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## Article

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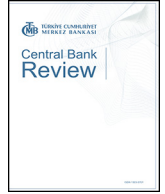
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# An analysis to detect exuberance and implosion in regional house prices in Turkey

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## ABSTRACT

The aim of this paper is to find out whether there is exuberance in regional house prices in Turkey. For this purpose, we analyze real hedonic house prices and price to rent ratios countrywide as well as for 26 geographic regions at the NUTS2 level from January 2010 to January 2019. We perform the right-tailed unit root testing procedures developed by Phillips et al. (2015) and Phillips and Shi (2018) and use their real time date-stamping strategy to determine periods of explosiveness and implosion. Our empirical findings indicate that there were exuberance episodes in house prices in Turkey for multiple periods, where an important contributor to these dynamics was the largest housing market, İstanbul. We also detect exuberance in some other regions, particularly in the neighboring NUTS2 regions of İstanbul and in İzmir after around 2014. However, we find out that explosive price behavior turned into implosion in many regions starting from 2018. © 2019 Production and hosting by Elsevier B.V. on behalf of Central Bank of The Republic of Turkey. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

Capital flows towards emerging market economies increased substantially due to quantitative easing policies implemented by the monetary authorities of advanced economies after the Global Financial Crisis (GFC). The surge in capital flows lowered interest rates and eased access to credit significantly, which helped sustaining economic growth and stimulated households' appetite in investing in housing. Inflation rates were low and economic growth rates were modest across the globe in this era, prolonging the global low interest rate environment and inducing global financial investors to emerging market economies in search for high returns. In short, monetary policies implemented in advanced economies created a suitable environment where bubbles could form in asset prices.

Case and Shiller (2003, pg. 299) define a rational bubble as a situation in which "excessive public expectations of future price increases cause prices to be temporarily elevated". In general, a housing bubble occurs when home buyers are willing to pay

excessive prices for houses with the expectation that house prices will continue to rise in the future. Housing demand will be reinforced if home buyers think that prices are not likely to fall in the near future or at least not likely to fall for a long time period and the perceived risk associated with home investment is negligible.

Empirical literature on testing for rational bubbles in house prices is quite rich, but it mainly concentrates on advanced economies (Phillips et al., 2011; Engsted and Nielsen, 2012; Phillips et al., 2015; Greenaway-McGrevy and Phillips, 2016; Engsted et al., 2016; Martinez-Garcia et al., 2016; Balcilar et al., 2018; Hu and Oxley, 2018). To the best of our knowledge, there are only a few papers on house prices for the emerging market economies (Caspi, 2016; Coşkun and Jadevicius, 2017; Coşkun et al., 2017 and Ganioglu and Seven, 2019). We limit our study to the case of an emerging economy, Turkey. While explosive house price increases in major cities is a global phenomenon, Turkish cities had been ranked among the highest in the world until very recently in rising property prices.<sup>1</sup> There exists only a few critical studies that examine house price bubble for Turkey (Coşkun et al., 2017; Coşkun and Jadevicius, 2017). A drawback of these papers is that they analyze house prices until 2014, while the acceleration in house price inflation

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<sup>1</sup> <https://www.weforum.org/agenda/2018/04/berlin-is-the-city-with-the-worlds-fastest-rising-property-prices/>.

becomes more evident after 2014. Therefore, those studies do not include a critical period of rapid increases in house prices in their bubble analyses. Furthermore, they only examine house prices at countrywide level and at most for three big cities. Henceforth, being consistent with the period of analyses, they basically do not find any bubble formation in their analyses.

The Turkish case is particularly interesting because there have been several additional critical factors contributing to housing demand, leading to significant increases in house sales in the recent past. One of these factors is demographic change, involving an increasing proportion of working-age individuals in total population. Another factor is the substantial amount of migration, both internally—from rural to urban areas—and externally—from Syria to particularly southeast part of the country, which has been increasing the demand for housing especially in cities. Furthermore, although the ratio of house sales to foreigners in total sales is limited, its market share grew considerably in recent years. Those factors have contributed to the remarkable increases in house prices in recent years, leading to the question of whether property prices might have explosive price behavior in Turkey or not, especially in big cities such as İstanbul. As a result of those considerations, the question of house price explosiveness has become particularly relevant for the Turkish economy.

In this paper, we analyze time series properties of changes in relative house prices of Turkey in 26 geographical regions at the NUTS2 level as well as countrywide to determine whether there are explosive behavior in house prices. The main research question is to find out the episodes when the house price elevations turn into periods of exuberance in the housing market in Turkey. We refrain from policy recommendations to address such behavior. Rather, our aim is to determine periods of explosive increases in house prices, but the methodology also allows us to identify periods of implosion. To that purpose, we examine variables such as real house prices and price to rent ratio. We use two measures of house prices, one is the House Price Index (HPI) and the other is the Hedonic House Price index (HHPI), which are both produced by the Central Bank of the Republic of Turkey (CBRT) from January 2010 to January 2019. To examine real house prices we use the ratio of HHPI to Consumer Price Index (CPI), and to explore price-to-rent ratio we use the ratio of HPI to the rent index that TurkStat produces as a sub-category under its CPI statistics. Hence, we consider the headline CPI and the rent index as proxy measures of fundamental variables.

The tool this paper uses to detect explosive periods is a novel methodology developed recently by Phillips et al. (2015) and later improved by Phillips and Shi (2018). We perform recursive right-sided unit root testing procedures to detect exuberance in house prices and to date-stamp the periods of explosive periods and implosion as suggested by Phillips et al. (2015) and Phillips and Shi (2018). Our choice of this methodology is inspired in part by a study by Martinez-Garcia et al. (2016), which forms the basis of the 'exuberance' data published by the Federal Reserve Bank of Dallas for 23 countries starting from 1984 on a quarterly basis.<sup>2</sup> Martinez-Garcia et al. (2016) use the methodology introduced by Phillips et al. (2015). In other words, we follow the example of Martinez-Garcia et al. (2016) and use the methodology of Phillips et al. (2015) to detect property price explosiveness.

Our contributions to the literature can be listed as follows. First, this paper extends empirical analyses on the Turkish housing market beyond the biggest three cities to 26 geographical regions at the NUTS2 level. Second, the empirical analysis in this paper covers a much longer time period than that is covered in the existing

literature for Turkey, which includes both expansionary and contractionary phases in house prices. It should be mentioned that house price increases accelerated especially in 2015 and 2016, but started to slowdown in 2017. That development enables us to detect both explosive periods and implosion in relative house price indicators for multiple periods. Finally, our empirical analysis allows us to spot explosive price behavior at the regional level, thereby avoiding the averaging nature of the national level data. The regional analysis also allows us to discuss the possible impact of the unevenly distributed migration of Syrian refugees on exuberance in regional house prices.

The empirical findings differ according to whether we use real hedonic house prices or the price-to-rent ratio. Between the two, tests based on the price-to-rent ratio generally detect more exuberance—they detect longer periods of exuberance in house prices in general and mildly explosive behavior in recent times, while tests relying on real hedonic house prices detect shorter periods of explosiveness and implosion in recent times. The main reason behind this difference in results is the fact that the rent index increases less rapidly than the headline CPI, while HPI increases more rapidly than HHPI. As a result, the price-to-rent ratio rises faster than the real hedonic house price index throughout the period of analysis. Consequently, the likelihood of detecting exuberance in the price-to-rent ratio is higher than in the real hedonic house price index.

Test results using price-to-rent ratio reveal that over much of the 2012–2015 period, exuberance has been detected for Turkey, due to rapid increases in house prices accompanied by relatively stable rent prices. On the other hand, we observe explosiveness in real hedonic house prices for shorter periods of time. We identify episodes of exuberance in house prices in İstanbul and in its surrounding regions starting from 2013, and also in İzmir especially starting from 2015 based on the price-to-rent ratio and from 2016 based on real hedonic house prices. Although we do not aim to find out the determinants of explosive behavior in house prices in this study, we address some factors such as impact of Syrian refugees that change the local dynamics in some regions. In this respect, one of the possible reasons of the observed explosiveness in house prices in some regions such as İstanbul and particularly TR62 (Adana, Mersin) can be the high Syrian refugee inflow to those regions.

The rest of the paper is organized as follows: The next section explains the methodology employed in the empirical analysis. The third section describes our data and sources. The fourth section presents and discusses the empirical results and the fifth section concludes the paper.

## 2. Methodology for explosive deviations

House price bubble occurs when price growth is driven by the expectations of future price increases (Case and Shiller, 2003). According to Glaeser and Nathanson (2014), if house price changes are persistent, buyers can be willing to pay higher prices than that is suggested by the fundamentals with an overoptimistic attitude. That type of behavior could result in exuberant pricing in the housing market.

Explosive dynamics in house prices can arise if a rational bubble exists.<sup>3</sup> Various ex-post econometric tests are proposed in the literature to detect 'rational' bubbles (see Gürkaynak (2008) for review). Rational bubbles can be tested through applying right-tailed unit root tests. Diba and Grossman (1988) were the first to propose a right-tailed unit root test using explosive alternative rather than the stationary alternative to detect the explosive

<sup>2</sup> The International House Price Database can be accessed online at <http://www.dallasfed.org/institute/houseprice/index.cfm>.

<sup>3</sup> For other factors that can cause explosive dynamics in house prices, see Martinez-Garcia et al. (2016).

behavior of rational bubbles in the stock market. On the other hand, Evans (1991) criticized this approach for not being effective to detect periodically collapsing bubbles. This failure is overcome by Phillips et al. (2011) who proposed an ex-ante approach built upon the idea of Diba and Grossman (1988).

To get rid of failures of running a single test over the whole sample period, right-tailed Augmented Dickey Fuller (ADF) test is run repeatedly over gradually increasing subsets of the sample. Such recursive right-sided unit root tests focus on possible departures from fundamentals and identify whether speculation might have fed price bubbles. This methodology is proven to be effective in detecting explosive behavior in the data, irrespective of its origins and applied to wide range of areas covering from foreign exchange to commodity and financial assets.<sup>4</sup> To clarify, the test can only tell whether a bubble has occurred or not. It cannot predict whether a price bubble will arise or whether a detected existing bubble will continue or burst in the upcoming periods.

Deviations from fundamentals are generally measured by ratios such as the price-to-rent ratio, which provides a measure of the rate of return, or the price-to-income ratio, which provides a measure of affordability. Martinez-Garcia et al. (2016) observe that right-tailed unit root tests applied to price-to-fundamental ratios (such as the price-to-rent ratio) can be more informative compared to results obtained from house prices alone, because the ratio of house prices to their fundamental is non-explosive when there is no bubble. As an example, increase in house prices could reflect a persistent increase in rents without being associated with any explosive behavior. In the framework of Martinez-Garcia et al. (2016), in the presence of bubbles, the rate of increase in house prices is greater than that of fundamentals, reflecting the impact of expectations on house prices.<sup>5</sup> On the other hand, even in the presence of explosive behavior in ratios such as the price-to-rent ratio, it is not possible to rule out the possibility of explosiveness driving from unobserved components of fundamentals. Since we may not be able to observe and measure all relevant fundamentals perfectly, results of right-tailed unit root tests based on the ratio of house prices to fundamentals can also in theory be considered inconclusive.

We use the right-tailed unit root test of Phillips et al. (2015) called a *generalized sup ADF* (GSADF) test to detect evidence of the periods of exuberance in housing market in Turkey. The GSADF test is based on repeated application of the standard ADF regression equation to gradually expanding subsets of the full series in question. It can be expressed more formally as follows:

$$\Delta y_t = \alpha_{r_1, r_2} + \beta_{r_1, r_2} y_{t-1} + \sum_{j=1}^k \psi_{r_1, r_2}^j \Delta y_{t-j} + \varepsilon_t, \varepsilon_t \sim^{iid} N(0, \sigma_{r_1, r_2}^2)$$

where  $y_t$  denotes the financial time series that is suspected to contain a bubble. The series  $y_t$  can be the price of an asset (such as house prices) or a measure of the rate of return (such as the price-to-rent ratio). In the equation  $k$  is the maximum number of lag order and  $r_1$  and  $r_2$  are the fractions of the sample ( $0 \leq r_1 < r_2 \leq 1$ ) that indicate that beginning and end of the segment of the original series to which the next iteration of the test would be applied. If  $T$  is the length of the full series, the examined window starts from  $r_1 T^{\text{th}}$  observation and ends in  $r_2 T^{\text{th}}$  observation.

As explained by Phillips et al. (2015), under the assumption that the *fundamentals* of the examined financial series can be represented as a  $I(0)$  or  $I(1)$  process, the series  $y_t$  would at most be  $I(1)$ . In contrast, in the presence of a bubble, asset prices can be explosive. Consequently, the methodology is based on the idea of testing for

explosive behavior in  $y_t$  by defining such behavior as a deviation away from the null of random walk in the direction of explosive behavior. More specifically, for each considered window, the null hypothesis of a unit root in the considered segment  $y_t$  is tested against the alternative of explosive behavior:

$$H_0 : \beta_{r_1, r_2} = 0, H_1 : \beta_{r_1, r_2} > 0.$$

GSADF test is the largest ADF test statistic obtained from recursive tests obtained from all possible values of  $r_1$  and  $r_2$ . Let  $ADF_{r_1}^{r_2}$  represent the ADF test statistics from a particular window. The window size of the regression  $r_w$  expands from  $r_0$  to 1,<sup>6</sup> where  $r_0$  is the minimum window size used. Note that the length of the considered window has to be longer than a minimum length for a meaningful application of the ADF test. That minimum length is expressed as fraction  $r_0$  of the full sample and its value is determined by a rule of thumb proposed by Phillips et al. (2015), as explained below. Together with that constraint, the beginning and the end points of the windows satisfy  $0 \leq r_1 \leq r_2 - r_0$  and  $r_1 + r_0 \leq r_2 \leq 1$ . In other words, the windows' end point  $r_2$  varies from  $r_0$  to 1, while the starting point  $r_1$  varies from 0 to  $r_2 - r_0$ :

$$GSADF(r_0) = \sup_{\substack{r_2 \in [r_0, 1] \\ r_1 \in [0, r_2 - r_0]}} \{ADF_{r_1}^{r_2}\}$$

When the null of a unit root in the considered window of  $y_t$  is rejected, then the dating strategy recommended by Phillips et al. (2015) under the GSADF approach based on *backward SADF* (BSADF) statistic can be used, which is defined as:

$$BSADF_{r_2}(r_0) = \sup_{r_1 \in [0, r_2 - r_0]} \{ADF_{r_1}^{r_2}\}$$

The backward SADF statistic is related to GSADF statistic as follows:

$$GSADF(r_0) = \sup_{r_2 \in [r_0, 1]} \{BSADF_{r_2}(r_0)\}$$

The estimated origination date of the period of exuberance,  $r_e$ , is defined as the first observation in which BSADF statistic exceeds its critical value:

$$\hat{r}_e = \inf_{r_2 \in [r_0, 1]} \{r_2 : BSADF_{r_2}(r_0) > scu_{[r_2 T]}^\alpha\}$$

and estimated termination date of explosive period,  $r_f$ , as the first observation after  $r_e$  where the BSADF statistic falls below its critical value:

$$\hat{r}_f = \inf_{r_2 \in [\hat{r}_e, 1]} \{r_2 : BSADF_{r_2}(r_0) < scu_{[r_2 T]}^\alpha\}$$

where  $scu_{[r_2 T]}^\alpha$  is the 100 (1- $\alpha$ ) % critical value of the SADF test.  $\alpha$  is the chosen level of significance.

### 3. Data

Our main data sources for house prices are HPI and HHPI, which are constructed by the CBRT from appraisal reports to monitor price movements in the housing market. Appraisal reports form the basis of the collateral value for housing loans and are prepared by real

<sup>4</sup> See Phillips and Shi (2018).

<sup>5</sup> Martinez-Garcia et al. (2016, pg. 426).

<sup>6</sup> The fractional window size of the regression  $r_w$  is greater than zero and related to  $r_1$  and  $r_2$  as follows:  $r_w = r_2 - r_1$ .

estate appraisal companies. The actual sale of the property and utilization of the loan is not required and price data for all houses appraised, regardless of their construction year, are used to develop the house price indices. House prices indicated in valuation reports prepared at the time of approval of individual housing loans are considered as a proxy for price, since the prices of properties are determined when they are actually sold. For this reason, the sample set, which is used to produce house price indices, is not limited to only houses that are sold, which avoids a potential sample selection bias. Moreover, valuation reports, which are written by real estate appraisal companies, are more realistic than asking prices that are advertised for by sellers. As a result, appraisal reports are considered a reliable basis for house price indices than available alternatives.

The “Stratified Median Price Method” is implemented in constructing HPI, since it measures price movements in the heterogeneous housing market. HPI is calculated using the Chain Laspeyres Index method and weights are updated each year. HHPI measures quality-adjusted price changes related to observed housing characteristics and it is produced by using a “characteristic-prices-based” hedonic regression method and a log-linear regression model. The log-linear regression model is applied for each stratum and for each period, which enables observing the price effects of quality component changes by stratum and in time (Hülagü et al., 2016). Data on house sales registered by the General Directorate of Land Registry and Cadaster are used as weights in constructing both indices.<sup>7</sup>

HPI and HHPI are announced monthly starting from January 2010 for the whole country and for 26 geographical regions at the NUTS2 level, with a base year of 2010. We examine house price developments from January 2010 to January 2019, which covers 109 months, a more than sufficient length for our econometric estimations. The behavior of HPI and HHPI show some similarities during this period, but HPI reaches a significantly higher level than HHPI (Fig. 1 and Fig. 2). HPI and HHPI increased by 20.7% and 15.5% annually on average between 2010 and 2018, respectively.<sup>8</sup>

Price indicators present a mixed picture for the housing market in the period of analysis. HPI and HHPI continued to increase, albeit at a decreasing rate, while price to rent ratio started to stabilize in the second half of 2016 and real hedonic house price inflation turned to negative in the first quarter of 2017 (Fig. 3 and Fig. 4). However, we observe that there are significant differences in price levels between 3 big cities and these differences are preserved even when we examine relative prices. Istanbul and İzmir always lie above country average, whereas Ankara remains subdued according to all price indicators. The stabilization in price-to-rent ratio mainly stems from the slowdown in house price inflation. Rent inflation was significantly above consumer price inflation at the beginning of 2000s, but it fell swiftly from the last quarter of 2008 till the third quarter of 2009, which coincides with the contractionary period in Turkey due to the GFC. In the subsequent periods, rent inflation stayed below headline inflation (Fig. 5). Rent inflation is generally higher than country average in Istanbul and İzmir, but it remains muted in Ankara. These empirical observations also reveal

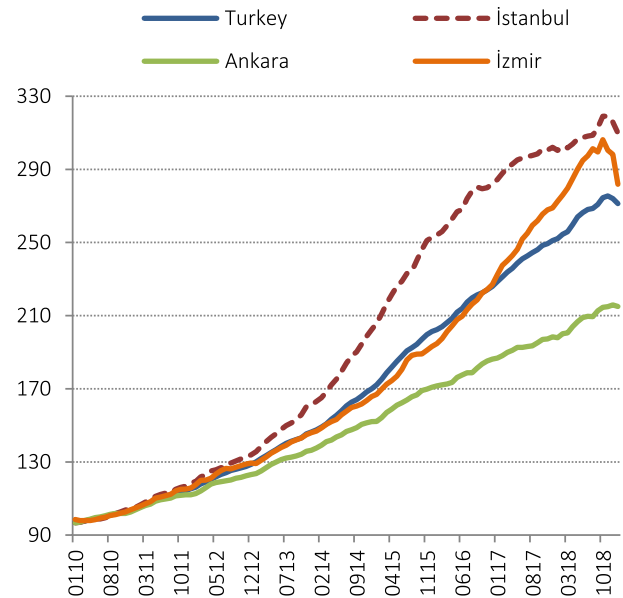


Fig. 1. House price index (2010 = 100)  
Source: CBRT

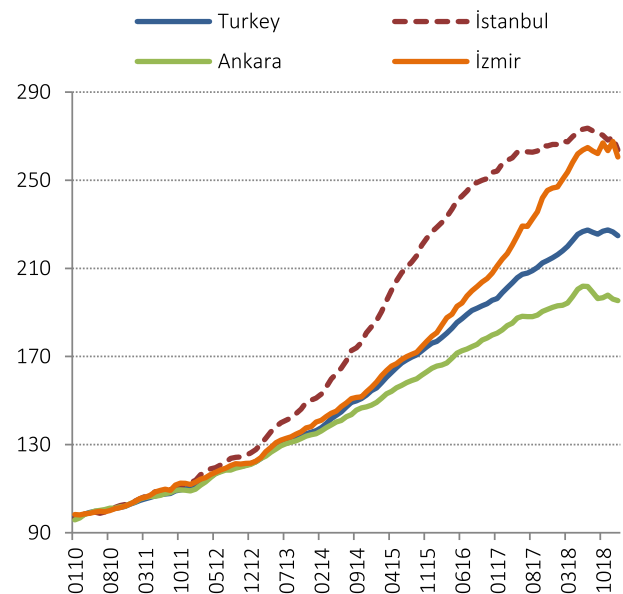


Fig. 2. Hedonic house price index (2010 = 100)  
Source: CBRT

the importance of analyzing relative price movements with respect to geographical regions. In the empirical analysis section, each 26 region will be tested rigorously using price-to-rent ratios and real hedonic house prices (Fig. 6).

According to HBS, housing and rent expenditures constitute the largest item in total household budget in Turkey. Although, its share in total household budget fell to 24.7% in 2017 from 27.3% in 2002, it still stands at a fairly high level. Moreover, TURKSTAT estimates that home-ownership rate declined to 57.4% in 2017 from 73.1% in 2002, while the percentage of tenants in total number of households increased to 26.3% in 2017 from 18.7% in 2002. Total number of households increased by 2.67% on average annually between 2002 and 2017, which can explain the fall in home-ownership rate partially. However, the percentage of households that own more than one house also increased significantly in this period.

<sup>7</sup> HPI is not disseminated after January 2019. Instead, the Residential Property Price Index (RPPI), which is basically the same index with the HHPI, is disseminated monthly starting from February 2019. [https://evds2.tcmb.gov.tr/index.php?evds/DataGroupLink/9/bie\\_hkfe/en](https://evds2.tcmb.gov.tr/index.php?evds/DataGroupLink/9/bie_hkfe/en) See CBRT web site for more information. <http://www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Statistics/Real+Sector+Statistics/Residential+Property+Price+Index/>.

<sup>8</sup> Building quality improved significantly in Turkey in the last two decades for two main reasons. First, there were major changes in the legal framework in the construction sector after the destruction caused by the earthquake in August 1999. For this reason, houses that are built after 2001 are generally considered as better. Second, sustained economic growth raised income per capita and also financial market conditions were favorable in this period, which stimulated demand for high quality buildings.

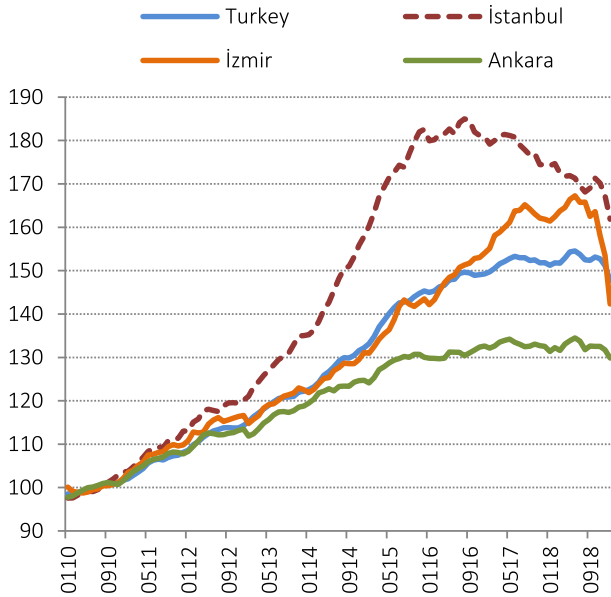


Fig. 3. Price to rent ratio (2010 = 100).  
Source: CBRT and TURKSTAT

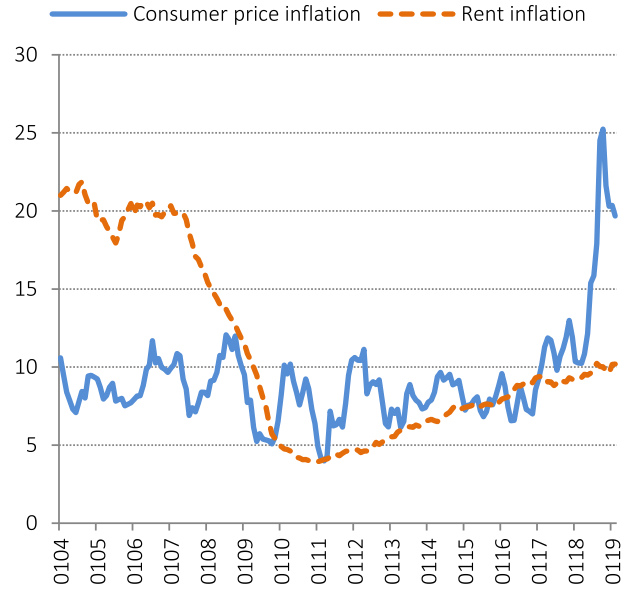


Fig. 5. Rent inflation (%).  
Source: CBRT and TURKSTAT

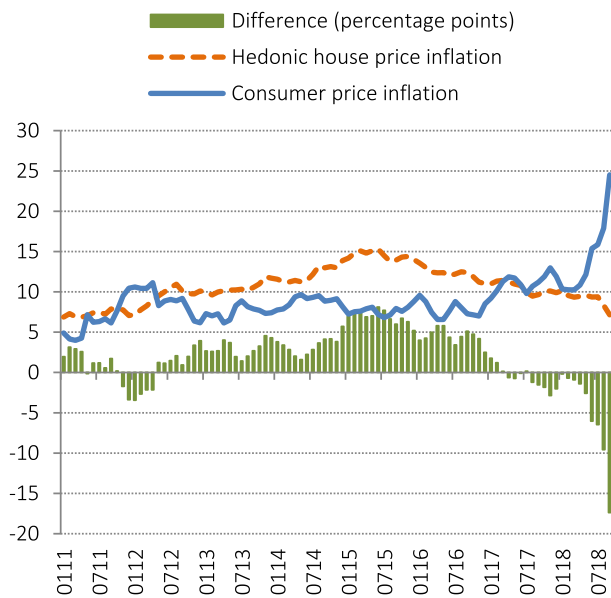


Fig. 4. Annual hedonic house price inflation (%).  
Source: CBRT and TURKSTAT

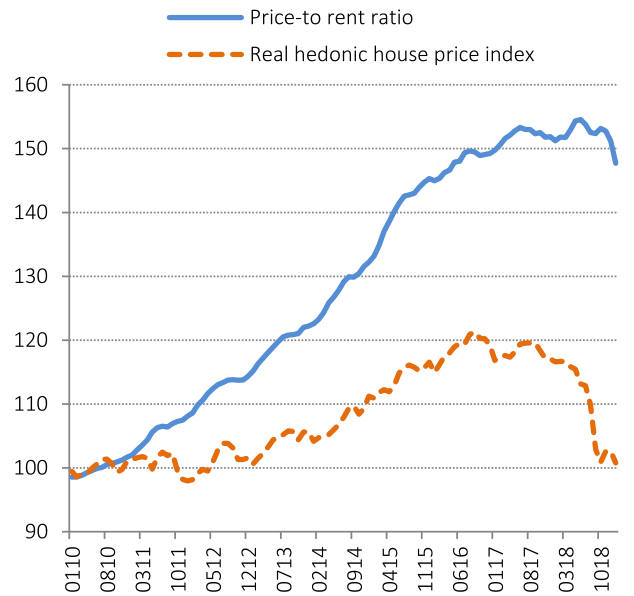


Fig. 6. Relative prices (2010 = 100).  
Source: CBRT and TURKSTAT

Therefore, we can argue that the decline in home-ownership rate despite strong house sales suggests that house purchases were also motivated with investment purposes. As a result, this approach might have led to explosiveness in house prices.

Going back to the house price indicators we employ in this study, the methodology requires relative price measures to determine periods of exuberance in house prices (Phillips et al., 2015; Caspi, 2016; Martinez-Garcia et al., 2016). Those relative price indicators would reveal whether house prices exhibit explosiveness in comparison to fundamental economic variables. The price-to-rent ratio and the price-to-income ratio are natural candidates for this study. However, income per capita figures are available only annually between from 2004 to 2017 at regional level, which does not provide enough observations for time-series analysis. For this purpose, we divide HPI, as noted, by the rent index, which is a sub-

item of CPI, to calculate the price-to-rent ratio. Similarly, we should divide HHPI with a quality-adjusted rent index, but such a rent index is not available for the Turkish economy. Therefore, we analyze real hedonic housing prices by dividing HHPI instead by headline CPI. The analysis of a relatively wide time span using two different measures, and doing the analysis countrywide as well as regionally, enriches our econometric results.

#### 4. Econometric results

The methodologies described in section 2 are applied to both the house price series and the price-to-rent ratio for the whole country and 26 geographical regions at the NUTS2 level. The technical details are as follows. We use a minimum window size of 19 months, in line with the recommendation of Phillips et al. (2015)

to choose  $r_0 = 0.01 + 1.8/\sqrt{T}$ . The autoregressive lag length,  $k$ , is chosen on the basis of the fixed lag length approach that is recommended again by the same authors. A fixed lag length is preferable because Phillips et al. (2015) indicate that more sophisticated lag length selection procedures could result in a reduction in the power of both SADF and GSADF tests.<sup>9</sup> Those authors also find that the size of SADF and GSADF tests is “reasonably well controlled when a small fixed lag length is used”, and that specifications with no or one lag have better size properties. Based on those findings, we perform our analysis using fixed lag length of one, i.e.,  $k = 1$ . The finite sample critical values are obtained by Monte Carlo simulations with 2,000 replications.<sup>10</sup>

While date-stamping the periods of exuberance, explosive periods of very short durations are excluded, following the practice adopted in Phillips et al. (2015, pg. 1052). The authors recommend a minimum duration for an explosive behavior to exist. In our study, we neglect very short periods of exuberance and require that the duration must be at least 2 months to be labeled as an explosive period.

We present our results below. As we observed earlier, rent inflation is lower than headline inflation in our sample on average. Moreover, house price inflation is higher than hedonic house price inflation. Consequently, the likelihood of detecting exuberance when we use the price-to-rent ratio is higher than when we use the real hedonic house price index.

We detect exuberance in the countrywide price-to-rent ratio over much of the 2012–2015 period for Turkey, due to rapid increases in house prices accompanied by relatively stable rent prices. On the other hand, we observe exuberance in real hedonic house prices for shorter periods of time. On the basis of this overall picture, we turn to the regional findings to shed light on our findings of explosive periods.

Before going into the details of regional findings, we should mention that one of the main factors affecting local dynamics that can lead to regional differences is the fact that a large number of Syrian refugees accumulated rapidly in Turkey, in a short period that started in 2012, with the official number of refugees reaching 3.6 million, close to 5% of the country's population, by 2019, even when the unofficial refugees are not taken into account.<sup>11</sup> These refugees are mostly concentrated in cities like İstanbul, Bursa, İzmir, Gaziantep, Konya, Hatay, Adana, Burdur, Mersin, Kilis and Şanlıurfa.<sup>12</sup> Therefore, we interpret the regional results taking this dynamic into account.<sup>13</sup>

We detect uninterrupted long periods of explosive house price increases in İstanbul starting from the second half of the 2013 till the second half of 2016 when we use the price-to-rent ratio. This has been the case from second half of the 2014 till the end of 2016 when the real hedonic house price index in the tests. The results from those two variables differ, however, in more recent times. The tests using the real hedonic house price index indicate that İstanbul experienced implosion in real house prices in the second half of 2018, while the detected implosion is of a much shorter duration when the price-to-rent ratio is used.

We find that İzmir experienced explosive behavior in the price-to-rent ratio between 2015 and 2017 almost continuously, while

the test results based on the real hedonic house price index indicate explosive house price increases in some of the months in 2016 and 2017. The difference between the two results is consistent with anecdotes regarding the prevalence of luxurious houses in new constructions in İzmir, and the fact that the HHPi adjusts prices to account for the higher quality in those new buildings. We do not observe implosion in house prices in İzmir in the tests using either of the variables.

At the same time, our empirical findings show that Ankara experienced explosive periods only briefly, i. e., in a couple of months of 2014 and 2015 on the basis of the tests using price-to-rent ratio. In contrast, the tests for Ankara using the real hedonic house price index indicate no explosiveness in those years and instead find implosion in house prices in most of the second half of 2018.

The differences in the econometric results for the metropolitan cities in Turkey might stem from social and/or demographic factors, which underlie the importance of carrying out empirical analyses at the regional level. İstanbul is the largest city by far in terms of population and approximately about a fifth of all houses in Turkey are located in the İstanbul region as of 2017. Furthermore, the ratio of house sales to foreigners in İstanbul is the highest among all cities in Turkey. Therefore, understanding the dynamics in İstanbul is of particular interest. As noted, tests based on both the price-to-rent ratio and the real hedonic house price index exhibit a comparably long period of exuberance in house prices for İstanbul. A contributor to this explosive behavior is the high demand from foreign buyers for housing in İstanbul, and another is the large number of Syrian refugees to that metropolitan area, which reached 546 thousand as of 2019. We observe similar effects (high Syrian refugee inflow accompanied by strong house prices) in some other regions as well, such as TR62 (Adana, Mersin).

Finally, consistent with the finding that Turkey has been experiencing declining real hedonic house prices recently, particularly after 2016, we detect negative bubbles in a number of regions corresponding to that decline. The price behavior flagged by the tests towards the end of the sample in real hedonic house prices is invariably associated with implosion episodes. We observe implosion episodes in Turkey as well as some particular regions such as TR10 (İstanbul), TRC3 (Batman, Mardin, Siirt, Şırnak), TRA1 (Erzurum, Erzincan, Bayburt), TRA2 (Ağrı, Ardahan, Kars, Iğdır), TRB2 (Van, Bitlis, Hakkari, Muş), TRC1 (Kilis, Adıyaman, Gaziantep), TRC2 (Diyarbakir, Şanlıurfa), TR42 (Bolu, Kocaeli, Sakarya, Yalova, Düzce), TR51 (Ankara), TR61 (Antalya, Burdur, Isparta), TR62 (Adana, Mersin), TR63 (Hatay, Kahramanmaraş, Osmaniye), TR33 (Afyonkarahisar, Kütahya, Manisa, Uşak).<sup>14</sup>

## 5. Conclusion

This study examines whether house prices exhibit explosive behavior in recent years, based on measures of price-to-rent ratios and real hedonic house prices using a sample from January 2010 to January 2019. An intriguing feature of our study is the use of a cross-sectional dimension, covering 26 geographic regions at the NUTS2 level for Turkey. The analysis also covers a relatively wide time span compared to the existing studies of the Turkish housing market. To that purpose, we employ a methodology developed by Phillips et al. (2015) and later improved by Phillips and Shi (2018) to detect explosive behavior as well as implosion in house prices, which provides a useful tool for policy makers to monitor house prices in real-time.<sup>15</sup> Main contribution of the work in this paper is

<sup>9</sup> Procedures such as the Modified Information Criteria of Ng and Perron (2001) and sequential hypothesis testing Ng and Perron (1995) have higher computational cost.

<sup>10</sup> Matlab computer codes accompanying Phillips and Shi (2018) provided at the link <https://sites.google.com/site/shupingshi/home/codes> are used to get finite sample critical values and BSADF statistics.

<sup>11</sup> [http://www.goc.gov.tr/jicerik3/gecici-koruma\\_363\\_378\\_4713](http://www.goc.gov.tr/jicerik3/gecici-koruma_363_378_4713).

<sup>12</sup> See the map on the above link and also Akgündüz et al. (2015).

<sup>13</sup> Akgündüz et al. (2015) found positive effect of Syrian refugee influx on house prices for the effected regions.

<sup>14</sup> See Table A1 for geographical regions.

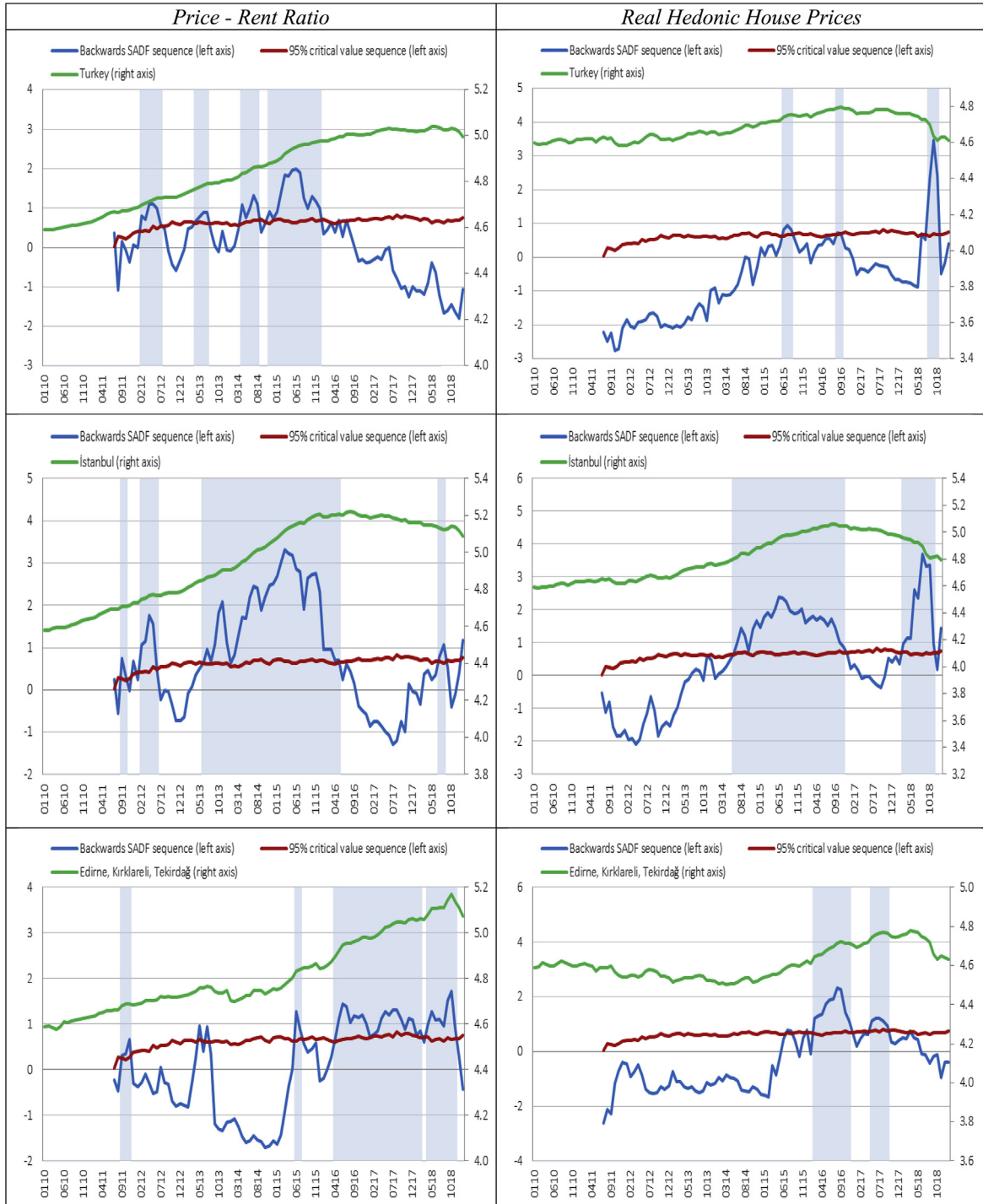
<sup>15</sup> For example, the FRB of Dallas utilizes that tool to create a database of exuberance to monitor price behavior in international housing markets.

to create a framework that enables analysis of house prices in Turkey countrywide as well by regions with an ability to judge when there is exuberance or implosion in house prices.

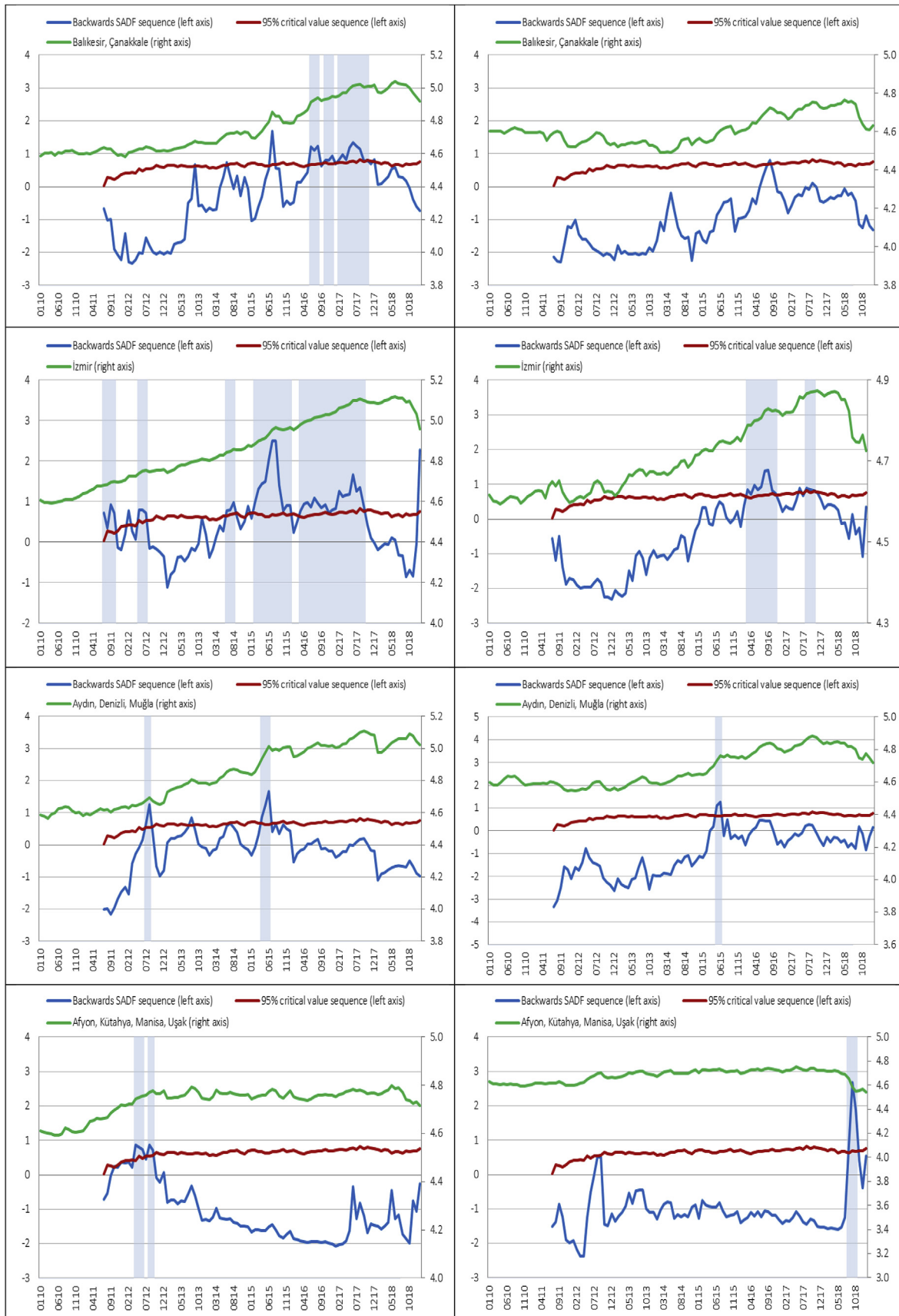
Our empirical findings indicate that there were explosive price movements in Turkey and especially in İstanbul and İzmir for multiple periods since 2013. Exuberance in house prices becomes evident after 2015. However, we discover that explosive price behavior turned into implosion in many regions starting from 2018. The evidence for exuberance is stronger in tests that rely on price-to-rent ratios, and stronger for implosion episodes in tests that rely on real hedonic house prices, reflecting the slower trend in rent

inflation relative to CPI over the sample period and the fact that hedonic measures rising less rapidly than the conventional measures of house prices. We also see signs of the impact of Syrian refugee inflows in house prices in some regions (e.g., İstanbul, Adana and Mersin). Our results depart from the existing studies on Turkey, where they do not find explosiveness in housing market.

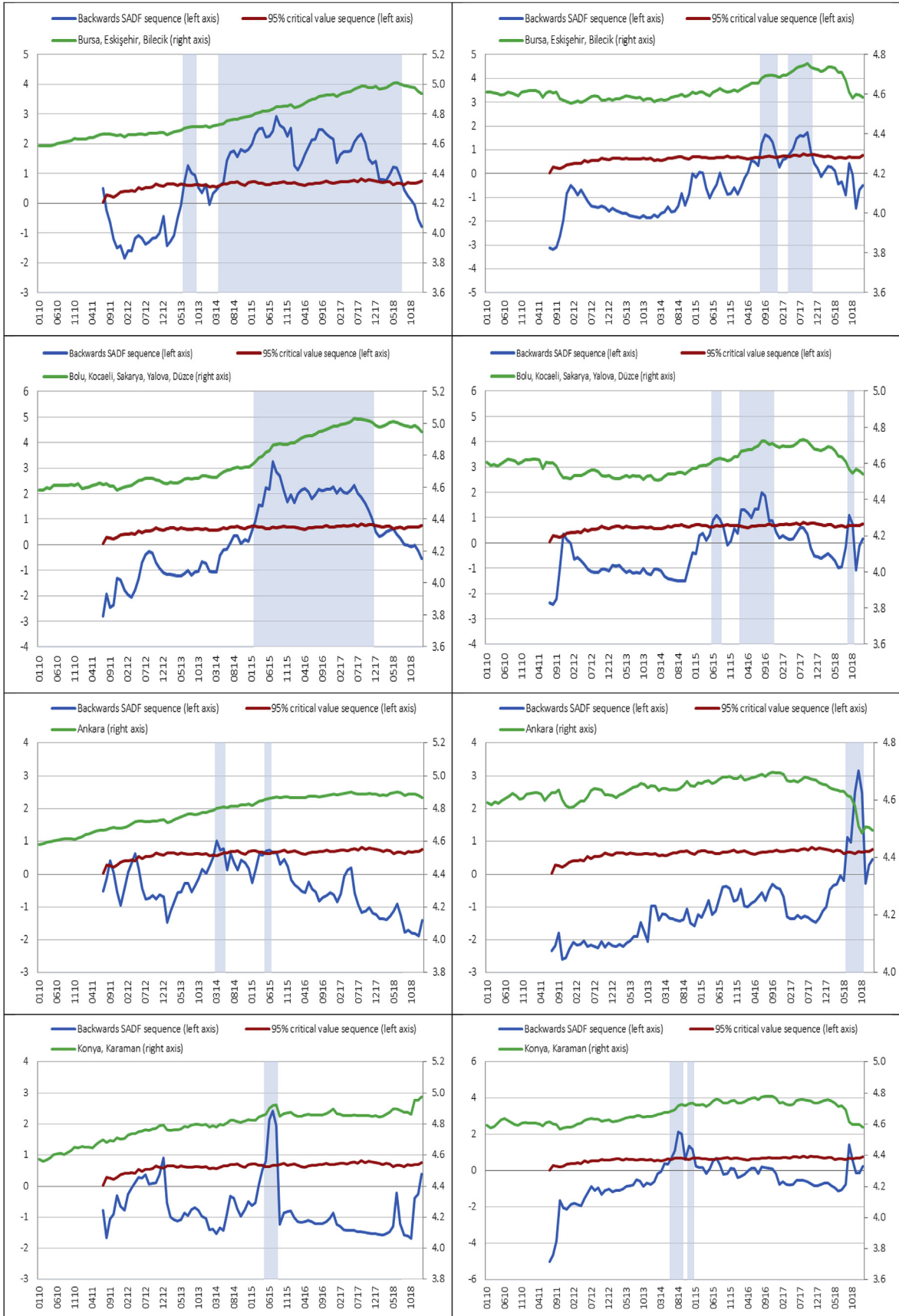
**Appendix 1. Test Results**



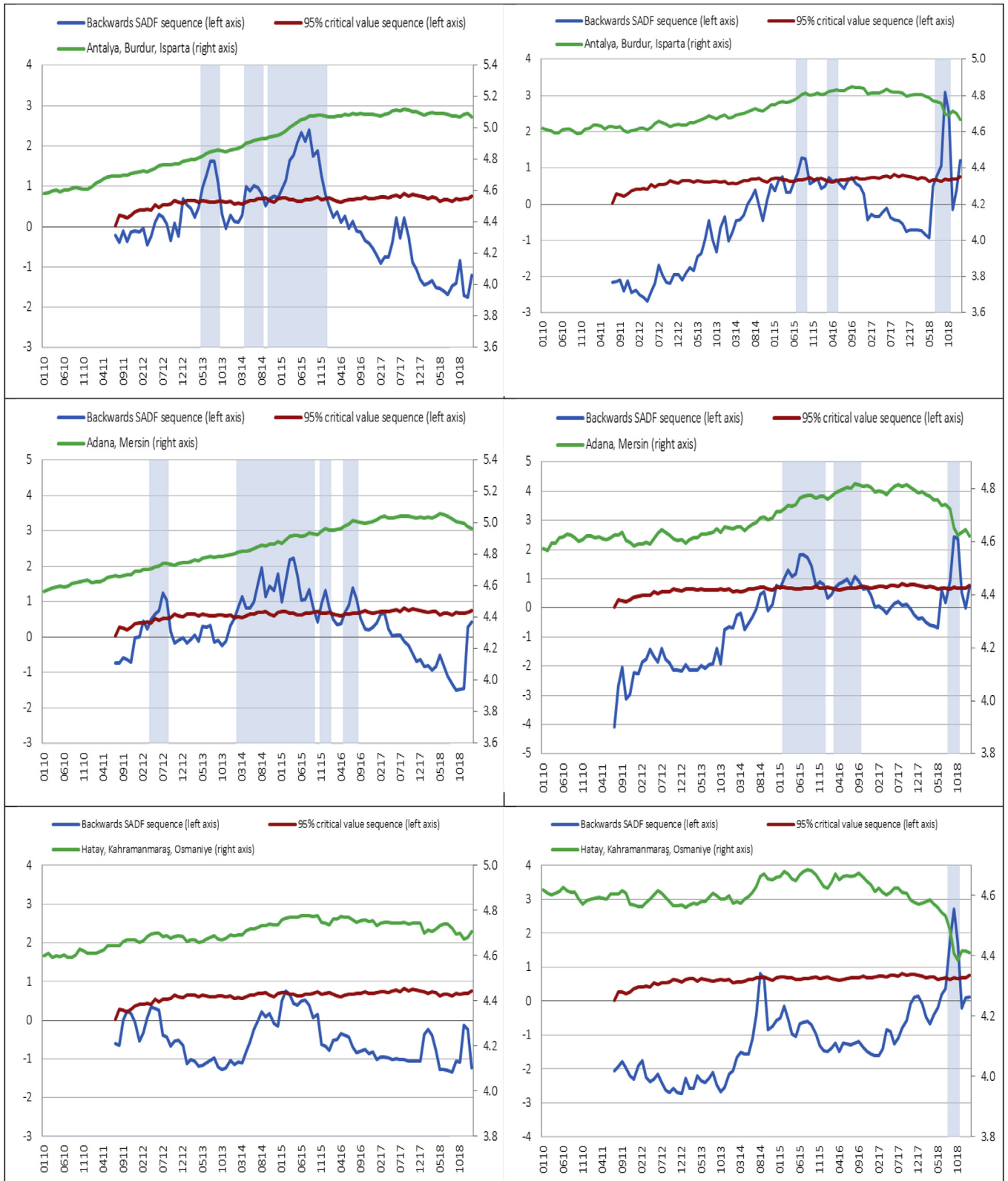




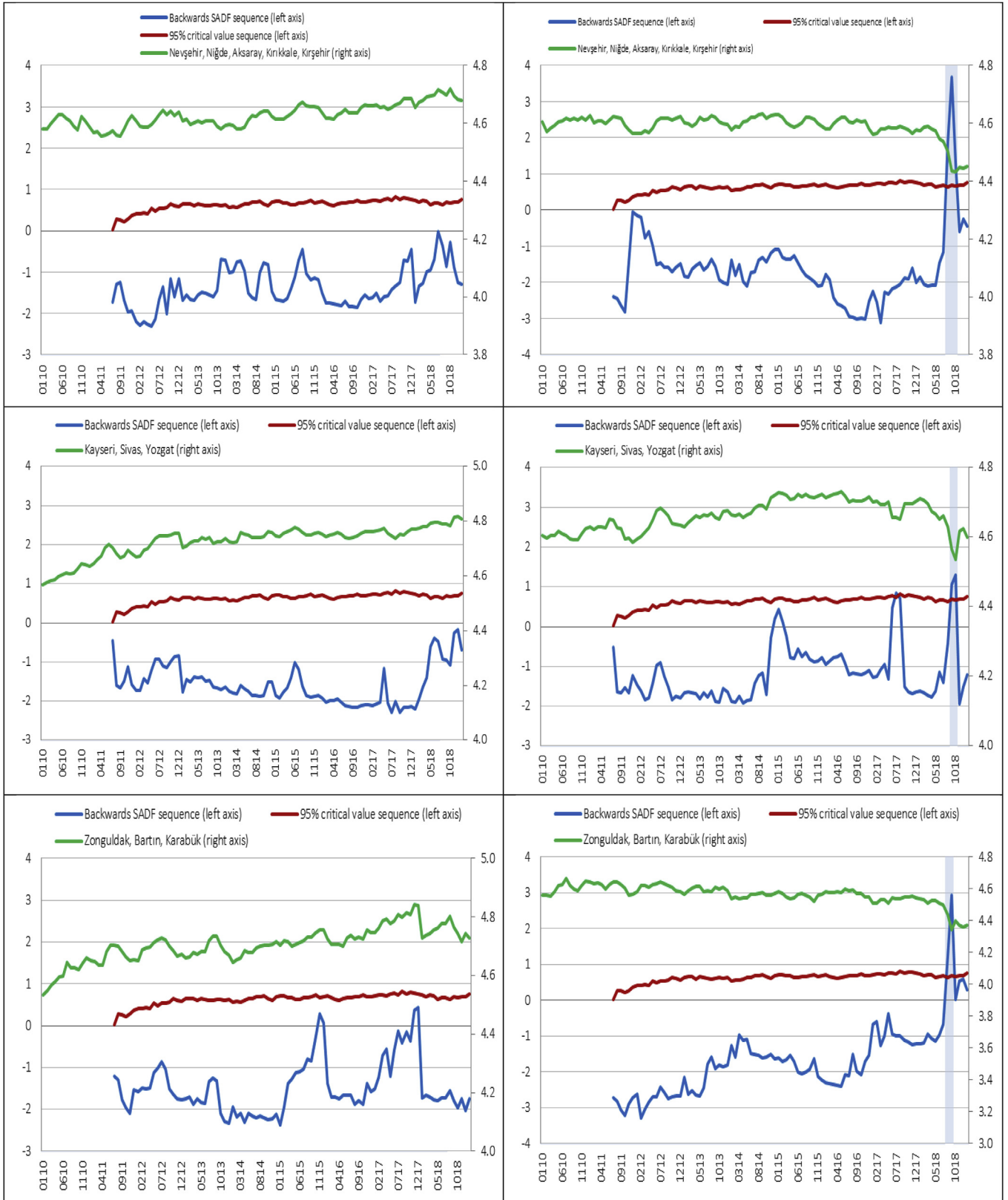
(continued).



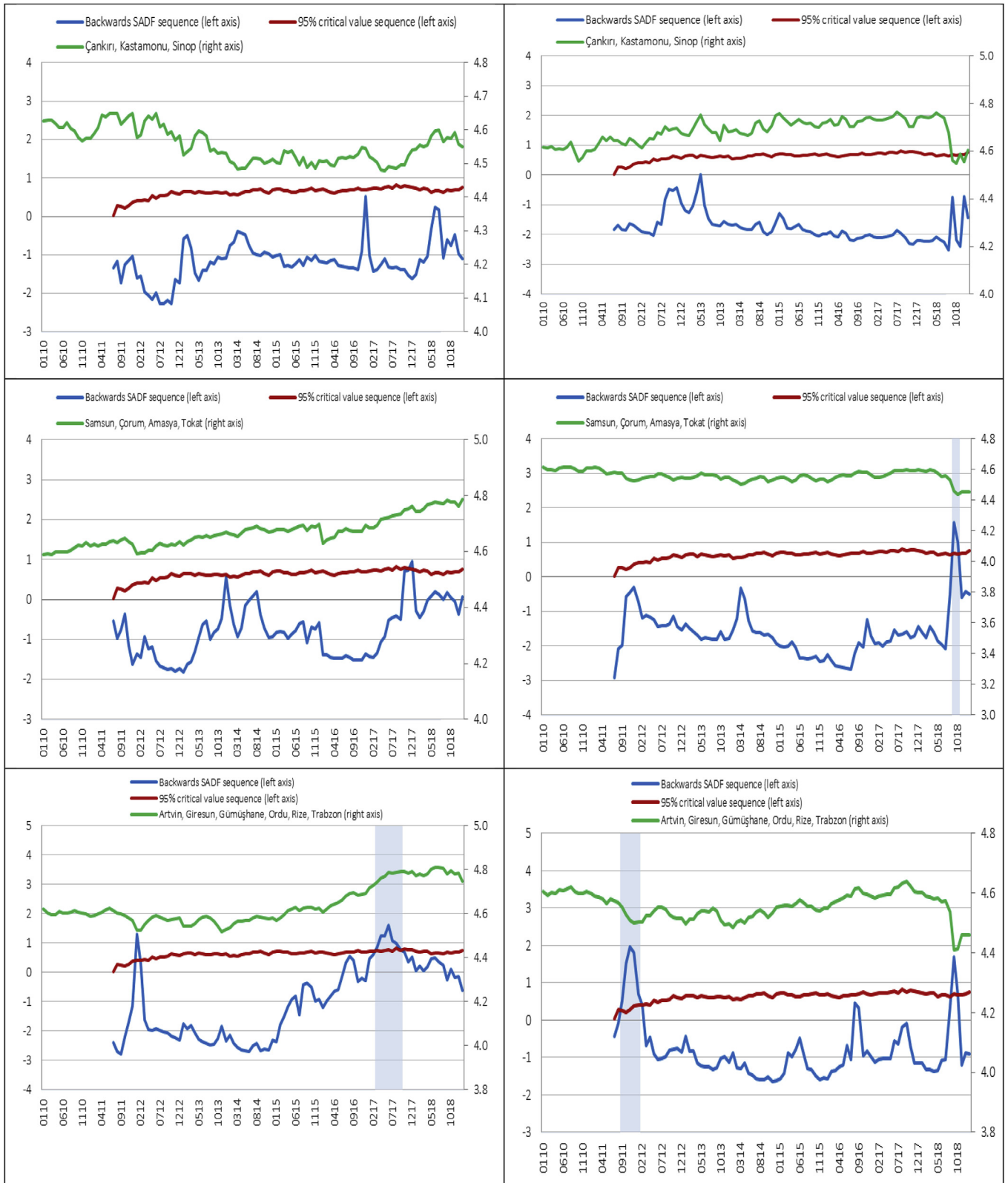
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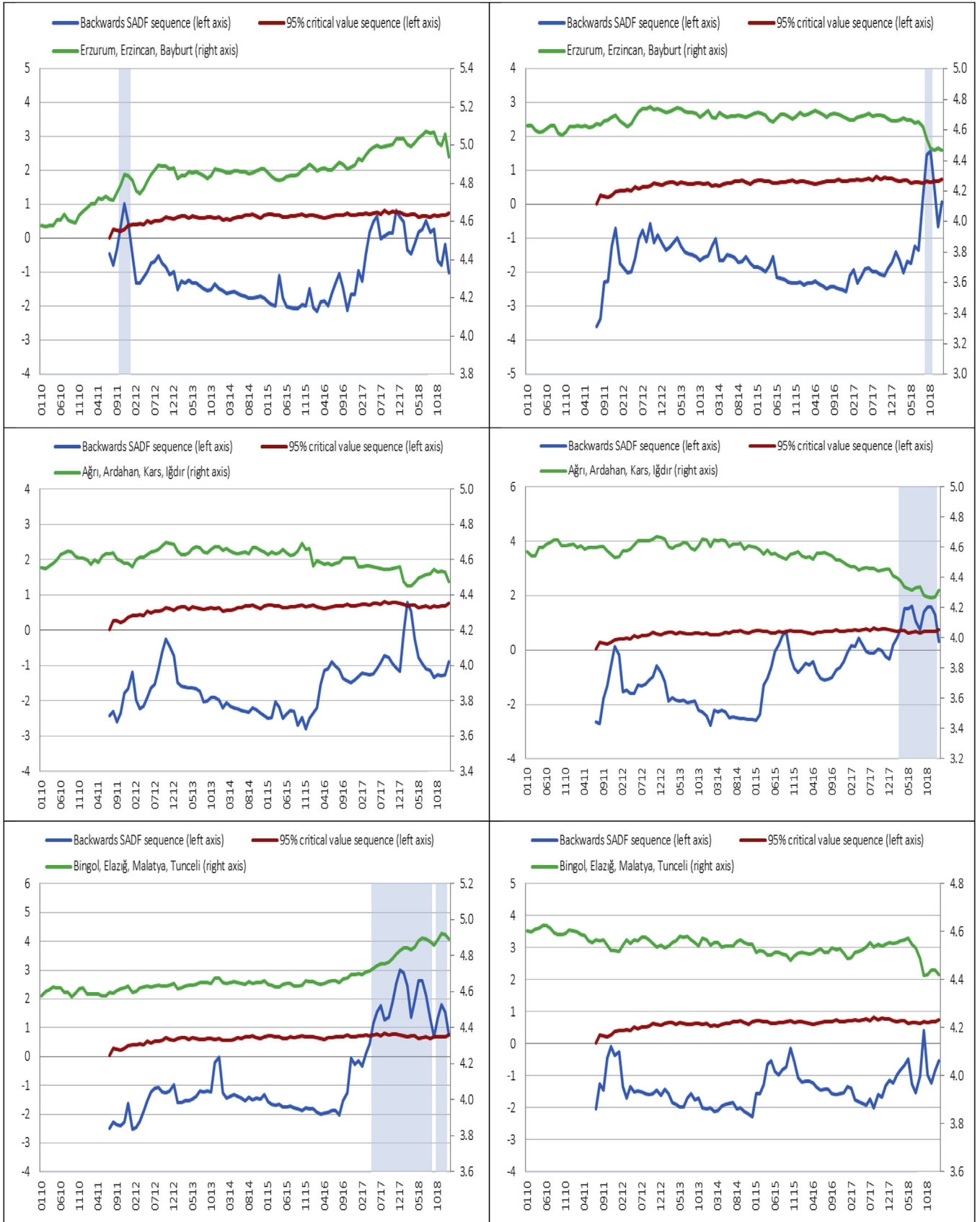
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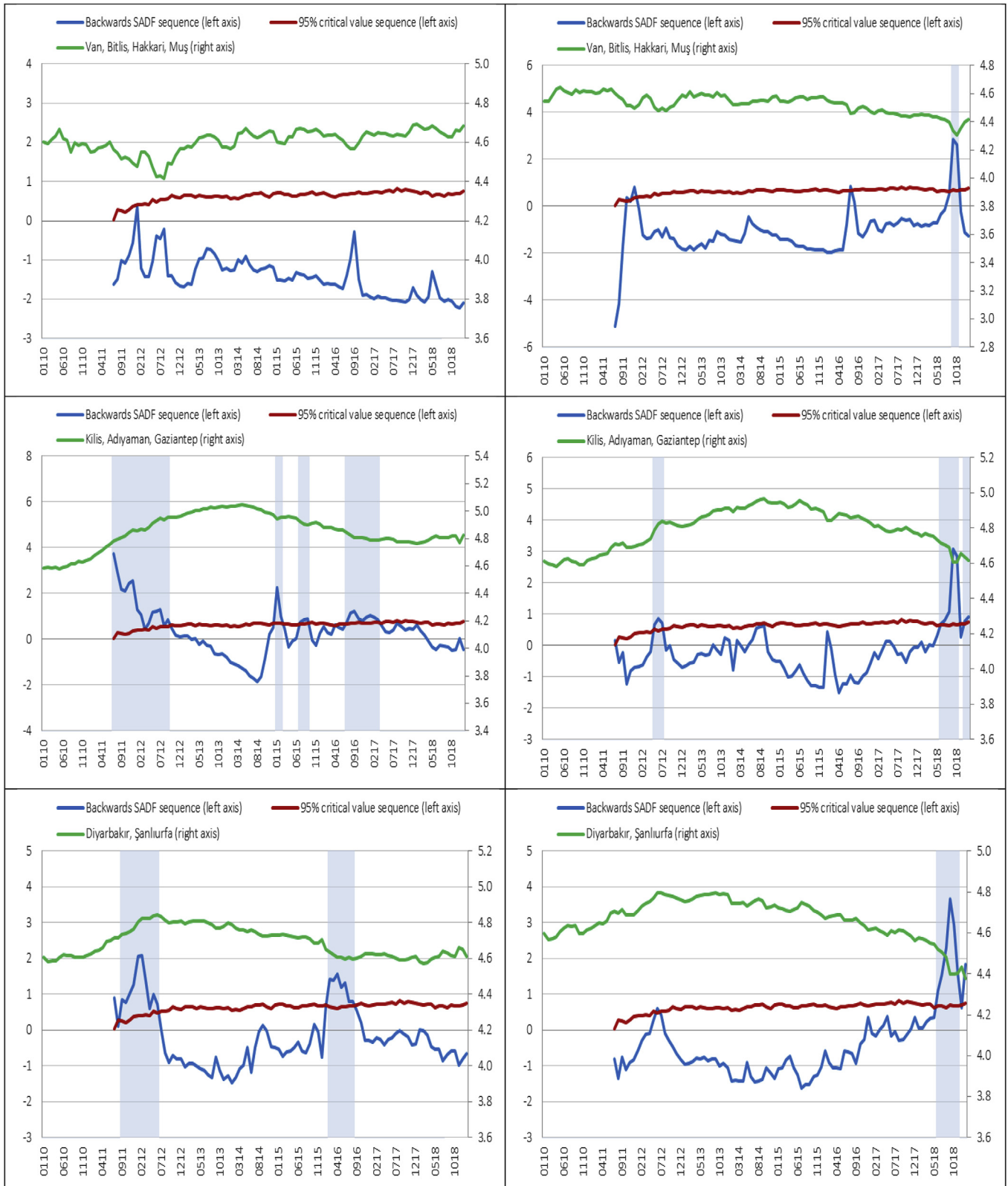
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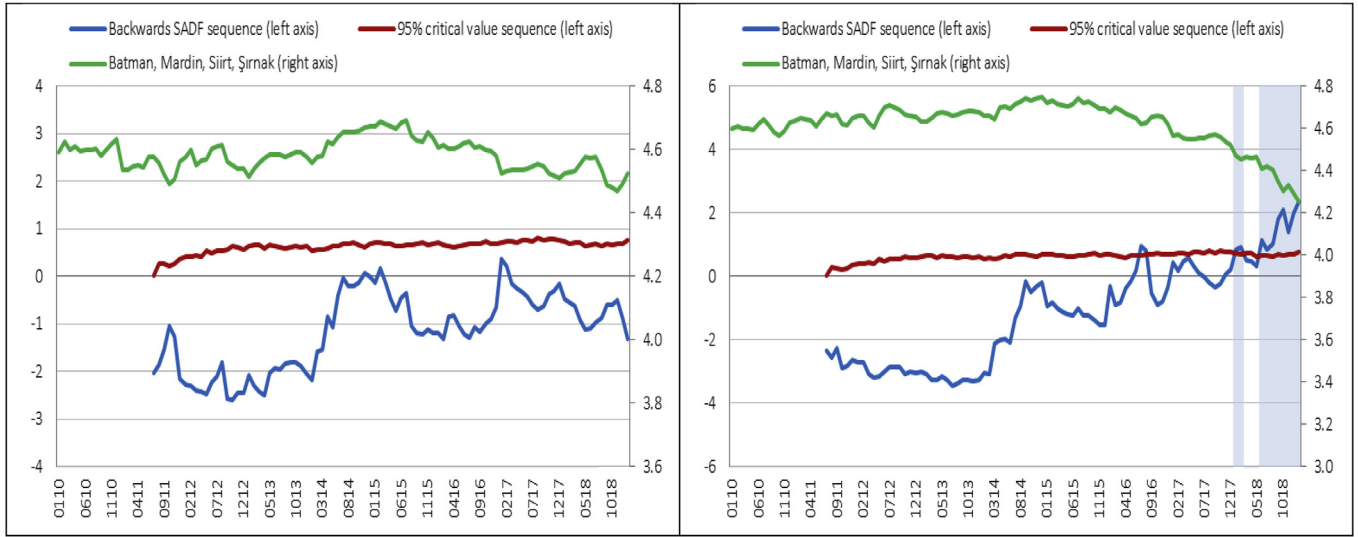
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(continued).

## Appendix 2. Geographical regions

**Table A1**  
TURKSTAT NUTS1 and NUTS2 Codes

Regions		Province		Regions		Province			
1	TR1	İstanbul	TR100	İstanbul	8	TR8	West Black Sea	TR811	Zonguldak
2	TR2	West Marmara	TR211	Tekirdağ				TR812	Karabük
			TR212	Edirne				TR813	Bartın
			TR213	Kırklareli				TR821	Kastamonu
			TR221	Balıkesir				TR822	Çankırı
			TR222	Çanakkale				TR823	Sinop
3	TR3	Aegean	TR310	İzmir				TR831	Samsun
			TR321	Aydın				TR832	Tokat
			TR322	Denizli				TR833	Çorum
			TR323	Muğla				TR834	Amasya
			TR331	Manisa	9	TR9	East Black Sea	TR901	Trabzon
			TR332	Afyonkarahisar				TR902	Ordu
			TR333	Kütahya				TR903	Giresun
			TR334	Uşak				TR904	Rize
4	TR4	East Marmara	TR411	Bursa				TR905	Artvin
			TR412	Eskişehir				TR906	Gümüşhane
			TR413	Bilecik	10	TRA	North East Anatolia	TRA11	Erzurum
			TR421	Kocaeli				TRA12	Erzincan
			TR422	Sakarya				TRA13	Bayburt
			TR423	Düzce				TRA21	Ağrı
			TR424	Bolu				TRA22	Kars
			TR425	Yalova				TRA23	Iğdır
5	TR5	West Anatolia	TR510	Ankara				TRA24	Ardahan
			TR521	Konya	11	TRB	Middle East Anatolia	TRB11	Malatya
			TR522	Karaman				TRB12	Elazığ
6	TR6	Mediterranean	TR611	Antalya				TRB13	Bingöl
			TR612	Isparta				TRB14	Tunceli
			TR613	Burdur				TRB21	Van
			TR621	Adana				TRB22	Muş
			TR622	Mersin				TRB23	Bitlis
			TR631	Hatay				TRB24	Hakkari
			TR632	Kahramanmaraş	12	TRC	South East Anatolia	TRC11	Gaziantep
			TR633	Osmaniye				TRC12	Adıyaman
7	TR7	Middle Anatolia	TR711	Kırıkale				TRC13	Kilis
			TR712	Aksaray				TRC21	Şanlıurfa
			TR713	Niğde				TRC22	Diyarbakır
			TR714	Nevşehir				TRC31	Mardin
			TR715	Kırşehir				TRC32	Batman
			TR721	Kayseri				TRC33	Şırnak
			TR722	Sivas				TRC34	Siirt
			TR723	Yozgat					



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