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## Article

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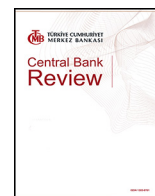
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# Do regional house prices converge? Evidence from a major developing economy

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## ABSTRACT

This paper analyzes the long-run convergence of regional house prices in a major developing country, Turkey. Using a non-linear time-varying factor model and quarterly hedonic house price data from 2010 to 2018, we find that house prices do not converge across 26 regions of Turkey. Results reveal that the regions can be grouped into seven convergence clubs and one divergent club, confirming the Turkish housing market's heterogeneity and complexity. We extend the analysis to explore the possible factors driving the convergence clubs. We find that income, population, education, unemployment, being in an earthquake zone, and inflow of Syrian refugees are significant driving forces in explaining convergence club formation. These outcomes will benefit home buyers/sellers, investors, regulators, and policymakers interested in analyzing the dynamic interlinkages among house prices and the effects of shocks originating from the regional housing markets in developing countries.

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## 1. Introduction

Housing is a type of asset that plays a dual role as consumption and investment goods. Housing loan debts also create one of the households' primary obligations as housing generally constitutes the largest component of households' financial assets. Furthermore, the housing sector contributes to a considerable portion of GDP in many countries. Hence, large corrections in house prices in the aftermath of the Global Financial Crisis (GFC) of 2007–2008 had severe impacts on households' wealth and consumption in many countries and residential investment (OECD, 2011). Accordingly, the dynamics of house prices are essential in terms of both household wealth<sup>1</sup> and business cycles.<sup>2</sup>

Following GFC, a growing literature has been devoted to studies investigating house price dynamics in developed and developing countries at both regional and national levels. In recent years, the focus is more directed to the interrelationship between regional

house prices since the co-movement and the dynamic interactions of house prices across regions can have implications for home buyers/sellers, investors, regulators policymakers. Therefore, it is crucial to understand how relative regional house prices behave over time. In addition, we question whether there is a reduction in the cross-sectional dispersion of house prices over time along with the issue of convergence. Several arguments have been raised to explain why house prices may converge across regions.<sup>3</sup> One assumption is that fundamentals affecting house prices, such as income or interest rate, may converge across regions. Since housing can be evaluated as an asset class, housing risk premia may converge across regions even when these fundamentals do not converge.

Conceptually, convergence refers to a decline in the dispersion among regions. Although convergence is more of an issue of achieving economic cohesion among countries in income growth rates,<sup>4</sup> it has also been applied to a wide range of areas such as energy consumption, macroeconomic convergence, financial development, labor income evolution, stock and bond markets,

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<sup>1</sup> See Catte et al. (2004) and Fry et al. (2010).

<sup>2</sup> See Quigley (1999) and Ghent and Owyang (2009).

<sup>3</sup> See, for example, Abbott and De Vita (2013), Hiebert and Moreno (2010), and Churchill et al. (2018), among others.

<sup>4</sup> See Azomahou et al. (2011), Borsi and Metiu (2015).

commodity markets, house prices, and so forth.<sup>5</sup> Among them, extensive research has been devoted to examining the convergence of house prices across regions and nations.<sup>6</sup>

Along with this line of research, co-movement of house prices has been studied mainly for developed countries such as the US and the UK, but there has been little research on these dynamics for developing countries. Thus, this study's core objective is to examine the long-run dynamics and the interlinkages of house prices for a developing country. We decided to examine Turkey's house prices since Turkey's housing sector is quite dynamic and represents a good case study in several ways. For instance, it provides an essential contribution to economic growth as the construction sector's growth rate has been very well above that of GDP on the occasion of positive growth rates for almost two decades. The share of the construction sector within overall GDP has been on a rising trend since 1998, reaching the highest share with 9 percent in 2016 and 2017.<sup>7</sup> In the meantime, nominal house prices have been surging persistently since 2010 based on increasing demand. The rate of increase in nominal hedonic house prices between January 2010 and December 2017 has been 122 percent, while the rate of increase has begun to decline since 2015. On the other hand, inflation-adjusted hedonic house price growth was about 17 percent for the 2010–2017 period.<sup>8</sup> Moreover, the prosperous growth of the housing sector in Turkey has been parallel to the young and growing population of Turkey. Turkey's population migrates from rural areas to urban cities, increasing the demand for new buildings in urban areas. Furthermore, the arrival of Syrian refugees after the civil war in Syria since 2011 has created a demand for the housing sector. Considering Turkey has hosted approximately 3.6 million refugees as of 2019,<sup>9</sup> local dynamics have changed a lot in some cities like İstanbul, Bursa, İzmir, Gaziantep, Konya, Hatay, Adana, Mersin, Kilis, and Şanlıurfa, leading to regional differences.<sup>10</sup> Henceforth, all these dynamics of the housing sector in Turkey have motivated us to explore long-run dynamics and interactions of house prices across Turkey's 26 regions over the 2010–2018 period.

The novelty of this paper is to comprise regional house price data of Turkey to question whether a unique long-run equilibrium exists for the Turkish housing market where all regions converge to, through employing a recent econometric methodology.<sup>11</sup> Since heterogeneous dynamics in regional house prices of Turkey require more than the conventional convergence tests can provide, we contribute to the literature by adopting the methodology (*log-t* test) introduced by Phillips and Sul (2007, 2009). Moreover, the analysis is extended to examine the potential drivers of convergence club formation, using a multinomial logit model.

In essence, our results propose the existence of multiple steady states in the Turkish housing market. In other words, there are

seven convergence clubs and one divergent club. All regions in each convergence club, except the four regions within the divergent club, converge to a common house price. On the other hand, none of the four regions in the divergent club presents a convergence pattern with any of the other 22 regions. These results suggest evidence for the heterogeneity in regional housing markets of Turkey. We also find that income, population, unemployment, and education are significant factors in explaining convergence club formation. Our results also suggest that refugees' immigration seems to have implications over the dynamics of house prices in Turkey.

The article is organized as follows: Section 2 briefly summarizes the related literature. Section 3 describes the data and empirical methodology. Section 4 includes empirical findings of the *log-t* test and the logit model. Section 5 discusses the concluding remarks.

## 2. Literature review

The empirical methodology employed to tackle the convergence issue has been through the traditional time series approach introduced by Carlino and Mills (1993) and Bernard and Durlauf (1995, 1996). This approach is based upon the existence of a cointegrating relationship between non-stationary variables. Recent methodologies employed in the convergence analysis include the principal components approach (e.g., Holmes and Grimes, 2008), the panel unit root tests (e.g., Levin et al., 2002), cointegration tests (e.g., Yunus, 2015), and dynamic panel data methodologies (e.g., Kılınc et al., 2017). Shortcomings of these methods emerge in the presence of individual heterogeneity. Besides, the time-series approach can be inadequate when there is heterogeneity across regions or countries. Although factor models have been widely used to integrate heterogeneous agent behavior into econometric modeling,<sup>12</sup> again these models do not provide any advantages over standard unit root tests (Kim and Rous, 2012). On the other hand, the standard unit root tests may suffer from over-rejections of the unit-root hypothesis (Ng and Perron, 2001).

Instead, the technique introduced by Phillips and Sul (2007) accounts for individual heterogeneity and accommodates for the evolution in heterogeneous behavior and the need to capture this behavior in empirical modeling. It develops an econometric test of convergence for the time-varying idiosyncratic components. This new regression test (*log-t* test) explores whether there exists a convergence towards a single common component in the long-run. It also questions the possible segmentation of the market in the form of a convergence club where they converge to their steady-state. To that aim, a club convergence clustering algorithm is employed, i.e., panel data is clustered into clubs with similar convergence characteristics. Thereby, this methodology is able to identify possible segmentation of the market in the form of a convergence club.

The methodology introduced by the seminal paper of Phillips and Sul (2007) has been applied in various fields to assess patterns of convergence. In the field of the housing market, several studies (e.g., Montanes and Olmos, 2013; Montagnoli and Nagayasu, 2015; Churchill et al., 2018; Kim and Rous, 2012; Holmes et al., 2019) have adopted this methodology to evaluate convergence across regional house prices, particularly in developed countries such as the UK, US, and Australia. Findings for the US provide little evidence of overall convergence across US states and metropolitan areas while indicating strong evidence of multiple convergence clubs (Kim and Rous, 2012). They furthermore extend

<sup>5</sup> See Herrerias et al. (2017) and Kim et al. (2006) for a detailed review of the related studies.

<sup>6</sup> See, for example, Abbott and De Vita (2013), Churchill et al. (2018), Kim and Rous (2012), Montanes and Olmos (2013), Montagnoli and Nagayasu (2015), Yunus and Swanson (2013), and Yunus (2015), among others.

<sup>7</sup> See [http://www.turkstat.gov.tr/PreTablo.do?alt\\_id=1108](http://www.turkstat.gov.tr/PreTablo.do?alt_id=1108) for the gross domestic product at current prices by kind of economic activity data.

<sup>8</sup> See Coskun et al. (2020) for the detailed stylized facts about the Turkish housing market.

<sup>9</sup> See [http://www.goc.gov.tr/icerik3/gecici-koruma\\_363\\_378\\_4713](http://www.goc.gov.tr/icerik3/gecici-koruma_363_378_4713).

<sup>10</sup> See the map on the above link (Footnote 9) and Akgunduz et al. (2015).

<sup>11</sup> Bilgili (2016) studied the city price convergence in Turkey by using regional consumer price indexes of 18 cities rather than house prices. The results revealed that thirteen out of eighteen consumer price indexes converge. The study that uses house prices in analyzing convergence in Turkey is the one by ÇatikAksekiAlpaslan, 2017. The methodology employed in this study is cointegration analysis; hence, heterogeneity across regional house prices is not adequately incorporated.

<sup>12</sup> See Stock and Watson (2002) and Bai (2003), among others.

the study to question the importance of individual characteristics that affect the likelihood of being a member of each convergence club. The existence of some degree of segmentation in the US housing market is also supported by Montanes and Olmos's (2013) study. Similarly, findings for the UK housing market suggest the existence of multiple steady states rather than a single steady-state (Montagnoli and Nagayasu, 2015; Holmes et al., 2019). Evidence for Australian cities is also quite similar in that house prices do not converge across Australian states, while the presence of convergence clubs is identified (Churchill et al., 2018).<sup>13</sup> All these cases confirm the heterogeneity and complexity of the housing market in these countries.

However, in the literature, the questions of whether house prices converge across regions and have a long-run relationship have not taken adequate attention for a developing country and in that respect for Turkey. Tomal (2019) used the *log-t* regression approach for a developing country and found no convergence in house prices across the Polish provincial capitals. He, however, found several convergence clubs in both primary and secondary markets in Poland. Moreover, Zhang and Morley (2014) studied the convergence of house prices for China, as they found little evidence for convergence across the regions.<sup>14</sup> Regarding the house price convergence in Turkey, there is only one study by ÇatıkAksekiAlpaslan, 2017 that addresses house price convergence across 18 cities of Turkey by employing cointegration analysis.

### 3. Data and empirical methodology

#### 3.1. Data

Our main data is the Hedonic House Price Index (HHPI), which measures quality-adjusted price changes related to housing characteristics.<sup>15</sup> The HHPI database is produced by the Central Bank of the Republic of Turkey (CBRT) and available monthly starting from January 2010 for the whole country and 26 geographical regions at the NUTS2 level. We utilize the HHPI in nominal values and quarterly over the period 2010Q1–2018Q4 for 26 regions.<sup>16</sup> Table 1 presents the summary statistics for the regional house prices of Turkey. Over the period examined, it is observed that TR10 (İstanbul) has the highest mean house price. The second region in that term is TRC1 (Kilis, Adiyaman, Gaziantep), which has hosted Syrian refugees since 2011.<sup>17</sup> On the other hand, the region of TRB2

<sup>13</sup> A recent study by Bashar (2020) applied the regression-based  $\beta$ -convergence test combined with spatial econometric models to study the house price convergence in the Melbourne metropolitan area. He found evidence of house price convergence after controlling for spatial effects.

<sup>14</sup> Though not necessarily using *log-t* test, some studies employed unit root and/or cointegration tests for examining the convergence of house prices in developing economies. Das et al. (2009) analyzed the house price convergence for five metropolitan areas of South Africa using the unit root tests. They found overwhelming evidence of the existence of Law of One Price in twelve of the fifteen cases. Similarly, Chung (2010) analyzed the short-run and long-run dynamics of regional house prices of Malaysia's three major urban areas using the bounds testing approach. He found that house prices in all three regions appear to be cointegrated.

<sup>15</sup> Although the CBRT and Reidin publish other indexes on house prices, we prefer to use the HHPI since it takes the quality-adjusted price changes into account.

<sup>16</sup> The number of observations becomes 36 for each geographical region and 936 for the whole sample.

<sup>17</sup> See <https://www.goc.gov.tr/gecici-koruma5638>. The total number of Syrian refugees in that region is 581,937.

<sup>18</sup> Since there have been some critics regarding the HP filter recently, we also use the Hamilton (2017) filter to remove the data's cyclical components. However, the convergence test results did not change significantly. Since Phillips and Sul (2007) applied the HP filter in their analysis, we decided to follow the same approach. The regression results using the Hamilton filter are available upon request.

**Table 1**  
Summary statistics.

Regions	Mean	Median	Maximum	Minimum	Std. Dev.
TR10	181.48	169.34	273.11	98.45	64.79
TR21	146.39	127.99	232.34	99.17	44.70
TR22	146.31	129.02	236.98	99.08	44.96
TR31	163.77	149.38	266.80	98.58	54.28
TR32	158.11	140.79	261.89	97.04	53.89
TR33	154.52	149.84	221.48	98.61	39.28
TR41	144.90	133.37	219.68	99.15	39.84
TR42	141.96	127.50	210.94	98.40	38.83
TR51	146.37	143.28	201.90	98.41	33.80
TR52	154.15	150.55	226.78	97.11	42.05
TR61	160.13	151.79	243.35	99.30	47.27
TR62	158.20	146.11	237.20	98.34	47.09
TR63	141.68	141.61	192.57	98.96	30.67
TR71	140.86	142.06	191.20	97.29	29.08
TR72	151.97	147.43	229.25	99.49	38.22
TR81	136.28	132.17	189.03	94.55	26.17
TR82	154.80	148.25	233.44	99.65	39.10
TR83	135.73	128.78	194.64	98.95	30.97
TR90	135.73	126.93	197.55	98.69	32.12
TRA1	152.94	152.37	211.98	97.78	33.43
TRA2	132.99	137.32	163.60	93.22	19.75
TRB1	133.82	130.94	192.82	98.65	28.08
TRB2	130.44	129.30	184.71	97.45	22.52
TRC1	178.03	196.95	242.81	99.06	46.28
TRC2	152.66	158.97	196.90	96.92	27.91
TRC3	141.78	150.15	168.06	97.64	24.16

**Note:** Regions: TR10 = İstanbul; TR21 = Edirne, Kırklareli, Tekirdağ; TR22 = Balıkesir, Çanakkale; TR31 = İzmir; TR32 = Aydın, Denizli, Muğla; TR33 = Afyonkarahisar, Kütahya, Manisa, Uşak; TR41 = Bursa, Eskişehir, Bilecik; TR42 = Bolu, Kocaeli, Sakarya, Yalova, Düzce; TR51 = Ankara; TR52 = Konya, Karaman; TR61 = Antalya, Burdur, Isparta; TR62 = Adana, Mersin; TR63 = Hatay, Kahramanmaraş, Osmaniye; TR71 = Nevşehir, Niğde, Aksaray, Kırıkkale, Kırşehir; TR72 = Kayseri, Sivas, Yozgat; TR81 = Zonguldak, Bartın, Karabük; TR82 = Çankırı, Kastamonu, Sinop; TR83 = Samsun, Çorum, Amasya, Tokat; TR90 = Artvin, Giresun, Gümüşhane, Ordu, Rize, Trabzon; TRA1 = Erzurum, Erzincan, Bayburt; TRA2 = Ağrı, Ardahan, Kar, Iğdır; TRB1 = Bingöl, Elazığ, Malatya, Tunceli; TRB2 = Van, Bitlis, Hakkari, Muş; TRC1 = Kilis, Adiyaman, Gaziantep; TRC2 = Diyarbakır, Şanlıurfa; TRC3 = Batman, Mardin, Siirt, Şırnak.

(Van, Bitlis, Hakkari) has the lowest mean house price.

We choose to eliminate cyclical components of the data to improve the finite sample power and size of the test, as suggested by Phillips and Sul (2007). Hence, we use the Hodrick and Prescott (1997) filter to remove the cyclical components of the data.<sup>18</sup>

#### 3.2. Empirical methodology

We apply Phillips and Sul (2007) methodology to test whether cross-sectional dispersion of regional house prices shows a tendency to decrease over time, i.e., converge. This methodology allows us to analyze heterogeneous transitional dynamics in house prices across regions.

Phillips and Sul (2007) developed the *log-t* regression test for the convergence hypothesis based on a non-linear time-varying factor model. The starting point of the model is to decompose the panel data  $X_{it}$  with time ( $t=1, \dots, T$ ) and region ( $i=1, \dots, N$ ) as:

$$X_{it} = g_{it} + a_{it} \quad (1)$$

where  $g_{it}$  represents the permanent component and  $a_{it}$  is the transitory component.

Since both components may contain a common factor across regions, Eq. (1) can be transformed as:

$$X_{it} = \begin{bmatrix} g_{it} + a_{it} \\ \mu_t \end{bmatrix} \mu_t = \delta_{it} \mu_t \quad (2)$$



where  $\mu_t$  is the single common component across regions and  $\delta_{it}$  is the time-varying idiosyncratic factor which captures the deviation of region  $i$  from the common growth path defined by  $\mu_t$ . To estimate  $\delta_{it}$ , we need to eliminate  $\mu_t$  through rescaling the panel average as

$$h_{it} = \frac{X_{it}}{\left(\frac{1}{N}\right)\sum_{i=1}^N X_{it}} = \frac{\delta_{it}}{\left(\frac{1}{N}\right)\sum_{i=1}^N \delta_{it}} \quad (3)$$

where  $h_{it}$  captures the transition path for the panel average at time  $t$ .

In order to test convergence and define club convergence, a semi-parametric form for the time-varying coefficients such that  $\delta_{it} = \delta_i + \sigma_{it}\omega_{it}$ , where  $\sigma_{it} = \frac{\sigma_i}{L(t)^{\alpha}}$ ,  $\sigma_i > 0$ ,  $t \geq 1$ , and  $\omega_{it}$  is weakly dependent over  $t$ , but  $iid(0, 1)$  across  $i$ , is required. The function  $L(t)$  equals  $\log(t)$  and increases in  $t$  and divergent, as  $t$  tends to infinity. In other words, whether or not  $X_{it}$  converges<sup>19</sup> toward  $\delta_i$  will be determined by the size of  $\alpha$ . Phillips and Sul (2007) show that the convergence is ensured if  $\alpha \geq 0$ , and this null hypothesis of convergence is:

$$\mathcal{H}_0 : \delta_i = \delta \text{ and } \alpha \geq 0$$

against the alternative hypothesis for non-convergence for some  $i$ :  $\mathcal{H}_A : \delta_i \neq \delta \text{ or } \alpha < 0$ .

Phillips and Sul (2007) developed a  $t$ -test for the null hypothesis of convergence, which can be tested using the following equation:

$$\log\left(\frac{H_1}{H_t}\right) - 2 \log(\log(t)) = c + b \log(t) + \varepsilon_t$$

for  $t = [rT], [rT + 1], \dots, T$  with  $r > 0$  (4)

where  $H_t = \frac{1}{N} \sum_{i=1}^N (h_{it} - 1)^2$  and  $b = 2\alpha$  and the null hypothesis is constructed as a one-sided test of  $b \geq 0$ .<sup>20</sup> A rejection of the null hypothesis at the 5% level of significance occurs when  $t_b < -1.65$ .

Rejection of the null hypothesis of convergence in the panel does not exclude the potential that convergence may occur in the panel subgroups because multiple equilibria can be present (Churchill et al., 2018). Henceforth, club-merging tests are performed, in which the strategy is to search for convergence across all combinations of regions until  $N - k = 1$ , where  $k$  is the number of regions in the convergence clubs.

In short, Phillips and Sul (2007) developed a data-driven algorithm to investigate the possibility of convergence clubs. The sequence of steps involved in the clustering algorithm can be explained as follows: (i) sorting individuals (regions in our case) according to the last time series observation in the panel; (ii) finding a core convergence group that yields the highest value of the  $\log-t$  test statistic to evaluate additional individuals for membership of this group; (iii) sieving individuals for club membership; (iv) performing the  $\log-t$  test for the subgroup of remaining individuals which are not sieved in the previous step and checking the test statistic for the evidence of convergence; and (v) performing the  $\log-t$  test for all pairs of the subsequent initial clubs to merge those clubs fulfilling the convergence hypothesis jointly.

<sup>19</sup> The convergence of  $X_{it}$  requires the following condition.  $\lim_{t \rightarrow \infty} \frac{X_{it}}{X_{jt}} = 1$ , for all  $i$  and  $j$ .

<sup>20</sup> The selection of the initiating sample fraction  $r$  might influence the regression results represented by Eq. (4). The Monte Carlo experiments indicate that  $r \in [0.2, 0.3]$  achieves a satisfactory performance. Specifically, it is suggested to set  $r = 0.3$  for the small or moderate  $T (\leq 50)$  sample and set  $r = 0.2$  for the large  $T (\geq 100)$  sample (Phillips and Sul, 2007).

**Table 2**  
Log( $t$ ) test results.

Variable	Coefficient	Standard Error	T-Statistic
House price	-1.22	0.08	-14.79*

**Notes:** \* denotes the rejection of the null hypothesis of convergence at a 5% significance level. The number of regions is 26. The number of periods is 36. The first 12 periods are discarded before regression; however, we obtain similar results when the trimming parameter,  $r$ , is varied between the values of 0.3 and 0.2 (as recommended by Phillips and Sul 2007).  $t$ -statistics are based on Newey and West (1987) heteroscedasticity and autocorrelation (HAC) standard errors.

#### 4. Empirical results

Table 2 presents the results of  $\log-t$  convergence test across 26 regions of Turkey.<sup>21</sup> The findings indicate rejection of the full panel convergence at 5 percent level of significance, since the value of the  $t$ -statistic (calculated as  $-14.79$ ) is less than  $-1.65$ . Hence, the result of the  $\log-t$  regression test suggests no evidence for house price convergence across all 26 regions of Turkey over the period 2010Q1-2018Q4.<sup>22</sup> In other words, this result supports the view of house price divergence across all 26 price series.

Since the null hypothesis of overall house price convergence is firmly rejected, we may now investigate whether house prices converge to their steady states within subgroups. In other words, at this stage, it becomes necessary to examine the potential club convergence pattern among 26 regions of Turkey. To that purpose, we apply the clustering procedure proposed by Phillips and Sul (2007).

Table 3 shows the results of these clustering procedures and club merging tests for 26 regions. Direct application of the clustering algorithm classifies the regional data into eight subgroups. We observe that seven of these subgroups form convergence clubs. Regarding these convergence clubs, we do not reject the null hypothesis of house price convergence for regions in each club. However, for the last subgroup, i.e., Club 8, convergence is significantly rejected, providing evidence for the divergence of four regions in this club: TR90 (Artvin, Giresun, Gümüşhane, Ordu, Rize, Trabzon), TRA2 (Ağrı, Ardahan, Kars, Iğdır), TRB1 (Bingöl, Elazığ, Malatya, Tunceli) and TRB2 (Van, Bitlis, Hakkari, Muş). In other words, none of these regions shows a pattern of converging to a common house price. Henceforth, the initial clustering suggests the existence of seven sub-convergence clubs and one divergent club.

On the basis of the results, convergence clubs can be summarized as follows: The first convergence club includes two regions: TR10 and TRC1. The second club again involves two regions, i.e., TR31 and TR32. The third club includes TR61 and TR62. The fourth club comprises seven regions: TR21, TR22, TR33, TR52, TR72, TR82, and TRA1. The fifth club includes four regions such as TR41, TR42, TR51, and TRC2. The sixth club includes TR63, TR71, and TRC3. The last convergence club includes two regions, like TR81 and TR83.

It is probable that the number of convergent clubs that we obtained, can be more than that actually exists, due to excessively

<sup>21</sup> We use a Stata module developed by Du (2017) to perform econometric convergence analysis and club clustering proposed by Phillips and Sul (2007).

<sup>22</sup> We also carry the  $\log(t)$  regression tests using the real hedonic house prices data obtained by deflating each region's nominal hedonic house price by a regional consumer price index. We did not observe any significant change in the convergence tests with real house price data, while the number of convergence clubs is reduced to four. As the related literature did not emphasize the difference between using real versus nominal prices, we prefer nominal house prices. The primary motivation behind choosing nominal house prices is that they show higher variations across time and regions, while the real house prices did not increase dramatically during the period of analysis in Turkey. The results with the real house prices are available upon request.

**Table 3**  
Initial convergence club classification.

Clubs	Regions	Coefficients	T-Statistics
Club 1	TR10, TRC1	−2.72	−1.63
Club 2	TR31, TR32	0.11	0.38
Club 3	TR61, TR62	0.43	15.63
Club 4	TR21, TR22, TR33, TR52, TR72, TR82, TRA1	0.31	2.14
Club 5	TR41, TR42, TR51, TRC2	1.11	1.97
Club 6	TR63, TR71, TRC3	0.02	0.04
Club 7	TR81, TR83	−0.28	−0.22
Club 8 (Divergent)	TR90, TRA2, TRB1, TRB2	−2.45	−9.95*

**Notes:** \* denotes the rejection of the null hypothesis of convergence at a 5% significance level. The t-statistic is the convergence test statistic, distributed as a simple one-sided t-test with a critical value of −1.65 (see Phillips and Sul (2007) for further details). See Table 1 for the definitions of the regions.

**Table 4**  
Club merging classification test.

Clubs	Coefficients	T-Statistics
Club 1 + Club 2	−0.62	−9.80*
Club 2 + Club 3	−0.64	−9.91*
Club 3 + Club 4	−0.63	−22.01*
Club 4 + Club 5	−0.22	−3.03*
Club 5 + Club 6	−0.39	−3.76*
Club 6 + Club 7	−1.18	−26.62*
Club 7 + Club 8	−2.09	−8.65*

**Notes:** \* denotes the rejection of the null hypothesis of convergence at a 5% significance level.

conservative nature of the clustering algorithm proposed by Phillips and Sul (2007). Hence, considering that these seven clusters can be more than that actually exists, we can now investigate whether any of the adjacently numbered clubs can be merged to form larger convergence clubs by following Phillips and Sul (2009).

The results of club merging analysis with estimated slope coefficients and t-statistics are presented in Table 4. Since the results provide no support to merge clubs as grouped in Table 4, the initially formed clubs are maintained. Hence, we can interpret these results as each club forms a different convergence club.

Based on the test results of initial convergence club classification and club merging, we have seven house price convergence clubs and one divergent club, which are pictured in Fig. 1 over the map of Turkey.

To interpret the test results better, we take the arithmetic average of house prices included in each club (see Table 3 for the members of each club). These new indexes constructed by averages are presented in Fig. 2. We can view that these indexes at the initial years of the sample are almost the same for all clubs. However, a different picture emerges towards the end of the sample. Although Clubs 4 and 7 have been in a correction period, house prices continue to have an upward trend in all other clubs.

To sum up, we find that, although hedonic house prices do not reflect convergence across regions, the Turkish housing market is subdivided into seven convergence clubs and one divergent club. Interesting features emerge on the basis of this convergence analysis. For instance, the regions of the divergent club, i.e., TR90 (Artvin, Giresun, Gümüşhane, Ordu, Rize, Trabzon), TRA2 (Ağrı, Ardahan, Kars, Iğdır), TRB1 (Bingöl, Elazığ, Malatya, Tunceli) and TRB2 (Van, Bitlis, Hakkari, Muş), which are economically less developed regions of Turkey, do not form a house price convergence club with any of the other 22 regions. In other words, these four divergent regions suggest strong evidence for regional heterogeneity in the housing market of Turkey. Regional heterogeneity in the Turkish housing market can be explained by economic (such as income, employment, etc.), social (such as migration, demography, etc.), and spatial factors.

When interpreting the results, one may speculate that there is a strong form of geographic proximity among club members, which

is more apparent in Fig. 1. This can be valid especially for Club 2 and Club 3. Club 2 involves cities on the west coast of Turkey, i.e., İzmir, Aydın, Denizli, and Muğla. Club 3 includes cities of the south coast, i.e., Antalya, Burdur, Isparta, Adana, and Mersin. Hence, geographical proximity (e.g., regions in Clubs 5, 6, and 7) and being in the coastal areas (regions in Clubs 2 and 3) can be the common characteristics of convergence clubs.

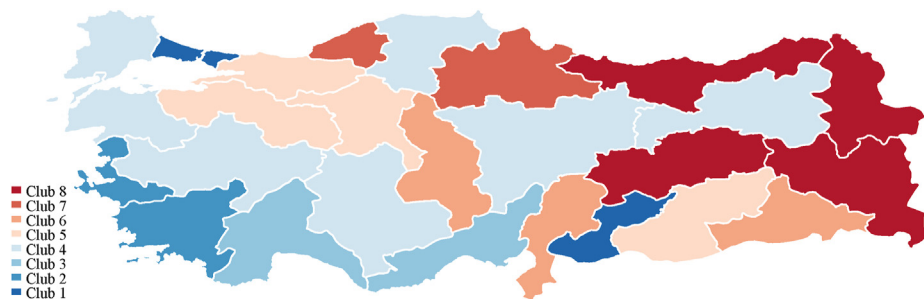
As we mentioned before, within each club, i.e., subgroup, house prices of regions tend to converge to their common prices. At this stage, we turn to investigate the potential drivers of convergence club formation. For that purpose, we estimate a multinomial logit model in order to find the variables that are expected to have a role in the probability of a region being in a specific convergence club. It is important to note that due to the lack of sufficient regional data in Turkey, we can only include explanatory variables with available data. To this end, we might be excluding some of the explanatory variables that might have a role in club formation.

Thus, we basically focus on available explanatory variables that are expected to affect the convergence club formation. We first use the logarithm of GDP per capita for measuring the impact of income, which is assumed to have a positive effect on housing demand and so house prices in the literature. To account for demographic influences, we use the logarithm of population. We use the percentage of individuals with a university degree within the whole population for each region as a measure of educational qualification.<sup>23</sup> Educational qualification is expected to be positively related to house prices. We also control for the effect of being in an earthquake zone in analyzing the convergence club formation. We construct a dummy variable to define whether a region is in an earthquake zone or not determined through the Turkey Earthquake Risk Map provided by the Disaster & Emergency Management Authority Presidential of Earthquake Department (AFAD).<sup>24</sup> Hence, if a region is in an earthquake zone, the dummy variable takes the value of 1; otherwise, it takes the value of zero. The GDP per capita, population, and educational data are obtained from the TurkStat and available until 2017. Therefore, the period of the analysis is restricted to 2010–2017. Moreover, we include the refugee rate and unemployment rate, which can be essential factors for the observed house price heterogeneity, in the regression. Since the data for these two variables are only available for a relatively short period (2013–2017), we re-estimate the multinomial logit model, including those variables.<sup>25</sup>

<sup>23</sup> Holmes et al. (2019) used a similar measure for school quality and found that it leads to a smaller likelihood that any two house price series belong to the same convergence club.

<sup>24</sup> See <https://deprem.afad.gov.tr/deprem-tehlike-haritasi?lang=en>.

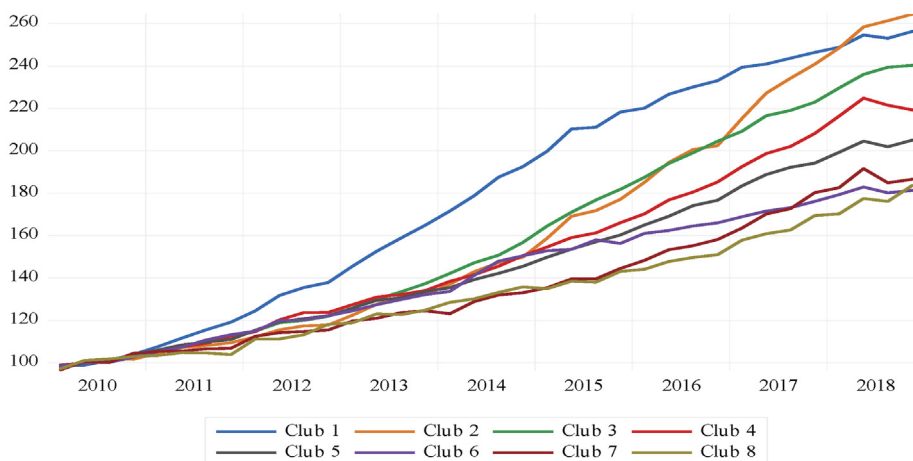
<sup>25</sup> The amount of housing credit would also be an explanatory variable for the convergence club membership; however, since the correlation coefficient between the GDP and total credit is so high in Turkey, we prefer not to include housing credit in the logit model.



**Note:** For details of the regions in each convergence club, see Table 3.

**Fig. 1.** Convergence clubs for the 26 regions of Turkey.

**Note:** For details of the regions in each convergence club, see Table 3.



**Notes:** Club1, Club2, Club3, Club 4, Club 5, Club 6, and Club 7 are the converged clubs, while Club 8 is the divergent one.

**Fig. 2.** The arithmetic means of house price indexes for each convergence club.

**Notes:** Club1, Club2, Club3, Club 4, Club 5, Club 6, and Club 7 are the converged clubs, while Club 8 is the divergent one.

**Table 5**  
Estimation results from multinomial Logit model.

Variables	Average Marginal Effects							
	Club = 1	Club = 2	Club = 3	Club = 4	Club = 5	Club = 6	Club = 7	Club = 8
Income	0.156** (0.075)	-0.341* (0.065)	0.224** (0.107)	0.883* (0.124)	0.305* (0.108)	0.085 (0.101)	-0.161** (0.077)	-1.151* (0.153)
Education	-0.379* (0.124)	0.602* (0.067)	-0.209*** (0.122)	-0.715* (0.153)	-0.401* (0.128)	-0.190*** (0.117)	0.266** (0.105)	1.026* (0.202)
Population	0.308* (0.063)	0.125* (0.045)	0.105* (0.035)	-0.646* (0.057)	0.448* (0.061)	-0.109* (0.041)	-0.130* (0.038)	-0.101** (0.044)
Earthquake zone	0.111* (0.021)	0.169* (0.019)	-0.221* (0.036)	0.163* (0.045)	-0.114* (0.033)	-0.062*** (0.033)	-0.005 (0.038)	-0.040 (0.038)
Observations	208	208	208	208	208	208	208	208

**Notes:** The dependent variable takes value 1 for price series in convergence Club 1, and so on until value 8 for price series in Club 8. The threshold parameters are not reported to save space. All variables, except earthquake zone, are in natural logarithms. Heteroskedastic standard errors are in parenthesis. \*, \*\*, \*\*\* denote 1%, 5% and 10% significance level, respectively.

Table 5 summarizes the estimated coefficients of the multinomial logit model along with their associated marginal effects, which show the marginal effect of each variable on the likelihood of being in a specific club. According to Table 5, an increase in income makes membership of Clubs 1, 3, 4 and 5 (Clubs 2, 7 and 8) more (less) likely in varying degrees. Moreover, an increase in educational qualification makes membership of Clubs 1, 3, 4, 5 and 6 (Clubs 2, 7 and 8) less (more) likely. Similarly, an increases in population

makes membership of Clubs 1, 2, 3 and 5 (Clubs 4, 6, 7 and 8) more (less) likely in varying degrees. We also observe that being in an earthquake zone makes membership of Clubs 1, 2 and 4 (Clubs 3, 5 and 6) more (less) likely.

Furthermore, we include additional explanatory variables such as refugee rate and the unemployment rate in the regression. The results of Table 6 suggest that an increase in the refugee rate affects the likelihood of being in Clubs 1, 4, 6 and 8 (Club 7) positively

**Table 6**  
Estimation results from multinomial Logit model (robustness checks).

Variables	Average Marginal Effects							
	Club = 1	Club = 2	Club = 3	Club = 4	Club = 5	Club = 6	Club = 7	Club = 8
Income	0.660* (0.131)	-0.151** (0.062)	0.075 (0.116)	0.834* (0.134)	0.163 (0.129)	-0.313*** (0.181)	-0.044 (0.109)	-1.223* (0.137)
Education	-1.442* (0.263)	0.424* (0.104)	0.009 (0.174)	-0.638* (0.195)	-0.332*** (0.191)	0.561** (0.285)	0.358*** (0.198)	1.059* (0.164)
Population	0.740* (0.131)	0.050 (0.073)	-0.256 (0.256)	-0.551* (0.120)	0.722* (0.237)	-0.533* (0.149)	-0.136* (0.050)	-0.034 (0.105)
Earthquake zone	0.119* (0.009)	0.159* (0.017)	-0.270* (0.045)	0.167* (0.037)	-0.032 (0.047)	-0.067** (0.027)	-0.007 (0.038)	-0.069** (0.032)
Unemployment	0.053 (0.039)	0.112** (0.048)	-0.042 (0.033)	-0.273* (0.075)	0.043 (0.045)	0.164* (0.048)	0.107 (0.077)	-0.165*** (0.085)
Refugee	0.016* (0.003)	-0.019 (0.018)	0.006 (0.008)	0.123** (0.052)	0.004 (0.006)	0.038* (0.013)	-0.248* (0.093)	0.080** (0.035)
Observations	156	156	156	156	156	156	156	156

**Notes:** The dependent variable takes value 1 for price series in convergence Club 1, and so on until value 8 for price series in Club 8. The threshold parameters are not reported to save space. All variables, except earthquake zone and refugee, are in natural logarithms. Heteroskedastic standard errors are in parenthesis. \*, \*\* and \*\*\* denote 1%, 5% and 10% significance levels, respectively.

(negatively). This result seems to be important since the regions such as TR10 (İstanbul) and TRC1 (Kilis, Adıyaman, Gaziantep), both of which have hosted a significant number of Syrian refugees<sup>26</sup> since 2011, formed the convergence Club 1. On the other hand, the convergence Club 7, which includes the TR81 and TR83 regions, has a relatively lower refugee rate than the other regions. Hence, these results imply that refugees' immigration to these cities has implications over the dynamics of house prices. Considering the unemployment rate, we find that an increase in the unemployment rate makes membership of Clubs 2 and 6 (Clubs 4 and 8) more (less) likely. Moreover, Table 6 shows that the inclusion of the unemployment rate and refugee rate does not dramatically change the results presented in Table 5, indicating the robustness of our results.

## 5. Conclusion

The focus of this study is to examine whether there is a reduction in the cross-sectional dispersion of house prices over time. To that purpose, dynamic interactions of house prices across 26 regions of Turkey have been examined through the convergence analysis. The analysis covers the period from 2010Q1 to 2018Q4. The underlying motivation behind this research is to get implications for dynamic interlinkages of house prices, which would be important for home buyers/sellers, investors, regulators, and policymakers. We question whether a unique long-run equilibrium exists for house prices where all regions converge. As to our knowledge, in the literature, this has been the first attempt to search for a long-run convergence path in the Turkish housing market, taking into account the heterogeneous dynamics present in regional house prices. In other words, transitional dynamics in the presence of individual heterogeneity have been taken into account, and the number of steady states among regions and the compositions of multiple equilibria are analyzed in this study. We also explore possible factors driving the convergence clubs in Turkey.

The results of this paper provide no evidence of house price convergence across the 26 regions of Turkey. On the other hand, findings suggest that the regional housing market can be characterized by multiple steady states in the Turkish housing market instead of a single steady state. We observe seven convergence clubs and one divergent club. In a nutshell, except for the four

regions within the divergent club, most of which are economically less developed regions of Turkey, all other regions show a converging pattern to a common house price. In other words, these four regions provide strong evidence for the heterogeneity in regional housing markets of Turkey.

Regarding the drivers of convergence clubs, we find that income, population, education, earthquake zone, unemployment, and refugees are significant factors in explaining convergence club formation. Henceforth, we may suggest that measures that raise income and educational qualification levels towards a common nationwide standard heighten the possibility of a single convergence club for the Turkish housing market. The convergence club analyses carried out in this study can be extended to other developing countries such as India, Malaysia, Israel, South Africa, Brazil, etc., which exhibited higher exuberance in house prices than Turkey over the last decade.

This study partially focuses on the possible causes of the observed heterogeneity in regional house prices subject to data availability constraints. However, improvements in the availability of regional data for macroeconomic, social, and demographic and different types of housing (detached, semi-detached, flats, etc.) variables will hopefully contribute to the research on the determinants of regional dispersion of house prices over time.

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<sup>26</sup> The number of Syrian refugees in Gaziantep, Kilis, Adıyaman, and İstanbul amounts to almost 1 million people. See, <https://www.goc.gov.tr/gecici-koruma5638>.



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