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ANALYSIS OF FOOD INFLATION CONVERGENCE IN NUTS II REGIONS OF TÜRKIYE

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Abstract

The aim of this paper is to augment the existing literature on convergence of food inflation, by considering the structural break to the convergence debate. To this aim, the stochastic convergence of food inflation in NUTS II regions of Türkiye for 2006-2022 is investigated by using panel unit root tests that captures smooth and sharp breaks. Furthermore, first and second-generation panel unit root test is applied to robust the findings. The findings differ depending on whether the tests take into account the cross-sectional dependence and structural breaks. The empirical results are as follows: (i) Yin and Wu (2001) test indicates that food inflation is generally stationary at the region-specific level and non-stationary at the panel level. (ii) Food inflation is overwhelmingly stationary in both region-specific and panel level according to PANIC, CA and Panel Fourier test findings. (iii) Carrion-i Silvestre et al. (2005) test shows that food inflation is generally stationary in both region-specific and panel level. These findings are strongly in favour of convergence of food inflation among NUTS-II regions.

Keywords ***:*** *Stochastic Convergence, Food Inflation, Structural Break*

JEL Classification ***:*** *P25, C23*

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TÜRKİYE'NİN DÜZEY II BÖLGELERİNDE GIDA ENFLASYONUN YAKINSAMASININ ANALİZİ

Öz

Bu araştırmanın amacı, gıda enflasyonunun yakınsamasına ilişkin mevcut literatüre, yakınsama tartışmalarındaki yapısal kırılmaları dikkate alarak katkıda bulunmaktır. Bu amaçla, Türkiye'nin NUTS II bölgelerinde 2006-2022 dönemi için gıda enflasyonunun stokastik yakınsaması, yumuşak ve keskin kırılmaları yakalayan panel birim kök testleri kullanılarak araştırılmıştır. Ayrıca, bulguları sağlamlaştırmak için birinci ve ikinci nesil panel birim kök testleri uygulanmıştır. Bulgular, testlerin yatay kesit bağımlılığını ve yapısal kırılmaları dikkate alıp almadığına bağlı olarak farklılık göstermektedir. Ampirik sonuçlar aşağıdaki gibidir: (i) Yin ve Wu (2001) testi, gıda enflasyonunun bölgeye özgü düzeyde genel olarak durağan olduğunu ve panel düzeyinde durağan olmadığını göstermektedir. (ii) PANIC, CA ve Panel Fourier test bulgularına göre gıda enflasyonu hem bölge hem de panel düzeyinde büyük ölçüde durağandır. (iii) Carrion-i Silvestre vd. (2005) testi, gıda enflasyonunun hem bölgeye özgü hem de panel düzeyinde genel olarak durağan olduğunu göstermektedir. Bu bulgular, NUTS-II bölgeleri arasında gıda enflasyonunun yakınsamasını güçlü bir şekilde desteklemektedir.

Anahtar Kelimeler ***:*** *Stokastik Yakınsama, Gıda Enflasyonu, Yapısal Kırılma*

JEL Sınıflandırması ***:*** *P25, C23*

INTRODUCTION

The concept of convergence, first first proposed by Jan Tinbergen (1959), builds on the neoclassical economic growth model developed by Solow (1956) (Tunay & Silpagar, 2007: 2). Convergence hypothesis has been one of the main research topics in the economic literature. According to the convergence hypothesis, growth among countries with different income levels and resource allocations will eliminate income differences. As a result of this situation, a poor country will catch up with the rich ones (Yeşilyurt, 2014: 305; Tıraşoğlu & Yurttagüler, 2018: 312). This is due to the assumption of diminishing returns. The marginal productivity of capital is higher in capital-scarce countries than in capital-abundant countries (Islam, 2003: 314).

In economics literature, there are three different convergence approaches: a) beta convergence, b) sigma convergence and c) stochastic convergence, which can be divided into two types: unconditional and conditional convergence (Ahmed et al., 2017: 87). Beta convergence is based on the examination of the relationship between the per capita income growth in the initial year and in the subsequent years. If the relationship has a negative sign, there is convergence, and if it has a positive sign, there is divergence (Karaca, 2004: 2-3). Beta convergence chronologically started with the concept of unconditional convergence and continued with the concept of conditional convergence (Islam, 2003: 316). Unconditional convergence foresees that economies will reach the same steady state due to their homogeneity, while conditional convergence foresees that economies will reach different steady states due to their heterogeneity (Sevinç et al., 2016: 11). Following the concept of conditional convergence, the concepts of sigma and stochastic convergence emerged (Islam, 2003: 316). Sigma convergence is based on the change in the distribution of series across countries over a period of time. Standard deviation is preferred as a measure of dispersion. A decrease in the standard deviation indicates convergence, while the opposite situation indicates divergence (Karaca, 2004: 3; Sevinç et al., 2016: 11). Stochastic convergence, developed by Durlauf and Johnson (1995), focuses on the persistence of shocks on relative variables. Unit root tests are generally used to test the stochastic convergence hypothesis. If the mean and variance of the series do not change over time, it is concluded that there is convergence between the units (Topallı, 2021: 609).

A review of the literature reveals that convergence hypotheses are predominantly used to analyse income and inflation convergence (Duran, 2016: 9). Although the first studies were on income convergence, inflation convergence has been examined increasingly in recent empirical studies (Tıraşoğlu & Yurttagüler, 2018: 314). Two factors underlie this growing interest in inflation convergence. The first is that inflation is the main concern for the actors responsible for monetary policy stability (Güriş et al., 2020: 86). The second is the developments toward the establishment of economic unions such as the European Union, which uses a common currency (Belke & Al, 2019: 302). Research on inflation convergence is conducted under three main headings: between geographical regions in a single country, between countries or groups of countries in the same geography and between groups of countries in different geographies (Tunay & Silpagar, 2007: 3).

The persistent spread of high inflation at the regional or country basis is the main motivation for research on inflation convergence. The rapid and persistent spread of high inflation adversely affects wage rates and leads to a decline in the standard of living of households. Moreover, this situation also reduces the efficiency of resource allocation (Das & Bhattacharya, 2008: 1-2). Therefore, inflation convergence is important both at the country and regional levels. Persistent differences in inflation across countries or regions lead to inequalities in real interest rates, making it difficult to implement a common monetary policy (Yılmazkuday, 2013: 593). The existence of different real interest rates across countries and regions affects the consumption and investment decisions of households and leads to differentiated public costs. As a result, the cost of public borrowing will decrease in countries or regions with low real interest rates, while the cost of public borrowing will increase in countries or regions with high real interest rates (Belke & Al, 2019: 302). These differences can be exacerbated by cyclical patterns (Karanasos et al., 2016: 241).

In addition to the real interest rate differentials, the Balassa-Samuelson effect is also thought to play a crucial role in the divergence of inflation across regions (Çakır & Gündüz, 2022: 1921). According to the Balassa-Samuelson effect, price convergence across regions is fast for traded goods and slow for non-traded goods (Tunay & Silpagar, 2007: 5). Although convergence among traded goods is thought to be rapid, the existence of trade barriers, especially non-tariff barriers such as transportation costs, tariffs, language, and cultural differences, slows down the speed of convergence (Tasic, 2007: 6-7). The course of food prices, which are among tradable goods and have a high share in consumer expenditures, is also an important indicator for inflation convergence. Especially in developing countries, inflation in food products is generally more persistent than in non-food products (Liontakis, 2012: 1). Moreover, the fact that the volatility in food prices remained outside the scope of monetary policy interventions has led to a deterioration in macroeconomic balances. As food inflation does not converge, the fact that low-income households, which allocate a significant portion of their income to food expenditures, will be most affected by increases in food prices has led policymakers and researchers to focus on this issue (TCMB, 2017: 2). Increases in food prices are considered to be one of the main reasons for the high inflation observed worldwide in recent years. It is claimed that the increase in food prices is caused by factors such as weather conditions, agricultural input costs, population growth, income growth, transport costs, intermediary commissions, and profit margins, and disruption of the supply chain network (Işık & Özbuğday, 2021:101; Cavlak & Selvi, 2022: 43). A critical issue is whether food inflation converges across regions as a result of transport costs and disruption of the supply chain network. In particular, it is necessary to examine the extent to which the structural break in the global economy caused by a rare event such as the Covid-19 pandemic affects the convergence of food inflation across countries or regions.

Although there are many studies on inflation convergence in the literature, there is a limited number of studies on food inflation convergence. In the literature, researchers such as Akdi & Şahin (2007), Tasic (2007), Yılmazkuday (2013), Apergis et al. (2021), and Woo et al. (2020), Fan et al. (2022), Çakır & Gündüz (2022) have analyzed the convergence of food inflation. Among these researchers, Akdi & Şahin (2007) and Apergis et al. (2021) used unit root tests, Woo et al. (2020) used cointegration order tests, Fan et al. (2022) and Çakır & Gündüz (2022) used log t test to determine the existence of food inflation convergence. Fan et al. (2022) and Çakır and Gündüz (2022) conclude that countries or regions do not converge to a single common food inflation but rather in the form of club convergence. Other researchers have found the existence of convergence to a single common food inflation across countries or regions. Akdi & Şahin (2007), Yılmazkuday (2013) and Çakır & Gündüz (2022) analyzed the existence of food inflation convergence across regions of Türkiye in different period samples and reached different findings. While Akdi and Şahin (2007) and Yılmazkuday (2013) found convergence of food inflation across regions, Çakır and Gündüz (2022) found no common convergence of food inflation. It is believed that the differentiation of research findings is due to structural factors specific to the periods analysed. The impact of recent global and country-based structural changes on this differentiation cannot be denied. It is thought that structural breaks such as the Covid-19 pandemic, which emerged in 2019 and affected the whole world in a short time, will also affect the food convergence between Türkiye's regions.

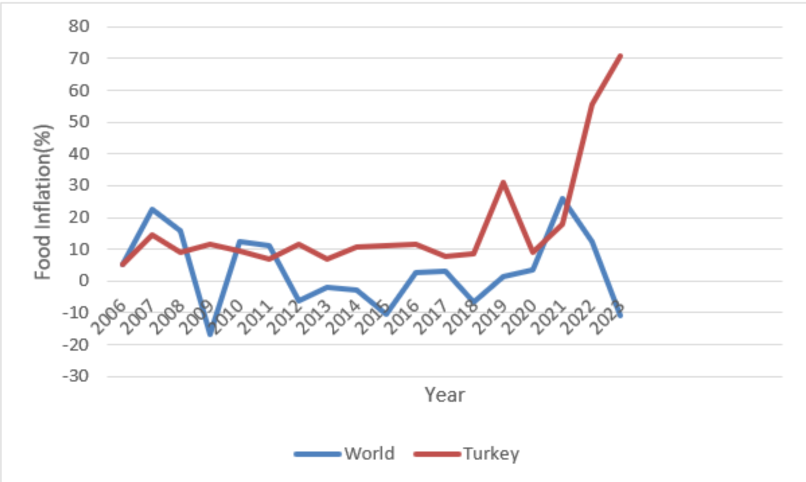
The main goal of the research is to investigate the stochastic convergence of relative food inflation across NUTS II regions for the period 2006:01-2022:04 using the Fourier KPSS test that takes into account smooth shifts and cross-sectional dependence. Four different unit root tests with and without structural breaks are also employed to check the robustness of the findings. This research contributes to the existing literature on food inflation convergence in two different ways. The first is that food inflation convergence has not been analysed before with a Panel Fourier KPSS test that also takes into account smooth breaks. The second is that it is the first research to analyse only food inflation convergence across NUTS II regions in the Türkiye sample.

The rest of the research is planned as follows. In the second part, the course of food inflation in the world and in Türkiye is presented and compared. Then, the distribution of food inflation across regions in Türkiye is presented and interpreted with the help of maps. In the third part, the methods used in the analysis of the research are introduced and then the findings are presented in the fourth part. In the conclusion part, the findings are evaluated, and recommendations are presented for researchers.

I. COURSE OF FOOD INFLATION IN THE WORLD AND TÜRKİYE

Food inflation is a problem that affects society in general with its economic and social aspects. Especially in low-income countries that allocate a large portion of their consumption expenditures to food, the rise in food prices increases the cost of nutrition, resulting in a loss of productivity. Loss of productivity also cyclically leads to a decrease in the GDP ratio in these countries. In addition to these problems, food inflation increases income inequality and deepens poverty. In addition to economic problems, food inflation also negatively affects the development of human capital and paves the way for the emergence of social problems (Şahin Kutlu, 2021: 586). The economic and social problems caused by food inflation have led policy makers and researchers to take an interest in food inflation. The course of food inflation in the world and in Türkiye over the years will give us a clue as to whether food inflation is caused by global or regional factors. It will also provide us with an opinion on how successful Türkiye has been in solving the food inflation problem compared to the world. Figure 1 shows the course of food inflation in Türkiye and the world between 2006 and 2023.

Figure 1. Course of Food Inflation in the World and Türkiye



Source: FAO (2023) & TUİK (2023)

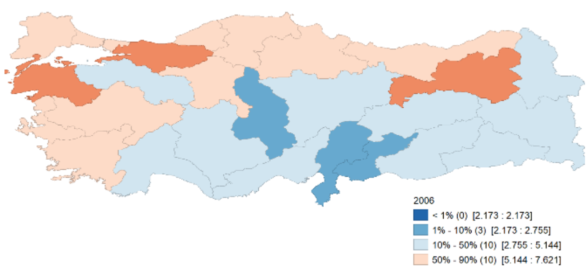
Figure 1 shows that global food inflation reached its peak in 2007, exceeding twenty percent. During this period, also known as the food crisis, food prices increased, and instability was observed intensely in almost all countries of the world. Türkiye had its share of this situation and faced an increase in food inflation during this period. As the effects of the 2008 global financial crisis began to fade, global food inflation fell sharply and took negative values. In the same period, there was no significant decline in food inflation in Türkiye. In 2010, food inflation in the world again caught upward momentum and reached ten percent in 2010 and 2011. For this period, there was no significant difference for food inflation between Türkiye and the world. However, food inflation in the world has been declining and taking negative values since 2012. In this period, the course of food inflation in Türkiye differs from the course of food inflation in the world. Food inflation in Türkiye followed a stable trend until 2018.

In 2018, due to structural breaks such as exchange rate shocks and deteriorating climatic conditions, it increased sharply to nearly thirty percent level. To prevent this increase, the Food and Agricultural Product Markets Monitoring and Evaluation Committee was established in 2016. Following the measures taken by the Committee and the mitigation of the effects of the exchange rate shock, the food inflation rate fell back to around ten percent. However, this situation reversed at the end of 2019 following the outbreak of the Covid-19 pandemic in China's Wuhan province, which affected the whole world in a short time. Measures taken to prevent the spread of the Covid-19 pandemic, such as limiting trade between countries, disrupted the supply chain network. The disruption of the supply chain network caused global food inflation to jump above twenty percent. As food inflation triggered consumer inflation, high inflation was observed around the world, and then countries implemented a contractionary monetary policy by increasing interest rates. Contractionary monetary policies soon took effect and global food inflation started to fall again.

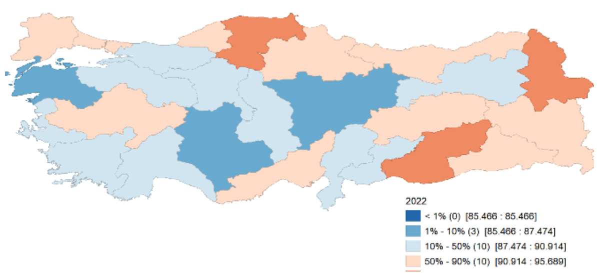
In Türkiye, on the other hand, the upward trend in food inflation continued and reached seventy percent by 2023. The recent divergence of the course of food inflation in Türkiye from the course of food inflation in the world can be attributed to two reasons. The first of is that countries around the world have been implementing contractionary monetary policy, while Türkiye has been implementing expansionary monetary policy. The second is the emergence of food supply problems that started with Russia's invasion of Ukraine before the impacts of the Covid-19 pandemic disappeared. Türkiye, which supplies many food products, especially cereals, from Ukraine and Russia, experienced problems in food supply due to the war between the two countries. As a result of these problems, domestic food supply failed to meet food demand, leading to an increase in food inflation.

The regional course of food inflation, which hovered around ten percent until the 2018s and has recently reached seventy percent, is also an important issue. The distribution of food inflation rates for 2006 and 2022 across NUTS II regions is mapped in Figure 2.

Figure 2. Regional Distribution of Food Inflation in Türkiye



Panel A: Distribution of Food Inflation by NUTS II Regions (2006)



Panel B: Distribution of Food Inflation by NUTS II Regions (2022)

Source: TUİK (2023)

According to Figure 2 Panel A, the regions with the highest food inflation in 2006 are TR22, TR42, and TRA1. The lowest food inflation is observed in TR63, TR72, and TRC1 regions. There are two reasons for the lower food inflation in these regions. The first one is that the TR63 and the TR71 regions are important agricultural production centres. The second reason is the low transportation costs of these regions due to their proximity to the other agricultural production centres. Furthermore, despite the lack of clarity in Figure 2 Panel A, it is possible to discuss a disparity between food inflation rates in the eastern and western regions. According to Panel A, food inflation rates in western regions are higher than food inflation rates in eastern regions. This can be explained by the fact that the agriculture and livestock sectors are more active in eastern regions compared to western regions.

Figure 2 Panel B shows that food inflation rates for 2022 are highest in TR82, TRA2, and TRC2 regions. The lowest rates are observed in TR22, TR52, and TR72 regions. Among these regions, the TR22 region was among the regions with the highest food inflation in 2006. The reason why this region lagged behind other regions in food inflation over the period should be analyzed. The low food inflation in TR52 and TR72 can be explained by the fact that these regions are important grain production centres and also they have low transportation costs due to their location. Moreover, unlike Panel A, there is no east-west disparity in Panel B. This can be explained by factors such as the decrease in transport costs during the period, the decline in the agriculture and livestock sector in the Eastern region and the import of food products.

II. METHOD

Research on convergence has gone through several stages: the cross-sectional approach, the time series approach, and the panel approach. Chronologically, convergence studies started with the cross-section approach, followed the time and panel series approaches. One of these approaches, the time series approach, has been widely used in attributed with conditional and unconditional convergence types (Islam, 2003: 313-316).

Time series research on convergence is usually based on unit root tests. Rejection of the null hypothesis is taken as evidence that the series converges to its equilibrium state. Any shock that alters the equilibrium disappears over time. The development of unit root tests in the panel framework by extending them to cross-sections has profoundly influenced the literature in measuring the convergence of macroeconomic variables (Lopez & Papell, 2012: 1441). Panel unit root tests have the methodological power to capture the temporal and spatial dynamics of convergence that cannot be explained by time series unit root tests or simple cross-sectional data (Goshu, 2015: 35). The most important advantage of using the panel data approach over other approaches is the increase in the efficient sample size. Therefore, they can significantly rise the power of statistical tests and estimation methods compared to alternatives (Yin & Wu, 2001: 276). Panel unit root tests with different properties are preferred in research to measure convergence (Güriş et al., 2020: 86). Panel unit root tests differ according to the consideration of cross-section dependence and structural breaks. Depending on the consideration of cross-section dependence, they are classified as first-generation and second-generation tests. While first-generation tests assume that there is no correlation between units, second-generation tests allow for the existence of correlation between units (Yerdelen Tatoğlu, 2018:21).

The emergence and development of the first-generation panel unit root tests are related to homogenous models. However, the existence of panel data sets from countries and regions with different characteristics has raised the credibility of the homogeneity assumption. In addition to the characteristics of different cross-section units, their parameters may also differ. Therefore, heterogeneity should also be taken into account in methods that investigate non-stationary features in panel data models (Yin & Wu, 2001:276). Yin and Wu (2001) allow for heterogeneous deterministic trends under different error structures in their model. The model used to test trend stationarity in univariate time series is:

$$y_t = r_t + \beta t + \varepsilon_t \tag{1}$$

In the above equation, r_t, which represents random walks, consists of two components.

$$r_t = r_{t-1} + \eta_t \tag{2}$$

It is also assumed that the symbols ε_t and η_t in the equation (1) and (2) are independent. The initial value is taken as r_0 and provides an intercept function. The simple definition of the null hypothesis of stationarity is σ_η^2=0. Since ε_t is presumed stationary under the null hypothesis, y_t is trend stationary. The null hypothesis can also be stated as H_0: q=0. If β = 0, the model will be reduced as follows and under the null hypothesis the trend will be level stationary instead of stationary (Yin & Wu, 2001:277).

Although the Yin and Wu (2001) panel unit root test allows for heterogeneity across units, it neglects the correlation between units. Inconsistent findings may be obtained when analyzed without considering the presence of correlation between units. Bai and Ng (2004, 2010) and Hadri & Kuruzomi (2012) developed tests that take into account cross-sectional dependence by modeling the correlation between units with the help of common factors. In their test, Bai and Ng (2004) examined the stationarity in residuals and factors separately. Therefore, this test is also called panel analysis of nonstationarity of idiosyncratic and common components (PANIC) (Yerdelen Tatoğlu, 2018: 91). The PANIC test is applied to two unobservable data components, one that is strongly correlated with many series and the other that is largely unit-specific. In short, given a factor model as follows (Bai & Ng, 2004:1127):

$$X_{it} = D_{it} + \Lambda_i' F_t + \varepsilon_{it} \tag{3}$$

In the above equation, D_{it} is the polynomial trend function, F_t is the r*1 dimensional vector of common factors and Λ_i is the vector of loadings. The series X_{it}, is the total of a deterministic component D_{it}, a joint component $\Lambda_i' F_t$ and a unique error term ε_{it} (Bai & Ng, 2004:1127-1128).

Following Bai & Ng (2004, 2010), Hadri & Kuruzomi (2011) adapted the approach of Pesaran (2007) to the panel stationarity test of Hadri (2000) and developed a new unit root test that provides efficient estimates under cross-section dependence. Like the KPSS (1992) test, it is based on the Lagrange Multiplier (LM) test, which is known to be locally optimal under the normality assumption. In this test, the initial step is to take the cross-sectional averages for eliminating the effect of common factors from the test statistics. The model, also called the cross-sectional averaging augmented (CA) test due to these features, is as follows (Hadri & Kuruzomi, 2011:167):

$$X_{it} = Z_t' \delta_i + r_{it} + \mu_{it} \qquad r_{it} = r_{it-1} \qquad \mu_{it} = f_t \gamma_i + \varepsilon_{it} \tag{4}$$

In the above equation, z_t, is deterministic and r_{i0}=0 for i=1,2,3,…..N and t=1,2,3,…..N. When δ_i =α_i, z_t is expected to be equal to z_t=1 or z_t=[1,t]. The null hypothesis of the test statistic is H_0=ρ=0. As in Pesaran (2007), cross-sectional averages are taken as follows (Hadri & Kuruzomi, 2011:167-168):

$$\bar{X}_{it} = Z_t' \bar{\delta}_\iota + \bar{r}_{it} + f_t \bar{\gamma} + \bar{\varepsilon}_{it} \tag{5}$$

In addition to considering cross-sectional dependence, structural breaks caused by structural transformations such as epidemics, natural disasters and crises should also be taken into account. If the structural break is not taken into account, the probability of rejecting the null hypothesis will decrease, and this will lead to incorrect inferences. Perron (1989) drew attention to this point and developed a unit root test in which the structural break is exogenously determined. New panel unit root tests with different specifications have been developed depending on the number of breaks and whether the break is endogenous or exogenous (Yeşilyurt, 2014: 311; Tıraşoğlu & Yurttagüler, 2018: 317).

Carrion-i-Silvestre et al. (2005), is an extended version of the Hadri (2000), which tests the null hypothesis of stationary against the non-stationary alternative, allowing for multiple structural breaks. This test allows the number of breaks and break dates to vary across units. In addition, Maddala & Wu (1999) take into account cross-section dependence by using parametric bootstrap critical values. The model is as follows (Güloğlu & İspir, 2011: 208):

$$Y_{it}=\alpha_i + \sum_{k=1}^{m_i} \varphi_{i,k}\ DU_{i,k,t} + \sum_{k=1}^{m_i} \theta_{i,k}\, DT_{i,k,t} + \beta_i t + \varepsilon_{i,t} \quad (6)$$

In the above equation, k, $D\left(T_{b,k}^{i}\right)_t$ ve $DT_{i,kt}$ represents break numbers and dummy variables, orderly. Dummy variables are as follows (Carrion-i- Silvestre et al., 2005: 161):

If $t > T_{b,k}^{i}$, $DU_{i,k,t}$ =1 otherwise 0 (7)

If $t > T_{b,k}^{i}$ $DT_{i,kt} = t - T_{b,k}^{i}$ otherwise 0 (8)

In studies that account for structural breaks, relying on a priori information for the number of breaks, as proposed in the Carrion-i-Silvestre et al. (2005) model, can diminish the accuracy of the tests. While these tests are successful in detecting hard breaks, they fail to detect structural breaks with smooth transitions. Recognizing this situation, Becker et al. (2006) and Enders and Lee (2012) developed a test process that does not require a priori information to determine the number of breaks by including Fourier terms in the model (Belke & Al, 2019:312). Following these developments, Nazlioglu & Karul (2017) developed a new panel unit root test by combining Becker et al. (2006) 's test in which structural breaks are modeled by using the Fourier approach and Hadri & Kuruzomi (2011) 's test in which cross-section dependence is expressed by a common factor structure. This test takes into account gradual structural breaks and cross-section dependence. It also allows for heterogeneity among the units in the panel. The model is as follows:

$$y_t=a_i(t)+r_{it}+\lambda_i F_t+\varepsilon_{it} \quad (9)$$

In the above equation, r_{it}, follows a random walk process with the initial value and is defined as follows.

$$r_{it}=r_{it-1} + \mu_{it} \quad (10)$$

Moreover, the deterministic term $a_i(t)$ in the equation is defined as a function of time. Structural breaks in this term can be captured by Fourier approximation regardless of the number and time of breaks. After the inclusion of Fourier terms, the deterministic term $a_i(t)$ is (Nazlioglu & Karul, 2017:182):

$$a_i(t)=a_i+b_i t+\gamma_{1i}\sin\left(\frac{2\pi kt}{T}\right) + \gamma_{2i}\cos\left(\frac{2\pi kt}{T}\right) \quad (11)$$

Like KPSS (1992), Nazlioglu & Karul (2017) panel unit root test, the null hypothesis point out that the series is stationary, and the alternative hypothesis states that the series has a unit root.

In this research, which examines the validity of stochastic convergence for relative food inflation in NUTS II regions, 5 different panel unit root tests are employed depending on whether cross-sectional dependence and structural breaks are taken into account. By comparing the test findings, it will be determined to what extent the results would differ if cross-sectional dependence and structural breaks are taken into account. In addition, the comparison of Carrion-i-Silvestre et al. (2005) and Nazlioglu & Karul (2017) panel unit root test findings, which are also used according to the a priori determination of structural breaks, provides clues about the extent to which the consideration of gradual structural breaks affects the results.

III. FINDINGS

The monthly data of food and non-alcoholic beverages, which is one of the twelve sub-product groups according to the classification of the Turkish Statistical Institute (TURKSTAT), for the period 2006:1-2022:04 are used in the research. The reason for not covering the period before 2006 is that the definition of inflation in the relevant periods has changed and NUTS II-based regional data have been published since 2005. Before proceeding with the analysis, descriptive statistics of regional food inflation rates derived from the food and non-alcoholic beverages price index are presented in Table 1.

Table 1. Descriptive Statistics

Regions	Mean	Median	Maximum	Minimum	Standart Deviation
TR10	13.709	11.820	91.256	-0.460	11.082
TR21	13.202	10.608	91.631	-2.261	11.180
TR22	13.537	11.243	85.466	-1.060	10.310
TR31	14.208	12.201	88.036	0.255	10.599
TR32	13.684	10.874	90.617	0.520	10.936
TR33	13.388	10.805	94.188	0.311	11.205
TR41	13.320	11.304	89.017	0.745	10.573
TR42	13.489	11.544	89.927	-1.950	10.926
TR51	13.733	11.275	88.930	0.840	10.498
TR52	13.691	11.562	87.152	0.379	10.859
TR61	13.603	11.113	90.577	1.078	10.829
TR62	14.089	11.546	93.008	0.627	10.676
TR63	13.484	11.040	88.568	0.626	10.692
TR71	13.827	12.059	87.779	2.121	10.400
TR72	13.761	11.708	87.440	-2.025	10.647
TR81	13.442	11.579	91.210	0.113	10.954
TR82	13.703	10.851	95.933	0.656	11.442
TR83	13.655	11.358	95.071	-0.082	11.321
TR90	13.859	11.768	93.008	1.569	10.798
TRA1	13.856	11.493	90.380	1.787	10.860
TRA2	13.748	10.762	95.757	1.429	11.297
TRB1	13.597	11.009	91.530	0.128	11.055
TRB2	13.773	10.902	93.969	1.563	11.351
TRC1	14.174	12.673	89.593	-1.284	11.249
TRC2	13.976	11.029	98.213	0.000	12.301
TRC3	13.809	11.560	93.906	-1.679	11.520

According to Table 1, average food inflation ranges between 13.202% and 14.208% in NUTS II regions. While the lowest average food inflation is observed in the TR21 region, the highest is observed in the TR31 region. It is also observed that the median values of the regional food inflation rates are lower than the average values. This also confirms the course of food inflation in Türkiye. Since 2021, food inflation rates have risen uncontrollably and reached 70%, widening the gap between the mean and median values. While the maximum regional food inflation rate ranges between 85.466% and 98.213%, the minimum regional food inflation rate ranges between -2.261% and 2.121%. The lowest minimum food inflation rate is observed in TR21, while the highest rate is observed in TR71. The width of the maximum and minimum regional food inflation range is noteworthy. This situation hints at the heterogeneity of the distribution of food inflation across regions. In contrast to the maximum and minimum values, the standard deviation values of regional food inflation rates indicate homogeneity. The range of standard deviation values of regional food inflation rates varies between 10.310% and 12.310%. Due to the necessity of taking the logarithm of the data in the research method, 3% was added to the observed values. The reason for adding this number to the observations is that the minimum value of regional food inflation rates is -2.261%. Figure 3 shows the historical development of relative food inflation, defined as the logarithm of food inflation for region i relative to the average of NUTS II regions for the period 2006-2022.

Figure 3. Historical Development of Relative Food Inflation in NUTS II Regions

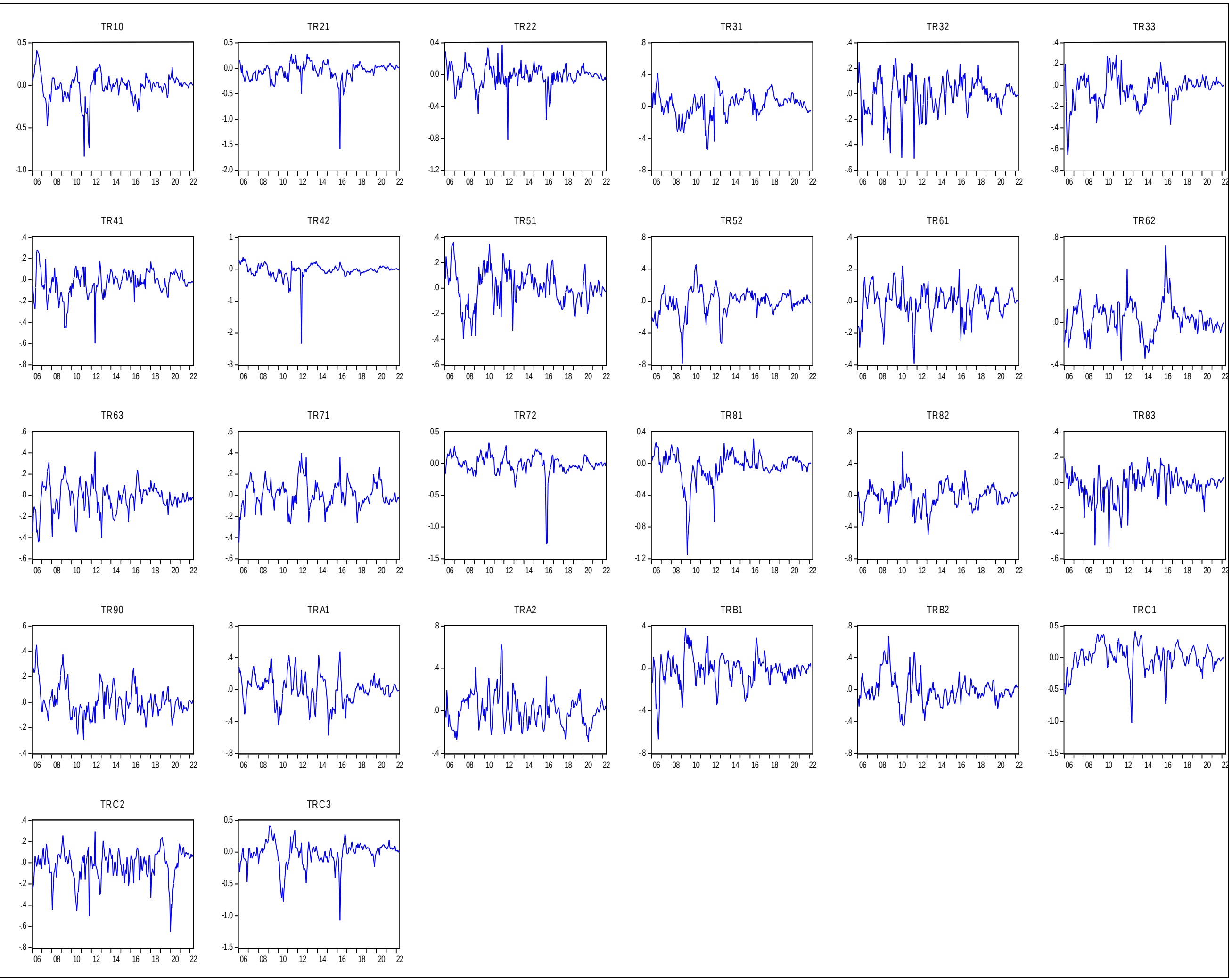


Figure 3 shows that there is little variability in relative food inflation from 2006 to 2022, with potential structural breaks. Figure 3 shows that the relative food inflation values of TR21, TR33, TR61, TR62, TR71, TR72, TRA1, TRC1 and TRC3 regions moved away from the average in 2016. Moreover, the relative food inflation values of many regions, especially TR10 and TRC2, deviated from the average in 2019 as well. Periods during which the relative food inflation levels of regions stray from the mean indicate the possibility of potential structural breaks. In the first stage of the analysis, the findings of the first-generation and second-generation unit root tests that ignore structural breaks are reported in Table 2.

Table 2. Findings for the Individual Regions from No-Break Tests

Regions	First-Generation		Second-Generation			
			PANIC		CA	
	Stat.	Prob.	Stat.	Prob.	Stat.	Prob.
TR10	0.084	0.249	0.021	0.978	0.032	0.861
TR21	0.097	0.178	0.077	0.295	0.077	0.295
TR22	0.100	0.164	0.053	0.538	0.023	0.958
TR31	0.093	0.196	0.040	0.741	0.041	0.724
TR32	0.140*	0.062	0.026	0.930	0.036	0.794
TR33	0.089	0.214	0.038	0.757	0.043	0.689
TR41	0.071	0.341	0.038	0.770	0.043	0.691
TR42	0.170**	0.030	0.012	1.000	0.083	0.251
TR51	0.076	0.301	0.084	0.250	0.038	0.765
TR52	0.056	0.505	0.034	0.823	0.033	0.847
TR61	0.057	0.495	0.095	0.185	0.030	0.876
TR62	0.144*	0.056	0.029	0.892	0.038	0.769
TR63	0.131*	0.075	0.049	0.599	0.036	0.789
TR71	0.065	0.401	0.038	0.757	0.029	0.891
TR72	0.089	0.217	0.024	0.951	0.029	0.890
TR81	0.068	0.368	0.073	0.327	0.072	0.340
TR82	0.051	0.566	0.038	0.764	0.043	0.682
TR83	0.132*	0.073	0.096	0.182	0.273***	0.003
TR90	0.114	0.116	0.067	0.385	0.054	0.530
TRA1	0.045	0.657	0.059	0.468	0.059	0.469
TRA2	0.033	0.846	0.038	0.762	0.041	0.725
TRB1	0.059	0.468	0.038	0.764	0.034	0.820
TRB2	0.070	0.350	0.051	0.562	0.050	0.591
TRC1	0.133*	0.073	0.114	0.115	0.108	0.134
TRC2	0.066	0.387	0.052	0.553	0.029	0.901
TRC3	0.143*	0.057	0.051	0.561	0.025	0.945
Türkiye	82.252***	0.005	2.245	0.988	34.669	0.969

*,**,*** indicate that the null hypothesis is rejected at a 10%, 5% and 1% significance level respectively.

According to the findings of the first-generation test, the null hypothesis of stationarity is rejected at a one percent significance level for the country as a whole, at a 5% significance level for the TR42 region, at a 10% significance level for the TR32, TR62, TR63, TR83, and TRC1 regions. The null hypothesis cannot be rejected for other regions. The PANIC test findings show that the null hypothesis cannot be rejected for all regions, including the country as a whole, in other words, stationarity is observed. The CA test findings show that the null hypothesis is rejected at a 1% significance level for the TR90 region and cannot be rejected for the other regions. According to Table 2, the findings of the Yin and Wu (2001) panel unit root test, which does not take cross-section dependence into account, suggest that there was no convergence in food inflation in some regions. While the PANIC test, which takes cross-section dependence into account, did not detect any convergence. In the CA test, the existence of convergence was found only in the TR83 region. It is observed that the findings of food inflation convergence between regions change according to the consideration of cross-sectional dependence. It is thought that taking into account structural breaks that cause deep effects in the global economy, such as the Covid-19 pandemic, causes changes in the findings. In this context, Table 3 summarizes the findings of the Carrion-i- Silvestre et al. (2005) panel unit root test where the number of breaks is determined a priori.

Table 3. Findings for the Individual Regions from the Sharp-Break Test

Regions	Bootstrap Critical Values				Breaks	Break Dates		
	Stat.	%10	%5	%1		TB1	TB2	TB3
TR10	0.022	0.031	0.035	0.045	3	2011-11	2016-02	2019-08
TR21	0.042	0.056	0.069	0.098	2	2016-02	2019-08	
TR22	0.027	0.035	0.041	0.055	3	2008-12	2016-02	2019-08
TR31	0.022	0.031	0.035	0.044	3	2011-11	2016-02	2019-08
TR32	0.050**	0.037	0.044	0.059	3	2008-07	2016-02	2019-08
TR33	0.038*	0.037	0.044	0.058	3	2008-07	2016-02	2019-08
TR41	0.022	0.037	0.043	0.058	3	2008-08	2016-02	2019-08
TR42	0.018	0.035	0.042	0.059	3	2013-02	2016-02	2019-08
TR51	0.043	0.057	0.067	0.093	2	2016-02	2019-08	
TR52	0.029	0.056	0.067	0.094	2	2016-02	2019-08	
TR61	0.031*	0.030	0.033	0.041	3	2010-11	2016-02	2019-08
TR62	0.057*	0.056	0.068	0.097	2	2016-02	2019-08	
TR63	0.053	0.056	0.067	0.097	2	2016-02	2019-08	
TR71	0.029	0.056	0.067	0.096	2	2016-02	2019-08	
TR72	0.067*	0.057	0.068	0.094	2	2016-02	2019-08	
TR81	0.013	0.035	0.041	0.053	3	2009-01	2016-02	2019-08
TR82	0.016	0.029	0.033	0.042	3	2011-06	2016-01	2019-08
TR83	0.034	0.037	0.043	0.058	3	2013-05	2016-02	2019-08
TR90	0.034	0.037	0.043	0.059	3	2013-05	2016-02	2019-08
TRA1	0.027	0.040	0.047	0.064	3	2013-12	2016-12	2019-08
TRA2	0.015	0.035	0.040	0.053	3	2009-01	2016-02	2019-08
TRB1	0.039	0.056	0.068	0.096	2	2016-12	2019-08	
TRB2	0.022	0.034	0.040	0.052	3	2009-04	2016-02	2019-08
TRC1	0.054	0.057	0.068	0.095	2	2016-02	2019-08	
TRC2	0.080**	0.056	0.067	0.095	2	2016-02	2019-08	
TRC3	0.022	0.032	0.037	0.048	3	2009-08	2016-02	2019-08

*,**,*** indicate that the null hypothesis is rejected at a 10%, 5% and 1% significance levels, respectively. TB represents the break dates.

According to Table 3, the null hypothesis is rejected at a 5% significance level for the TR32 and TRC2 regions and at a 10% significance level for the TR33, TR61, TR62, TR72, and TRC2 regions. The null hypothesis cannot be rejected for other regions. It is observed that the number of hard structural breaks is between two and three. In the structural break dates, the periods 2016-02 and 2019-08 are particularly prominent. The 2016-02 break date coincides with the period when food inflation rates started to decline as a result of the establishment of the food committee and the policies implemented. The 2019-08 break date coincides with the period when the increase in the food inflation rate as a result of the 2018 exchange rate crisis was suppressed by tightening monetary policies. The other prominent structural break dates are the months at the end of 2008 and the beginning of 2009. These structural break dates correspond to the period of global food inflation. The table shows that sharp structural breaks during the period are taken into account while smooth structural breaks are neglected. The findings of Nazlioglu & Karul (2017) panel unit root test, which allows for smooth structural breaks through Fourier functions, are presented in Table 4.

Table 4. Findings for the Individual Regions from the Smooth-Shifts Tests

Regions	k=1		k=2		k=3	
	Stat.	Prob.	Stat.	Prob.	Stat.	Prob.
TR10	0.024	0.624	0.031	0.694	0.031	0.791
TR21	0.048*	0.088	0.034	0.634	0.088	0.190
TR22	0.023	0.673	0.023	0.854	0.025	0.890
TR31	0.017	0.904	0.034	0.621	0.035	0.724
TR32	0.028	0.477	0.026	0.795	0.038	0.673
TR33	0.027	0.505	0.032	0.676	0.040	0.637
TR41	0.024	0.629	0.033	0.653	0.038	0.671
TR42	0.048*	0.086	0.060	0.293	0.085	0.203
TR51	0.032	0.358	0.029	0.721	0.046	0.557
TR52	0.015	0.947	0.032	0.659	0.036	0.702
TR61	0.015	0.947	0.034	0.626	0.017	0.976
TR62	0.034	0.296	0.027	0.778	0.038	0.667
TR63	0.030	0.403	0.027	0.763	0.038	0.665
TR71	0.021	0.747	0.026	0.790	0.031	0.787
TR72	0.015	0.944	0.026	0.795	0.021	0.934
TR81	0.041	0.157	0.047	0.424	0.067	0.321
TR82	0.041	0.157	0.039	0.537	0.045	0.569
TR83	0.102***	0.001	0.176**	0.017	0.270***	0.003
TR90	0.024	0.644	0.048	0.412	0.058	0.410
TRA1	0.016	0.920	0.050	0.384	0.066	0.332
TRA2	0.030	0.398	0.055	0.339	0.039	0.649
TRB1	0.033	0.312	0.026	0.784	0.032	0.768
TRB2	0.025	0.592	0.046	0.431	0.052	0.476
TRC1	0.053*	0.055	0.100	0.100	0.103	0.129
TRC2	0.018	0.879	0.025	0.804	0.028	0.838
TRC3	0.017	0.890	0.021	0.898	0.028	0.838
Türkiye	57.433	0.280	36.239	0.953	41.435	0.853

*,**,*** indicate that the null hypothesis is rejected at a 10%, 5% and 1% significance level respectively. k indicates frequency level.

According to Table 4, when the frequency level is one, the null hypothesis is rejected at a 1% significance level for the TR83 region and at a 10% significance level for TR21, TR42, and TRC1 regions. When the frequency level is two and three, the null hypothesis is rejected at 1% significance level only for the TR83 region. For the other regions, the null hypothesis cannot be rejected and the existence of convergence is detected. While these findings do not coincide with the findings of Carrion-i- Silvestre et al. (2005) test, they coincide with the findings of the CA test, one of the second-generation tests. Table 5 summarizes the test findings in order to reveal the extent to which the test findings used in the study are in line with each other.

Table 5. Summary of the Region-Specific Findings

Regions	First-Generation	Second-Generation		Sharp Breaks	Smooth Breaks		
		PANIC	CA		k=1	k=2	k=2
TR10							
TR21					X		
TR22							
TR31							
TR32	X			X			
TR33				X			
TR41							
TR42	X				X		
TR51							
TR52							
TR61				X			
TR62	X			X			
TR63	X						
TR71							
TR72				X			
TR81							
TR82							
TR83	X		X		X	X	X
TR90							
TRA1							
TRA2							
TRB1							
TRB2							
TRC1	X				X		
TRC2				X			
TRC3							

Note: X indicates that the null hypothesis of stationarity is rejected at a significance level of at least 10 percent, implying that there is no convergence of food inflation rates in a given region.

Table 5 shows that first-generation unit root tests reject the null hypothesis more often than second-generation unit root tests. First-generation tests neglect cross-section dependence and common factors across units may affect regional food inflation with different weights. This may lead to misleading findings. The null hypothesis is rarely rejected when employed PANIC and CA tests, which take into account common factors across units. Just like ignoring cross-section dependence, not considering structural breaks may also lead to misleading findings in the rejection of the null hypothesis. According to Table 5, the null hypothesis is rejected more often for tests that consider hard breaks compared to the tests that also consider smooth breaks. This indicates that the inclusion of smooth breaks provides more evidence for the convergence of regional food inflation. The different test findings in Table 5 provide strong evidence for the absence of relative food inflation convergence in the TR83 region. For other regions, there is insufficient evidence for the convergence of relative food inflation in test findings that take into account the presence of smooth structural breaks.

CONCLUSION

Recent global shocks such as the Covid-19 pandemic and the Russia-Ukraine war have placed the concept of food inflation at the center of the economic agenda. Türkiye's food inflation, which has been hovering around ten percent since the 2000s, reached seventy percent due to the Covid-19 pandemic and the Russia-Ukraine war. The motivation of the research is to investigate whether the recent global shocks have affected the convergence of food inflation by damaging trade in food products across regions. In this context, the aim of the research is to examine the stochastic convergence of relative food inflation in NUTS II regions using panel unit root tests with and without structural breaks.

The test findings differ according to whether or not cross-section dependence and structural break are taken into account. The null hypothesis is rejected less frequently in the tests where cross-section dependence is taken into account than in the others. While the null hypothesis is rejected for six regions in the first-generation test results, the null hypothesis is rejected for only one region in the second-generation tests. Moreover, the findings differ according to the a priori determination of the number of structural breaks. While the null hypothesis is rejected for six regions for the test findings that consider hard structural breaks, the null hypothesis is rejected for one region for the test findings that consider smooth structural breaks. Moreover, the findings of the second-generation test and the test considering smooth structural breaks are similar. According to the findings, there is food inflation convergence in all regions except TR83 region. This confirms the Balassa-Samuelson effect. It is understood that global shocks did not damage the food supply chain between regions and therefore food products continue to be traded goods between regions. The differentiation of TR83 region from other regions can be explained by the regional effects of the Russia-Ukraine war. The fact that a significant portion of the trade with Russia and Ukraine is realized through the port of Samsun explains why this region was affected by the Russia-Ukraine war more than others.

In line with the findings of the analyses, it is recommended that researchers examine food inflation convergence in NUTS II regions in the European sample including Türkiye. The use of techniques that take into account spatial interaction to examine how neighbouring countries are affected by the recent global shocks may add a different dimension to the issue.

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