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The Devil's Triangle: Empirical Evidence from Turkey on Growth, Current Account Deficit, and Inflation

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Abstract:
Determining the existence of the relationship between economic growth, current account deficit, and inflation will guide the selection of policies to be implemented. The distortions that may be caused by the policies to be preferred can be minimized by the measures to be taken if the relations are known. From this point of view, this study is a metaphorical study emphasizing *the Bermuda Triangle*, which caused unexplained losses due to the name given to the study. In the study, to determine the existence and direction of the relations between the variables, Turkey's annual growth, current account deficit, and inflation data for the 1974–2020 period were taken and subjected to various analyzes. In this study, carried out from this point of view, to determine the existence and direction of the relations between the variables, the annual growth, current account deficit, and inflation data of Turkey for the 1974–2020 period were taken and subjected to various analyzes. Augmented Dickey-Fuller (ADF) (1979, 1981) and Philips-Perron (PP) Unit Root tests (1988) and Lee-Strazicich Unit Root Test (2003) were used for stationarity tests. Regression was used since the variables were determined to be stationary at the level and cointegration could not be obtained. The current account deficit changed by 0.181812 units in the negative direction as a result of a one-unit rise in growth, according to the regression analysis (GDP). Furthermore, it has been shown that if inflation increases by one unit, the current account deficit moves in the positive direction by 0.042096 units. Toda Yamamoto Causality Analysis (1995) was used to investigate short-term causality links, and as a consequence, a two-way relationship between GDP and inflation, one-way from GDP and inflation to current account deficit was discovered.
Keywords: economic growth, current account deficit, inflation, regression, Toda Yamamoto.

1. Introduction

Many unexplained aircraft and ships were lost in the Bermuda Triangle in the Atlantic Ocean, previously thought to be magnetic, but contrary to popular belief, it was understood to be a natural gas source that emerged with the effect of ocean currents [1]. Bermuda is at one corner of this triangle, and Miami and San Juan (Puerto Rico) are at the other corners [2]. Based on the Bermuda Triangle, an economic devil's triangle was created by placing the important economic variables, economic growth, current account deficit, and inflation, in the corners with a metaphorical approach; it is a fact that there is something lost in this triangle as well. Based on the Bermuda Triangle, an economic devil's triangle was created by placing the important economic variables, economic growth, current account deficit, and inflation, in the corners with a metaphorical approach; it is a fact that there is something lost in this triangle as well. Economic growth, price stability, and current account balance, which constitute the main macro-economic targets aimed at economies, create a paradoxical situation, especially in the short run. Expansionary monetary and fiscal policies should be pursued if economic growth is the goal. However, the current account deficit and inflation rates will rise in this circumstance. This time, actual growth remains below potential growth as a result of the tight monetary and fiscal policies that will be undertaken in the case of targeting the war on inflation and the current account deficit. The existence of a relationship between growth, current account deficit, and inflation will serve as guidance for decision-makers faced with a choice dilemma in the selection of policies to be implemented. Disruptions that may be caused by the policies to be preferred can be minimized with the measures to be taken if the relations are known.

There are four components to this study, which were conducted to determine the presence of a relationship between growth, current account deficit, and inflation, as well as the direction of causality. Following the introduction, the second section will include a literature review, the third section will introduce the model and data to be used in the study, the empirical methods and findings will be presented, and the study will be concluded in the fourth and final section by addressing the discussions and policy implications.

2. Literature Review

In this section, empirical studies on the causal relationships between the variables of the study will be examined in three different categories: *(i)* Causality relationships between inflation and growth, *(ii)* Causality relationships between inflation and current account deficit, and *(iii)* Causality relationships between growth and current account deficit.

i) Causality Relationships Between Inflation-Growth. Ensuring price stability and stable growth are among the main macroeconomic targets. It is a matter of debate whether these two variables affect each other, whether there is a relationship between them, and if there is a relationship, the direction of causality. While some studies have determined that there is no relationship, we see that there are also differences in studies that detect a relationship. While some studies reveal that growth is positively affected by inflation, some studies show the opposite. For example, Tun Wai (1959) [3], Bhatia (1961) [4], Johnson (1967) [5], Bullard and Keating (1995) [6], Chowdhury (2002) [7], Hineline (2004) [8], and Vaona (2006) [9] did not find any relationship between inflation and economic growth. Ericsson, Irons, and Tyron (2001) [10] found in their study that there was no long-term relationship between the variables. On the other hand, Lucas (1973) [11], Karras (1993) [12], Black, Dowd, and Keith (2001) [13], Mallik & Chowdhury (2001) [14], Rapach (2003) [15], Benhabib & Spiegel (2006) [16], and Mahmoud (2015) [17] find that there is a positive relationship between growth and inflation. While saying that there is a relationship, Romer (1996) [18] in his

study for the USA found that a 0.1% increase in inflation causes a 1% increase in growth. Yakışık (2007) [19], in his empirical study based on the Kyrgyzstan data, determined that an 11% increase in inflation causes a 1% increase in growth. Similarly, Ahmad & Joyia (2012) [20] found that a 1% increase in inflation increased growth in Pakistan by 0.45%. While all these studies reveal that growth is positively affected by inflation, the opposite is also the case. For example; Edwards (1982) [21], Fischer (1983) [22], Kim & Willett (2000) [23], Faria & Carneiro (2001) [24], Hodge (2006) [25], Karaca (2003) [26], Yapraklı (2007) [27], Taban (2008) [28], and Karacor et al. (2009) [29] demonstrated this situation empirically. In the same vein, Barro (1995) [30], in his study involving 100 countries, found that a 1% increase in inflation reduces GDP per capita by 2-3%. Chari, Lary & Manuelli (1996) [31] found that 10% increase in inflation reduces growth by 0.5%. With his regression study, Karaca (2003) [32] determined that 1 unit increase in inflation causes a 0.37 unit decrease in growth. The results of empirical studies looking at the causal linkages between inflation and economic growth vary as well. The research found *i)* From inflation to growth (Table 1), *ii)* From growth to inflation (Table 2), and *iii)* Bidirectional causality links (Table 3), but no relationship between the variables [33], [34], [35], [36].

Researcher	Period/Country	Method	Result
Karaca (2003) [37]	1987-2002, Turkey	Granger Causality and Regression Analysis	INF→GDP
Berber & Artan (2004) [38]	1987:1-2003:2, Turkey	Granger Causality Analysis	INF→GDP
Tarı & Kumcu (2005) [39]	1983-2003, Turkey	Correlation Analysis	INF→GDP
Türkekul (2007) [40]	1988:1-2007:1, Turkey	Granger Causality and VAR	INF→GDP
Yapraklı (2007) [41]	1987:1-2007:1, Turkey	Granger Causality Analysis	INF→GDP
Göçer & Gerede (2016) [42]	2000:1-2014:4, Turkey	Hacker and Hatemi-J (2012), Based on Toda-Yamamoto (1995) Test Khatami-J (2012) Method	INF→GDP

Table 1. Causality Relationships Between Inflation-Growth (INF→GDP)

Researcher	Period/Country	Method	Result
Uslu (2018) [43]	2003:1–2017:4, Turkey	Granger Causality Analysis	GDP→INF
Karabulut (2019) [44]	2003:1-2018:1, Turkey	Granger Causality Analysis	GDP→INF
Dinçsoy & Dinçsoy (2020) [45]	2004:1-2017:4, Turkey	Johansen Co-integration and VECM Granger Causality Tests	GDP→INF

Table 2. Causality Relationships Between Inflation-Growth (GDP→INF)

Researcher	Period/Country	Method	Result
Uçan&Çebe (2018) [46]	2000-2016, Turkey	ARDL Bounds Testing	INF↔GDP

Table 3. Causality Relationships Between Inflation-Growth (INF↔GDP)

ii) Causality Relationships Between Inflation and Current Account Deficit. Very few studies have

been conducted to question whether there is a relationship between inflation and current account deficit, and the direction of the causal relationship if any. Bozgeyik and Kutlu (2019)[47] found a negative relationship between current account deficit and inflation in their study, which they conducted in 2019 for Turkey (using dynamic conditional correlation coefficients (DCC) obtained from the MV-GARCH model) covering the period 1992 to 2017. In the other three studies that could be detected in the literature review, some findings differ from each other (Table 4).

Researcher	Period/Country	Method	Result
Akçay & Erataş (2012) [48]	1993-2011 Brazil, Russia, India, China, Turkey	Panel Causality Analysis	CAD→INF
Yüksel & Özsarı (2016) [49]	1994:1-2015:3, Turkey	Johansen Cointegration and Toda Yamamoto Causality Analysis	INF↔CAD
Bölükbaş (2019) [50]	2006:1-2018:11, Turkey	VAR (Vector Autoregressive) Analysis, Granger Causality Test	INF→CAD

Table 4. Causality Relationships Between Inflation and Current Account Deficit

iii)Causality Relationships Between Economic Growth and Current Account Deficit. Although Eken (1990) [51] and Morsy (2009) [52] did not find a relationship between economic growth and CAD, studies investigating the causal relationships between growth and current account deficit *i)* From growth to current account deficit (Table 5), *ii)* From current account deficit to growth (Table 6) and *iii)* It is possible to see that it reached three different results, two-way (Table 7) between growth and current account deficit.

Researcher	Period/Country	Method	Result
Kandil & Greene (2002) [53]	1960-2000, USA	Cointegration Test	GDP→CAD
Erkılıç (2006) [54]	1980-2004, Turkey	Granger Causality Analysis and VAR Method	GDP→CAD
Karabulut & Çelikel Danışoğlu (2006) [55]	1991:1-2004:1, Turkey	Cointegration Test, VEC	GDP→CAD
Erbaykal (2007) [56]	1987:1-2006:3, Turkey	Toda and Yamamoto (1995) Causality Analysis	GDP→CAD
Çeviş & Çamurdan (2008) [57]	1990-2006, 18 Countries with Inflation Targeting	Panel Data Analysis	GDP→CAD
Lebe et al. (2009) [58]	1997:2-2007:3, Turkey, Romania	Structural Vector Autoregressive Analysis (SVAR)	GDP→CAD
Telatar & Terzi (2009) [59]	1991:4-2005:4, Turkey	Granger Causality Analysis and VAR Method	GDP→CAD
Sekmen & Çalışır (2011) [60]	1998–2009, Turkey	ARDL Bounds Test	GDP→CAD
Yılmaz & Akıncı (2011) [61]	1980–2010, Turkey	Hansen Cointegration and Granger Causality Tests	GDP→CAD CAD≠GDP
Avcı (2015) [62]	1998:1-2014:1, Turkey	Causality Test and VAR Analysis	GDP→CAD

Yurdakul & Uçar (2015) [63]	1999:1-2014:2, Turkey	Granger Causality and VAR Analysis	GDP→CAD
Göçer & Gerede (2016) [64]	2000:1-2014:4, Turkey	Hatemi-J (2012) Method based on Toda-Yamamoto (1995) Test	GDP→CAD
Duman (2017) [65]	2003-2017, Turkey	VAR, Granger Causality and Impact Response Tests, Variance Decomposition	GDP→CAD
Uçak (2017) [66]	1980-2015, Turkey	VAR, Granger Causality and Impact Response Tests, Variance Decomposition	GDP→CAD
Efeoğlu & Pehlivan (2018) [67]	1987-2016, Turkey	Johansen Cointegration Test, Impulse Response Analysis, Granger and Toda-Yamamoto Causality Tests	GDP→CAD
Çiğdem (2019) [68]	1974-2018, Turkey	Engle Granger and Johansen Cointegration Tests	GDP→CAD
Kızıldere (2020) [69]	1974-2015, Turkey	Granger Causality Analysis	GDP→CAD

Table 5. Causality Relationships Between Growth and Current Account Deficit (GDP→CAD)

Researcher	Period/Country	Method	Result
Tarı & Kumcu (2005) [70]	1983-2003, Turkey	Correlation Analysis	CAD→GDP
Akçay & Erataş (2012) [71]	1993-2011, BRICT (Brazil, Russia, India, China)	Westerlund Error Correction Model (ECM) Cointegration Test	CAD→GDP
Sağlam & Erataş-Sönmez (2019) [72]	1993-2015, Visegrad Quartet (Poland, Czech Republic, Hungary, Slovakia)	Durbin-H Test, Dumitrescu-Hurlin (2012) Causality Test	CAD→GDP

Table 6. Causality Relationships Between Growth and Current Account Deficit (CAD→GDP)

Researcher	Period/Country	Method	Result
Yanar & Kerimoğlu (2011) [73]	1975-2009, Turkey	Johansen Cointegration Test and Vector Error Correction Model	GDP↔CAD
Songur & Yaman (2013) [74]	1981-2010, 10 Developing Countries	Panel VECM Method	GDP↔CAD
Akbaş et al. (2014) [75]	1990-2011, 20 Developing Countries (including Turkey)	Panel Causality Test	GDP↔CAD
Kandemir (2015) [76]	1998-2013, Turkey	Granger Causality Test and Least Squares Method	GDP↔CAD
Erdoğan & Acet (2016) [77]	2003:1-2015:4, Turkey	Causality Test, VAR Model	GDP↔CAD
Şit & Alancıoğlu (2016)	1980-2014, Turkey	VAR Model, Granger Causality	GDP↔CAD

[78]		and Action-Response Tests	
Züngün (2016) [79]	2000-2015, China	Granger Causality Test	GDP↔CAD
Arslan et al. (2017) [80]	1980-2014, OECD Countries	VECM Granger Causality Test	GDP↔CAD
Ersungur et al. (2017) [81]	1998-2014, Turkey	Johansen Cointegration, VECM	GDP↔CAD
Karahan & Akçaçakır (2021) [82]	2003-2019, Turkey	Johansen Cointegration and Granger Causality Tests	GDP↔CAD

Table 7. Causality Relationships Between Growth and Current Account Deficit (CAD↔GDP)

Kostakoğlu and Dibo (2011) [83] found a negative relationship between growth and current account deficit by performing VAR Analysis with the data for the period 1991:1-2010:2 for Turkey. Uysal et al. (2015) [84] applied VAR, Johansen Cointegration, Impact-Response Analysis and Variance Decomposition to the 1980-2012 period data for Turkey and found a long-term relationship between the variables. Kaygısız et al. (2016) [85], on the other hand, found a one-way causality relationship between growth and current account balance by applying Toda-Yamamoto and Granger Causality Tests to Turkey data for the years 1980-2014.

3. Data, Methods and Empirical Results

Regression analysis and Toda Yamamoto Causality Test were used in this study, which was carried out to test the existence of the relationship between growth, current account deficit, and inflation in Turkey and to determine the direction of causality. In this section, first of all, the data set and pre-tests will be given, and then the analysis will be started.

3.1. Data Set

Annual data from the World Bank database, encompassing 47 observations for the period 1974-2020, were used in the analyses. Figure 1 shows timeline graphs showing the trajectory of the variables used in the analyses in Table 8 across the relevant timeframe.

Variables	Data Frequency	Abbreviation	Unit	Database
Current Account Deficit	*Annually*	*CAD*	% of GDP	World Bank
Growth	*Annually*	*GDP*	%	World Bank
Inflation	*Annually*	*INF*	%	World Bank

Table 8. Introduction of Macroeconomic Variables

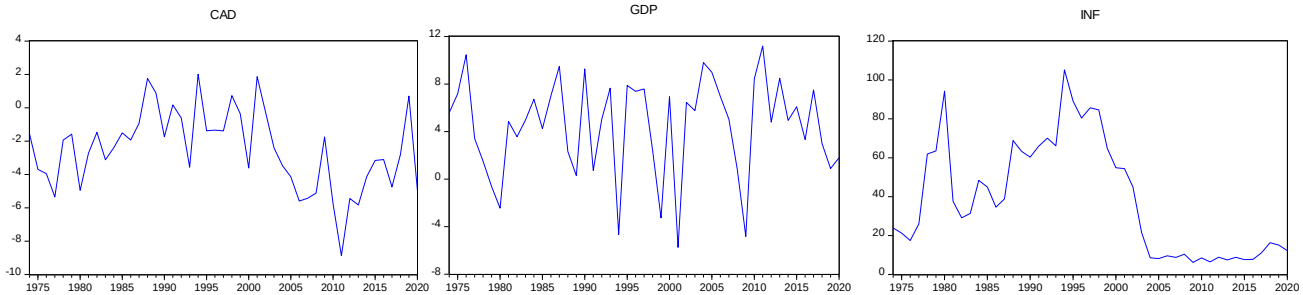

Figure 1. Time Path Plots of Variables

When the graphs created from annual data containing 47 observations used in the analyzes are evaluated together with unit root analysis, it is seen that Turkey provides stability in the current account deficit. As the current account deficit variable, the growth and inflation variables, which are refractory stable (Table 9), are also seen to be stable in terms of instability. The model created is shown in Equation 1;

$$CAD_t=\alpha_0+\alpha_1 GDP_t+\alpha_2 INF_t+u_t \quad (1)$$

In the model, CAD: current account deficit, GDP: growth, INF: inflation, and *t* index is the time series dimension of the variables. α_1 and α_2 are the coefficients, and *u* is the error term.

3.2. Method and Empirical Findings

Before starting the analysis, Augmented Dickey-Fuller (ADF) (1979) [86] (1981) [87], Phillips-Perron (PP) (1988) [88], and Lee-Strazicich Unit Root Tests (2003) [89] were performed for the stationarity tests, which is the first and mandatory step, and the results are given in Table 9.

GDP					
		%1	%5	%10	NOTE
ADF, Level	-6.455748	-3.581152	-2.926622	-2.601424	
PP, Level	-6.447450	-3.581152	-2.926622	-2.601424	
LS, Level	-8.1909	-6.8630	-6.2680	-5.9560	8,1909> 6.2680 H_0 rejected, Stationary with structural breaks, 2003:01-2009:01
CAD					
		%1	%5	%10	
ADF, Level	-4.181439	-4.170583	-3.510740	-3.185512	
PP, Level	-4.336447	-4.170583	-3.510740	-3.185512	
LS, Level	-7.4883	-6.8210	-6.1660	-5.8320	7,4883>6,1660 , H_0 rejected, Stationary with structural breaks 2003:01-2012:01
INF					
ADF, Level	-2.340864	-4.170583	-3.510740	-3.185512	
ADF, 1st Level	-7.182145	-4.175640	-3.513075	-3.186854	
PP, Level	-2.273895	-4.170583	-3.510740	-3.185512	
PP, 1st Level	-7.309929	-4.175640	-3.513075	-3.186854	
LS, Level	-8.0452	-7.1960	-6.3120	-5.8930	8,0452>6,3120, H_0 rejected, Stationary with structural breaks 1990:01-2002:01

Table 9. The Results of ADF, PP, and Lee Strazicich Unit Root Tests

As can be seen from Table 9, it is seen that all variables are stationary at the level. Since

cointegration could not be achieved, regression was applied. As a result of the analysis, double structural breaks were detected (Table 10).

Variables	Break 1	Break 2
GDP	2003:01	2009:01
CAD	2003:01	2012:01
INF	1990:01	2002:01

Table 10. Structural Breaks

It is clear that the break dates for the variables are related to the 1990 Gulf Crisis, the 22 November 2000 Crisis, the February 2001 Crisis, and the 2008 Global Financial Crisis.

Variables	Coefficient	Std. Error	t-Statistics	Prob.
C	-3.370794	0.584355	-5.768396	0.0000
GDP	-0.181812	0.064962	-2.798746	0.0076
INF	0.042096	0.009257	4.547530	0.0000

Table 11. Regression Results

The dependent variable CAD				
Variables	Coefficient	Std. Error	t-Statistics	Prob.
Constant	-3.370794	0.584355	-5.768396	0.0000
GDP	-0.181812	0.064962	-2.798746	0.0076
INF	0.042096	0.009257	4.547530	0.0000
Model Information				
F Statistics	20.35776			
R^2	0.480615			
Diagnostic Tests and Specification Tests			Statistics	Prob.
Breusch-Godfrey Autocorrelation Test			2.489100	0.0829
Breusch-Pagan-Godfrey Test of Differential Variance			0.968571	0.3712
Jarque-Bera Normality Test				0.0760
Ramsey RESET Test				

Table 12. Estimation of Regression Model

In the study, it is seen that the independent variables GDP and INF are statistically significant. The model is significant. According to the results obtained; as a result of a 1 unit increase in GDP, CAD changes in the negative direction by 0.181812 units. If INF increases by 1 unit, CAD increases by 0.042096 units in the positive direction.

Value	Probability	Decision	Direction of Causality
5.763258	0.0560	001636470 < 0,05 H_0 rejected, causality exists.	GDP→CAD
12.04205	0.0024	0,00052014 < 0,05 H_0 rejected, causality exists.	INF→CAD
2.572833	0.2763	0,10871288 > 0,05 H_0 cannot be rejected, no causality.	CAD≠GDP
4.462614	0.1074	0,03464444 < 0,05 H_0 rejected, causality exists.	INF→GDP
0.439847	0.8026	0,50719631 > 0,05 H_0 cannot be rejected, no causality.	CAD ≠ INF
6.522800	0.0383	0,01065002 < 0,05 H_0 rejected, causality exists.	GDP→INF

Table 13. Toda Yamamoto Causality Test Results

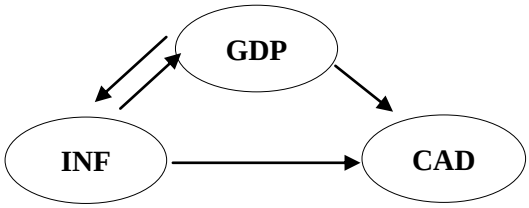

Figure 2. Toda Yamamoto Causality Test Results

As a result of Toda Yamamoto Causality Analysis (1995) [90]; there is a bidirectional relationship between GDP and inflation, and a unidirectional relationship from GDP and inflation to the current account deficit.

4. Conclusion and Discussions

Determining the existence of the relationship between economic growth, current account deficit, and inflation will guide the selection of policies to be implemented. If the relationships are known, the deterioration that may be induced by the recommended policies can be minimized by the steps to be taken. This study was carried out from this point of view. Referring to *the Bermuda Triangle*, which causes unexplained losses, a triangle is formed metaphorically by using growth, current account deficit, and inflation, which causes losses in the Turkish economy. To determine the existence and direction of the relations between the variables forming this triangle, the annual growth, current account deficit, and inflation data of Turkey for the 1974-2020 period were obtained from the World Bank and subjected to various analyzes. Stationarity tests included the Augmented Dickey-Fuller (ADF) (1979) [91], (1981) [92] and Philips-Perron (PP) (1988) [93] Unit Root tests, as well as the Lee-Strazicich Unit Root Test (2003)[94]. Regression was used since the variables were determined to be stationary at the level and cointegration could not be obtained. In the regression analysis, it was determined that the current account deficit changed by 0.181812 units in the negative direction as a result of a 1 unit increase in growth (GDP). In addition, it has been determined that if inflation increases by 1 unit, the current account deficit changes by 0.042096 units in the positive direction. To question the short-term causality relations, Toda Yamamoto Causality Analysis (1995) [95] was applied and as a result, a two-way relationship between GDP and inflation and a one-way relationship from GDP and inflation to the current account deficit was determined.

The results obtained are consistent with the following studies;

i. Uçan ve Çebe (2018) [96], who found bidirectional causality between inflation and growth,

ii. Khan & Knight (1983) [97], Milesi-Ferretti & Razin (1998) [98], Bagnai & Manzocchi (1999) [99], Kandil & Greene (2002) [100], Herrmann & Jochem (2005) [101], Erkılıç (2006) [102], Karabulut & Çelikel Danışoğlu (2006) [103], Erbaykal (2007) [104], Lebe et al. (2009) [105], Çeviş & Çamurdan (2008) [106], Telatar & Terzi (2009) [107], Sekmen & Çalışır (2011) [108], Yılmaz & Akıncı (2011) [109], Avcı (2015) [110], Yurdakul & Uçar (2015) [111], Göçer & Gerede (2016) [112], Kaygısız, et al. (2016) [113], Duman (2017) [114], Uçak (2017) [115], Efeoğlu & Pehlivan (2018) [116], Bakaç (2019) [117], Çiğdem (2019) [118], Kızıldere (2020) [119], who found one-way causality from GDP to current account deficit,

iii. Bölükbaş (2019) [120] who found a unidirectional causality relationship from inflation to current account deficit.

This study, besides contributing to the expansion of the typology, is a contribution to the literature, especially since few studies question the existence of a relationship between inflation and the current account deficit and the direction of causality.

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