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TWIN DEFICITS OR NEGATIVE REVERSE CAUSALITY? A NONLINEAR APPROACH TO THE TURKISH BUDGET AND CURRENT ACCOUNT BALANCES[1]

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Abstract

The budget deficit causing an increase in the current account deficit is named twin deficits. In addition, the budget and current account balances represent the internal and external balance of the economy. As in many developed and developing countries, revealing the relationship between internal and external imbalances in the Turkish economy in terms of determining economic policies is very important. Most of the studies on twin deficits in the literature are based on analyzes with linear models. The aim of this study, unlike other studies in the literature, is to examine the relationship between the budget and current account balance in the Turkish economy with nonlinear time series analysis. For this purpose, nonlinear unit root and cointegration tests were applied to the data covering the period 1994-2021. The findings show that the negative reverse causality hypothesis is valid instead of the twin deficits hypothesis in the Turkish economy in the analyzed period. Accordingly, there is a negative relationship from the current account balance to the budget balance in both the long and short run.

Keywords: *Budget Balance, Current Account Balance, Nonlinear Unit Root Test, Nonlinear Cointegration Test, STAR-ARDL Model*
JEL Classification: *H62, F32, C22*

İKİZ AÇIKLAR MI YOKSA NEGATİF TERS NEDENSELLİK Mİ? TÜRKİYE BÜTÇE VE CARİ İŞLEMLER DENGELERİ ÜZERİNE DOĞRUSAL OLMAYAN BİR YAKLAŞIM

Öz

Bütçe açığının cari işlemler açığında artışa neden olması ikiz açıklar olarak adlandırılır. Ayrıca bütçe ve cari işlemler dengeleri ekonominin iç ve dış dengesini de temsil etmektedir. Gelişmiş ve gelişmekte olan birçok ülkede olduğu gibi Türkiye ekonomisinde de iç ve dış dengesizlikler arasındaki ilişkinin ortaya konulması ekonomik politikaların belirlenmesi açısından oldukça önemlidir. Literatürdeki ikiz açıklarla ilgili çalışmaların çok büyük bir kısmı doğrusal modellerle yapılan analizlere dayanmaktadır. Bu çalışmanın amacı, literatürdeki diğer çalışmalardan farklı olarak, Türkiye ekonomisinde bütçe ve cari işlemler dengesi arasındaki ilişkiyi doğrusal olmayan zaman serileri analizi ile incelemektir. Bu amaçla 1994-2021 dönemini kapsayan verilere doğrusal olmayan birim kök ve eşbütünleşme testleri uygulanmıştır. Elde edilen bulgular, incelen dönemde Türkiye ekonomisinde ikiz açıklar hipotezi yerine negatif ters nedensellik hipotezinin geçerli olduğunu göstermektedir. Buna göre hem uzun hem de ksa dönemde cari işlemler dengesinden bütçe dengesine doğru negatif bir ilişki bulunmaktadır.

Anahtar Kelimeler: *Bütçe Dengesi, Cari İşlemler Dengesi, Doğrusal Olmayan Birim Kök Testi, Doğrusal Olmayan Eştümleşme Testi, STAR-ARDL Modeli*
JEL Sınıflandırması: *H62, F32, C22*

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1. Introduction

The budget balance (BB), which indicates the relationship between public sector income and expenditures, represents the internal balance of the economy together with the savings-investment balance. Therefore, deteriorations in the BB will adversely affect the internal balance and macroeconomic variables such as inflation, interest rate, and debt stock. On the contrary, the current account balance (CAB), which indicates the goods, services, and unrequited transfers in the economy, represents the external balance. Therefore, the course of CAB is essential in terms of showing the country's relations with the economies of other countries, as well as the developments in the external balance. Since the current account also expresses the savings-investment balance in the economy, it also partially represents the internal balance of the economy. Hence, developments in the BB and CAB provide important information about the general situation of the economy. In addition, the ratio of BB and CAB to national income is one of the indicators used in the comparison of national economies. For this reason, the course of the BB and CAB is of great importance in terms of both observing the general balance of the economy and enabling comparison with other countries.

The relationship between budget deficits (BD) and current account deficits (CAD), which is called twin deficits in the literature, started to be discussed in the United States (US) economy in the 1980s. The huge BD and CAD in the US economy in this period brought about the emergence of external and internal unbalances in the economy. The twin deficits problem has emerged in many European Union (EU) countries, especially Germany and Sweden, in the following years. Many developing countries, like Asian and Latin American countries, faced this problem in the 1990s. In this context, the fact that many different countries have experienced this problem has led to the twin deficits relationship becoming popular and has led to the emergence of different hypotheses, opinions, and studies on this issue.

With the 2008 global crisis, BB and CAB imbalances emerged in different countries economies. In this period, the credit rating of the US economy decreased for the first time in its history due to the BD. In the same period, the BB of a significant part of EU countries deteriorated, and foreign trade deficits tended to increase. For all these reasons, the twin deficit relationship stands out as an economic phenomenon that has been studied for many years and does not lose its popularity.

Thanks to the decisions of January 24, 1980, and the liberalization of capital movements in 1989, the Turkish economy has become an open economy. Thus, the path followed by the CAB has gained greater importance. Thanks to the tight fiscal policy implemented after the 2001 economic crisis, the BB began to be disciplined and became a size that was carefully examined. As in many developed and developing countries, it is extremely important to determine the relationship between the BB and the CAB in order to determine the internal and external unbalances in the Turkish economy. The determination of the said relationship will also help to reveal the policy recommendations to be applied in the solution of the current imbalances. In this context, the main purpose of the study is to determine the long and short run relationships between the BB and the CAB and to present appropriate policy recommendations on the subject. Almost all of the studies on twin deficits in the literature are based on analyzes performed with linear models. On the other hand, the number of analyzes carried out with nonlinear models of the mentioned relationship is very few. However, recently, serious developments have emerged in nonlinear time series analysis based on the possibility that macroeconomic variables can follow nonlinear processes. This study aims to contribute to the literature by examining the relationships between twin deficits with the help of nonlinear analysis.

In line with the explanations mentioned above, the study consists of six chapters. In the second part of the study, hypotheses regarding the relationship between the BB and the CAB are given. In the third chapter, the literature part, in which studies examining the BB and CAB are presented. In the fourth part of the study, information is given about the data set, the predicted models, and the applied econometric method. In the fifth chapter, empirical results obtained from nonlinear time

series analysis are discussed. Lastly in the conclusion part, a general evaluation was made by using the empirical findings obtained from the study.

2. The Relationship and Theoretical Connection Between Budget and Current Account Balances

The theoretical connection of the twin deficits issue can be explained through the national income account. Considering that individuals dispose of their income (Y) by consuming (C), saving (S), or paying taxes (T), the national income equation is written as follows:

$$Y=C+S+T \quad (1)$$

National income also consists of domestically sold consumer goods (C), investment goods (I), public goods (G), and net foreign country goods (X-M).

$$Y=C+I+G+(X-M) \quad (2)$$

When equations (1) and (2) are combined, equation (3) below is obtained.

$$T-G= (I-S)+(X-M) \quad (3)$$

In the above equation (T-G), (X-M), and (I-S) indicates public BB, foreign trade balance, and domestic investment-savings balance, respectively. According to equation (3), the public budget surplus is equal to the sum of the foreign trade surplus and the portion of investments exceeding savings. Assuming that the government cuts taxes without making any changes in public expenditures, a deficit will occur in the budget. In such a case, either the foreign trade surplus or the portion of investments exceeding savings or both surpluses must be reduced (Bernheim, 1988: 3). If the budget, foreign trade, and investment-savings balances in an economy are in deficit, equation (3) is written as follows:

$$(G-T)=(S-I)+(M-X) \quad (4)$$

According to equation (4), the BD is equal to the sum of the portion of domestic savings exceeding investments and the CAD. The CAD can be eliminated by an inflow of foreign capital or by net foreign savings (S_F). In this case, equation (4) is written as:

$$(G-T)=(S-I)+S_F \quad (5)$$

To analyze the causality relationship from BD to CAD under a flexible exchange rate regime in an open economy, if net foreign savings are assumed to be equal to the CAB, equation (5) is written as:

$$(G-T)=(S-I)+CAD \quad (6)$$

According to the above equation, a rise in the BD is financed by an increase in total savings, a decrease in domestic investments, or an increase in the CAD (Salvatore, 2006: 703).

There are two main hypotheses regarding the relationship between the BB and the CAB. The first is the 'Twin Deficit Hypothesis', also called the traditional view, and asserts a one-way positive relationship from the BD to the CAD. The second is the 'Ricardian Equivalence Hypothesis' (REH), which asserts no connection between the BD and the CAD. In addition to these two hypotheses accepted in the literature, there is also the 'Current Account Targeting Hypothesis', which suggests a unidirectional relationship from the CAD to the BD, and the 'Bidirectional Causality' relationship.

2.1. Twin Deficits Hypothesis

The twin deficit hypothesis, which is also called the traditional view, argues that one-way relationship between BD and CAD. Although the transmission mechanisms differ, the relationship between these deficits is explained by the Mundell-Fleming and Keynesian absorption approaches.

For the Mundell-Fleming approach, an increase in the BD creates upward pressure on the interest rate in the flexible exchange rate regime. The increased interest rate leads to foreign capital inflows, causing the appreciation of the national currency and a decrease in net exports. Therefore, with the assumption of a flexible exchange rate, a rise in the BD causes deterioration in the CAB. In the fixed exchange rate regime, interest arbitrage leads to the equalization of domestic and foreign interest rates. Thus, a deterioration in the BB causes an increase in the national income or the general level of prices and worsens the current account. Under the flexible exchange rate regime, there is no change in income, savings, and tax variables in the face of an increase in the public deficit, while the same proportional increase occurs in the foreign trade deficit. On the other hand, the increase in the BD in the fixed exchange rate regime both raises the level of national income and causes a smaller increase in the foreign trade deficit (Dibooğlu, 1997; Baharumshah et al., 2006).

As a result, although the transmission mechanisms are different in the Mundell-Fleming approach, a positive relationship from BD to CAD is valid in both fixed and flexible exchange rate regimes.

- BD↑ → foreign capital inflow↑ → appreciation of national currency↑ → exports (X)↓, imports (M)↑ → CAD↑

(in flexible exchange rate regime)

- BD↑ → Y↑, P↑ → X↓ (due to increase in P), M↑ (owing to increase in Y) → CAD↑

(in fixed exchange rate regime)

On the other hand, for the Keynesian absorption view, a rise in the BD increases the level of domestic expenditure, causing an increase in M and a deterioration in the CAB (Daly and Siddiki, 2009: 1156). The absorption approach is the Keynesian current account model of the open economy and is based mainly on the work of Alexander (1952), Meade (1951), Herberger (1950) and Johnson (1958) (Murshed, 1997: 13). According to this view, a rise in the BD will lead to an ascent in domestic absorption (total expenditure) and national income, thereby increasing import demand. Increasing import demand, on the other hand, will decrease net exports and cause an increase in the CAD.

- BD↑ → Domestic Absorption↑ → Import Demand↑ → Net Exports↓ → CAD↑

2.2. Ricardian Equivalence Hypothesis (REH)

Unlike the traditional view, the REH, which argues no relationship between the BD and foreign trade deficits, was first put forward by Barro (1974). According to this hypothesis, it is the general principle to balance the public debt with future taxes and because the consumer is farsighted enough, he sees that future taxes are equivalent to current taxes. For this reason, the financing realized by the public through borrowing will be equal to the financing realized through taxation. Since David Ricardo made the first theoretical discussion on this subject, the hypothesis is called Ricardian equivalence (Mankiw, 2009: 493).

The REH argues that a rise in the BD because of tax cuts will not have any effect on either the foreign trade balance or the CAB. Assuming that public expenditures are fixed and no borrowing constraint, a reduction in the current tax rate will not affect domestic savings (Vamvoukas, 1999: 1094). Because the households, who are aware that the current tax cut will lead to a tax increase in the future, will save outside of their disposable income in order to pay the future tax burden. This increase in private sector savings will exactly offset the decline in public savings because of tax cuts. Therefore, national savings will remain unchanged (Mankiw, 2009: 493). As a result, public sector deficits will not affect the equilibrium levels of macroeconomic aggregates such as trade balance, CAB, interest rate, national savings, and money demand (Vamvoukas, 1999: 1094).

2.3. Current Account Targeting Hypothesis (Reverse Causality)

The current account targeting hypothesis, which is another hypothesis related to the relationship between the BB and the CAB, is based on the principle is unidirectional causality from the external deficit to the internal deficit. This reverse causality relationship from CAB to BB was named "current account targeting" by Summers (1988). This relationship, which is seen especially in developing countries, is generally caused by foreign borrowing and a slowdown in economic growth.

A country experiencing a financial or payment crisis, as it constantly runs a large CAD, may resort to issuing large amounts of public funds in order to relieve its economic recession and correct the disruptions in its financial sector. For example, after the 1997 crisis, BDs were allowed in Korea to provide economic vitality and expand the social safety net. In this recovery process in the economy, the causality relationship was from the CAD to the BD (Kim and Kim, 2006: 676). This reverse linkage between BD and CAD is more common, especially in emerging economies with high external debt stock (Baharumshah and Lau, 2005: 7). In such countries, which resort to external borrowing to end CAD, the repayment of foreign debts causes the CAD to increase even more.

The current account targeting hypothesis, which expresses the opposite of the traditional view, is especially valid in small open country economies whose economic growth is dependent on foreign capital inflows. In developing economies, the BB is affected by large amounts of foreign capital inflows or high debt accumulation, and therefore the economy eventually runs into a BD. Latin America and some East Asian countries' experiences are cited as examples (Baharumshah et al., 2006: 350; Kalou and Paleologou, 2012: 233).

- CAD↑ → External borrowing (issuance of public funds) → External debt repayment → BD↑

On the other hand, the CAD may cause deterioration in the BB by slowing down economic growth. Reducing imports in countries whose economic growth is heavily dependent on imported inputs brings about a slowdown in economic growth. This slowdown in growth reduces tax revenues on the one hand and increases public expenditures (to stimulate domestic demand) on the other. As a result of all these, an increase in BD occurs.

- CAD↑ → Current account targeting → M↓ → Economic growth↓ → Tax revenue↓, Public expenditure↑ → BD↑

In economies whose economic growth is largely based on imported inputs, the sign of this reverse relationship from the CAD to the BD will be negative instead of positive, if the current account targeting is not applied or if no measures are taken to reduce the CAD. Accordingly, increases in the CAD will lead to an increase in economic growth by increasing imports, and thus, tax revenues will increase, and BD will decrease (Telatar, 2013).

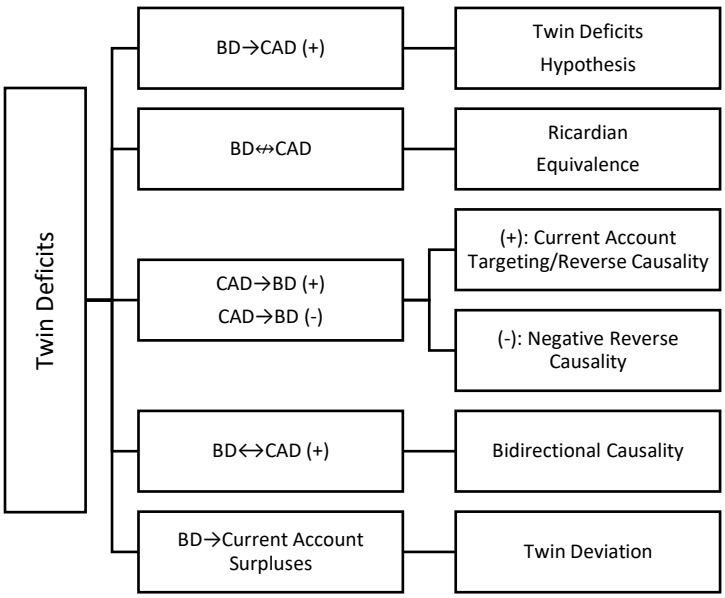
- CAD↑ → M↑ → Economic growth↑ → Tax revenue↑→ BD↓ (negative reverse causality)

2.4. Bidirectional Causality

Another possible relationship between the budget and the CAB is bidirectional causality. In this case of causality, BDs affect CAD through transmission mechanisms like in the traditional view while CAD affects BD through reverse causation. Besides, in the case of bidirectional causality, the effects of deficits on each other simultaneously or by triggering each other vary as regards the country, period, and different economic conditions. In a significant part of the studies on the twin deficits relationship, it is argued that in order to reduce the CAD, it is necessary to reduce the BD, increase the private sector savings rate, and thus increase national savings. However, in cases of reverse or bidirectional causality, narrowing the BD alone may not be sufficient to end the CAD (Kouassi et al., 2004: 521). Sometimes, in addition to reducing the BD, additional practices such as exchange rate strategy, decision of interest rate, and export incentive policies may be required (Kalou and Paleologou, 2012: 234).

In addition to the hypotheses described above, there are different views on twin deficits in the literature. One of them is put forward by Kim and Roubini (2008), which asserts a twin deviation relationship between the BB and the CAB rather than a twin deficit. Accordingly, continuous increases in production, on the one hand, improve the BB with the productivity shocks they create, on the other hand, it worsens the CAB by increasing investments. The Feldstein-Horioka (F-H) hypothesis, which indirectly addresses the issue of twin deficits, is another related view. This hypothesis determines the validity of the twin deficit relationship depending on the level of international capital mobility. According to the F-H hypothesis, domestic savings are needed to finance investments in a closed economy with no international capital mobility. In such a case, the relationship between national savings and national investments will be quite strong. On the other hand, since investments can be financed with foreign savings in an economy where international capital mobility is unlimited, the strength of the domestic savings-investment relationship will also weaken. Therefore, in the event that international capital movements are unlimited (the F-H hypothesis is invalid), high capital mobility ensures that the BB and CAB move together. For this reason, it can be decided whether the BB and CAB move together, based on whether the F-H hypothesis is valid or not. The basic hypotheses about the budget and CAD are shown below with the help of figure 1.

Figure 1: **Hypotheses Regarding the Twin Deficit Relationship**



Note: The Figure has created by the author inspired by Chang and Hsu (2009).

3. Literature Review

The emergence of BD and CAD together in the United States in the 1980s led to the discussion of these deficits. This discussion, which started only for developed countries such as the USA, continued to include developing and underdeveloped countries in the following years. There is no consensus in the literature on the relationship between the BB and the CAB. The results obtained from the studies carried out on the subject differ according to the method applied, the period in question and the type of country examined.

Most of the studies investigating the twin deficits relationship in developed countries consist of studies on the USA. In these studies, in which econometric methods such as cointegration, Vector Autoregressive (VAR) and regression analysis were applied, different empirical findings were obtained. For example, Abell (1990), Bachman (1992), and Salvatore (2006) studies suggest the validity of the twin deficits hypothesis, while Enders and Lee (1990) state that REH is valid. On

the other hand, Kim and Roubini (2008) revealed a twin deviation rather than a twin deficit, and Darrat (1998) a reciprocal causality relationship.

A significant part of the studies examining the twin deficits relationship in developing countries consists of studies on Asian countries. Structural changes and the high debt burden in Asian economies, especially with the 1997 economic crisis, led to the questioning of the twin deficits relationship in these countries. Similarly, some EU countries, which have faced serious economic problems and large BDs in recent years, and countries whose economic activities are based on oil export revenues are examples of other countries examined under this heading. The results obtained from the studies on developing countries in the literature cannot reveal a definite finding of the validity of the twin deficits hypothesis, as in the studies on developed countries.

Studies on twin deficits in Türkiye began to come to the fore in the 1990s when the import substitution industrialization policy was abandoned, and international capital movements were completely liberalized. As in the studies of other countries, there is no consensus on the relationship between the BD and CAD in the studies on Türkiye. While the studies of Zengin (2000), Akbostancı and Tunç (2002), Günaydın (2004) demonstrated the validity of the twin deficits hypothesis, Kuştepeli (2001), Aksu and Başar (2009) revealed that the REH is valid. On the other hand, Utkulu (2003) and Altıntaş and Taban (2010) found that bidirectional causality is valid.

Most studies on twin deficits in the literature are based on linear method model estimation. On the other hand, the number of studies with nonlinear estimation methods is very limited. The number of studies dealing with this relationship with nonlinear methods in terms of the long run is much less. Among these studies, Telatar (2013) is the first study to examine the twin deficits with nonlinear methods in terms of long run. The author investigated the relationship between BB and CAB in Türkiye with quarterly data for the period 1991-2013 using nonlinear time series analysis. According to the findings obtained from the study, the variables are cointegrated and there is a negative relationship from CAB to BB in both the long and short run. In other words, the negative reverse causality hypothesis is valid instead of the twin deficits hypothesis in Türkiye in the period under consideration. Accordingly, increases in the CAD lead to decreases in the BD. There is no consensus among the results of studies on nonlinear methods in the literature too, just like the studies used linear methods. The results of the studies may differ according to the country and period of study. For example, Bhat and Sharma (2018), Antonakakis et al. (2019), Bilman (2021), and Mallick et al. (2021) supported the twin outputs hypothesis, while Telatar (2013), Turan and Karakaş (2017) reached the result of reverse causality. A summary of the literature on the twin deficits issue is presented in Table 1.

Table 1: **Summary of the Empirical Literature on Twin Deficit Relationship**

Author	Period	Country	Method	Applied Findings
Bernheim (1988)	differs for countries	US, Canada, UK, Germany, Japan, Mexico	-Ordinary least squares (OLS)	• BB $\rightarrow$ CAB (US, Canada, UK, Germany) • BB $\not\rightarrow$ CAB (Japan)
Darrat (1988)	1960:Q1-1984:Q4	US	-Granger causality	• BD$\leftrightarrow$Foreign Trade deficit
Roubini (1988)	differs for countries	18 OECD countries	-Vector autoregressive (VAR)	• BD$\rightarrow$CAD (for 12 countries) • F-H not valid (for 13 countries)

Tablo 1 (Contunied): Summary of the Empirical Literature on Twin Deficit Relationship

Author	Period	Country	Method	Applied Findings
Abell (1990)	1979:02-1985:02 (monthly)	US	-VAR	• BD→Foreign Trade deficit
Dewald and Ulan (1990)	1961-1985 1954-1987	US	-OLS	• BD ↛ CAD
Enders and Lee (1990)	1947:Q3-1987:Q1	US	-VAR	• BD→CAD/ unrestricted VAR • BD ↛ CAD/restricted VAR
Bachman (1992)	1974:Q1-1988:Q4	US	-Engle-Granger cointegration test -VAR	• no cointegration • BD→CAD
Kasa (1994)	differs for countries	US, Japan, Germany	-VAR	• BB→CAB (US, Japan, Germany)/ unresricted VAR • BB→CAB (US)/ resricted VAR • BD ↛ CAD (Japan, Germany)/ restricted VAR
Dibooğlu (1997)	1960:Q1-1994:Q4	US	-Johansen cointegration test -VAR	• BD→CAD
Vamvoukas (1999)	1948-1994	Greece	-Engle-Granger cointegration test -Granger causality	• cointegrated • BD→Foreign Trade deficit
Zengin (2000)	1987:Q1-1998:Q1	Türkiye	-VAR	• BD→Foreign Trade deficit
Kuştepeli (2001)	1975-1995	Türkiye	-Johansen cointegration test	• BD ↛ CAD
Akbostancı and Tunç (2002)	1987:Q1-2001:Q4	Türkiye	-Johansen cointegration test	• cointegrated • BD→Foreign Trade deficit
Hatemi and Shukur (2002)	1975:Q1-1998:Q2	US	-VAR	• BD→CAD (1st sub sample) • CAD→BD (2nd sub sample)
Utkulu (2003)	1950-2000	Türkiye	-Engle-Granger cointegration test	• BD↔ Foreign Trade deficit

Tablo 1 (Contunied): Summary of the Empirical Literature on Twin Deficit Relationship

Author	Period	Country	Method	Applied Findings
Günaydın (2004)	1987:Q1-2003:Q2	Türkiye	-Toda-Yamamoto causality test	• BD→Foreign Trade deficit
Bussière and et al. (2005)	1960-2003	21 OECD countries	-Panel regression analysis	• BD ↛ CAD
Baharumshah et al. (2006)	differs for countries	Indonesia, Malaysia, Philippines, Thailand	-Johansen cointegration test -Granger causality	• cointegrated • BD→CAD (Thailand) • CAD→BD (Indonesia) • BD↔CAD (Malaysia, Philippines)
Kim and Kim (2006)	1970-2003	Korea	-Granger causality	• CAB→BB
Salvatore (2006)	1973-2005	G-7 countries	-OLS	• BD→CAD
Puah and et al. (2006)	1970-2005	Malaysia	-Johansen cointegration test -Toda-Yamamoto causality test	• no cointegration • CAD→BD
Beetsma et al. (2008)	1970-2004	14 EU countries	-Panel VAR	• BD→CAD
Kim and Roubini (2008)	1973:Q1-2004:Q1	US	-VAR	• BD→Current account surpluses (twin deviation)
Aksu and Başar (2009)	1989:01-2003:12 (monthly)	Türkiye	-Autoregressive Distributed Lag (ARDL)	• cointegrated • BD→Foreign Trade deficit
Altıntaş and Taban (2010)	1974-2007	Türkiye	-ARDL	• cointegrated • BD↔CAD
İyidoğan (2011)	1987:Q1-2005:Q4	Türkiye	-Nonlinear causality test	• CAD→BD
Kalou and Paleologou (2012)	1960-2007	Greece	-Johansen cointegration test	• cointegrated • CAD→BD
Miszta (2012)	1999:Q1-2010:Q2	Latvia Lithuania Estonia	-VAR	• CAD→BD
Telatar (2013)	1991Q1-2013Q1	Türkiye	-KSS unit root test -Dufrénot et al. (2006) contegration -STAR-ARDL	• cointegrared • CAD→BD (-) (negative reverse causality)

Tablo 1 (Contunied): Summary of the Empirical Literature on Twin Deficit Relationship

Author	Period	Country	Method	Applied Findings
Çatık et al. (2015)	1994-2012	Türkiye	-Thresold VAR	• BD→CAD (in upper regime) • BD→ Current account surpluses (in lower regime)
Turan and Karakaş (2017)	1998Q1-2016Q4	Türkiye	-Nonlinear ARDL (NARDL)	• cointegrated • CAD→BD
Bhat and Sharma (2018)	1970-2016	India	-NARDL	• BD→CAD
Antonakakis et al. (2019)	1791-2013	US	-Quantile ARDL (QARDL)	• BD→CAD
Yılmaz and Tütüncü (2020)	1975-2017	Türkiye	-Hacker and Hatemi-J causality test	• CAD→BD • BD↔CAD (for 1980-2008)
Bilman (2021)	2006Q1-2020Q2	Türkiye	-Fourier Engle-Granger cointegration test	• cointegrated • BD→CAD
Mallick (2021)	1998Q2-2017Q4	İndia	-NARDL	• BD→CAD

4. Data, Model, and Methodology

This study aims to investigate the validity of the twin deficits hypothesis in the Turkish economy. Most of the studies on this subject in the literature are based on linear time series analysis. Pötscher and Prucha (1997), Marmer (2008), and Enders (2010) argue that a significant part of the macroeconomic variables and the series obtained as a result of the data creation process may have a nonlinear structure. In this context, changes in factors such as the calculation methods, base years, and sub-items of the variables may cause nonlinear structure in the variables. Enders (2010) argues that the probability of nonlinearity increases, especially in series where the lengths of declination and expansion periods differ. For this reason, there has been a significant increase in the number of studies conducted with nonlinear time series analysis in recent years. Despite the increase in the number of studies with nonlinear models in the literature, the number of studies examining the twin deficits relationship with nonlinear methods is quite limited.

Considering the change made in 2006 in the calculation method of the BB variable used in this study and the differences in the lengths of the increase and decrease periods of the GDP variable, there is a possibility that a nonlinear structure may emerge. For this reason, unlike other studies, in this study, the twin deficits issue was examined with nonlinear time series analysis, and thus it was aimed to contribute to the literature.

The data of the BB and the CAB variables were included in the analysis as a ratio to GDP and seasonally adjusted. The BB variable was obtained from Republic of Türkiye Ministry of Treasury and Finance, and the CD variable was obtained from The Central Bank of the Republic of Türkiye Electronic Data Delivery System (EVDS) databases. Because BD data have been published monthly since 1994 in the database of the Ministry of Treasury of the Republic of Türkiye, 1994 is the beginning of the sample period of the study. The estimated models in the study, in which data between 1994Q1-2021Q4 were used as the analysis period, are shown below.

$$CAB_t=\alpha_0+\alpha_1 BB_t+u_{1t} \quad (7)$$

$$BB_t=\beta_0+\beta_1 CAB_t+u_{2t} \quad (8)$$

4.1. Nonlinear Unit Root Analysis

Kapetanios et al. (2003a) developed a new unit root test called the KSS (Kapetanios, Shin and Shell) test in the literature, which takes into account the nonlinear structure, unlike the classical unit root tests. According to the KSS test, the null hypothesis states that the series follows a linear process by having unit root. On the contrary, the alternative hypothesis asserts that the variable is stationary but, unlike ADF, it follows a nonlinear exponential smooth transition autoregressive (ESTAR) process (Bahmani-Oskooee and Gelan, 2006: 1). The hypotheses in the KSS test and the process of obtaining the model to be estimated are presented below (Kapetanios et al., 2003a: 361-364).

If the univariate first order smooth transition autoregressive (STAR) model is taken into account at the beginning:

$$y_t = \beta y_{t-1} + \gamma y_{t-1}\Theta(\theta; y_{t-d}) + \varepsilon_t, \quad t=1,\ldots,T \tag{9}$$

In equation (9), $\Theta(\theta; y_{t-d})$ represents the transition function. θ is the transition parameter of the STAR process (which determines the transition rate), and lastly, ε_t is the error term that has an identically and independently distributed (iid) process.

If the transition function is expressed as the exponential form of the STAR model,

$$\Theta(\theta; y_{t-d}) = 1 - exp(-\theta y_{t-d}^2) \tag{10}$$

The above expression assumes θ is greater than or equal to zero and *d* is greater than or equal to one ($\theta \geq 0$, $d \geq 1$). Hence, the transition function is between 0 and 1.

$$\Theta(0) = 0; \qquad \lim_{x\to\pm\infty} \Theta(x) = 1$$

Using equations (9) and (10), the following ESTAR model is obtained.

$$y_t = \beta y_{t-1} + \gamma y_{t-1}[1 - \exp(-\theta y_{t-d}^2)] + \varepsilon_t \tag{11}$$

When the equation (11) is reparameterized,

$$\Delta y_t = \emptyset y_{t-1} + \gamma y_{t-1}[1 - \exp(-\theta y_{t-d}^2)] + \varepsilon_t \tag{12}$$

Assuming θ to be positive allows the speed of mean revision to be effectively defined. For y_t to follow the unit root process in the middle regime, $\emptyset$ must be assumed to be zero. With the assumption that $\emptyset$ and θ are equal to zero ($\emptyset$=0, θ=0) the null hypothesis (H_0) states the linear unit root process. In other words, failure to reject H_0 indicates that the series is not stationary and has a linear structure. On the other hand, under the assumption that $\emptyset$ is equal to zero and θ is greater than zero ($\emptyset$=0, θ> 0), the alternative hypothesis (H_1) states that y_t is stationary but follows a nonlinear process.

Assuming $\emptyset$=0 and *d*=1, equation (12) will be rewritten as.

$$\Delta y_t = \gamma y_{t-1}\{1 - exp(-\theta y_{t-1}^2)\} + \varepsilon_t \tag{13}$$

The KSS unit root test relies directly on the estimation of parameter θ. Therefore, the hypotheses to be tested are as follows.

H_0: $\theta = 0$

H_1: $\theta > 0$

Since the γ parameter is not defined under the H_0 hypothesis, it will not be appropriate to test the null hypothesis directly. Hence, by applying the first-order Taylor series approach, the below auxiliary regression is obtained.

$$\Delta y_t = \delta y_{t-1}^3 + \varepsilon_t \tag{14}$$

The hypotheses of equations (14) are as follows.

H_0: $\delta=0$

H_1: $\delta>0$

Testing of the null and alternative hypotheses is carried out by using the t-statistic (t_{NL}) of the parameter δ to be obtained from the estimation of equation (14). The t_{NL} statistic is calculated by dividing the estimated coefficient by the standard error as in the equation below.

$$t_{NL} = \hat{\delta}/\text{s.e}(\hat{\delta}) \quad (15)$$

In equation (15), $\hat{\delta}$ is the OLS prediction result of δ, and s.e. is the standard error of $\hat{\delta}$. The t_{NL} statistic, which does not have asymptotic normal distribution, is compared with the table values prepared by Kapetanios et al. (2003a) instead of the t-table value. Accordingly, if the calculated t_{NL} statistic is less than the critical table value, the H_0 cannot be rejected. In this case, it is decided that the relevant series is not stationary but has a linear process. On the other hand, H_0 is rejected if the calculated t_{NL} statistic is greater than the critical table value. In this case, it is decided that the series does not have a unit root but follows a nonlinear process.

4.2. Nonlinear Cointegration Analysis

Advances in the nonlinear estimation method have led to an increase in nonlinear cointegration tests. One of these tests is the Kapetanios et al. (2003b) cointegration test, which investigated the existence of cointegration according to the STAR process. According to this test, the existence of cointegration can be detected in two different ways. The first one is to determine the cointegration by a nonlinear error correction mechanism. The other is to transform the linear Engle-Granger cointegration approach into the nonlinear structure. Similarly, Dufrenot et al. (2006) cointegration test refers to the nonlinear form of the Engle-Granger cointegration test.

In this study, the existence of cointegration between variables was examined using the Dufrénot et al. (2006) cointegration test. The theoretical background of this test is based on the process presented below.

Let z_t be the error terms obtained from the OLS model estimation, which is the first step of the cointegration test. When assuming that z follows the STAR process with a delay of 1 for simplicity, the nonlinear cointegration test is performed as follows (Dufrénot et al. 2006):

$$z_t = \rho_1 z_{t-1} + \rho_1^* z_{t-1} F(x_{t-d}, \theta) + v_t \quad (16)$$

In equation (16), the transition variable, which represents the regime transition dynamic in the correction process, is x_{t-d}. In addition, the logistic or exponential function type of the STAR model is denoted by $F(.)$ and the series of error terms are denoted by v_t.

$$F(x_{t-d}) = \{1 + exp[-\gamma(x_{t-d} - c)]\}^{-1}, \qquad \gamma > 0 \quad \theta = (\gamma, c) \quad (17)$$

$$F(x_{t-d}) = 1 - \exp[-\gamma(x_{t-d} - c)^2], \qquad \gamma > 0 \quad \theta = (\gamma, c) \quad (18)$$

In equation (17) and equation (18), the transition parameter, which controls the size of the transition between regimes, and the threshold value are shown by γ and c, respectively. z_{t-d} or Δz_{t-d} represent the transition variables. Of these two parameters, z_{t-d} indicates the effect of the current deviation on the future deviation, and Δz_{t-d} denotes the variability property of the deviation in the long run equilibrium. Considering the assumptions ρ=1 and -2< ρ_1* <0, the equation (16) will be rewritten as:

$$\Delta z_t = [\tilde{\rho}_1 + \rho_1^* F(x_{t-d}, \theta)] z_{t-1} + v_t, \qquad \tilde{\rho}_1 = \rho_1 - 1 \quad (19)$$

The H_0 and H_1 hypotheses to be tested here are as follows.

$H_0: \tilde{\rho}_1 = \rho_1^* = 0$ (random walk)

$H_1: \tilde{\rho}_1 = 0, \quad -2 < \rho_1^* < 0$ (nonlinear mean-reversion)

In the null hypothesis above, the parameters of the STAR models are not defined. For this reason, the following auxiliary regression model containing the logistics function of Δz_t is created.

$$\Delta z_t = \phi_0^1 z_{t-1} + \phi_1^1 z_{t-1} x_{t-d} + \phi_3^1 z_{t-1} x_{t-d}^3 + \omega_t^1 \quad (20)$$

The above equation assumes $\phi_0^1 = 0$, $\phi_1^1 < 0$, and $\phi_3^1 > 0$. z_t represents the residuals that are obtained in the first step of the cointegration test, and x_t represents the independent variable of the cointegration equation. Furthermore, $z_{t-1}x_{t-d}$ represents the interaction term and the d subscript represents the optimum lag length. The H_0 hypothesis that the variables are not cointegrated is as follows:

$$H_0: \phi_1^1 = \phi_3^1 = 0$$

Testing the H_0 hypothesis can also be done using two statistics, named STAT1 and STAT2.

$$STAT1 = \frac{T(SSR_0 - SSR_1)}{SSR_0} \quad (21)$$

$$STAT2 = \left[\frac{(SSR_0 - SSR_1)}{SSR_0}\right]\left[\frac{nd_1}{(nd_0 - nd_1)}\right] \quad (22)$$

In the above equations, *T* is the number of observations, and SSR_0 and SSR_1 represent the sum of the squared residuals of the H_0 and H_1, respectively. In addition, nd_0 and $nd_1$are the degrees of freedom under the H_0 and H_1, respectively.

5. Empirical Results

In this study, the KSS unit root test was applied to the variables, considering the possibility that BB and CAB variables have a nonlinear structure. The results of the relevant unit root test are shown in Table 2.

Table 2: **The Results of Nonlinear Unit Root Test**

t_{NL} statistic		case	asymtotic critical values		
BB	**CAB**		**0.01**	**0.05**	**0.10**
-2.544**	-1.729	raw	-2.82	-2.22	-1.92
-2.676***	-1.925	de-meaned	-3.48	-2.93	-2.66
-3.052***	-2.006	de-meaned & de-trended	-3.93	-3.40	-3.13

Notes: [a] The asymptotic critical values were acquired from Kapetanios et al. (2003a).[b] ** and *** indicate that the null hypothesis is rejected at 5% and 10%, respectively.

As seen in Table 2, the t_{NL} statistic values of the BB variable were obtained -2.54, -2.67, and -3.05 for the case of raw, de-meaned, and de-trended, respectively. These statistics obtained are greater than the critical table value (as absolute value) at the significance level of 5% for the raw case, and 10% for de-meaned and de-trended cases. Therefore, the null hypothesis for the BB series is rejected. Accordingly, the BB series is stationary and follows a nonlinear process. In other words, the budget variable does not contain unit root and has a nonlinear structure. On the contrary, the t_{NL} statistics for the CAB variable are smaller (as an absolute value) than the critical table value for all three cases. For this reason, the null hypothesis for the CAB series could not be rejected. Hence, the CAB series contains unit root but has a linear structure. In summary, according to the KSS test results, the BB series follows a nonlinear process, while the CAB series follows a linear process. Especially since the BB series follows a nonlinear process, estimating an empirical model which included the BB variable with linear methods may lead to incorrect estimation results. Therefore, the model with the BB variable should be estimated using nonlinear methods. Hence, the existence of cointegration between variables should be investigated by a nonlinear cointegration test. For this reason, in the study, the Dufrénot et al (2006) cointegration test was used to reveal whether the variables are cointegrated or not. The results of this test, which was

carried out by applying unit root to the residuals obtained from the estimation of the cointegration model, are presented in Table 3.

Table 3: **The Result of Nonlinear Cointegration Test**

Model/Model Number	*d*	ϕ_0^1	Decision
CB=f(BB)/Model I	1	-0.059	H_0 non rejected (not cointegrated)
BB=f(CAB)/Model II	1	-0.131**	H_0 rejected (cointegrated)

Notes: [a] ϕ_0^1 and *d* are the coefficient of z_{t-1} and the optimal lag length of the interaction term in Equation (20), respectively. [b] ** indicates that the null hypothesis is rejected at 5%.

As seen in Table 3, the ϕ_0^1 coefficient is statistically insignificant in the model in which CAB is the dependent variable and BB is the independent variable. Accordingly, there is no long run relationship from the BB variable to the CAB variable. In other words, the twin deficits hypothesis is not valid for the period under consideration. On the other hand, in the model where BB is the dependent variable and CAB is the independent variable, the ϕ_0^1 coefficient is statistically significant. Accordingly, the null hypothesis which suggested that the variables were not cointegrated, was rejected. In other sayings, the variables are cointegrated and there is a long run relationship from the CAB variable to the BB variable. As a result, according to the findings obtained from the nonlinear cointegration test, the reverse causality hypothesis proposed by Summers (1998) is valid instead of the twin deficits hypothesis in the long run between the variables.

After determining the existence of cointegration between the variables in Model II, nonlinear ARDL model estimation was performed in order to determine the long and short run coefficients in the study. The estimation results and long and short run coefficients of the STAR-ARDL model are presented in Table 4 and Table 5.

Table 4: **The Estimation Results of STAR-ARDL Model (Dependent Variable: BB)**

Regressor	Coefficient	t-stat.
Constant	-0.010**	-2.396
BB(-1)	0.918*	28.434
CB(-1)	-0.232***	-1.817
$CAB^3(-1)$	21.217	1.208
R^2=0.92	F=316.379*	LM=1.960[0.161]

Notes: [a] *, **, and *** indicate that the null hypothesis is rejected at 1%, 5%, and 10%, respectively. [b] LM is the Breusch-Godfrey LM test statistic for first order autocorrelation. [c] The value in square brackets represents the probability value.

The first lag of residuals from the STAR-ARDL model was added as an independent variable to the error correction model. The findings obtained as a result of the estimation of the error correction model are presented in Table 5. According to the findings presented in Table 5, the long run coefficient of the CAB variable is negative and statistically significant. This finding reveals that there is a negative relationship from the CAB variable to the BB variable in the long run. Therefore, the reverse causality hypothesis is valid in the long run between the variables.

On the other hand, the lag of the error correction term [ECT(-1)] in the estimated error correction model is also negative and statistically significant. This finding shows that the error correction model is performing and the results of the nonlinear cointegration test are valid. In other words, the variables are cointegrated, that is, they move together in the long run. The ECT(-1) coefficient was estimated to be -0.82. The negative sign of the coefficient indicates that in the event of a shock in the system, a deviation from the equilibrium will return to the current period

equilibrium. Accordingly, approximately 82% of the deviation in the current period equilibrium will be compensated in the next period. In other words, the ECT(-1) value of -0.82 indicates that when the system is faced with a shock, it will take approximately one and a half periods for the system to return to its long run equilibrium. In addition, the coefficient of the CAB variable is negative and statistically significant. Accordingly, there is a negative relationship from the CAB variable to the BB variable in the short run as well as in the long run. In summary, the negative reverse causality hypothesis is valid instead of the twin deficits hypothesis between the variables in both the long and short run. Accordingly, improvements in the CAB variable (decrease in the current account deficit) cause worsening in the BB variable (increase in the budget deficit).

Table 5: **The Long and Short Run Coefficients of STAR-ARDL Model**

long run coef. (dependent variable: BB)		
Regressor	**Coefficient**	**t-stat.**
Constant	-0.121*	-3.450
CAB	**-2.397*** **	**-1.802**
CAB^3	86.421	0.391
short run coef. (dependent variable: ΔBB)		
Regressor	**Coefficient**	**t-stat.**
Constant	-6.43E-05	-0.035138
ECT(-1)	**-0.822344****	**-2.168600**
$ECT^3(-1)$	-10.30318	-0.787290
ΔBB(-1)	0.937560*	2.504348
ΔCB(-1)	**-0.252933***	**-2.518126**

Notes: [a] *, **, and *** indicate that the null hypothesis is rejected at 1%, 5%, and 10%, respectively. [b] Δ denotes the first difference.

6. Conclusion

The large-scale budget and CAD in the US economy in the 1980s led to debates on the validity of the twin deficit relationship. The fact that the aforementioned relationship began to be seen in many developed and developing countries in the following period made the twin deficits popular and led to the formation of different views and hypotheses in this field. The fact that the Turkish economy has become open to the outside since 1980 and the liberalization of capital movements has increased, has made the course of the balance of payments and current account important. Since the BB and CAB also represent the general balance of the economy, they are also important for removing internal and external imbalances.

Pötscher and Prucha (1997), Marmer (2008), and Enders (2010) argue that in addition to most macroeconomic variables, especially the series obtained as a result of the data generating process may have a nonlinear structure. In this sense, the changes made in the calculation methods of the variables, the calculated base years, and their sub-items increase the possibility of nonlinear structure in the variables. The change made in the calculation method of the BB in Türkiye in 2006 may cause this variable to follow a nonlinear process. Similarly, the change in the base year of the GDP may transform both variables used in the study, and therefore the models to be established, to nonlinear. Due to the possibility that macroeconomic variables can follow nonlinear processes, the opinion that classical unit root tests and linear time series analyses may be insufficient in estimating and drawing conclusions has been frequently expressed by economists recently. Therefore, in recent years, researchers have started to turn toward nonlinear dynamics. Despite the increase in studies conducted with nonlinear analysis in the literature, the number of studies examining the relationship between BB and CAB with nonlinear analysis is very few. Therefore, it is aimed to contribute to the literature by examining the twin deficits relationship with nonlinear analysis in this study.

In the study, the validity of the twin deficits hypothesis was investigated using quarterly data for the period 1994: Q1-2021:Q4. The nonlinear time series analysis performed within this framework consists of three main stages. In the first stage, the nonlinear unit root test was performed to determine whether the series followed a nonlinear process or not. In the second stage, the cointegration relationship between the variables was decided by using a nonlinear cointegration test. In the last stage, the long and short run coefficients of the variables were determined by estimating the STAR-ARDL model.

According to the results of the nonlinear unit root test, the CAB variable contains the unit root, BB variable does not. In other words, while the CAB variable follows a linear process, the BB variable follows a nonlinear process. Since the BB series has a nonlinear structure, estimating the model in which this variable takes place with linear time series methods may lead to obtaining incorrect findings. Therefore, in this study, the effects between BB and CAB were investigated by nonlinear time series analysis. Due to the possibility that macroeconomic variables can follow nonlinear processes, the opinion that classical unit root tests and linear time series analysis may be insufficient in estimating and drawing conclusions has been frequently expressed by researchers recently. Therefore, in recent years, researchers have started to turn toward nonlinear dynamics. Despite the increase in studies with nonlinear analyzes in the literature, the number of studies about the twin deficits issue examined with nonlinear models is limited. For this reason, this study aims to contribute to the literature by examining the twin deficits relationship with nonlinear analysis. In order to determine the long run comovement between the variables, Dufrénot et al. (2006) cointegration test was used. According to the results obtained from the cointegration test, there is no long run relationship from the BB variable to the CAB variable. On the contrary, there is a long run relationship from the CAB to BB. The CAB and BB variables are co-integrated, in other words, they move together in the long run. The long run coefficient of the CAB variable is negative. Accordingly, there is a negative long run relationship from the CAB variable to the BB variable. In other saying, increases in the CAD cause a decrease in BD. In addition, the short run coefficient obtained from the estimated STAR-ARDL model indicates a similar result. The sign of the short run coefficient of the CAB variable is also negative. As a result, the negative reverse causality hypothesis is valid instead of the twin deficits hypothesis in the Turkish economy in the short and long run. According to this hypothesis, decreases in the CAD cause economic growth to decrease in countries that grow based on imported inputs. In this case, there is a decrease in the tax revenues of the country, especially on imports tax. In addition, an increase in public expenditures can be made to revive the economy and improve growth performance. As a result, the decrease in the CAD causes a deterioration in the BB.

As in many developing countries, production in the Turkish economy is generally based on imports of intermediate goods. Therefore, increases in production bring about CAB deterioration. It is a clear indicator of this situation that high economic growth rates occur in periods when CAD is too high, and low growth rates occur in crisis periods with a current account surplus. For this reason, it can be stated that the reverse causality relationship revealed by the nonlinear analysis is valid for the Turkish economy. Although the CAD, which is one of the main problems of the economy, affects many variables negatively, it has a positive effect on the BB in Türkiye. The production structure based on the import of intermediate goods causes large CAD with the effect of interest and exchange rates. The fact that the share of intermediate goods imports in total imports is constantly large causes this production structure to be permanent. Since it is very difficult to change the production structure based on imported inputs in the short run, the economic growth performance will continue to be shaped by the size of the CAD in the coming periods. Although the increases in the CAD lead to improvements in the BB through economic growth, they cause the BB to be dependent on the CAD to some extent. While increases in CAD lead to improvements in BB through economic growth, on the other hand, they cause BB to become dependent on CAD. Therefore, changing the production structure in question will be significantly beneficial in eliminating the dependence of the BB on the CAD. Although the measures

that can be implemented in the short run are limited, the production structure based on imported inputs can be changed with the support to be given to domestic industries producing intermediate goods in the long run. Thus, in economic growth, both the decrease in dependence on imports and the increase in employment in the sectors producing intermediate goods will decrease the unemployment rate. At the same time, disciplining the BB will not be dependent on the condition of running a CAD.

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