



## CONVERGENCE ANALYSIS WITH FOURIER- TYPE UNIT ROOT TESTS IN TERMS OF RURAL VALUE ADDED IN TÜRKİYE AND EUROPEAN UNION COUNTRIES

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### ABSTRACT

*This study investigates whether there has been convergence between Turkey and the European Union (EU) countries in terms of rural value added from 1995 to 2024. Annual data on rural value added(RVA) is used. Studies in the literature use RVA, ecological footprint(EF) and carbon emissions(CE) as variables. What distinguishes this study is the use of RVA as a variable. The Fourier Becker Enders Lee(FBEL) and the Fourier Ranjbar, Chang, Elmi, Lee & Sollis unit root test(URT) are applied in the study. Accordingly, based on the results of the two Fourier URT and the F test, stationarity is reported, and thus, Turkey appears to be converging with EU countries in terms of RVA. Consequently, it is believed that Turkey could catch up with EU countries in terms of RVA if certain conditions are met.*

**Keywords:** Rural Value Added, Agricultural, Agricultural Policy, Cross Country Output Convergence.

**JEL Codes:** Q18, O13, O47.

### 1.INTRODUCTION

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**Research Article**

The Common Agricultural Policy(CAP) specifies the policies to be implemented for the regulation and development of the agricultural sector in EU member states. The CAP's characteristics are divided into three: First, the Single Market Principle, which implies the free movement of agricultural products among member states without restrictions. Second, the Community Preference Principle, which prioritizes agricultural products within the Community over those outside the Community. Third, the Fiscal Solidarity Principle, which requires a common economic strategy among the countries within the Union for the single market and Community preferences to be implemented. The Fiscal Solidarity Principle implies that all costs related to the CAP are jointly borne by the member states, and all revenues generated by the CAP are considered common revenue of the Community (Dinler, 2021).

Agricultural growth and agricultural carbon emissions negatively impact EU countries biological elements and ecosystems, as well as climate change. Some agricultural practices in the past protected biodiversity and ecosystems. However, these practices have been abandoned or replaced by agricultural systems that, even if maximizing agricultural yields through the misuse of natural resources, are detrimental to biodiversity and ecosystems. The CAP plans the EU's agricultural sector and supports practices that contribute to environmental problems. (Pe'er et al., 2020).

Encouraging urban density in countries facilitates economic prosperity. However, the role of large urban structures as a primary driver of growth is questionable. Factors such as proximity to nature and improved quality of life increase the importance of rural areas (Giannakis and Bruggeman, 2020). Contract farming appears to be one of the most suitable solutions to address farmers economic uncertainty and to mitigate the challenges faced during the marketing process for agricultural industries. Contract farming, implemented in industries that rely on the production of certain critical agricultural products, allows agricultural producers to determine their product supply by defining and implementing contract terms, while ensuring that industrial enterprises obtain the appropriate quantity and quality of product to meet their needs (Gürler, 2016).

In 1956, Solow stated that when the returns on additional investment are close to zero, there is no need for more production factors in regions with high income. Accordingly, the concept of convergence emerges because positive differences are observed in regions with low income. The first contributions to convergence theory were made by Mankiw, Romer and Weil (1992), who examined the concept of convergence in many countries and added human capital as a vital condition. Subsequently, Barro and Sala-i Martin (1992a) continued the discussion at the regional level in order to understand domestic differences. The initial empirical literature on regional convergence models suggests a significant catching-up effect across countries. Despite early findings that the convergence framework could indeed

explain regional inequalities, evidence from the 2000s onwards highlights the inadequacy of this approach by emphasising different channels (Karahasan, 2019).

One of the fundamental objectives of the EU is to reduce development disparities among member states. The reduction of development disparities among EU countries is referred to as convergence. This concept broadly refers to the process by which less developed countries catch up with developed countries. Convergence is a key focus of common strategies and policies such as the CAP, one of the EU's integration policies (Adamowicz, 2019).

According to neoclassical growth theory, it is predicted that diminishing returns on investment and technological change will create a path of convergence in the long term between developed and developing countries, with developing countries growing relatively faster and “catching up “ with developed countries. On the other hand, according to endogenous growth theory, there are permanent differences in productivity levels between countries that address technological change internally, taking into account structural differences between them. This contradiction has led to the convergence hypothesis being tested in recent years (Galanopoulos et al., 2011).

Convergence is divided into two types: absolute convergence and conditional convergence. Absolute convergence includes  $\sigma$  convergence and absolute  $\beta$  convergence. Conditional convergence(CC) refers to conditional  $\beta$  convergence. While  $\sigma$  convergence indicates that rural development efficiency decreases over time, absolute  $\beta$  convergence indicates that areas with low rural development efficiency have a greater propensity for growth than areas with high rural development efficiency. Accordingly, it is thought that rural development productivity in different regions will reach the same level. This concept expresses the internal convergence mechanism of economic growth in neoclassical economic growth theory (Yu et al., 2020).

Robert Solow's convergence hypothesis states that underdeveloped countries, among countries with the same population growth rate and technological development rate, will grow faster than developed countries and the gap with developed countries will decrease in the long run (Berber, 2019).

Rural industrial convergence refers to the synchronised movement of the agricultural sector alongside the service sector ensure the development of the rural economy through detailed planing. Furthermore, rural industrial convergence facilitates the efficient use of natural resources On the other hand, rural industrial convergence operates with an integrated plan, differing from traditional agriculture. With the processing of agricultural products, rural tourism and the emergence of rural development in the agricultural sector, the rural economy can diversify and develop. Accordingly, rural industrial convergence aims to generate more income and employment in the agricultural sector (Qi et al, 2024).

Most studies focusing on convergence between rich and poor countries find evidence of conditional convergence(CC). CC is the concept in which developing countries gain an advantage over developed countries. In the traditional Barro approach, conditional divergence occurs when conditional convergence ceases. Conditional divergence is the concept in which the gap between developing and developed countries widens (Nell, 2020).

Compared to the classical production function, stochastic frontier analysis allows countries to differentiate themselves in terms of agricultural sector through increased productivity in both the agricultural and technical sectors. Furthermore, because increased technical efficiency indicates technological catch-up, it indicates that a developing country is converging with developing countries in terms of agriculture (Yuan et al, 2021).

Given the significant impact of income convergence on food demand, the fundamental question is whether food growth can drive demand growth. While national income is treated as exogenous in equilibrium models involving the supply and demand of agricultural products, this approach is quite limited. Most changes in a country's income are the result of changes in productivity. To the extent that changes in productivity are driven by agricultural policy changes, these changes are likely to increase productivity in the agricultural sector (Martin, 2019).

The current study is based on the studies of Bayraktar et al. (2023), Akçayır and Akın (2024) and Gökmenoğlu (2025). Studies in the literature use variables such as CE and EF. In this study, the convergence between Turkey and EU countries on the basis of RVA is determined using the Fourier URT between Turkey and EU countries in the period 1995 – 2004. The reason for choosing the 1995 – 2024 period is that Turkey was trying to adapt to the an EU agricultural policy, in 1995.

## 2. LITERATURE REVIEW

It turns out that the studies are mostly about carbon emissions and rural value added.

**Table 1. Literature Review**

| Authors                                 | Data Period | Variables  | Analysis  | Result  |
|---|-------------|--|---|---|
| Kijek, Kijek, Nowak and Skrzypek (2019) | 2004 – 2016 | Total factor productivity in the agricultural sector | Cross-sectional dependence test and Pesaran URT | According to the findings of the study, there is convergence in agricultural productivity in other EU countries except Belgium. |

|  |             |   |  |  |
|--|-------------|---|--|--|
| Zhang, Pang, Chen and Lu (2019)                        | 1996 - 2015 | Agricultural CE, Agricultural Energy Consumption and Agricultural Economic Growth                 | ADF and DF-GLS URT, ARDL Bound Test, CUSUM Test, Error Correction Granger Causality Test(GCT) Impulse – Response Analysis and Variance Decomposition | According to the results of the study, there is a bidirectional causality relationship between agricultural CE and agricultural economic growth, while there is a unidirectional causality relationship between agricultural energy consumption and other variables. |
| Işık, Ahmad, Ongan, Özdemir, Irfan and Alvarado (2021) | 1961 - 2016 | EF  | Panel Threshold URT  | According to the study’s results, the EF diverges in the USA and converges in Mexico. Accordingly, the United States, Canada and Mexico should jointly prioritize environmental policies.  |
| Raza, Khan, Khan and Kakar (2021)                      | 1980 - 2018 | CE, Electricity Consumption, RVA, Food Production, Forest Covered Area and Forest Production Area | NG Perron Unit Root Test, ARDL Bounds Test, VECM GCT and CUSUM Test  | According to the results of the study, there is a negative and significant relationship between RVA and CE.  |

|   |                          |  |  |   |
|---|--------------------------|--|--|---|
| Gyamfi, Onifade, Erdoğan and Baba Ali (2023)                                  | 1990 - 2019              | GDP per capita, RVA, Renewable energy consumption, Economic globalization, Total natural resource rent, Electricity production from oil, gas and coal resources, and EF  | Cross – Section Dependence Test, First and Second generation URT, Kao cointegration test, Fully Modified Least Squares Estimator and Dynamic Ordinary Least Squares Method and Pairwise Dumitrescu Hurlin Causality Test | According to the results of the study, it is seen that electricity production from fossil fuels, globalization and RVA variables increase the EF.   |
| Bayraktar, Koç, Toprak, Özyılmaz, Olgun, Balsalobre – Lorente ve Soylu (2023) | 1992 - 2017              | EF   | ADF URT, Fourier ADF URT, Fractional Frequency Fourier ADF URT   | According to the findings of the study, according to the Fourier ADF URT, there is convergence in China and Russia.   |
| Martinez Garcia, Alonso and Masot (2024)                                      | 2007 – 2013, 2014 – 2020 | Demographic Variables (total population, population growth and migration balance rate), Agricultural Variables (Number of Established Enterprises, Livestock Unit), Socio-Economic Variables (Unemployment Rate and Contracts in the Agricultural Sector) and CAP Aid (Direct Payments, Indirect Payments, Agricultural Competitiveness) | Principal Component Analysis   | According to the findings of the study, it is observed that the rural population is more developed socio-economically in the districts where developed agricultural systems are provided with CAP supports. |
| Akçayır and Akın (2024)   | 1961 – 2022              | EF   | Fourier KSS URT  | According to the results of the study, Turkey converges with China, parts of the Asian continent, and the African continent in terms of its EF.   |

|                           |             |  |   |   |
|---------------------------|-------------|--|---|---|
| Danquah and Barnor (2025) | 1980 - 2022 | Trade Balance, Foreign Direct Investment, Government Expenditures, Agricultural Growth, Inflation and Real Exchange Rate | ADF and PP URT, ARDL Model, Threshold regression model and CUSUM test | According to the findings of the study, an increase in the trade balance in the long run appears to increase agricultural growth.     |
| Gökmenoğlu (2025)         | 1960 – 2022 | CE   | KPSS URT  | According to the results of the study, while the CE variable has a common orientation has not yet been achieved in BRICS-T countries. |

### 3. ECONOMETRIC ANALYSIS

This study attempts to determine whether there has been a convergence in the RVA variable between Türkiye and the EU countries between 1995 and 2024. The data in the study is annual. The data is obtained from the World Bank.

#### 3.1. Fourier Becker Enders Lee URT

In the  $H_0$  hypothesis of the relevant test, when the test statistic is smaller than the critical values, the variables have stationarity, while in the  $H_1$  hypothesis, when the test statistic is larger than the critical values, the variables have a unit root (Heapsağ, 2022). The presence of stationarity in the study causes convergence between countries in terms of the relevant variable.

**Table 2. Fourier Becker Enders Lee URT (With Constant and Trend)**

| Test Statistics    | % 1 Critical Value | % 5 Critical Value | % 10 Critical Value |
|--------------------|--------------------|--------------------|---------------------|
| 0.48               | 1.22               | 1.11               | 1.00                |
| <b>Prob. Value</b> | 0.24               |                    |                     |

According to the output results in Table 2, the RVA variable is found to be stationary because the test statistic values are less than the critical values and the probability value is greater than 5 percent. The results of the F test, which is conducted after stationarity is established, reinforce the stationarity of the variable.

With the stationary result, there is a convergence between Türkiye and EU countries in terms of RVA.

### 3.2. Fourier Ranjbar, Chang, Elmi, Lee (2018) Sollis URT

It differs from other Fourier-type URT because it takes into account soft breaks and nonlinearity in the deterministic components. The  $H_0$  hypothesis states that the variables have a unit root, while the  $H_1$  hypothesis states that the variables are stationary. Furthermore, stationarity can be reported in the F test when the test statistic is greater than the critical value (Alper and Alper, 2024).

**Table 3. Ranjbar, Chang, Elmi, Lee Fourier Sollis URT(Constant)**

| Test Statistics    | %1 Critical Value | %5 Critical Value | %10 Critical Value |
|--------------------|-------------------|-------------------|--------------------|
| 107.403            | 7.091             | 4.8125            | 3.7171             |
| <b>Prob. Value</b> | 0.000             |                   |                    |

According to the results in Table 3, since the test statistic is greater than the 5% critical value and the same result is obtained in the F-test, the current test is reported as stationary.

**Table 4. Ranjbar, Chang, Elmi, Lee Fourier Sollis URT(Constant and Trend)**

| Test Statistics    | %1 Critical Value | %5 Critical Value | %10 Critical Value |
|--------------------|-------------------|-------------------|--------------------|
| 164.34             | 20.60             | 14.81             | 12.31              |
| <b>Prob. Value</b> | 0.000             |                   |                    |

According to the results of Table 4, it is seen that the stationarity result is strengthened because the test statistic is greater than the 5 percent critical value and in the F test, the test statistic is greater than the 5 percent critical value.

## 4. CONCLUSION

Agricultural Gross Value Added is an indicator of economic development in agricultural areas. In EU countries, rural development funds such as the OTP and EAFRD aim to develop rural value added by directing technological developments and innovation towards the agricultural sector in EU countries are leading to temporary declines in agricultural employment.

In the study, it is tried to determine whether there is convergence between Turkey and EU countries in terms of RVA by using FBEL URT and Fourier Ranjbar, Chang, Elmi, Lee (2018) Sollis URT. The reason for starting the study in the 1995 – 2024 period is that this is the year Turkey began to adapt to EU agricultural policies. As a result of two constant and trend Fourier- Type URT and the F test, stationarity is reported in the RVA variable. Accordingly, based on the stationarity in RVA, there is convergence between Turkey and EU countries. In the literature review, it is observed that the Fourier-type URT used in the current study were used for the EF, CE, and total factor productivity variables in the agricultural sector, which were included in the studies of Gökmenoğlu (2025), Bayraktar et al. (2023), and Kijek et al. (2019). A distinguishing feature of the current study is the use of Fourier-type URT with the RVA variable. Consequently, Turkey is expected to convergence with EU countries that

are economically similar or better off in terms of RVA by achieving greater growth in the agricultural sector.

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