth of house prices over the sample period and the initial (log) level of house prices. The covariate (beta) coefficient is expected to be negative and statistically significant in the case of absolute convergence. Sigma convergence, which measures the cross-sectional dispersion of house prices over time, is calculated based on the coefficient of variation of house prices across cities. When the dispersion of house prices across cities falls over time, there is sigma convergence. The results from conventional convergence tests presented in Figure 1 reject the absolute convergence because there is no reduction of disparities among cities over time and the beta coefficient is positive [6]. However, as discussed above, the rejection of convergence does not rule out convergence clubs. A scatter plot with the regression line implies that the cities may converge to different equilibrium and forming clusters. Still, without a sophisticated analysis, it is challenging to reach such a conclusion [7].

Therefore, similar to recent studies on house price convergence, we follow the PS approach to test for convergence and identify convergence clusters endogenously. The PS clustering algorithm provides empirical modelling of long-run equilibria within a heterogeneous panel. This algorithm based on a log t regression test clusters city-level house prices with a common unobserved factor in the variance. It produces a more suitable framework for analysing convergence since it considers possible transitional heterogeneity across countries over time and does not suffer from small sample properties of conventional unit root and cointegration tests (Panapoulou and Pantelidis, 2009; Phillips and Sul, 2007, 2009).

We apply the methodology of PS to test for convergence and the identification of convergence clubs. Specifically, we consider a framework in which X_{it} denotes quarterly house price, with $i = 1, \ldots, N$ and $t = 1, \ldots, T$ representing cross-section and time dimension of the 55 cities over the period of 2010Q1-2018Q4. This can be decomposed into $X_{it} = \delta_{it}\mu_t$, where μ_t is a time varying common component and δ_{it} is a time-varying idiosyncratic component which is the deviation of city i between the common trend component μ_t and X_{it}, such that δ_{it} can be expressed as $\delta_{it} = \delta_i + \sigma_i \zeta_{it} \mathrm{L}(t)^{-1} t^{-\alpha}$ where δ_i is the individual specific effect, $\zeta_{it} \sim iid\ (0,1)$, and $L(t)$ is a time varying function of time ($L(t) \to \infty$ as $t \to \infty$). PS recommend testing for convergence under the null hypothesis that there is convergence and it is accepted if $\alpha > 0$ and $\delta_{it} \to \delta_i$.



Note(s): The standard deviation of house price levels across cities is divided by the average of price levels to generate the coefficient



Note(s): The vertical axis represents the quarterly average growth rate of house prices (2010q1-2018q4), and the horizontal axis represents initial log house prices. The trend line provides abeta-convergence equation

Figure 1.
Sigma (coefficient of variation) and beta convergence results

The long-run stability and convergence are based on the use of the relative transition coefficient (h_{it}), which captures not only the convergence, but also the divergent behaviour where

$$h_{it} = \frac{X_{it}}{N^{-1}\sum_{i=1}^{N} X_{it}} = \frac{\delta_{it}}{N^{-1}\sum_{i=1}^{N} \delta_{it}} \tag{1}$$

In the case of convergence, h_{it} converges towards unity, while the variance of h_{it} (which is H_t) goes to zero, when t moves towards infinity. In other words:

$$H_{it} = N^{-1}\sum_{i=1}^{N} (h_{it} - 1)^2 \rightarrow 0 \text{ as } t \rightarrow \infty \tag{2}$$

PS undertake the test in two stages. First, the presence of overall convergence and then the presence of club convergence is investigated. To test for overall convergence, a logarithmic regression on time is carried out based on cross-sectional variance ratio H_1/H_t. PS call it the log t regression test:

$$\log\frac{H_1}{H_t} - 2\log[L(t)] = a + \beta\log(t) + u_t, \quad \text{with } t = [rT] + 1, \ \ldots, T \tag{3}$$

Briefly, the log t-test consists of three steps. First, we construct (the log of) the variance (H_1/H_t) ratio. Then, the conventional robust t statistic, $t\widehat{\beta}$, for the coefficient $\widehat{\beta}$ is computed using Eq. (3), where the variance ratio is regressed on a positive function of time. In the third step, an autocorrelation and heteroscedasticity robust one-sided t-test, where the null hypothesis is $\alpha \geq 0$ is applied, using the estimated coefficient $\widehat{\beta}$ and heteroscedasticity and autocorrelation (HAC) standard errors. If the t-statistic, $t\widehat{\beta}$, suggests that $\widehat{\beta}$ is either positive or equal to zero, we conclude that the panel converges. Otherwise, if it indicates that $\widehat{\beta}$ is negative and lower than -1.65 at 5% significance level, we reject the null hypothesis of convergence [8]. The regression test of convergence is estimated with a certain fraction of r, around 1/3 of the sample. PS recommend $r = 0.3$. We also used this setting. On the other hand, rejection of the null hypothesis of convergence, which implies convergence of all cities, does not reject convergence in subgroups of cities.

PS suggest a four-step clustering algorithm to test for the number of potential subgroups (i.e. convergence clubs) and nonconforming units. We briefly outline the respective algorithm for club convergence.

Step 1 (last observation ordering)

Order the panel members (cities in our case) according to the value of the last observation, as the convergence is generally more apparent in recent periods.

Step 2 (forming core group)

After selecting the first k highest ordered city in the panel to form the subgroup for some $2 \leq k \leq N$, run the log t regression and calculate convergence t-statistic, t_k, for that subgroup. Choose the core group size k^* maximising the t-statistics over k^* subject to $t_k > 1{:}65$.

Step 3 (sieving units for club membership)

Sieve the data by adding one city at a time to the core group. Run the log t-test, add a new member if the associated t-statistic is greater than the critical value. Make sure that the club satisfies the convergence criterion.

Step 4 (recursion and stopping rule)

Form a subgroup for the cities not selected in Step 3, run the log t regression for this group of cities to see if the associated t statistic is greater than critical value and converges, then these cities form a second club. If not, repeat steps 1–3 to expose some smaller subgroups of convergent clusters. If there is no core group in Step 2, then the remaining cities diverge.

We isolate the cyclical component and extract the trend component of the house price series using the Hodrick and Prescott (1997) filter [9]. We make convergence club identification through both Stata and R codes [10]. We also employ a modified version of the club merging algorithm proposed by Von Lyncker and Thoennessen (2017) when there are divergent units. The panel logarithmic house price data for cities is an input to detect convergence clubs.

4. Club convergence analysis

We present our empirical results of the log t-test in Table 1. It provides an estimate of the slope coefficient equal to -1.33 and t-statistic of -78.98, which indicates the rejection of house price convergence across 55 cities in Turkey at 1% significance level.

		Beta coefficient	*t*-value
Panel A: Club convergence tests		−1.339	−78.982
Club 5	Istanbul, Mugla	1.062	7.027
Club 4	Antalya, Çanakkale, Yalova, Adana, Balıkesir, Aydın, Isparta, Denizli, Izmir, Bursa, Sakarya, Tekirdag, Kocaeli, Rize, Edirne, Mersin, Manisa, Gaziantep, Kırklareli, Ordu	−0.225	−2.817
Club 3	Trabzon, Eskişehir, Ankara, Bolu, Zonguldak, Konya, Afyonkarahisar, Samsun, Kayseri, Karaman, Usak, Tokat, Aksaray, Karabuk, Malatya, Adıyaman, Kahramanmaras	0.085	4.517
Club 2	Amasya, Giresun, Kutahya, Bilecik, Hatay, Sivas, Corum, Elazig, Kırıkkale, Diyarbakir, Sanliurfa	0.674	8.573
Club 1	Kırsehir, Nevsehir, Nigde, Osmaniye, Yozgat	0.069	4.896
Number of divergent units	–		
Panel B: Club merging analysis			
Club 5			
Club 4			
Club 3	No clubs can be merged. Same		
Club 2			
Club 1			
Number of divergent units			

Note(s): *t*-values are based on Newey and West (1987) heteroscedasticity and autocorrelation (HAC) standard errors

Table 1.
Club convergence tests for 55 cities

As Table 1 shows, the evidence suggests five convergence clubs, which is also visualised in Figure 2. The first club (Club 5) includes Istanbul and Muğla. Istanbul is one of the largest metropolises in the world, where over 15 million people live, and it has a population density of 2.813 people per square kilometre. It is the economic hub of Turkey, generating over 30% of the country's GDP annually and employing 20% of the country's industrial labour. Muğla is a coastal city in the Aegean region and home to Turkey's most popular holiday destinations like Bodrum, Marmaris, Datça and Fethiye. The second club (Club 4) includes Antalya, Çanakkale, Yalova, Adana, Balıkesir, Aydın, Isparta, Denizli, İzmir, Bursa, Sakarya, Tekirdağ, Kocaeli, Rize, Edirne, Mersin, Manisa, Gaziantep, Kırklareli and Ordu. These cities are located predominantly in the western parts of Turkey, specifically in the three urban centres: the Marmara region, the Aegean and the Mediterranean coasts. The third club (Club 3) includes Trabzon, Eskişehir, Ankara, Bolu, Zonguldak, Konya, Afyonkarahisar, Samsun, Kayseri, Karaman, Uşak, Tokat, Aksaray, Karabük, Malatya, Adıyaman and Kahramanmaras. These cities are mostly inland cities and adjacent to the cities in Club 4. They are spread over the central Anatolia and the Black Sea coasts. The fourth club (Club 2) comprises of Amasya, Giresun, Kütahya, Bilecik, Hatay, Sivas, Çorum, Elazıg, Kırıkkale, Diyarbakir and Sanlıurfa and spread across various parts of Anatolia. The last club (Club 1) contains Kırşehir, Nevşehir, Nigde, Osmaniye and Yozgat that are located in the eastern part of the central Anatolia region.

To develop this result further, we investigate the likelihood of conforming to smaller convergence clubs by applying the PS clustering algorithm. This algorithm checks whether or not two consecutive clubs can be merged and form a group. However, the result in the Panel B of Table 1 shows that there is no evidence to support the merging of original convergence clubs. Hence, we maintain an initially formed number of clubs.

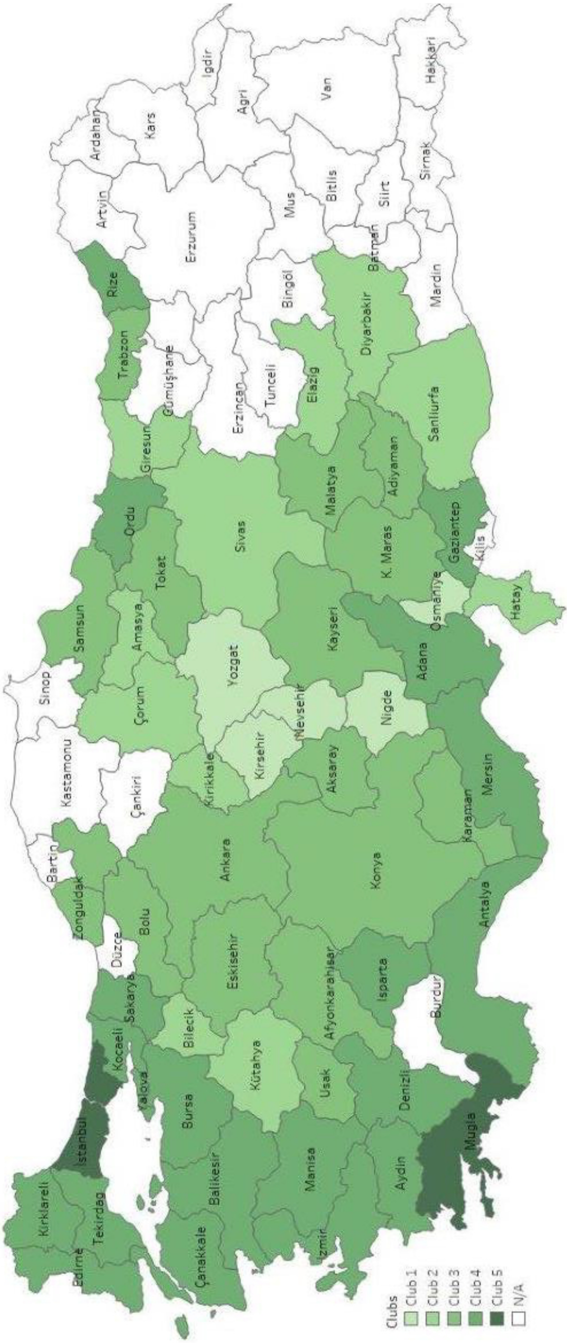


Figure 2.
Map of Turkey:
convergence clubs

These findings align with those of the regional economic development studies in Turkey (Aksoy *et al.*, 2019). Considerable disparities between its regions characterise Turkey. Historically, most developed cities are located in the provinces of Marmara, Aegean and Mediterranean regions. There are remarkable differences in per capita income between eastern and western parts of Turkey and between coastal and interior areas (see Gezici and Hewings, 2007; Yildirim *et al.*, 2009). The levels of GDP per capita roughly match with geographic population distribution. The bulk of Turkey's population resides along the Aegean coast, the western Black Sea region and the European part of the country. The centre and the east of the country are harsh, arid regions interspersed with large steppe areas, resulting in considerably lower population density. Disparities are equally noteworthy in terms of socio-economic factors such as life expectancy, literacy rates, employment rates and access to health services and education. These interregional inequalities have also contributed to inward migration from east to west. Thus, convergence test results of house prices seem to be consistent with the differences in wealth and spending power, population density, climate and other socio-economic indicators across regions and cities in Turkey.

Figure 3 illustrates the relative transition paths across five convergence clubs. The relative transition path, $h_{it,}$ traces an individual trajectory for each club (or city) relative to the average. If the house prices in different cities or clubs converge, then the relative transition parameters converge to unity. It measures a city's relative departure from the common steady-state growth path (μt). Overall, relative transition curves suggest no convergence across clubs. In particular, Club 5, containing Istanbul and Mugla continues to diverge from the rest of the clubs all over the period. It is not surprising since Istanbul is the centre of commerce, finance, investment, and tourism in Turkey, having the highest population density. Moreover, Istanbul hosts many foreign people coming to Turkey as either qualified workforce or refugees.

Figure 4 shows relative transition paths for cities within each club. The cities in each club seem to be more converging toward their mean after 2014. It may be attributed to changing global and local economic factors such as liquidity and labour market conditions (see, among others, Cecen and Atas, 2017). More specifically, house prices seem to increase and diverge from each other in times of economic expansion, while they start to decline and converge during recession periods. For example, Turkish financial markets have become more volatile after Fed's tapering policy in 2013. Credit default swap (CDS) premiums for Turkey and domestic interest rates have dramatically risen to 246 and 10.30% in January 2014 from 119 to

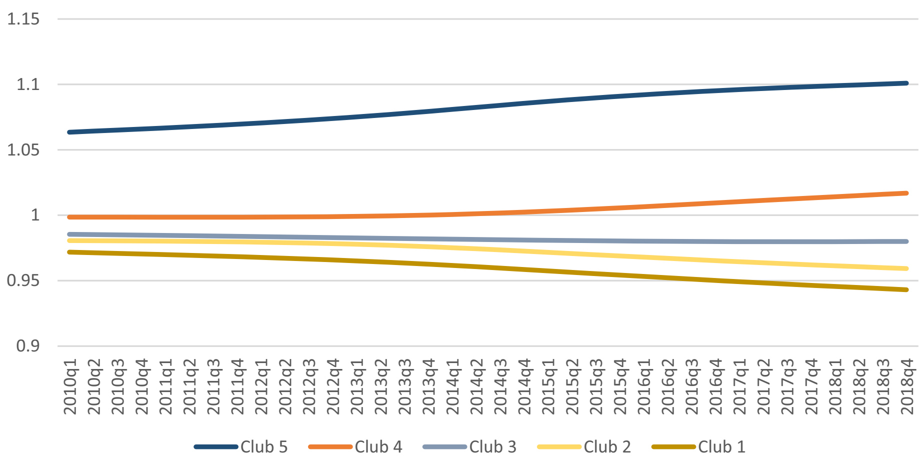


Figure 3.
Relative transition paths across converging clubs

5.16% in May 2013, respectively. After that, domestic political issues such as failed military coup attempt in 2016 and the change in global risk appetite continued to support negative sentiment in the housing market.

Meanwhile, one can observe some distinctive movements in a couple of cities. For example, Izmir in Club 3 has a different relative transition curve from the rest of the cities. It has a divergent pattern with an increasing trend over the years. Coskun and Ertugrul (2016) also suggest different volatility clustering patterns in Izmir and Istanbul. Gaziantep in Club 4 and Sanlıurfa in Club 2, which are the border cities to Syria, depict dramatic house price increase after 2010, reach a peak in and around 2013 and decline afterwards quickly. Adana in Club 4 also shows a similar path. Soaring demand from Syrian refugees caused real estate prices to skyrocket in border provinces (Tumen, 2016).

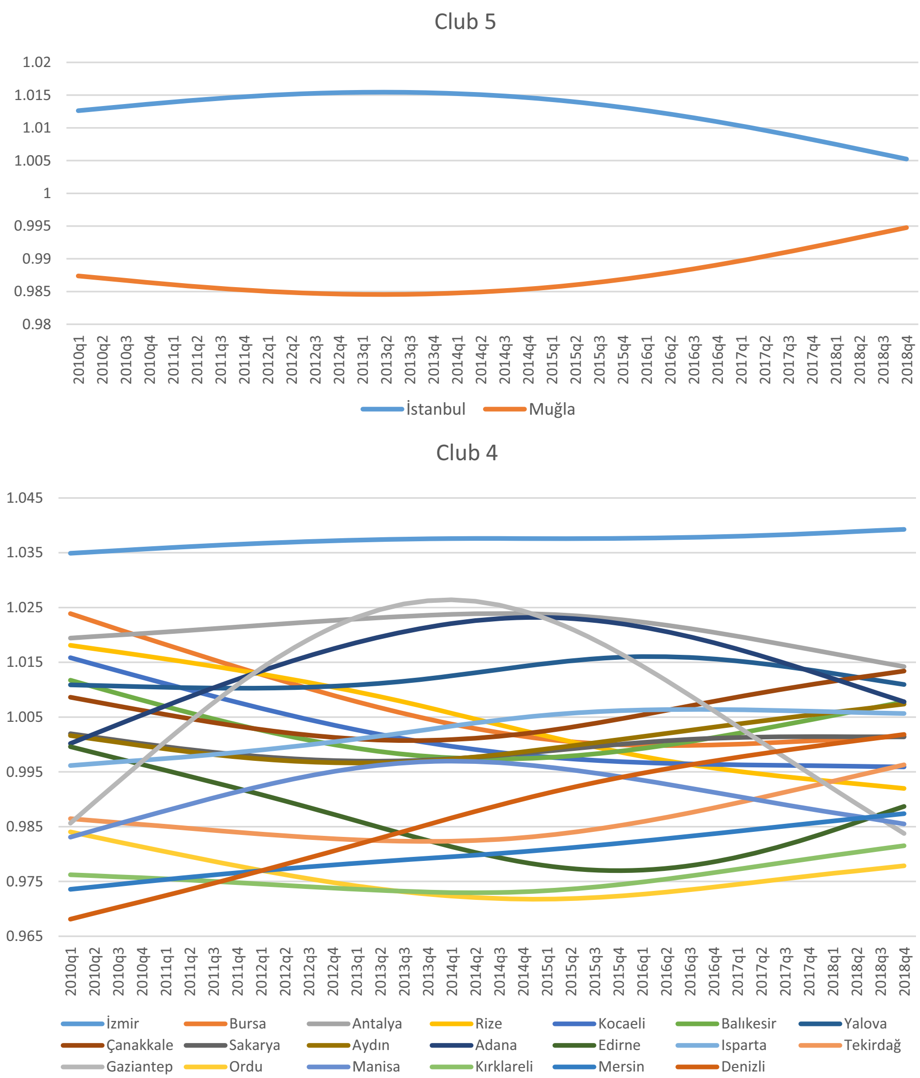


Figure 4.
Relative transition paths within each converging club

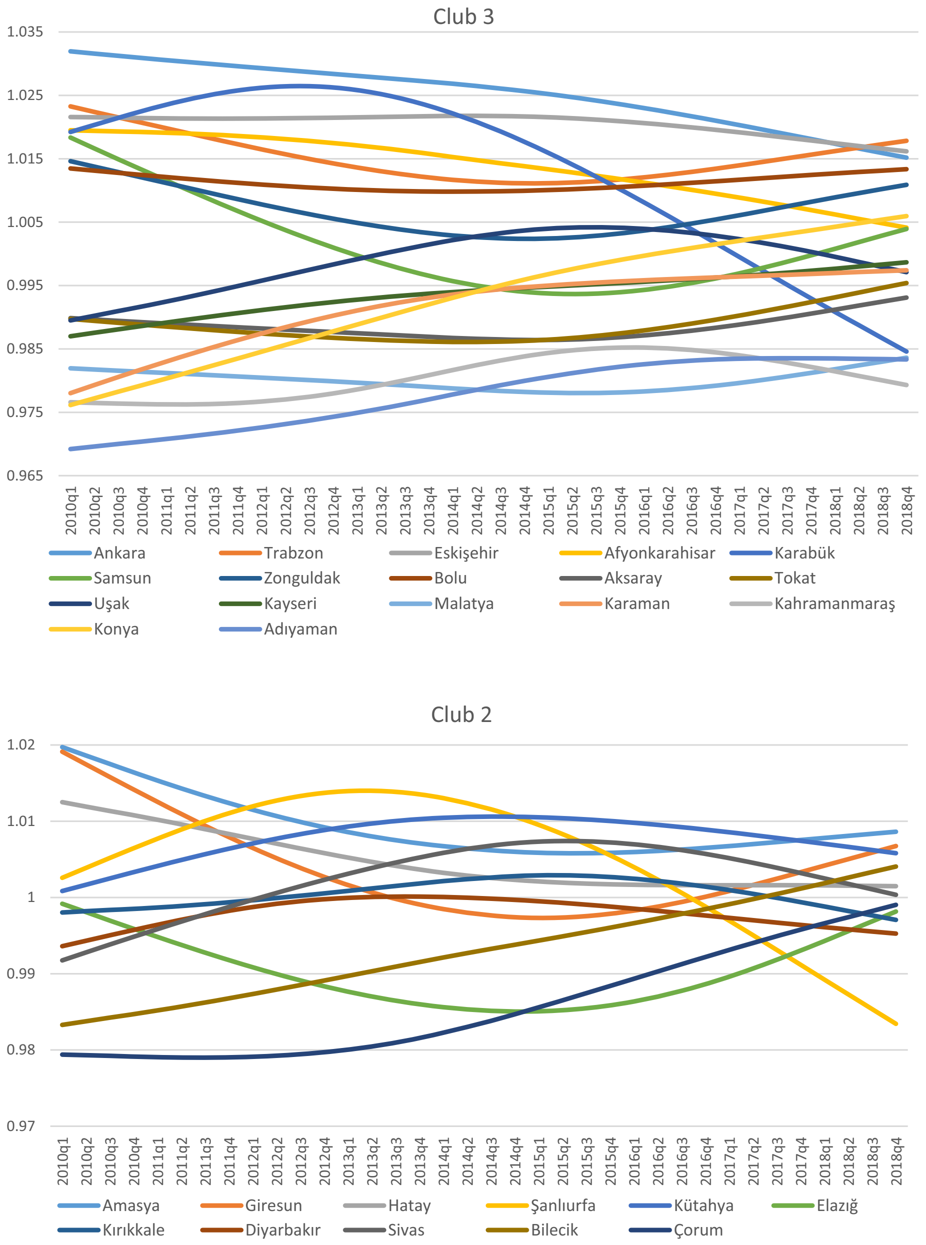


Figure 4.

According to Phillips and Sul (2007), the beta coefficient is a scaled estimator of the speed of convergence parameter α such that $\beta = 2\alpha$. Accordingly, beta coefficients provide an estimated speed of convergence for each club and support the visual inspection of relative transition paths. For example, Club 5, which includes Istanbul and Mugla, has the highest convergence rate with $\alpha = 0.531$ among the five clubs. They are rich and unique cities. Club 1 members also have a high degree of convergence ($\alpha = 0.337$), but the lowest house price levels. They are all located in the eastern part of central Anatolia province and are relatively underdeveloped cities. These clubs are followed by Club 3, 4 and 2, with a relatively much lower convergence speed. It seems that the speed of convergence is somewhat related to the level of economic development and location.

We also examine the development of house prices by focusing on how our findings would vary over time. Table 2 reviews the recursive analysis results that show the number of convergence clubs and divergent units when we change the end of the period. As one may note, the number of convergence clubs first declines from five to three, then exhibits an increasing pattern, which is more visible after 2015 and ends up in five in 2018. This continuity in multiple convergence clubs confirms the heterogeneity of the Turkish housing market. Moreover, there are diverging cities in several periods that do not become members of any convergence club. Istanbul and Mugla consistently become diverging units until 2017. Izmir and Yozgat join them in some periods. Yozgat becomes the only diverging unit after 2017. As designated in the relative transition curves in Figures 3 and 4, Istanbul, Mugla in particular, and Izmir occupy the top places of the housing market. At the same time, Yozgat, a central Anatolian province with a very low population density, has the lowest house price increase.

The convergence club testing does not directly investigate the explosive price behaviour. Still, the test results that show the presence of the same diverging cities over multiple periods can help shed light on such issues. Accordingly, one could argue that any diverging unit, as in Istanbul and Mugla, might have been due to explosive house prices in some periods. Recent literature on exuberant house price behaviour in Turkey supports the existence of diverging

Period	Number of convergence clubs	Divergent cities
2013Q1	5	Istanbul, Mugla
2013Q2	5	Istanbul, Mugla
2013Q3	5	Istanbul, Mugla
2013Q4	4	Istanbul, Mugla, Yozgat
2014Q1	4	Istanbul, Mugla, Yozgat
2014Q2	4	Istanbul, Mugla, Yozgat
2014Q3	4	Istanbul, Mugla
2014Q4	3	Istanbul, Mugla, Yozgat
2015Q1	3	Istanbul, Mugla, Yozgat
2015Q2	3	Istanbul, Mugla
2015Q3	4	Istanbul, Mugla
2015Q4	4	Istanbul, Mugla
2016Q1	4	Istanbul, Mugla
2016Q2	4	Istanbul, Mugla, Yozgat
2016Q3	4	Istanbul, Mugla, Izmir, Yozgat
2016Q4	4	Istanbul, Mugla, Izmir
2017Q1	4	Yozgat
2017Q2	4	Yozgat
2017Q3	5	–
2017Q4	4	–
2018Q1	4	–
2018Q2	4	–
2018Q3	4	Yozgat
2018Q4	5	–

Note(s): Table 2 reflects the results of cluster analysis by changing the end of the sample

Table 2. Recursive convergence club analysis

or overshooting house prices in some cities. For example, Ceritoglu *et al.* (2019) show explosive price movements, especially in Istanbul and Izmir, for multiple periods since 2013. Exuberance in house prices turns out to be apparent after 2015. They notice that explosive price behaviour starts to subside in several regions after 2018 [11]. Cagli (2019) also finds evidence of explosiveness in Istanbul and Izmir. This phenomenon is, in fact, global. Capital cities are likely to experience much more volatile, and more substantial house price fluctuations than the other parts of the countries and house prices in capital cities tend to overshoot (see among others Nijskens *et al.*, 2019). Extant literature on the ripple effects implies that major cities often experience house price changes ahead of other cities.

We also carry out the same analysis using the Reidin data set as a robustness check, first for the seven major cities in Turkey for the period between 2007Q3 and 2018Q4, and then for 62 cities for the period between 2013Q1 and 2018Q4 [12]. The results confirm that there are two clubs and one diverging unit in the case of seven cities. The recursive analysis also indicates that most of the time, there are two clubs but with two diverging units [13]. In the case of 62 cities, the results again confirm the heterogeneity of the housing market in Turkey. There is no single club but five convergence clubs. A word of caution is required here to interpret the Reidin data set results, as the sample period is not more than 20 quarters and sample coverage is different [14]. Nevertheless, it supports our findings.

5. Drivers of convergence clubs

There is no study focusing on city-specific determinants (micro determinants) of house prices across Turkey probably due to lack of data to the best of our knowledge. Most of the previous convergence studies do not focus on its determinants either. Therefore, it is essential to understand the potential determinants of convergence club formation.

To identify the factors that explain the formation of convergence clubs, we employ an ordered logistic regression. Our dependent variable indicates the club to which a city belongs according to the endogenized grouping procedures obtained in Section 4. Accordingly, housing is cheapest in Club 1, with prices increasing on average in subsequent clubs, Club 2, Club 3, Club 4, and reaching the highest in Club 5. We assume that the membership to a particular club is driven by a combination of demand and supply-side factors. Following Kim and Rous (2012), Blanco *et al.* (2016) and Holmes *et al.* (2019), we mostly rely on demand related explanatory variables and proceed with some measurement of local economic conditions such as employment, population density, education level and climate as the key determinants of local house prices. In addition, we consider the city’s topography (coastal dummy) and housing taxes (metropolitan dummy) as supply-side explanatory factors.

Several recent studies emphasise the role of local economic factors in the determination of house prices. Among these factors, local employment rates are noteworthy. It is argued that employment opportunities attract workers from other regions, leading to an increase in housing demand and then in house prices. Hwang and Quigley (2006) explain how this process takes place in the US metropolitan regions. Boheim and Taylor (2002) find that a desire to move motivated by employment reasons has the single most significant positive impact on the probability of moving between regions in Britain. Agnew and Lyons (2018) point out to access to employment as one of the most valuable amenities offered by cities and a strong positive link between the housing market and the labour market in the case of Ireland. High employment rates mean that good macroeconomic conditions will essentially promote urbanisation, increase the house purchasing ability of potential buyers and drive up housing prices. We consider the employment rate as a critical determinant of local house prices as well. It serves well not only as a good measure of economic conditions at the urban level but also as an essential driver of internal migration in the case of Turkey.

We consider population density per kilometre square in logarithm to account for demographic factors as in Holmes *et al.* (2019). Past research has also demonstrated the importance of weather as a consumption amenity (Rappaport, 2007). People will move to places with a pleasant climate as their income level increases. Like Kim and Rous (2012), we include pleasant climate as another determinant of local house prices and measure it as the logarithm of annual average temperature. Turkey is surrounded by water on three sides, and coastal cities with relatively higher average temperature are famous for their clean and pleasant weather. Another variable of potential interest could be the quality or level of education in a city. We are condemned to employ the percentage of higher education graduates in each city as our education variable. All of our variables are annual averages over the sample period of 2010–2018. Climate variable is received from the Turkish State Meteorological Service, while the rest of the variables are obtained from the Turkish Statistical Institute [15].

Housing supply is also critical to understand housing markets [16]. There is limited data in this regard, but we consider two relevant issues as supply-side factors. First, the city's topography has a role in determining the supply of land. Many cities that developed historically to serve as ports in Turkey have a semi-circular structure. This characteristic reduces the supply of land. The climate variable employed also captures this supply-side characteristic because coastal cities have warm weather but also have relatively limited land supply. One can therefore conjecture coastal/port dummy as a supply-side factor. Second, housing taxes are not homogenous across the cities in Turkey. They differ with respect to the type of municipalities [17]. For example, property taxes double in the cities governed by metropolitan municipalities relative to city municipalities. Metropolitan municipalities also have legal power in determining land prices and take advantage by keeping the land prices high to increase their revenues. To reflect differences in housing and other property-related taxes across cities, we include a metropolitan dummy to refer to metropolitan municipalities. There are 27 metropolitan municipalities out of 55 cities in the sample.

In Table 3, we present descriptive statistics of these key determinants by convergent clubs. Cities in Club 5 have the highest house prices, the highest population density, the highest employment rate, the highest education level, and the second-best climate. Cities in Club 1, on the contrary, have the lowest value in almost all variables. There is a clear pattern that higher club members also showing higher housing prices, have higher employment rates, better climate, higher population density and higher education level. Most of the metropolitan municipalities also have higher house prices.

We display the results for key determinants of club membership in Table 4. In this regard, we estimate two ordered logit models. Model 1 shows that all explanatory variables,

	Population density	Climate	Employment rate	Education	Metropolitan
Club 1	3.987 (0.651)	2.470 (0.260)	0.443 (0.040)	0.122 (0.017	0/5
Club 2	4.177 (0.627)	2.591 (0.218)	0.435 (0.068)	0.124 (0.017)	3/11
Club 3	4.295 (0.566)	2.554 (0.145)	0.470 (0.035)	0.137 (0.030)	8/17
Club 4	4.860 (0.653)	2.742 (0.128)	0.485 (0.032)	0.141 (0.017)	14/20
Club 5	6.079 (2.605)	2.673 (0.058)	0.489 (0.036)	0.168 (0.010)	2/2

Note(s): The entries are the mean values of key club determinants, and the numbers in parentheses denote their standard deviations. Metropolitan refers to the number of metropolitan municipalities over the number of cities in the club

Table 3. Summary statistics of key club determinants

Table 4.
OLS and ordered logit estimates of house price convergence clubs

Independent variables	OLS model Coefficients (SE)	Model 1 Coefficients (SE)	z	$p > z$	Odds ratio	Model 2 Coefficients (SE)	Z	$p > z$	Odds ratio
Employment	0.114 (0.022)***	0.303 (0.072)	4.20	0.000	1.354	0.297 (0.072)	4.08	0.000	1.346
Climate	0.098 (0.047)**	0.272 (0.137)	1.98	0.047	1.313	0.329 (0.146)	2.25	0.024	1.389
Metropolitan	0.560 (0.251)**	1.543 (0.719)	2.14	0.032	4.680	1.383 (0.728)	1.90	0.050	3.988
Population density	0.307 (0.155)**	1.022 (0.473)	2.16	0.031	2.780	0.827 (0.495)	1.67	0.095	2.287
Education						0.176 (0.130)	1.35	0.176	1.192
/cut1		19.658 (4.484)***				21.508 (4.747)***			
/cut2		21.731 (4.635)***				23.639 (4.919)***			
/cut3		24.028 (4.848)***				26.0114 (5.149)***			
/cut4		28.517 (5.356)***				30.576 (5.677)***			
AIC	126.768	*126.048*				*126.132*			
BIC	136.804	*142.107*				*144.198*			
Adjusted R^2	0.506								
Log-likelihood		*−55.024*				*−54.06628*			
McFadden Pseudo R^2		*0.2809*				*0.2934*			
LR χ^2		*42.98****				*44.89****			
Degrees of freedom		8				9			

Note(s): $N = 55$. Table 4 includes both the estimation results of OLS and ordered logistic regression in which the dependent variable takes on value 1 for house price series in convergence club 1, and so on until value 5 for price series in convergence club 5. Metropolitan is a dummy variable in which 1 refers to a metropolitan municipality and 0 denotes (city) municipality. ***$p < 0.001$. **$p < 0.05$. *$p < 0.1$

population density, climate, employment rate and metropolitan have a positive coefficient, and they are all statistically significant at conventional levels [18]. It suggests that increases in these independent variables make it more likely for cities to belong to a high house price club. Moreover, when we treat the dependent variable as continuous and run an OLS regression, the results still suggest that these variables are statistically significant predictors of the club formation [19]. Overall, we find that employment rate, population density, climate and metropolitan are among the key drivers of local house prices in Turkey. The ratio of higher education graduates to the local population is not, however, statistically significant. These results are consistent with previous studies on the drivers of convergence club formation. We point out that population density, as in the case of Holmes *et al.* (2019), and climate as in the case of Kim and Rous (2012) are important drivers. The climate is understandably essential given that coastal cities, especially in the Aegean and Mediterranean coasts, have enjoyable weather and are economically more developed provinces [20]. Additionally, we find employment rate and having a metropolitan municipality as essential determinants of convergence clubs in Turkey.

In Table 5, we also present the associated marginal effects of Model 1 from Table 4. These effects refer to the average marginal effect (AME) and the marginal effect at the mean (estimated by setting each independent variable to its mean value (MEM)). These two approaches yield similar statistically significant results, although average marginal effects have lower probabilities than those of marginal effects at the mean for the same clubs. According to the results in Table 5, increases in population density, climate, employment and having a metropolitan municipality make memberships of Clubs 1, 2 and 4 more (less) likely in varying degrees. For example, concentrating on the average marginal effects from Model 1, the results yield that a one-unit rise in population density increases the likelihood of being in the high price convergence club (Club 4) by 9.5%. One unit increase in climate increases the likelihood of being in Club 4 by 2.5%. An increase in the employment rate increases the likelihood of being in Club 4 by 2.8%. Having a metropolitan municipality increases the likelihood of being in Club 4 by 14.4%.

Inevitably, one should need to take a degree of caution in interpreting the results of the ordered logit model. First, the overall sample size is not very big due to lack of data. Second, the number of cities for some dependent variable categories such as Club 5 is tiny.

6. Conclusion and discussion

We empirically study the nature of house price convergence across Turkish cities over the period between 2010Q1 and 2018Q4 by using a unique data set obtained from an official source of information and employing Phillips and Sul (2007, 2009) methodology. The results show that house prices across 55 major cities in Turkey do not converge to a single equilibrium over the years. In other words, absolute convergence or the law of one price in house prices does not hold among Turkish cities. Conventional convergence tests such as beta and sigma convergence also reject absolute convergence. Instead, five subgroups of cities tend to converge to their long-run equilibrium path (steady-state).

The results also suggest that there are different levels of market segmentation in the Turkish housing market. Istanbul and Mugla occupy the positions at the top. Istanbul is one of the largest metropolises in the world, with a population of over 15 million inhabitants. It is the economic powerhouse of Turkey, generating over 30% of the country's GDP annually and employing 20% of the country's industrial labour. Mugla is a coastal city in the Aegean region and home to some of the Turkey's most popular vacation spots. These cities are followed by the ones located in the western part of the country, particularly by those along the Aegean and Mediterranean coasts. House prices in the central and eastern part of Turkey form other convergence clubs and experience much lower house price increases. In rare cases, a city located in the east part of Turkey is clustered in a higher house price club with those of

Table 5. Marginal effects for the determinants of convergence clubs (Model 1)

Variables	Club1 AME	Club1 MEM	Club 2 AME	Club 2 MEM	Club 3 AME	Club 3 MEM	Club 4 AME	Club 4 MEM	Club 5 AME	Club 5 MEM
Employment	−0.019*** (0.006)	−0.007* (0.003)	−0.020*** (0.006)	−0.034*** (0.011)	0.002 (0.004)	−0.027 (0.018)	0.028*** (0.007)	0.066*** (0.017)	0.009* (0.005)	0.001 (0.001)
Climate	−0.017* (0.009)	−0.006 (0.004)	−0.0184* (0.010)	−0.030* (0.016)	0.001 (0.004)	−0.024 (0.020)	0.025** (0.013)	0.059* (0.031)	0.008 (0.006)	0.001 (0.001)
Metropolitan	−0.097* (0.054)	−0.035 (0.024)	−0.104** (0.050)	−0.173* (0.092)	0.010 (0.026)	−0.137 (0.105)	0.144** (0.060)	0.338** (0.161)	0.046 (0.033)	0.008 (0.008)
Population density	−0.064* (0.034)	−0.023 (0.016)	−0.069** (0.034)	−0.115** (0.058)	0.007 (0.016)	−0.091 (0.072)	0.095** (0.045)	0.224** (0.108)	0.030 (0.021)	0.005 (0.005)

Note(s): AME = Average Marginal Effect, MEM = Marginal Effect at the Means. Marginal effects for continuous variables measure the instantaneous rate of change, while marginal effects for dummy (metropolises) variable measure the discrete change. The standard errors are in parentheses. *** $p < 0.001$. ** $p < 0.05$. * $p < 0.1$

the western part. For example, Gaziantep, a city located in the southeastern region, initially depicts a dramatic house price increase, and then has a decline afterwards. It seems that soaring demand from Syrian refugees have caused real estate prices to skyrocket in the border provinces. Overall, these findings align with the interregional economic disparities in Turkey, which is quite understandable given that real estate is an essential part of people's wealth and their primary investment and saving channel.

The findings also reveal that convergence club formation starts to arise after 2015. Initially, we find some cities such as Istanbul, Mugla and Izmir to be diverging in most of the periods from other convergence clubs, indicating localised house price overvaluations or bubbles. When house prices start to decline, these divergent cities become a member of convergence clubs. It may suggest that cluster analysis discovers more divergent behaviour and hence, housing bubbles in good times.

Moreover, the ordered logit model and OLS regression results point out that the differences in employment rate, climate, population density, and having a metropolitan municipality play a significant role in determining convergence club membership. The cities with higher employment rates, better weather, higher population density and metropolitan municipalities are more likely to belong to a club with a relatively higher house price level. Employment opportunities in large urban cities of the western part of Turkey attract workers from rural regions and then push up housing prices. The climate is essential given the fact that urban coastal towns, particularly on the Aegean and Mediterranean coasts, have lovely weather to live in. Demographic factors such as higher population density also play a role in the housing demand. Moreover, metropolitan cities have higher housing taxes and land prices that ultimately affect house prices. Indeed, these drivers do not necessarily imply a causal relationship, but they can still offer some policy recommendations. For instance, large-scale policy measures aiming to increase employment opportunities in rural cities of central and eastern provinces and providing lower land prices and property taxes in the metropolitan cities of Turkey can help mitigate some of the divergence in house prices across cities.

Finally, it seems that convergence club formation does not perfectly conform to conventional geographic regions in Turkey. Although there is a positive association between being in the same geographic area and being a member of the same convergence club, we need more robust results. Thus, one may conduct further research on house price convergence by covering all the cities in Turkey and using a more extensive set of characteristics when the data are available. For the moment, using club convergence to define the housing market will improve our understanding as the cities that share similar house price dynamics and characteristics are clustered in the same club.

Notes

1. https://www.rbnz.govt.nz/monetary-policy/about-monetary-policy/monetary-policy-framework
2. Absolute convergence refers to the law of one price in house prices (Apergis *et al.*, 2015).
3. Please see PS's Google scholar account for related citations. https://scholar.google.com/citations?user=TBvhBwgAAAAJ&hl=en&oi=sra
4. Apergis *et al.* (2015) examine only the middle segment of the South African housing market with the data collected from a private bank and find three convergence clubs across nine provinces. One should note that the extent of regional aggregation could mask insights regarding what is going on within the metropolitan cities and convergence club formation.
5. https://www.reidin.com/en/.
6. A positive value of beta is compatible with a transitory increase of income dispersion due to either random shocks or due to the fact that the initial level of inequality is below its equilibrium (steady state) value.

7. Intuitively, there seem to be two quick ways to obtain the clusters or groups using the raw data. First, one may create a histogram chart. However, the results will differ from one trial to another because the charts depend on the bin width. More importantly, histograms are not very useful as they consider the price levels (e.g., averages) but not the price changes relative to each other, which is essential in the house price convergence. Second, one can choose the clusters based on geographical characteristics. In that case, one should decide on the nomenclature of territorial units for statistics (NUTS). It can be NUTS1 (12 regions) or NUTS 2 (26 sub regions). Note that our sample covers 55 cities, and there is data unavailability for some towns.
8. We take the t-statistic value as −1.70 since our sample size is less than 60.
9. The use of the HP filter is recently criticized, especially in decomposing monthly time series into its trend and cyclical components. Like Apergis *et al.* (2015), we use quarterly data and follow the convention where the multiplier lambda (?) parameter has a value of 1,600. We also set a lower lambda multiplier to consider high-periodicity stochastic cycles by following Alp *et al.* (2011) and Churchill *et al.* (2018). As the results showed no difference, we followed Apergis *et al.* (2005) and presented the results accordingly. Moreover, we could perhaps use Hamilton (2017) filter as an alternative, but it would reduce our sample by eight-quarters.
10. See Du (2017) and https://cran.r-project.org/web/packages/ConvergenceClubs/index.html. Both of the codes yielded consistent results with each other. We here report the results by using Du (2017).
11. According to the ULI/PwC Emerging Trends in Real Estate® Europe report (2018), Istanbul has fallen to the 28th place in 2018, being the bottom city in Emerging Trends Europe's prospects league. It was among the top five cities five years ago.
12. The results are available upon request.
13. In many periods, Izmir and Bursa appeared to be diverging units. Only in the last period ending in 2018Q4, Antalya became the diverging city.
14. When we assign different r values such as 0.15, 0.20, 0.25 and 0.30, the final number of clubs varied between 3 and 5 clubs. To test the possible merging of diverging units, we used the algorithm suggested by von Lyncker and Thoennessen (2017).
15. http://www.turkstat.gov.tr/Start.do and https://mgm.gov.tr/eng/forecast-cities.aspx
16. The private sector carries out over 90 per cent of housing development in Turkey. Mass Housing Administration (TOKI), a government agency, builds residential houses mostly for relatively poor people, mainly in the less developed regions.
17. https://www.tbb.gov.tr/en/local-authorities/municipal-finances/
18. We also contrasted a model in which no variables are constrained to meet the parallel lines assumption with a model in which all variables are constrained to meet the assumption. We found insignificant LR chi-square test (Prob > chi2 = 0.3858) suggesting that parallel regression assumption is not rejected.
19. Running an OLS regression is widely done when the dependent variable has five or more categories. One should note that we checked the variables for collinearity and found that variance inflation factors are less than two.
20. Indeed, when we use a coastal/port city dummy instead of the climate variable as a supply-side factor, we find that coastal cities are statistically significant. Therefore, our results suggest that one can safely employ either a dummy variable for coastal cities as a supply-side variable or average temperature to measure pleasant weather as a location-specific factor. The results do not change, at least in the case of Turkey.

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Corresponding author
Lokman Gunduz can be contacted at: lgunduz68@gmail.com