RIPPLE EFFECT AND REGIONAL HOUSE PRICES: EVIDENCE FROM TURKEY

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Abstract

This paper investigates the existence of ripple effect and regional converge of house prices for Turkey via employing the Autoregressive Distributed Lag (ARDL) co-integration method. In this paper, the house price index is used from 2010:1 to 2018:6 for the biggest three regions of Turkey, which are Istanbul, Ankara, and Izmir. The empirical findings confirm the existence of ripple effect between three regional housing markets and the long-run convergence of regional house prices. The findings also show that diversity in regional housing prices has changed according to the different regions in both short-term and long-term. However, the adjustment speed for the long-term equilibrium also differs between regions.

Keywords: House Prices, Ripple Effect, Turkey Housing Market, Cointegration

JEL Classification: C01, C32, R12, R31

DALGALANMA ETKİSİ VE BÖLGESEL KONUT FİYATLARI: TÜRKİYE'DEN BULGULAR

Öz

Bu çalışma, Türkiye ekonomisinde bölgesel konut fiyatlarındaki yakınsamanın ve dalgalanma etkisinin varlığını ARDL eşbütünleşme yöntemi kullanılarak araştırmaktadır. Bu çalışmada Türkiye'nin üç büyük kenti olan Istanbul, Ankara ve İzmir bölgelerine ait hedonik konut fiyat endeksleri 2010:1-2018:6 dönemi için kullanılmaktadır. Ampirik bulgular, üç büyük bölgesel konut piyasasında dalgalanma etkisinin varlığını ve konut fiyatlarında uzun dönemli bir yakınsamanın gerçekleştiğini saptamaktadır. Bulgular ayrıca, bölgesel konut fiyatlarındaki farklılığın hem kısa hem de uzun vadede farklı bölgelere göre değiştiğini göstermektedir. Bununla birlikte uzun dönemdeki denge için uyumlanma hızı da bölgeler arasında farklılık göstermektedir.

Anahtar Kelimeler: Konut Fiyatları, Dalgalanma Etkisi, Türkiye Konut Piyasası, Eşbütünleşme

JEL Sınıflaması: C01, C32, R12, R31

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1. Introduction

After the financial crisis, which occurred in US housing markets in 2007 and expanded to the rest of the world, researchers and policy-makers have been paid attention to find out the fluctuation of house price so that implement much more stable policies. These experiences have finally given rise to a new research agenda dates back to 1990s that especially investigate the relationship contiguous dependence and transmission across the regional housing markets (Meen, 1999; Teye and Ahelegbey, 2017). Although house prices mainly vary depending on location and time, house price mobility in regions may affect each other in some way. Moreover, as house prices are spatially related to each other over time, governments and policymakers try to figure out regional transmission mechanism for the purpose of establishing a policy to control the comprehensive process of the housing market.

After the 2000 and 2001 crisis in Turkey, there has been introduced many structural reforms in Turkey. Among the most important ones are the Housing Development Administration (TOKİ), which undertook more effective responsibility in 2004 and the establishment of Mortgage Law in 2007. With the mentioned law, households had the opportunity to provide housing finance with long-term borrowing from banks and other institutions authorized by law. The decline in the nominal interest rates, which accompanied by these structural changes, also led to a decline in the interest rates on housing loans.

The decline in the housing market loan interest rate was one of the most important factors in the demand for housing afford of households, which it leads to increase in the households' demand for housing. Furthermore, this process has given rise to rapid increases in house prices in Turkey. In that period, this rapid rise in house prices was accompanied by the change in the share of the housing sector in GDP and employment level. The share of the housing sector in GDP (i.e. construction sector) remarkably increased until to 9.1 % in mid of 2017, then started to lessen with the contraction of the GDP.

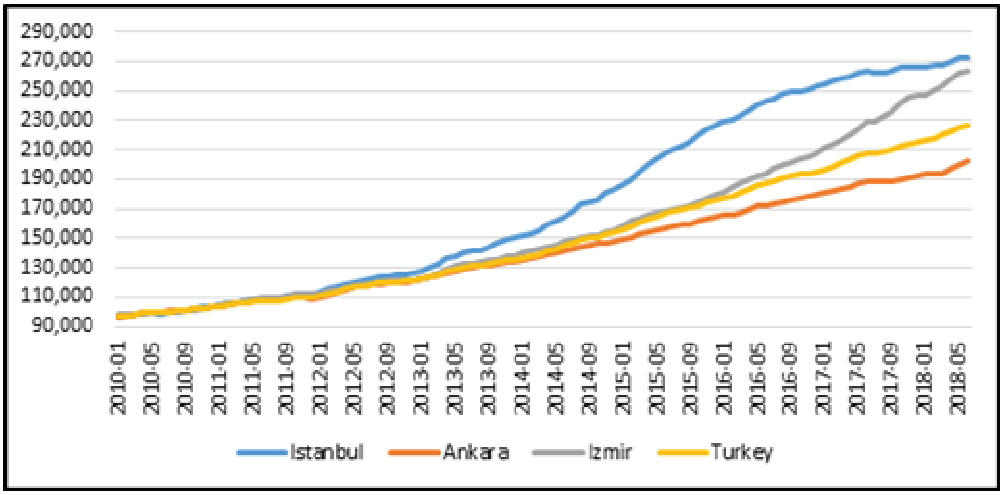
House prices in Turkey are also sensibly correlated across different regions. The reasons behind this correlation may be largely explained by the main factors that determine house prices in those regions. However, regional differences in house prices appear because housing markets are local markets and are exposed to local effects. Potentially, diffusion of house prices may occur in three major regional housing markets such as Istanbul, Ankara,

and Izmir. These provinces, as the principal regional economy of Turkey, have some advantages such as the attraction of mass industry and high regional migration from other regions of the country. This fact promotes a rise in housing demand, which in turn increases the prices of regional housing.

Figure 1 displays the four hedonic house price series in Turkey for the sample period, 2010:1-2018:6. Hedonic house price index in Turkey, based on Central Bank of Republic of Turkey (CBRT) data, has increased by 132 percent from 2010 to 2018. In a similar way, house prices in Istanbul (Ist), Ankara (Ank), and Izmir (Izm) has risen by 182,5%, 110.75%, and 168.39%, respectively in those regions. Over the first part of the sample almost all regions house prices act a similar trend; after mid of 2013, house prices in Istanbul appears to diverge with Ankara and Izmir. With the end of 2017, Istanbul house prices tend to co-move the other regions house prices. As Figure 1 illustrates, house prices have tended to remain highest in Istanbul and lowest in Ankara. According to Figure 1, it is seen that house prices in Istanbul are the first to diverge when compared to Ankara and Izmir regions. This consequence arises the question that whether house prices in Istanbul ripples to the other regional house prices in Turkey.

These recent rapid increases in house prices both in Istanbul and in Izmir may be explained the following reasons: besides the largest city in Turkey, Istanbul exhibits so many urban transformation projects and large-scale public residential investment. These factors, mostly, triggers new housing investment by leading to increase the housing (real estate) prices. Regarding to Izmir, the most important factor behind huge increases in recent years could be the high number of immigrants who are coming from Istanbul during 2014-2018 periods. Furthermore, the new investment companies that are originated from Istanbul might also give rise to huge increases in the Izmir housing market.

Figure 1. Turkey Regional Hedonic House Price Index (2010=100), 2010:1-2018:6



Source: CBRT

The ripple effect is the spillover of shocks in house prices across regions, where prices converge over time (Meen, 1999). The ripple effect is defined as the market fact that shows that house price shocks in one region affect house prices in the other region of the country (Drake, 1995; Meen, 1999; Cook, 2003; Balcilar et al., 2013; Tsai, 2014; Teye et al., 2017). This market feature indicates the case which house prices shock in one region reflects the situation in which shocks are transferred to house prices in other regions, either permanently or temporarily (Canarella et al., 2012; Balcilar et al., 2013; Teye and Ahelegbey, 2017).

To understand the economic underpinnings of the ripple effect, Meen (1999) classifies the reasonable clarifications for the interactions that bring about the pattern recognized of diffusion in house prices. According to Meen (1999), four attainable evidence of ripple effect can be characterized as follows: migration, equity transfer, spatial arbitrage, and spatial patterns in the determinants of house prices.

The first evidence is migration, which implies that if house prices in one region are high relative to the other regions, then someone may expect households migrate to the North, which leads to equal housing prices. This migration gives rise to a ripple effect on the regional house prices. The second important factor that causes the ripple effect is equity transfer, which implies that buyers with more purchasing power in the region where house

prices are higher will be forced to price in other regions to rise. The third is spatial arbitrage, which occurs over space to remove the yield differences in the regional house prices. The final evidence is spatial patterns in the determinants of house prices, which put forward that if the determinants of house prices pursue identical characteristic, it shows that housing prices will be similar to the observed ripple effect, even if there is no regional link between housing markets.

Table 1 shows the number of migrations about interregional migration between Istanbul, Ankara, and Izmir for the 2010-2018 period. It can be seen from Table 1, the number of migrations for both Ankara and Izmir from Istanbul has remarkably increased from 15.368 to 20.216 and from 11.117 to 20.529 in last 8 years, respectively. On the other hand, the number of migrations from Izmir to Ankara has risen from 6.764 to 7.277 and 7.046 to 9.916 from Ankara to Izmir. In 2018, Istanbul has received 19.091 immigrants from Ankara and 14.151 immigrants from Izmir. Overall, migration between three big provinces exhibits an increasingly dynamic structure. When we consider only three provinces, it can be seen that Istanbul has given more migration then it has received in the last two years.

Table 1. Number of Migrations between Ankara, Istanbul, and Izmir (1000 people)

Migration-receiving	**Ankara**		**Istanbul**		**Izmir**	
Sending province	**İstanbul**	**İzmir**	**Ankara**	**Izmir**	**Ankara**	**Istanbul**
2010	15368	6764	18864	15267	7046	11177
2011	16864	8047	20882	17003	6944	11339
2012	14988	5879	17913	13903	6474	11179
2013	16594	6863	19436	15238	7237	12355
2014	18014	7097	18688	14013	10160	16458
2015	18775	8596	19021	15559	8116	16129
2016	18907	6673	18066	13237	8013	17124
2017	19986	7399	17740	13816	8882	18506
2018	20216	7277	19091	14151	9916	20529

Source: TUİK

Because housing is the greatest asset for many economic agents, changes in house prices have a powerful wealth effect, which may also determine the magnitude of economic activity through consumption decisions, policymakers pay much more attention the existence of ripple effects (Teye et al., 2017). For this reason, the ripple effect is important in

providing information about the predictability of house price trends in other regions. This may provide substantial information about the consumption patterns and regional wealth distribution that may affect the entire economy. Furthermore, the ripple effect also suggests that there occurs long-term convergence with the time of adjustment varies across regions between regional house prices (Meen, 1999; Payne, 2012; Teye, 2017).

This paper intends to provide several contributions for the following reasons. Firstly, although many papers have investigated the ripple effect in a developed country such as the US, UK, the Netherlands, this study presents the findings from Turkey. Therefore, when considering the rapid urbanization and interregional massive internal migration, Turkey case may reveal quite different and remarkable results. Secondly, this paper applies the ripple effect process to house prices for the three regional housing markets, described by the main state capital cities so as to assess the diversity and convergence across the behaviors of house prices in the different regions. This paper tries to answer the following questions: (1) How does a shock that hit a regional housing market transmit to another region of Turkey? (2) Are regional house prices in Turkey tending to converge in the long-run? (3) Does the speed of adjustment toward long-run equilibrium differ in throughout the regions? Thirdly, even though many studies[2] have explored the determinants of house prices in Turkey, the literature about the ripple effect of regional house prices in Turkey has not yet been researched. Because of that reason, this study focuses on the ripple effect on the housing market in Turkey aims to provide a contribution to the empirical literature.

The remainder of this study is organized as follows. Section 2, presents a short summary of previous empirical studies about the ripple effect in the housing market. Section 3, discusses the theoretical model, methodology, and data. The estimation results are specified in Section 4. Section 5 presents the conclusions.

[2] See Akseki et al. 2014, Yıldırım and İvrendi; 2017, Coskun and Jadevicius, 2017, Coskun et al. 2017; Kırıkkaleli et al. 2018.

2. Empirical Literature

The number of studies that take into account the ripple effect on house prices is quite considerable. The earlier debates about the regional housing market interactions in the literature date are based on the developments in UK housing markets (Giussani and Hadjimatheou, 1991). Diversity in house prices across South and North regions tended to shrink again in the 1990s while increasing in the 1980s. Thus, "ripple effect" and regional housing market integration arguments started to develop in that literature. There are comprehensive literature has appeared that examines the spatial diffusion of house prices in the UK (MacDonald and Taylor, 1993; Alexander and Barrow, 1994; Drake, 1995; Meen, 1996; Meen, 1999; Cook, 2003; Holmes and Grimes, 2008). Pollakowski and Ray (1997) examine the interconnection among regional house price changes in the US. They reveal the evidence which the ripple effect may exist between regions that are hit by economic shock and then cause spillover effects to other regions. They also point out that these spillover effects need not necessarily border each other. Drake (1995) reach the presence of a ripple effect arising from the house price change, which is more intense and primarily in South East England than in the rest of the UK regions. Similarly, Meen (1996) points South East England house prices affect the house prices in the rest of the UK regions. Cook (2005) presented supportive that the ripple effect occurs in house prices in the UK.

Although the existence of the ripple effect on the US economy is not very strong in the first studies by Tirtiroglu (1992), Clapp and Tirtiroglu (1994), recent studies by Pollakowski and Ray (1997), Meen (2002), Holly et al. (2010), Canarella et al. (2012) prove the spatial convergence on house prices in the metropolitan areas of the United States. Gupta and Miller (2012a, 2012b) investigate the ripple effect for the US and reach argument of house price interrelation across eight Southern California metropolitan statistical areas and between Los Angeles, Las Vegas and Phoneix.

There have been also many studies have found findings approving the ripple effect on house prices for the rest of the world. Berg (2002) points that the validity of house prices diffusion in the Stockholm, while Oikarinen (2005) reveals that house prices changes spillover first from the Helsinki metropolitan area to the regional centers and spread to the outside regions. The spatial diffusion effect of the house prices in Australia is investigated by Luo et al. (2007). Their results show that the eight capital cities of Australian states support

the ripple effect of house prices. Buyst and Helgers (2013) investigate the impact of spatial diffusion on Belgium regional house prices. Their findings point which a tendency of convergence occurs virtually all regional house prices in the long-term. Stevenson (2004) study the ripple effect validity for Ireland and between the Republic and Northern Ireland. His findings reveal that there occurs a substantial of convergence in house prices, which come about from Dublin to the other region. In studies on the Spanish economy, Larraz-Iribas et al. (2008) and La Paz et al. (2017) found the argument of the spatial diffusion on house prices among Spanish regions. Balcilar et al. (2013) study the spatial diffusion on house prices in South Africa, by separating three different sized houses. Their findings prove that house prices display a strong ripple effect in five regions. Akseki et al. (2016) reveals that there is not a convergence for regional house prices for seven big provinces in Turkey. They also point the importance of the new mortgage law in explaining the divergence of regional house prices in Turkey. Teye et al. (2017) study the validity of a spatial diffusion both Amsterdam and to the rest of the Netherlands. Their results conclude that Amsterdam house prices have an effect on almost all the Dutch regions, excluding Zeeland. Teye and Ahelegbey (2017) investigate the spatial interrelation between house prices in the twelve regions of The Netherland. Their findings support the existence of the ripple effect of house prices in the Netherlands. In the international area, Hiebert and Roma (2010), Yunus (2015), and Demir and Yildirim (2017) show the existence of real convergence in house prices in the global housing market, including North America, Europe, Asia, and OECD countries.

Apart from these, several papers investigate the ripple effect of house prices for Chinese cities (Wang et al., 2008; Hong et al., 2007; Huang et al., 2010, Li and Li, 2011). Primarily, the so-called papers obtained the regional diffusion of housing markets across various provinces. One of the recent studies on China, Gong et al. (2016) examine the ripple effect of housing markets in China. Their findings display a spatial diffusion that is broadly available across housing regions, where there is a one-way causative relation from the eastern-central area to western China.

Briefly, empirical literature displays a significant amount of paper about the ripple effect of regional house prices and points spatial diffusion across regions in different areas. Nonetheless, studies so far not shown the necessary attention to the existence of a ripple

effect on the regional housing market in Turkey. Therefore, the main contribution of the current paper is to investigate this spatial investigation of the diffusion process in Turkey.

3. Methodology and Data

3.1. Methodology

There are many econometric methods in the literature that can be used to study the cointegration relationship between macroeconomic variables. Engle-Granger (1987) and Johansen (1988,1991) can be named to be the most widely used techniques in this field. In this study, the Autoregressive Distributed Model (ARDL) method introduced by Pesaran et al. (2001) is adopted owing to its superiority over competing methods. The above-mentioned superiorities can be grouped under four main headings. First of all, while other techniques require variables to be stationary in the same order, the ARDL technique permits variables to be stationary at different orders. In other words, variables that are I(0) and I(1) stationary can be used in the same analysis. The second advantage of the ARDL technique is that it has valid t statistics and long-term unbiased estimation results even if there is endogeneity problem between model variables since by construction model does not allow residual correlation (Narayan, 2005; Odhiambo, 2009). The third advantage of the ARDL technique is that it allows working with small samples when compared with the Johansen co-integration technique (Ghatak and Siddiki, 2001; Payne, 2003). Finally, the ARDL technique provides short and long-run effects of a variable on another variable simultaneously and separates these effects from each other (Bentzen and Engsted, 2001).

The research question, which figure out the ripple effect of regional house prices in Turkey, can be expressed by the following ARDL model:

$$\Delta Ist_t = \alpha_0 + \sum_{i=0}^{p} \beta_i \Delta Ist_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta Ank_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta Izm_{t-i} + \delta_1 Ist_{t-1} + \delta_2 Ank_{t-1} + \delta_3 Izm_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta Ank_t = \alpha_0 + \sum_{i=0}^{p} \beta_i \Delta Ank_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta Ist_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta Izm_{t-i} + \delta_1 Ank_{t-1} + \delta_2 Ist_{t-1} + \delta_3 Izm_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta Izm_t = \alpha_0 + \sum_{i=0}^{p} \beta_i \Delta Izm_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta Ist_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta Ank_{t-i} + \delta_1 Izm_{t-1} + \delta_2 Ist_{t-1} + \delta_3 Ank_{t-1} + \varepsilon_t \quad (3)$$

where Δ is the first difference operator, α_0 is the drift component, ε_t is the white noise error terms, and p is the maximum number of delays. It is possible to evaluate the ARDL bounds test approach as a two-step process. In the first step, the existence of a long-run relationship between regional house prices is tested by means of F test, which establishes the joint significance for the lagged level variables in Equation 1, 2, and 3. The null hypothesis (*H*0: δ1= δ2= δ3=0) that rejects the long run relation is tested against the alternative hypothesis (*H*1: δ1≠ δ2≠ δ3≠δ4≠0) that accepts the long run relationship between variables by using F-test. The upper and lower critical values of this test are provided by Pesaran et al. (2001). If the calculated F statistic is higher than the upper critical value, the null hypothesis is rejected and the existence of a long-term relationship is accepted. If on the other hand, the calculated F-statistic is below the lower critical value, the existence of a long-term relationship is rejected. Finally, it is not possible to reach a final judgment if the test statistic falls between the lower and upper critical values. Determination of the optimal lag length is also an important point. The most frequently used criteria for determining the level of the ARDL model are the Schwarz Bayesian Criteria (SBC), the Hannan-Quinn (HQ) criterion and the Akaike Information Criteria (AIC).

Following the establishment of the long run relation, in the second step short run coefficients should be obtained. In this context, the following error correction models will be estimated:

$$\Delta Ist_t = \alpha_0 + \sum_{i=0}^{p} \beta_i \, \Delta Ist_{t-1} + \sum_{i=0}^{p} \gamma_i \, \Delta Ank_{t-1} + \sum_{i=0}^{p} \mu_i \, \Delta Izm_{t-1} + \pi ECM_{t-1} + \varepsilon_+ \quad (4)$$

$$\Delta Ank_t = \alpha_0 + \sum_{i=0}^{p} \beta_i \, \Delta Ank_{t-1} + \sum_{i=0}^{p} \gamma_i \, \Delta Ist_{t-1} + \sum_{i=0}^{p} \mu_i \, \Delta Izm_{t-1} + \pi ECM_{t-1} + \varepsilon_+ \quad (5)$$

$$\Delta Izm_t = \alpha_0 + \sum_{i=0}^{p} \beta_i \, \Delta Izm_{t-1} + \sum_{i=0}^{p} \gamma_i \, \Delta Ist_{t-1} + \sum_{i=0}^{p} \mu_i \, \Delta Ank_{t-1} + \pi ECM_{t-1} + \varepsilon_+ \quad (6)$$

The error correction model results indicate the speed of convergence to the long-term equilibrium in response to a short-term shock. Here, the coefficient (π) of lagged error correction term (ECM_{t-1}) governs the long-term convergence dynamics. If this coefficient is statistically significant and lies between 0 and -1, it is an important indicator of a model's tendency to reach long-run equilibrium.

3.2. Preliminary Analysis

In this study, the short and long-term relationship between regional house prices in Turkey is examined by using the ARDL method for 2010:1-2018:6 period with monthly data. The hedonic house price index is used in the analysis. Hedonic house price index monitors the house price changes without taking the quality of housing into consideration, using a hedonic regression method. The hedonic house price indices are gained from Central Bank of Republic of Turkey (CBRT)[3]. All series in the analysis are in real terms and natural logarithms have been taken for all three regions[4], which are Istanbul (Ist), Ankara (Ank), and Izmir (Izm). Furthermore, regional house prices are seasonally adjusted with Census X-13 technique. Table 2 presents the summary statistics of the hedonic house prices in the national and three regional housing markets.

Table 2. Summary Statistics of Variables

Region	Obs.	Mean	Median	Minimum	Maximum	Std. Dev.
Ist	102	174,51	143,50	96,63	273,00	61,92
Ank	102	142,40	138,28	95,83	201,97	31,93
Izm	102	156,21	143,50	98,09	263,67	48,46
Turkey	102	149,59	140,64	97,05	226,73	39,94

Note: Turkey shows the hedonic house price index. Ist, Ank, Izm are the hedonic house price of Istanbul, Ankara, and Izmir, respectively.

It can be observed from Table 2 that the mean house prices for the Ankara and Izmir regions are closest to the national (Turkey) mean. It is also seen that house prices in Istanbul are higher than in other regions. Prior to the ARDL cointegration analysis, it is necessary to

[3] https://evds2.tcmb.gov.tr/
[4] In this study, region and province are used for interchangeably.

perform unit root tests for the variables. Unit root test results are presented in Table 3. Use of the ARDL approach requires the variables in the analysis to be I (1) or I (0) and it is not appropriate to use variables with a higher degree of stationary. For this reason, ADF and PP tests are carried out to make sure that the variables are suitable for ARDL analysis and to determine the stationary of the corresponding variables in the model.

Table 3. ADF and PP Unit Roots Tests

Variables	ADF		PP		
	Level	1.dif	Level	1.dif	Decision
Ist	0.68 (0.99)	-4.89 (0.00)**	-0.04 (0.99)	-5.50 (0.00)**	I(1)
Ank	0.54 (0.99)	-8.62 (0.00)**	0.50 (0.99)	-8.59 (0.00)**	I(1)
Izm	-2.84 (0.30)	-7.50 (0.00)**	-2.54 (0.30)	-7.38 (0.00)**	I(1)

Note: Test results are reported for a model with constant and trend. (**) indicates significance at the level of 5%. The critical value of ADF and PP is -3.56 for 5%.

Both ADF and PP unit root tests are in agreement that three house prices indices are integrated of order (1). As the unit root test results indicate none of the variables is I(2), one can be proceeded to the bounds testing procedure.

4. Empirical Results

Table 4 shows the F-statistics associated with the null hypothesis of a long run relationship among the regional house prices along with with the critical values of the bounds testing procedure. It can be inferred that the F values calculated for three models (5.95, 8.30 and 13.18) are higher than the upper limit value obtained at three significance levels (10%, 5%, and 1%). There is strong evidence of a long-run co-integration relationship between the Istanbul, Ankara and Izmir regional house prices. In other words, the house prices of Istanbul, Ankara, and Izmir are moving together in the long-run.

Table 4. ARDL Tests of Long-Run Relationships[1]

Model 1- Dependent Variable: Istanbul (Ist) Hedonic HPI		
F(ist|ank, izm) k=2	5.95[b]	
Model 2- Dependent Variable: Ankara (Ank) Hedonic HPI		
F(ank|ist, izm) k=2	8.30[a]	
Model 3- Dependent Variable: Izmir (Izm) Hedonic HPI		
F(izm|ist, ank) k=2	13.18[a]	
Significance	**I(0) Lower Bound**	**I(1) Upper Bound**
% 10	3.17	4.14
% 5	3.79	4.85
% 1	5.15	6.36

Note: Significance levels: a(%1), b(%5), c(%10)

Table 5 presents the long-run coefficients according to each region. It can be interpreted as a long-term elasticity finding because the regional house prices are in natural logarithms. Table 5 indicates slightly different conclusions regarding the impact of house prices on each other. The long-run elasticity estimates of the region's house prices differ from -1.01 to 2.05. In the long run, the house prices in Istanbul impact both Ankara house prices and Izmir house prices. In a similar way, house prices in Izmir also affect house prices in two regions, Istanbul and Ankara. However, house prices in Ankara impact the house prices Izmir and do not affect the house prices in Istanbul.

Table 5. Long-Run Estimating Results

Independent Variables	**Dependent Variables**		
	İst	**Ank**	**İzm**
İntercept	0.59 (0.25)	-0.57 (0.000)[a]	-1.01 (0.000)[a]
İst	---	0.28 (0.000)[a]	0.604 (0.000)[a]
Ank	0.09 (0.94)	---	-1.40 (0.010)[a]
İzm	2.05 (0.005)[a]	-0.28 (0.001)[a]	---

Note: Brackets present the probability values.

Table 6 presents the error correction in models. The short-run relationship between the regions 'house prices is investigated with the error correction model based on the ARDL approach. The Ect variable in the model is the error correction term. This term indicates how much of the imbalance in the short run caused by a shock will be tolerated in the long run.

Table 6. ARDL Error Correction Models

Independent Variables	Dependent Variables		
	ΔIst	ΔAnk	ΔIzm
ΔIst	---	0.32 (0.002)[a]	0.50 (0.000)[a]
ΔAnk	0.284 (0.003)[a]	---	0.44 (0.000)[a]
ΔIzm	0.48 (0.000)[a]	0.39 (0.000)[a]	---
Ect (-1)	0.03 (0.061)[c]	-0.21 (0.000)[a]	0.07 (0.005)[a]

Note: Brackets present the probability values. Significance levels: a (%1), c (%10)

The short-run elasticity estimates for each region (Istanbul, Ankara, and Izmir) are 0.03, -0.21 and, 0.07 respectively. In the short-run, all of regions house prices impact the other regions. This value indicates that this deviation can be corrected in future periods if there are any deviations from the long run equilibrium. Table 6 reveals that the speed of adjustment to fix long-run equilibrium across regions differs for each region. The house prices in İstanbul display the slowest adjustment toward long-run equilibrium, which takes around 33 months. The adjustment toward long-run equilibrium in Izmir takes place in 14 months. The fastest adjustment occurs in Ankara, around 5 months. According to ECT (-1) coefficient, the speed of adjustment differs in across regions, which they change from 5 months to 33 months, with the average speed of adjustment of 17.33 months.

5. Concluding Remarks

This paper studies the validity of the ripple effect and long-run convergence of Turkey regional house prices using the ARDL co-integration method. The extent of house prices spillover between Istanbul, Ankara and, Izmir has been investigated for the period 2010m1-2018m6 in this paper. In this paper, it has been tried to be figured out the answer to the

following questions. Firstly, how does a shock that hit a regional housing market transmit to another region of Turkey? The findings show that the impact of shocks on regional housing markets are not homogeneous for all regions. Some regions have a greater influence than others, regardless of spatial link, both in the short term and in the long term. Secondly, it is questioned whether the regional house prices in Turkey have a tendency for convergence in the long term. The empirical findings of the models reveal that regional house prices indicate the tendency of convergence characteristics in the long-term. Thirdly, does the speed of adjustment toward long-run equilibrium differ in throughout the regions? The findings display that the speed of adjustment differ in for each region, which they vary from 5 months to 33 months (33 months for Istanbul, 14.2 months for Izmir and 4.7 months for Ankara), with the average speed of adjustment of 17.33 months. These conclusions may have important consequences for policymakers while urban plans are made for regional housing markets. Besides, these findings could be informative for investors and portfolio managers in the decision-making process for their housing portfolios accordingly.

This study also makes a contribution to the increasing literature on the ripple effect of house prices by analyzing the Turkish economy. The result that reveals existing the ripple effect on regional house prices in Turkey is similar to many studies investigate for the developed countries in the literature (Stevenson, 2004; Payne, 2012; Teye et al., 2017; Balcılar, et al. 2013). As suggested by Meen (1999) one of the reasons for the existence of ripple effect is the interregional migration between Istanbul, Ankara, and Izmir happen especially in recent years. The immigration, particularly, from Istanbul to Ankara and Izmir play a key role to explain the tendency of convergence for regional house prices. Besides, high affordability of households who live in that three regions may be a significant factor that revealing the validity of spatial diffusion on house prices. Another factor can be explained by considering the equity transfer and spatial arbitrage motivation of households. Households in Turkey invest their savings in housing as a way of protecting against inflation, expecting that the increase in house prices will exceed inflation. Because of that motivation, the demand for housing in that three-province leads to be an increase in inter-regional house prices.

In future research, to investigate the effects of long-term convergence and spatial diffusion of house prices in Turkey may be useful to consider the broader regions. In addition to

this, the different housing market variables, such as housing transaction volume, housing permits can be considered to investigate the long-term convergence relation across regional housing markets in Turkey.

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APPENDIX

Table 7. Diagnostic Tests of Model-1 (ist|ank, izm)

Diagnostic Tests
$R^2 = 0.99$
$\bar{R}^2 = 0.98$
Breusch-Godfrey LM Test= 1.29 (0.24)
Breusch-Pagan-Godfrey = 1.27 (0.81)
Jarque-Bera Normality Test= 0.71 (0.70)
Ramsey Reset Test = 0.54 (0.47)

Table 8. Diagnostic Tests of Model-2 (ank|ist, izm)

Diagnostic Tests
$R^2 = 0.99$
$\bar{R}^2 = 0.99$
Breusch-Godfrey LM Test= 0.72 (0.32)
Breusch-Pagan-Godfrey = 1.26 (0.27)
Jarque-Bera Normality Test= 1.58 (0.45)
Ramsey Reset Test = 0.98 (0.65)

Table 9. Diagnostic Tests of Model-3 (izm|ist, ank)

Diagnostic Tests
$R^2 = 0.99$
$\bar{R}^2 = 0.99$
Breusch-Godfrey LM Test= 0.84 (0.14)
Breusch-Pagan-Godfrey = 2.01 (0.18)
Jarque-Bera Normality Test= 1.58 (0.45)
Ramsey Reset Test = 0.84 (0.56)

Figure 2. Cusum and CusumQ of Model 1- Dependent Variable: (ist|ank, izm)

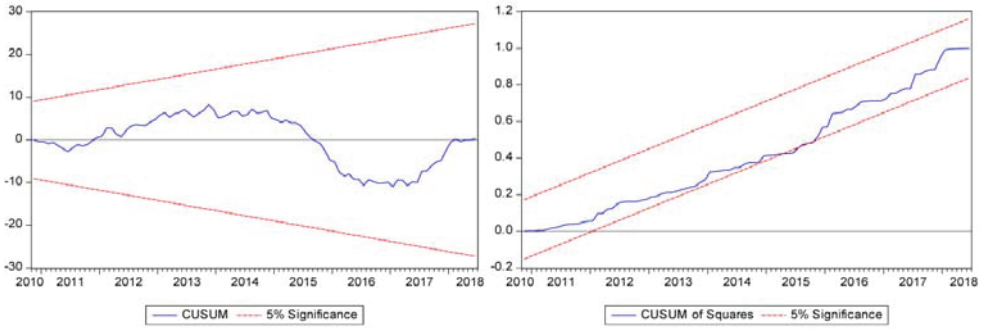

Figure 3. Cusum and CusumQ of Model 2- Dependent Variable: (ank|ist, izm)

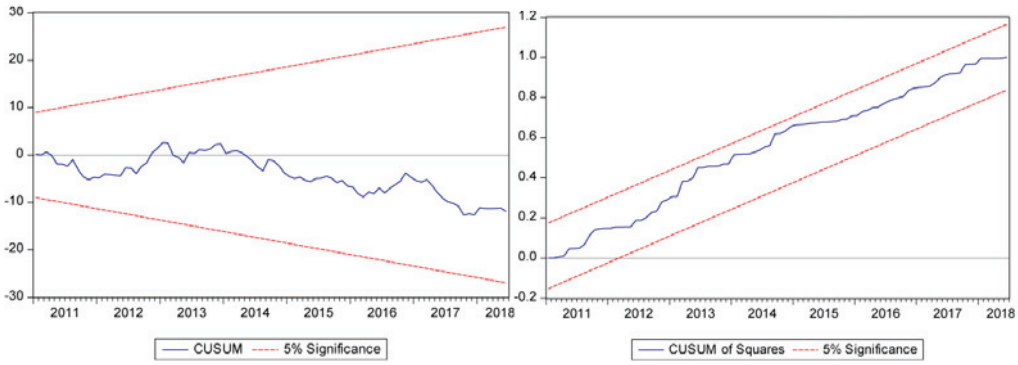

Figure 4. Cusum and CusumQ of Model 3- Dependent Variable: (izm|ist, ank)