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Testing The Prebisch-Singer Hypothesis for the Turkish Economy: Evidence from Recent Time Series Techniques

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Abstract: *The Prebisch-Singer hypothesis suggests that the terms of trade will change over time against primary goods and in favour of manufactured goods. In this context, terms of trade are generally considered to be in a downward trend for countries that produce and export primary goods. The aim of this study is to investigate the validity of the Prebisch-Singer hypothesis in the Turkish economy. Monthly data are used in the study and the data range covers the period between January 2002 and June 2024. RALS-LM unit root test, trend analysis and AARDL methods were used in the study. In the study, the analyses were applied in two sub-periods. According to the findings of the study, the Prebisch-Singer hypothesis is invalid for the period 2002-2012, but valid for the period 2013-2024. In other words, terms of trade in Turkey tends to deteriorate as of 2013-2024.*

Keywords: Prebisch-Singer hypothesis; Terms of trade; Trend analysis; RALS-LM unit root test; AARDL

JEL Classification: C22, C32, F14

Introduction

The Turkish economy entered a transformation process with the January 24, 1980 decisions and liberal economic policies became dominant in parallel with the global trend. The main emphasis of the January 24 decisions can be expressed as minimizing state intervention in the economy. In this context, liberal policies such as determining the prices of goods and services under free market conditions, liberalizing foreign exchange prices, raising interest rates and lowering real wages were targeted (Çavdar,

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2004: 258). In foreign trade, first of all, international goods movements were liberalized. As a growth model, import substitution growth approach was abandoned and export-led growth model was adopted (Karluk, 2005: 497). The January 24 decisions were most successful in exports and exports quintupled in ten years (Boratav, 2015: 161). Following the liberalization of goods movements, capital movements were liberalized in 1989 and the Turkish economy took an important step in the globalization process. With the liberalization of capital movements, the Central Bank's foreign exchange liabilities increased and an intense dollarization process started in the economy (Kepenek and Yentürk, 2001: 254). Moreover, the external fragility of the Turkish economy increased and it became vulnerable to financial crises. As a matter of fact, in the financial crisis of 1994, Kazgan (1999) states that there was a net capital outflow of 4.2 billion dollars from the country. In this context, it can be said that globalization and foreign trade had positive and negative effects on the Turkish economy.

In 2000 and 2001, the Turkish economy faced financial crises again and especially the banking sector was adversely affected by the crises. The open positions of banks and their financial fragility lay at the heart of these crises (Özatay, 2009: 86). With the measures taken, the effects of the 2001 crisis were quickly overcome and the economy experienced an expansion process until the 2008 global crisis. In 2009, when the negative consequences of the 2008 global crisis were experienced, the Turkish economy contracted. After the effects of the crisis were overcome, the economy expanded again, but became vulnerable in 2013 when the US started to implement a tight monetary policy and slowed down its bond purchases. Indeed, the international investment bank Morgan-Stanley named Türkiye as one of the fragile five, along with Brazil, India, Indonesia and South Africa. The Turkish economy, which was caught in the pandemic process under these unfavorable conditions, has faced economic problems, especially inflation, in the process extending to the present day.

The aim of this study is to test the validity of the Prebisch-Singer hypothesis in the Turkish economy. In this context, it is aimed to determine whether Türkiye has benefited from foreign trade processes. The most important aspect of the study that differs from the literature can be stated as the methods applied. As discussed in detail in the literature section, traditional statistical and econometric methods are generally used in the existing studies. This study, on the other hand, aims to obtain more robust results by using up-to-date time series techniques. In their separate studies, Prebisch (1950) and Singer (1950) stated that in the long run the terms of trade change in favor of manufactured goods and against primary goods. In this context, it can be stated that the terms of trade of developing countries producing primary goods will deteriorate over time. This approach, which is referred to in the literature as the Prebisch-Singer hypothesis, is based on Ricardo's theory of relative advantage. Developing countries, which have a relative advantage in primary goods, tend to industrialize less than developed countries that specialize in the production of manufactured goods. The terms of trade of developing countries, which are deprived of the productivity and profitability increases brought by industrialization, deteriorate over time. The economic mechanism for the deterioration in the terms of trade of developing countries is explained through the concept of elasticity. Developing countries generally export primary goods and import manufactured goods when trading with developed countries. In the long run, this leads to a decline in the income elasticity of demand for primary goods and an increase in the elasticity of demand for manufactured goods. In this framework, terms of trade deteriorate against developing countries (Aneja and Arjun, 2022: 2562). Moreover, Laursen and Metzler (1950) argue that the deterioration in the terms of trade has a negative impact on the income and savings of countries. In other words, the macroeconomic consequences of the terms of trade are also important.

In the second section of the study after the introduction, the studies in the literature on the subject are presented. In the third section, the data set of the study is introduced and the methods used are presented. The fourth section presents the findings obtained from the study. The last section is devoted to the conclusion.

Literature

There are few empirical tests of the Prebisch-Singer hypothesis for the Turkish economy in the literature. However, the international literature is more extensive. These studies are presented below.

Grilli and Yang (1988) analyzed the 1900-1986 period for developed and developing countries. As a result of the study in which regression analysis was applied, they showed that the prices of primary goods decreased by 0.5% on average annually. In the case of non-fuel primary goods, the decline was 0.6% on average annually. In other words, the study provides evidence in favor of the Prebisch-Singer hypothesis.

Pamuk (1994) developed foreign trade indices for the Ottoman Empire for the period 1854-1913 and calculated the terms of trade. As a result of the study in which the Prebisch-Singer hypothesis was tested through terms of trade, it was found that the terms of trade decreased by 0.18% on average annually. In this context, the Prebisch-Singer hypothesis was found to be valid in the period in question.

Yamak and Yamak (1997) re-tested the Prebisch-Singer hypothesis for the period 1854-1913 using Pamuk (1994) data. The autocorrelation problem was taken into account and the results of the study revealed that the Ottoman terms of trade do not exhibit a long-run trend.

Chaudhuri (2000) stated that a large portion of the export revenues of developing countries stem from the exports of primary goods. In the study, the effects of oil price shocks on the volatility of primary goods prices between 1973 and 1996 were investigated. In this framework, the cointegration relationship between oil prices and prices of primary goods was analyzed. As a result of the study, the two variables were found to be cointegrated and it was determined that the price volatility of primary goods was driven by oil price shocks. In this context, it is emphasized that developing countries should evolve towards semi-finished and finished goods production.

Blattman et al. (2003) tested the validity of the Prebisch-Singer hypothesis for 35 different countries. In the study, which covers the period between 1870-1938, panel data analysis method was applied and countries were divided into five subgroups. According to the findings of the study, the terms of trade of the countries in the first group (USA, France, Germany, UK, Sweden) increased over time. In the other groups, there has been no upward trend in the terms of trade. On the other hand, a downward trend in terms of trade has been detected in Latin America and Asian countries, including Turkey. In line with the results obtained, the Prebisch-Singer hypothesis is confirmed.

In their study, Yamak and Korkmaz (2006) tested the Prebisch-Singer hypothesis and the Small Economy Assumption, which argues that the terms of trade are exogenously determined in world markets, for the Turkish economy. Time series techniques were utilized in the study, which covers the period 1989-2004 as quarterly data. As a result of the study, no long-run relationship was found between export and import price indices, but the terms of trade tended to deteriorate over time. Moreover, using VAR model, it is found that the terms of trade are exogenously determined.

Cambazoğlu and Karaalp (2012) investigated the validity of the Prebisch-Singer hypothesis for Türkiye. The study covers the 1982-2011 period and VAR model is used as the methodology. According to the results of the study, the trend in terms of trade is found to be in favor of Türkiye. In other words, the Prebisch-Singer hypothesis is not valid for the Turkish economy.

Taşçı and Erçakar (2016) investigated the validity of the Prebisch-Singer hypothesis for the Turkish economy. Using time series methods, the study analyzed monthly data for the 1982-2015 period. According to the findings of the study, the Prebisch-Singer hypothesis was not found to be valid as of the analyzed period.

Cinel et al. (2022) investigated the validity of the Prebisch-Singer hypothesis for the Turkish economy. The data range of the study covers the years 1982-2020 and quarterly data are used. Linear trend, Hodrik-Prescott filter and ARDL cointegration test methods are applied and the results of the study show that the Prebisch-Singer hypothesis is not valid for the Turkish economy in the analyzed period.

Methodology

In this study, export unit value index and import unit value index data were used as the data set. Monthly data are used in the study and the data range is determined as the period between January/2002-June/2024. The terms of trade series is constructed by dividing the export unit value index by the import unit value index. All data are obtained from TurkStat (2024) database. Data are included in the analysis with their logarithmic values.

In the study, the Augmented ARDL (AARDL) method was applied. However, it is important to determine the stationarity status of the variables before applying AARDL. Residual Augmented (RALS) unit root tests were applied to determine the stationarity of the variables. The first unit root test in the literature was developed by Dickey and Fuller (1979). Following this test, unit root and stationarity tests such as Extended Dickey-Fuller (1981), Phillips-Perron (1988), Kwiatkowski et al. (1992) were developed. However, these unit root tests do not take into account structural changes in time series and assume that shocks to the series are not permanent. Nelson and Plosser (1982), on the other hand, showed that shocks may not be transitory. Moreover, Perron (1989) showed that if the structural break in time series is not taken into account, results tending towards the acceptance of the null hypothesis of unit root can be obtained. The first unit root test that takes structural breaks into account was also developed by Perron (1989). Following Perron's test, various unit root tests with structural breaks have been developed such as Zivot-Andrews (1992), Lumsdaine-Papell (1997), Perron (1997), Lee-Strazicich (2003, 2004), Kapetanios (2005), Carrion-i Silvestre et al. (2009), Narayan-Popp (2010). An important assumption for unit root tests is that the residuals obtained from the model conform to a normal distribution. If the residual series do not conform to the normal distribution, the results of unit root tests lose their reliability. In case the residuals do not conform to the normal distribution, stronger results can be obtained from the RALS-type unit root tests developed by Im et al. (2014), Meng et al. (2014) and Meng et al. (2017).

The first RALS-type unit root test in the literature is the RALS-ADF unit root test developed by Im et al. (2014). However, ADF and RALS-ADF tests do not take structural breaks into account. In this context, the result may be biased towards the acceptance of the null hypothesis of unit root. This criticism can be overcome with RALS-LM unit root tests that take structural breaks into account. Traditional LM tests also take structural changes into account and these tests are based on the Lagrange multiplier developed by Schmidt and Phillips (1992). The Schmidt-Phillips (1992) test utilizes the following model.

$$y_t = \delta' z_t + x_t ve\, x_t = \beta x_{t-1} + \varepsilon_t \tag{1}$$

In the above equation, z_t denotes the constant term and trend variable. The Schmidt and Phillips (1992) test auxiliary regression equation is defined as follows.

$$\Delta y_t = \delta' z_t + \varnothing \widetilde{y_{t-i}} + \varepsilon_t \tag{2}$$

In the above equation, the variable $\widetilde{y_t}$ denotes the trend-adjusted version of y_t The main and alternative hypotheses of the Schmidt-Phillips (1992) unit root test are as follows.

$$H_0 : \varnothing = 0 \tag{3}$$

$$H_1 : \varnothing < 0 \tag{4}$$

The unit root test developed by Schmidt and Phillips (1992) also does not take structural breaks into account. However, Lee and Strazicich (2003, 2004) introduced a unit root test with structural breaks by constructing z_t as follows.

$$z_t = \left[1, t, D_{1,t}, D_{2,t}, DT_{1,t}, DT_{2t}\right] \tag{5}$$

In the above equation, $D_{i,t}$ represents structural breaks in the constant, while $DT_{i,t}$ is added to the model as shadow variables representing structural breaks in the constant and trend.

The RALS-LM unit root tests developed by Meng et al. (2014) and Meng et al. (2017) are defined as an extension of the LM tests with residuals. In LM tests, if the residuals obtained from the model are not normally distributed, the test results lose their reliability, whereas stronger results can be obtained from RALS-LM tests. In the first stage of RALS-LM tests, traditional test regressions are estimated by the least squares method and the residual series are obtained. In the second stage, we obtain extended variables defined as in equations (6) and (7) below.

$$\widehat{w_{2t}} = \hat{\varepsilon}_t^{2} - m_2 \tag{6}$$

$$\widehat{w_{3t}} = \hat{\varepsilon}_t^{2} - m_3 - 3m_2 \hat{\varepsilon}_t \tag{7}$$

The moment value m_j in the above equations is calculated as follows.

$$m_j = \frac{\sum_{t=1}^{T} \varepsilon_t^{j}}{T} \tag{8}$$

In the third stage, these variables are added to the test regression to obtain the following equation.

$$\Delta y_t = \delta' z_t + \varnothing \widetilde{S_{t-1}} + \theta_2 \widehat{w_{2t}} + \theta_3 \widehat{w_{3t}} + v_t \tag{9}$$

Equation (9) above identifies model specifications for four different cases of z_t For one break in the constant, two breaks in the constant, one break in the constant and trend, and two breaks in the constant and trend, z_t is defined as follows, respectively.

$$z_t = \left[1, t, D_{1,t}\right] \tag{10}$$

$$z_t = \left[1, t, D_{1,t}, D_{2,t}\right] \tag{11}$$

$$z_t = \left[1, t, D_{1,t}, DT_{1,t}\right] \tag{12}$$

$$z_t = \left[1, t, D_{1,t}, D_{2,t}, DT_{1,t}, DT_{2t}\right] \tag{13}$$

The main and alternative hypotheses of the RALS-LM unit root test are formulated as follows for all models.

$$H_0 : \varnothing = 0 \tag{14}$$

$$H_1 : \varnothing < 0 \tag{15}$$

The test statistic is calculated as follows.

$$\tau_{RALS-LM} = \rho\tau_{LM} + \sqrt{1-\rho^2 Z} \tag{16}$$

In the above equation, Z is defined as any variable with zero mean and constant variance. The ρ value is defined as the correlation coefficient between the traditional LM model residuals and the RALS-LM residuals. The testing process is completed by comparing the calculated test statistic with the critical values developed by Meng (2014) for models with constants and Meng (2017) for models with constants and trends. If the calculated test statistic is smaller than the critical value in absolute terms, the null hypothesis cannot be rejected and it is concluded that the series follows a unit root process with structural breaks.

In order to determine the relationship between the variables, the AARDL method developed by Sam et al. (2019) was applied. In the traditional ARDL method developed by Pesaran et al. (2001), unlike other cointegration tests, the variables are not required to be stationary of the same order. However, it is important that none of the variables are stationary of the second order. Moreover, an important difference of the AARDL method from the traditional ARDL method is that the dependent variable can also be stationary at level. The AARDL method can be used if all variables are stationary at level. The following three different model specifications are used in the AARDL method.

$$\Delta y_t = \sum_{i=1}^{m}\alpha_{1t}\Delta y_{t-i} + \sum_{i=0}^{n}\alpha_{2t}\Delta x_{t-i} + \alpha_3 y_{t-1} + \alpha_4 x_{t-1} + \varepsilon_t \tag{17}$$

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{m}\alpha_{1t}\Delta y_{t-i} + \sum_{i=0}^{n}\alpha_{2t}\Delta x_{t-i} + \alpha_3 y_{t-1} + \alpha_4 x_{t-1} + \varepsilon_t \tag{18}$$

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{m}\alpha_{1t}\Delta y_{t-i} + \sum_{i=0}^{n}\alpha_{2t}\Delta x_{t-i} + \alpha_3 y_{t-1} + \alpha_4 x_{t-1} + \alpha_5 trend + \varepsilon_t \tag{19}$$

The above models are expressed as model without constant, model with constant, model with constant and model with trend, respectively. In the equations, y_t is the dependent variable, x_t is the independent variable and α coefficients are defined as the parameters of the model. For all models, three different test statistics are calculated, denoted as $F_{overall}$, t_{DV}, F_{IDV}. The first two test statistics are compared with the critical values of Pesaran et al. (2001) and the third one is compared with the critical values of Sam et al. (2019) and the testing process is terminated. The main and alternative hypotheses for the $F_{overall}$ test statistic are stated as follows.

$$H_0 : \alpha_3 = \alpha_4 = 0 \tag{20}$$

$$H_1 : \textit{At least one of different from zero}. \tag{21}$$

If the $F_{overall}$ test statistic is greater than the upper critical value calculated by Pesaran et al. (2001), the null hypothesis that the series are not cointegrated is rejected. If the test statistic is less than the lower critical value, the null hypothesis cannot be rejected. If the test statistic is between the lower and upper critical value, no conclusion can be reached.

In the second step of the AARDL test, the calculated t_{DV} test statistic is compared with the Pesaran et al. (2001) critical values. The main and alternative hypotheses for the test statistic are as follows.

$$H_0 : \alpha_3 = 0 \tag{22}$$

$$H_1 : \alpha_3 \neq 0 \tag{23}$$

If the calculated test statistic is greater than the Pesaran et al. (2001) upper critical value in absolute value, it is concluded that the series are cointegrated. If the test statistic is less than the lower critical value in absolute value, it is concluded that there is no cointegration relationship. If the test statistic is between the lower and upper critical value, no conclusion can be reached.

In the last stage of the test, the F_{IDV} test statistic is compared with the critical values of Sam et al. (2019). The main and alternative hypotheses for the test are stated as follows.

$$H_0 : \alpha_4 = 0 \tag{24}$$

$$H_1 : \alpha_4 \neq 0 \tag{25}$$

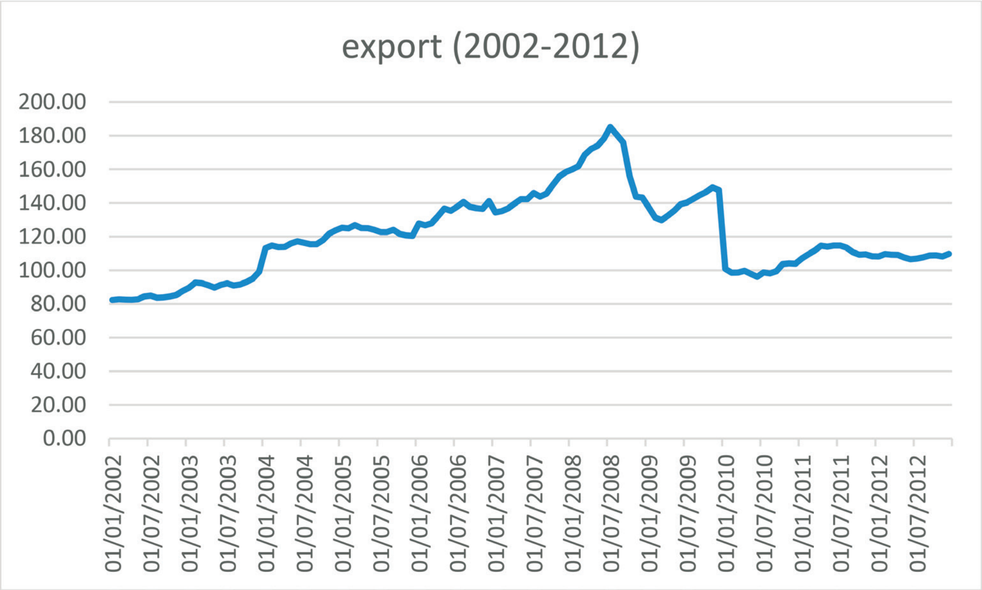
If the calculated F_{IDV} test statistic is greater than the upper critical value, the series are cointegrated. If the test statistic is less than the lower critical value, there is no cointegration relationship. If the test statistic is between the lower and upper critical value, no conclusion can be reached.

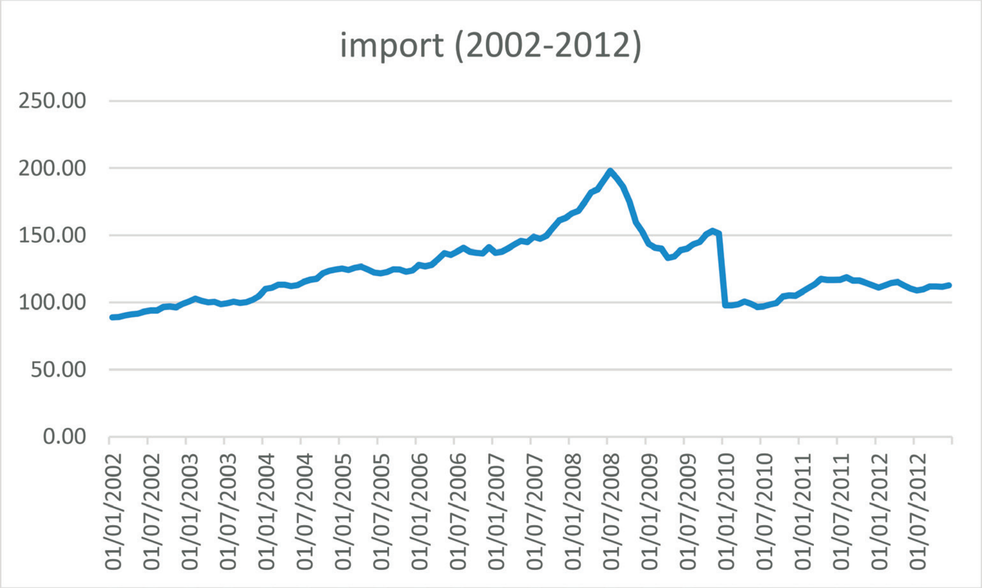
In line with the above explanations, in order for the cointegration relationship between the variables to be valid, all calculated test statistics should provide the cointegration relationship.

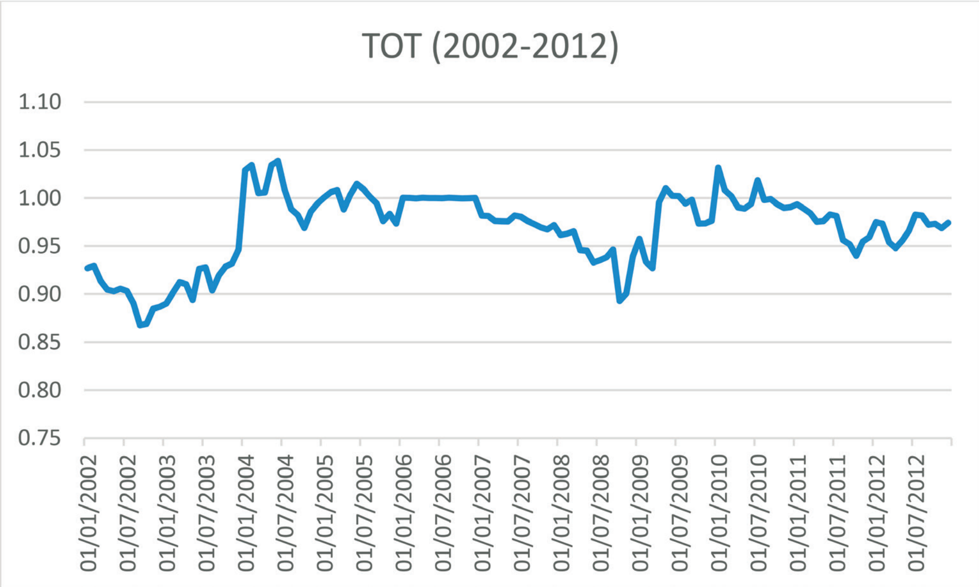
Findings

Firstly, time path graphs of the variables are presented in Figure 1.

Figure 1: Graphical Representation of Variables






TOT (2002-2012)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
01/01/2002
01/07/2002
01/01/2003
01/07/2003
01/01/2004
01/07/2004
01/01/2005
01/07/2005
01/01/2006
01/07/2006
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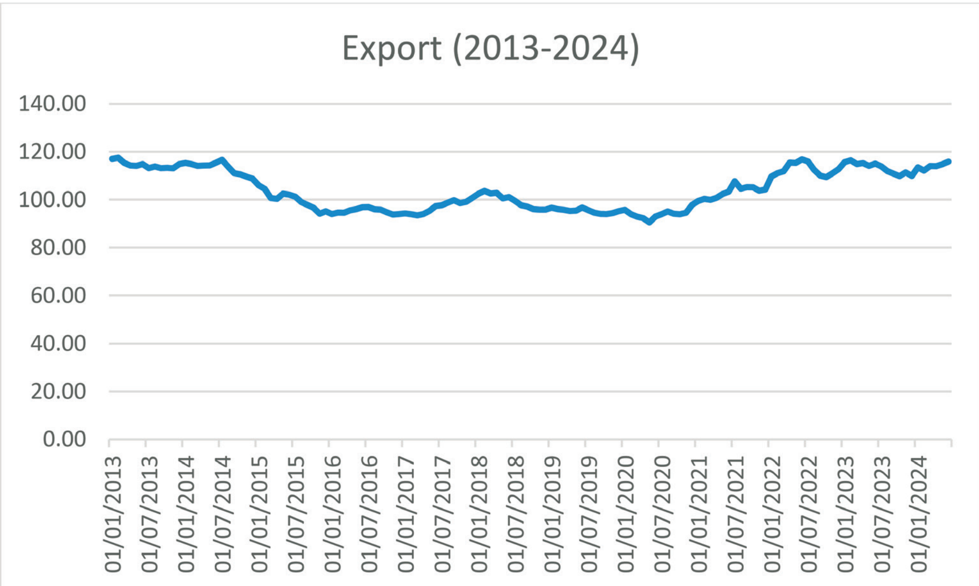
01/07/2011
01/01/2012
01/07/2012


Export (2013-2024)
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
01/01/2013
01/07/2013
01/01/2014
01/07/2014
01/01/2015
01/07/2015
01/01/2016
01/07/2016
01/01/2017
01/07/2017
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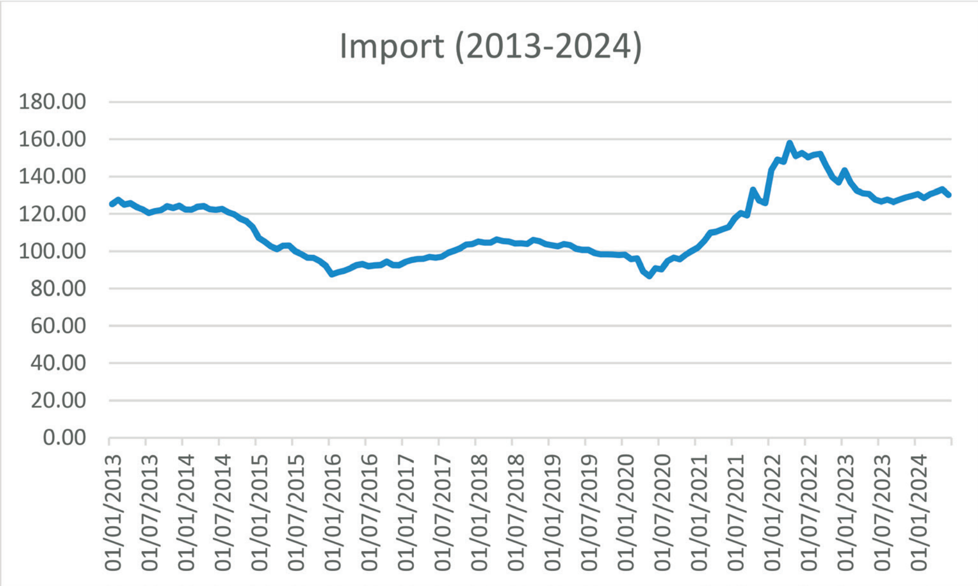
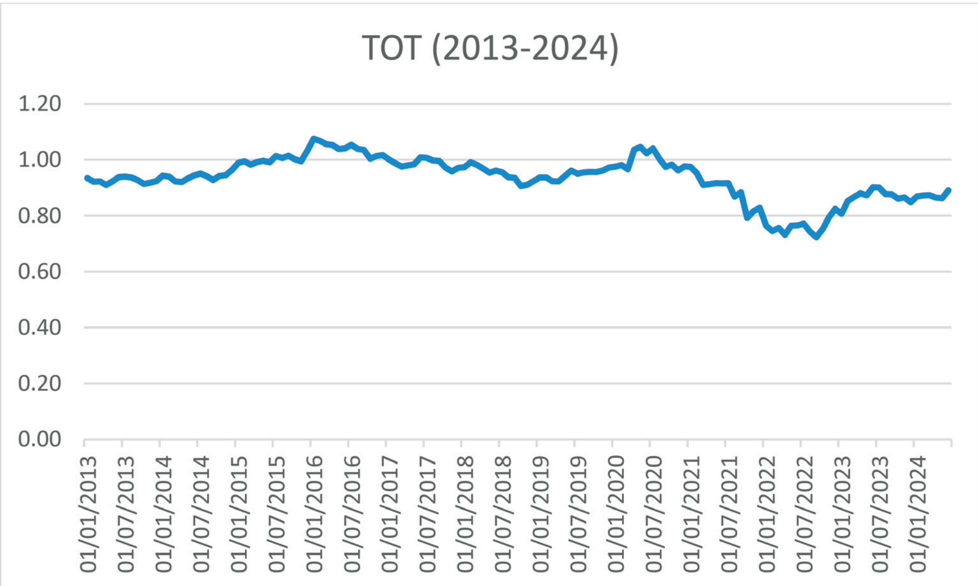
01/07/2023
01/01/2024





Firstly, the analysis was carried out for the period 2002-2012. In this context, the stationarity of the terms of trade was investigated. In order to determine the stationarity status, unit root tests with structural breaks were utilised and the results of the LM unit root test are presented in Table 1.

Table 1: LM Unit Root Test Results

Break in Constant		
	One Break	**Two Breaks**
Lag Length	0	4
Break Dates	04/2004	02/2002-12/2012
Test Statitics	-3,3474	-3,3351
Critical Value (%1)	-3,9986	-4,6981
Critical Value (%5)	-3,3990	-4,1537
JB Test Statistics	275,653014	274,920320
Probability (JB)	0,000000	0,000000
Break in Constant and Trend		
	One Break	**Two Breaks**
Lag Length	0	0
Break Dates	03/2004-03/2009	02/2002-12/2012
Test Statistics	-4,3448	-3,6021
Critical Value (%1)	-6,1768	-4,0976
Critical Value (%5)	-5,5488	-3,5903
JB Test Statistics	271,395387	275,430929
Probability (JB)	0,000000	0,000000

As seen in Table 1, the calculated test statistics are greater than the critical values. In this context, the null hypothesis of unit root with structural break cannot be rejected. However, according to all models, the residual series do not exhibit a normal distribution. In this framework, the results of the LM test are not reliable. In order to determine the stationarity status more precisely, the RALS-LM unit root test, which takes into account the non-normal distribution of the residual series, was applied and the test results are presented in Table 2.

Table 2: RALS-LM Unit Root Test Results

Break in Constant		
	One Break	**Two Breaks**
Lag Length	3	8
Break Dates	12/2003	12/2003-03/2009
p^2	0,7	0,8
Test Statistics	-1,84975	-2,74051
Critical Value (%1)	-3,515	-3,554
Critical Value (%5)	-2,903	-2,962
Break in Constant and Trend		
	One Break	**Two Breaks**
Lag Length	4	3
Break Dates	12/2009	11/2003-02/2004
p^2	0,7	0,7
Test Statistics	-3,13369	-5,04390*
Critical Value (%1)	-4,046	-4,498
Critical Value(%5)	-3,458	-3,918

* denotes 1% significance level.

As seen in Table 2, the test statistics are smaller than the critical values except for the model specification with two structural breaks in the constant and trend. In this framework, it can be said that evidence in favour of the null hypothesis of unit root with structural breaks is obtained. In this context, the condition of stationarity of the terms of trade series, which is a necessary condition of the Prebisch-Singer hypothesis, is not met. In other words, it is understood that the hypothesis is not valid in the analysed period.

In order to test the Prebisch-Singer hypothesis for the period 2013-2024, the stationarity of the terms of trade series must first be determined. In order to determine the stationarity status, unit root tests with structural breaks were utilised. The results of the LM unit root test applied in this context are presented in Table 3.

Table 3: LM Unit Root Test Results

Break in Constant		
	One Break	**Two Breaks**
Lag Length	12	12
Break Dates	04/2023	05/2020 – 04/2023
Test Statistics	-2,7194	-2,8791
Critical Value (%1)	-4,019	-4,0967
Critical Value (%5)	-3,4023	-3,5892
JB Test Statistics	135,744598	135,758968
Probability (JB)	0,000000	0,000000
Break in Constant and Trend		
	One Break	**Two Breaks**
Lag Length	12	12
Break Dates	08/2021	10/2015 – 08/2021
Test Statistics	-4,8648*	--5,9783**
Critical Value (%1)	-4,6675	-6,0695
Critical Value (%5)	-4,1161	-5,4933
JB Test Statistics	137,157479	149,897218
Probability (JB)	0,000000	0,000000

* denotes 1% significance level, ** denotes 5% significance level.

As seen in Table 3, the test statistics calculated for the model considering breaks in the constant are greater than the critical values. The null hypothesis of unit root under structural breaks could not be rejected. However, according to the JB normality test for the error terms obtained from the model, the probability value is below 0.05. In other words, the null hypothesis that the residuals are normally distributed is rejected. Regarding the LM test, the assumption that the residuals are normally distributed is not met. In this context, the results obtained from the LM test are not reliable. The second part of Table 1 shows the results of the model specification considering breaks in the constant and trend. The calculated test statistics are smaller than the critical values. The null hypothesis of unit root under structural breaks is rejected and it is concluded that the series follows a trend stationary process under structural breaks. The series with unit root in the model considering structural breaks in the constant is found to be trend stationary according to the model considering breaks in the constant and trend. However, the residual series does not conform to the normal distribution according to the model considering breaks in the constant and trend. In this framework, the LM test results are not reliable. In order to determine the stationarity status more precisely, the RALS-LM unit root test, which takes into account the non-normal distribution of the residual series, was applied and the test results are presented in Table 4.

Table 4: RALS-LM Unit Root Test Results

Break in Constant		
	One Break	**Two Breaks**
Lag Length	11	6
Break Dates	09/2021	09/2021 – 01/2023
p^2	0,8	0,8
Test Statistics	-2,67440	-3,23797**
Critical Value (%1)	-3,560	-3,554
Critical Value (%5)	-2,963	-2,962
Break in Constant and Trend		
	One Break	**Two Breaks**
Lag Length	12	12
Break Dates	08/2021	08/21 – 11/2022
p^2	0,9	0,9
Test Statistics	-3,41804	-7,88257*
Critical Value (%1)	-4,207	-4,717
Critical Value (%5)	-3,609	-4,146

* denotes 1% significance level, ** denotes 5% significance level.

As seen in Table 4, the test statistics calculated for the models considering one break are larger than the critical values. The null hypothesis of unit root under structural break cannot be rejected. According to the results of the model considering two breaks, the test statistic is smaller than the critical values at the 5% significance level in the model considering a constant break and at the 1% significance level in the model with two breaks. In this context, the terms of trade series is trend stationary with two structural breaks. The stationarity of the terms of trade series, which is a necessary condition for the confirmation of the Prebisch-Singer hypothesis, is ensured. At this stage, we proceeded to the deterministic trend analysis for the terms of trade series. Firstly, the trend is estimated by the Least Squares Method and the results are presented below.

$$\begin{array}{c} y = 1{,}010011 - 0{,}001119 Trend \\ (44{,}97488) \quad (-3{,}667753) \end{array} \tag{26}$$

In equation (26), the values in brackets indicate the t statistics for the parameters. As seen in the above equation, the parameter for the trend variable is negative and statistically significant (3,66>1,96). In this context, the sufficient condition of the Prebisch-Singer hypothesis is also met. The above estimates are obtained with Newey-West estimators against the autocorrelation problem. In the second stage of trend analysis, RALS terms are included in the model and parameter estimation is performed again and the estimation results are shown in the equation below.

$$\begin{aligned} y = {} & 1{,}007496 - 0{,}001082 Trend - 0{,}506926 w2t + 208{,}7486 w3t \\ & (44{,}76803) \quad (-3{,}586555) \qquad (-0{,}088010) \qquad (2{,}534186) \end{aligned} \tag{27}$$

The two break points obtained from the RALS-LM test are important for the Turkish economy. 2021 August break can be considered as a result of the interest rate cuts made despite the upward trend for a long time. As a matter of fact, while the dollar exchange rate was 8.30 TL in August, it rose to 9.50 TL in November. The 2022 November break can be handled in various ways. In particular, the effects of the exchange rate-protected deposit practice and the upward trend in inflation are the prominent issues. Moreover, the interest rate cuts implemented until November were abandoned as of December. In equation (27), the values in brackets indicate the t statistics for the parameters As seen in the above equation, the model estimation with RALS terms shows that the negative and statistically significant trend structure persists. In this context, the deterioration trend in the terms of trade proposed in the Prebisch-Singer hypothesis is confirmed for the Turkish economy.

Another approach to test the Prebisch-Singer hypothesis is to analyze the cointegration relationship between export and import unit value indices. In order to verify the results obtained from trend analysis, cointegration analysis was used at this stage. In this framework, the stationarity of the series should be determined first. LM unit root test is applied to export and import unit value indexes series and the test results are presented in Table 5.

Table 5: LM Unit Root Test Results

Export Unit Value Index		
Break in Constant		
	One Break	**Two Breaks**
Lag Length	12	12
Break Dates	10/2021	04/2018 – 11/2020
Test Statistics	-2,2803	-2,4657
Critical Value (%1)	-4,0025	-4,0965
Critical Value (%5)	-3,4030	-3,5890
JB Test Statistics	8,585856	8,571771
Probability (JB)	0,013665	0,013761

Break in Constant and Trend		
	One Break	**Two Breaks**
Lag Length	12	12
Break Dates	11/2018	05/2015 – 11/2021
Test Statistics	-3,8990	-4,9122
Critical Value (%1)	-4,7178	-6,0744
Critical Value (%5)	-4,1767	-5,4985
JB Test Statistics	8,670818	8,552486
Probability (JB)	0,013097	0,013895
Import Unit Value Index		
Break in Constant		
	One Break	**Two Breaks**
Lag Length	11	11
Break Dates	12/2021	12/2021 – 03/2023
Test Statistics	-2,4239	-2,6106
Critical Value (%1)	-4,0025	-4,0965
Critical Value (%5)	-3,4030	-3,5890
JB Test Statistics	294,852990	296,327438
Probability (JB)	0,000000	0,000000
Break in Constant and Trend		
	One Break	**Two Breaks**
Lag Length	12	12
Break Dates	05/2020	06/2015 – 05/2021
Test Statistics	-4,1800**	-5,2922
Critical Value (%1)	-4,7089	-6,0744
Critical Value (%5)	-4,1641	-5,4985
JB Test Statistics	299,028415	327,873894
Probability (JB)	0,000000	0,000000

As seen in Table 5, the test statistics calculated for all models for both index series are greater than the critical values. Only in the model specification that considers one structural break in the constant and trend, the test statistic is smaller than the critical value at 5% significance level. However, the model with two breaks yielded a unit root result. In this context, it is concluded that the series are unit rooted under structural breaks. However, when the probability values of the JB test statistics are analyzed, it is seen that they are less than 0.05. In other words, the assumption of normal distribution of the residual series is not met and the LM test results are not reliable. In this framework, the RALS-LM unit root test, which takes into account the non-normal distribution of the residuals, was applied and the test results are presented in Table 6.

Table 6: RALS-LM Unit Root Test Results

Export Unit Value Index		
Break in Constant		
	One Break	**Two Breaks**
Lag Length	10	8
Break Dates	12/2021	10/2015 – 12/2021
p^2	1,0	1,0
Test Statistics	-2,97357	-1,18094
Critical Value (%1)	-3,637	-3,695
Critical Value (%5)	-3,062	-3,100
Break in Constant and Trend		
	One Break	**Two Breaks**
Lag Length	12	12
Break Dates	05/2020	11/2021 – 05/2022
p^2	0,9	1,0
Test Statistics	-3,43004	-4,98005*
Critical Value (%1)	-4,207	-4,804
Critical Value (%5)	-3,639	-4,252
Import Unit Value Index		
Break in Constant		
	One Break	**Two Breaks**
Lag Length	11	11
Break Dates	12/2021	09/2021- 12/2021
p^2	0,7	0,8
Test Statistics	-2,95193**	-3,37991**
Critical Value (%1)	-3,515	-3,554
Critical Value (%5)	-2,903	-2,962
Break in Constant and Trend		
	One Break	**Two Breaks**
Lag Length	12	12
Break Dates	05/2020	04/2020 – 05/2022
p^2	0,8	0,9
Test Statistics	-4,50775*	-4,38874**
Critical Value (%1)	-4,127	-4,717
Critical Value (%5)	-3,554	-4,166

* denotes 1% significance level, ** denotes 5% significance level.

The results in Table 6 differ from the conventional LM test. The export unit value index series is found to be trend stationary according to the model of the RALS-LM test that takes into account two structural breaks in the constant and trend. The import unit value index series is trend stationary in all model specifications. Considering the non-normal distribution of the residual series, both series are found to be stationary in level. The cointegration relationship between level stationary series can be analyzed with the AARDL model. In this context, the extended ARDL results are presented in Table 7.

Table 7: Augmented ARDL Model Results (Dependent Variable: Export Unit Value Index)

	Test Statistics	I(0)	I(1)
$F_{overall}$	5,45905**	4,04	4,78
t_{DV}	-3,23916*	-2,86	-3,22
F_{IDV}	10,22141*	3,79	7,21

* denotes 1% significance level, ** denotes 5% significance level.

As seen in Table 7, all statistical values are greater than the upper critical value in absolute terms. In this context, it is understood that the variables are cointegrated. In other words, the variables move together in the long run. Diagnostic tests for the assumptions that must be met for the cointegration relationship to be valid are applied and reported in Table 8.

Table 8: Diagnostic Test Results

Test	Test Statistics	Probability
White	15,498559	0,07812057
Breusch-Godfrey	2,937522	0,08654340
Jarque-Bera	5,525932	0,063104
RESET	0,0276874	0,8681005

As seen in Table 8, all probability values are greater than 0.05. In this context, the assumptions of homoskedasticity, no autocorrelation among error terms and normal distribution of error terms are met. Moreover, there is no specification error in the extended ARDL model. After the assumptions are met, parameter estimations are performed at this stage and the estimation results are presented in Table 9.

Table 9: Long Run Parameter Estimation Results (Dependent Variable: Export Unit Value Index)

Variable	Coefficient	Standart Error	t Statistics	Probability
Constant	0,211919879	0,079088369	2,67953	0,0083
Import Unit Value Index	0,254989684	0,040729357	6,26059	0,0000

As seen in Table 9, the t statistics for the constant term and the independent variable parameter are statistically significant. Since the variables are considered with their logarithmic values, the independent variable parameter can be considered as elasticity. A 1% increase in the import unit value index increases the export unit value index by approximately 0.25%. The variables move together, but the import unit value index increases faster than the export unit value index. This result shows that the terms of trade tends to deteriorate in the analyzed period. In other words, it is understood that the Prebisch-Singer hypothesis is valid for the Turkish economy. In order to verify this result, the import unit value index variable was taken as the dependent variable and parameter estimation was performed and the estimation results are presented in Table 10.

Table 10: Long Run Parameter Estimation Results (Dependent Variable: Import Unit Value Index)

Variable	Coefficient	Standart Error	t Statistics	Probability
Constant	-3,317668	0,655103	-5,064349	0,0000
Export Unit Value Index	1,730636	0,141186	12,25784	0,0000

As seen in Table 10, a 1% increase in the export unit value index increases the import unit value index by 1.73%. In other words, the import unit value index increases faster than the export unit value index. This result is an indicator of the deterioration in terms of trade. In this context, it can be stated that another evidence in favour of the Prebisch-Singer hypothesis has been obtained.

Conclusion

This study investigates the validity of the Prebisch-Singer hypothesis for the Turkish economy. The hypothesis is tested with two different approaches: trend analysis and AARDL model. Both methods provide evidence in favour of the Prebisch-Singer hypothesis for the Turkish economy for the period 2013-2024. The results obtained from the study contradict the studies of Cabzoğlu and Karaalp (2012), Taşçı and Erçakar (2016), Cinel et al. (2022). In these studies, it was concluded that the Prebisch-Singer hypothesis was not valid. However, unlike the literature, this study utilises up-to-date time series techniques that take into account both structural breaks and non-normal distribution of residuals. In this context, it can be stated that one of the reasons for the difference from the studies in the literature is the methods applied. Moreover, considering the differences between the periods analysed, cyclical effects are also important. As a matter of fact, in this study, the Prebisch-Singer hypothesis is found to be invalid in the 2002-2012 period.

The results obtained from this study can be interpreted in various ways. The deindustrialization phenomenon, which has been discussed for the Turkish economy in recent years, can be considered as the source of the deterioration in the terms of trade. In other words, the decline in manufacturing industry earnings in an economic structure where the service sector gains weight can be interpreted as a natural process. Moreover, the fact that the industrial products exported by Türkiye are generally low-tech products also explains the deterioration trend in terms of trade. The fact that domestically produced and exported industrial goods are low-tech products leads to international competition based on prices. Within the framework of price competition, international prices of exported goods tend to fall and the terms of trade deteriorate to Türkiye's detriment. Another source of the validity of the Prebisch-Singer hypothesis in Türkiye can be considered as imported input dependency. In particular, the inability to produce high-tech inputs domestically leads to a lack of control over production costs. Moreover, exchange rate volatility due to financial instability in the country can also lead to sudden increases in input prices. Since the increased production costs through this mechanism cannot be directly reflected on export prices, which are determined exogenously in international markets, the terms of trade tend to deteriorate.

The continuous deterioration in the terms of trade adversely affects the sustainability of the current account deficit. An increase in the current account deficit is considered as the most important signal of economic crises. In this context, it is important to reverse the negative trend in the terms of trade. Türkiye's transformation into a service sector-dominated economy without completing the industrialization process can be expressed as early deindustrialization. Reversing this process in favor of industry will have a positive impact on the terms of trade of the Turkish economy. Shifting industrial production towards medium and high technology products and investing in intermediate goods and investment goods will increase Türkiye's strength in international competition and pull the terms of trade upwards. Prioritizing imported inputs in this transformation will also contribute to reducing imported input dependency. Finally, ensuring macroeconomic stability will reduce vulnerability, particularly in foreign exchange, and contribute positively to foreign trade. Moreover, combating inflation and turning expectations into a positive outlook in this framework are important for macroeconomic stability.

Declarations

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Conflicts of interest/Competing interests

There is no conflict of interest/Competing interests

Availability of data and material

The data that support the findings of this study are openly available in the website of World Bank (www.worldbank.org).

Code Availability

The computer program results are shared through the tables in the manuscript.

Authors' Contributions

This manuscript was written by a single author.

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