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INVESTIGATING THE RELATIONS BETWEEN COFFEE PRICES AND THE GROWTH OF SELECTED COFFEE EXPORTING COUNTRIES*

Eşref KULOĞLU[1]

Nuri Çağrı AKAR[2]

Abstract

Coffee, one of the most important commodities traded in the world, is mainly grown in Latin America and Africa under certain altitudes and climatic conditions. In this study, causality relationships between world coffee prices and GDPs of four coffee producer countries, two from Latin America (Brazil and Colombia) and two from Africa (Kenya and Ethiopia), were tested. Using the series from 1981-2021, the relationships were investigated empirically with Engle-Granger cointegration analysis, error correction model, and Toda-Yamamoto causality methods. According to the analysis, while unidirectional causality between GDP and world coffee price was found for Brazil, Colombia, and Kenya, there was no causality for Ethiopia. As a result of the Engle-Granger cointegration analysis, which tests the long-term relationship, a significant relationship has been found between GDP and coffee prices for all selected countries. According to the results of the error correction model results model that tests the short-term relationship, the relationship between GDP and world coffee price is obtained for Brazil and Colombia. However, such a relationship could not be found in Kenya and Ethiopia.

Keywords: Coffee Prices, Toda-Yamamoto Causality, Engle-Granger Co-integration, Error Correction Model.

Jel Codes: Q14, C22, N16, N10.

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[1] Dr. Öğr. Üyesi, Bayburt Üniversitesi, E-posta: esrefkuloglu@bayburt.edu.tr, ORCID: 0000-0001-8117-6224.

[2] Dr. Öğr. Üyesi, Bayburt Üniversitesi, E-posta: nakar@bayburt.edu.tr, ORCID: 0000-0001-5648-8787.

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KAHVE FİYATLARI İLE KAHVE İHRAÇ EDEN SEÇİLMİŞ ÜLKELERİN BÜYÜMELERİ ARASINDAKİ İLİŞKİLERİN ARAŞTIRILMASI

Öz

Dünyada ticareti yapılan en önemli emtialardan biri olan kahve, ağırlıklı olarak Latin Amerika ve Afrika'da belirli rakım ve iklim koşullarında yetiştirilmektedir. Bu çalışmada, ikisi Latin Amerika'da (Brezilya ve Kolombiya) ve ikisi Afrika'da (Kenya ve Etiyopya) olmak üzere dört kahve üreticisi ülkenin dünya kahve fiyatları ile GSYH'leri arasındaki nedensellik ilişkileri test edilmiştir. 1981-2021 serisi kullanılarak ilişkiler Engle-Granger eşbütünleşme analizi, hata düzeltme modeli ve Toda-Yamamoto nedensellik yöntemleriyle ampirik olarak araştırılmıştır. Analiz sonuçlarına göre Brezilya, Kolombiya ve Kenya için GSYH ile dünya kahve fiyatı arasında tek yönlü nedensellik bulunurken, Etiyopya için nedensellik saptanmamıştır. Uzun dönemli ilişkiyi test eden Engle-Granger eşbütünleşme analizi sonucunda seçilen tüm ülkeler için GSYH ile kahve fiyatları arasında anlamlı bir ilişki bulunmuştur. Kısa dönemli ilişkiyi test eden hata düzeltme modeli sonuçlarına göre Brezilya ve Kolombiya için GSYH ile dünya kahve fiyatı arasındaki ilişki saptanmıştır. Ancak Kenya ve Etiyopya'da böyle bir ilişkiye rastlanmamıştır.

Anahtar Kelimeler: Kahve Fiyatları, Toda-Yamamoto Nedensellik, Engle-Granger Eşbütünleşmesi, Hata Düzeltme Modeli.

Jel Kodları: Q14, C22, N16, N10.

1. INTRODUCTION

Coffee is the most known and popular beverage after water (Bosso et al., 2023, p.394). Before coffee became a beverage, it was discovered by chance during the 3th century, according to a legend. Although humanity's foundations of recognizing the coffee fruit date back to the 15th century, it took time to spread worldwide. In this century, coffee has been seen in travelers' notes for the first time. Humanity's first realization of coffee is rumored to have increased the movement of goats grazing by a shepherd in a region currently located within the borders of Ethiopia due to a fruit they ate.

Coffee is a beverage made by collecting, processing, roasting, and grinding the fruit of a tropical shrub-type tree in the Rubiacaeae family, the coffee genus. There are nearly 120 types of coffee fruit. Among these species, two types of Arabica and Robusta cover most of the world's production. The homeland of Arabica is Ethiopia, and it constitutes 75% of the world's coffee production (Girginol, 2007, p.21). The largest producers are Brazil and Colombia. Robusto coffee, which has almost two times more caffeine than the Arabica type, is grown at lower altitudes and has a high yield but a low quality, so its price is also low. It is mostly produced in Indonesia, Brazil, and Vietnam (Gürsoy, 2005, as cited in Tüzün, 2018).

The introduction of coffee, which is thought to have spread from Ethiopia, accepted as its homeland, as a beverage started in the Yemen region. With the spread of coffee in Egypt and the Arabian Peninsula, the first coffeehouse opened in Mecca. During the Ottoman period, first

coffeehouse was opened in the Istanbul Grand Bazaar in the middle of the 16th century, and it was embraced in all parts of the empire by spreading out of Istanbul. It can be said that coffee has entered a period of very rapid spread with the spread of coffee houses that sell coffee as a beverage to the whole European continent since the 1600s by travelers, traders, and diplomats, and the high interest of the bourgeoisie class in some major centers such as Paris.

The commercial volume of coffee comes after petroleum (Bosso et al., 2023, p. 394, Tüzün,2018, p. 4, Akdeniz Ar and Öztürk, 2019, p. 642). The annual sales figure of coffee is around 70 Billion $, and it has been an occupation to an average of 20 million people in the World (Tüzün, 2018, p.4).

Coffee is greatly affected by climatic features as an agricultural product. In this sense, although its production is made only in tropical regions, its consumption is mostly in northern countries. According to the data obtained from the report of the International Coffee Organization (ICO, 2022), Brazil is the largest coffee-producing and exporting country in the world, and it has a share of approximately one-third of the world coffee market. Vietnam ranks second in export figures after Brazil, with a share of 26%. Colombia follows this country with a share of about 10%. Countries such as Indonesia, Ethiopia, and Honduras follow. Coffee is one of the most important commodities for their national income for non-industrialized and agricultural economies such as Kenya and Ethiopia, some African countries suitable for growing coffee, and some small South American countries such as Chile and Panama.

This research investigates the relationship between the growth of selected coffee exporting countries and the price of coffee. In this sense, co-integration and causality relationships between the gross domestic product of some selected coffee-producing countries and relatively underdeveloped countries in industrialization and global coffee prices will be investigated in this study. In the context of the sub-dimensions of this primary purpose, the long-term relationship (Co-integration model), short-term relationship (Vector error correction model), and causality relationship between the export figures of the relevant countries and global coffee prices will be tested. Engle-Granger co-integration analysis will be used for long-term relationships, the Vector Error Correction model will be used for short-term relationships, and the Toda Yamamoto analysis will be used for causality relationships.

2. LITERATURE REVIEW

Since there is no direct study dealing with coffee prices and economic growth in the literature review, similar studies that have the closest and indirect connection to the subject are included.

Empirical evidence suggests local liberalization and a temporary coffee price boom are the main factors behind Uganda's remarkable growth performance and consequent poverty reduction (Appleton, 2001).

The Deininger and Okidi (2003) paper uses micro-level survey and panel data outputs from Uganda covering the years 1992-2000 to explore the factors underlying economic growth and poverty reduction in Africa. The importance of the prices of agricultural tradable products represented by coffee supports Uganda's emphasis on the rapid and decisive liberalization of output markets for agricultural products in the early 1990s. Moreover, the fact that such price changes are particularly beneficial for the poor not only blasts the thesis that liberalization is anti-poor, but more importantly points to the possible potential for a decline in cotton prices and related agricultural opportunities in the North.

Chant et al. (2004) investigate 1994-1995 coffee price boom with an iterative dynamic CGE model. The most important consequence is short-term welfare gains accrue to farmer households. It can be explained that urban households have benefited enormously from the initial sizeable genuine appreciation accompanying the coffee price boom. In later periods, welfare gains decline, and rural households return in favor.

Bussolo et al. (2006) used data from three household surveys for Uganda covering the 1990s and confirmed a strong correlation between changes in free market coffee prices and poverty reduction.

Gilbert et al. (2013) studied the effect of 1975-2009 Cameroon cocoa, banana and coffee exports on economic growth using the augmented Neoclassical Cobb-Douglas production function. In the study, short- and long-term relationships were determined using the Engle-Granger cointegration method. According to the findings, while banana and coffee exports affect economic growth positively, the effect of cocoa exports is negative.

Tigist (2015) study investigated the effects of exports of oilseeds, coffee and pulses on the growth of the Ethiopian economy for 1973-2013. According to the findings, oil seeds and coffee exports have positive and significant effects on Ethiopia's growth both in the short run and in the long run. However, the effect of pulse exports on growth was found to be negative and insignificant in the short term, and positive and insignificant in the long term.

According to Gizaw et al. (2022) investigated the effects of coffee exports on Ethiopia's economic growth for 1980-2017. Johansen cointegration, conventional VECM and Granger causality methods were used. Results; In the short run, the effect of coffee exports is

insignificant, but it has a significant and positive effect in the long run. A bidirectional causality relationship was found between Ethiopia's coffee export and economic growth.

Hundie and Biratu (2022) Granger causality test result shows that causality runs from world coffee price to coffee price traded in Ethiopian Commodity Exchange (ECX) without any feedback in the long run. The volume of coffee exported Granger causes ECX coffee price only in the short run, while the Granger causality runs from GDP to ECX coffee prices in both the short run and the long run.

The Oviedo-Gomez and Viafara (2022) study analyzed the effects of changes in commodity prices on economic growth excluding welfare, using a VAR model estimate for Colombia covering the period 2001-2016. The prices of petroleum, coal, nickel and coffee commodities are used in the estimation of VAR and the results of the impulse-response and variance decomposition are interpreted. According to impulse-response analysis; the increase in oil prices had a significant and positive effect on GDP for about a quarter, but positive shocks in coffee, coal and nickel prices did not have a significant effect on GDP. The increase in coffee prices has a positive and significant effect on the terms of trade for five and four periods on the trade balance. According to the variance decomposition results, the percentages of variance explained by commodity prices for GDP were found to be 1.2 for oil, 1.4 for coffee, 0.8 for coal and 1.4 for nickel.

3. DATA AND METHODOLOGY

The data period and sources of selected countries in the study are shown in Table 1. The data used in the study is within the widest date range available for all countries' data sets. Therefore, the data are chosen from 1981.

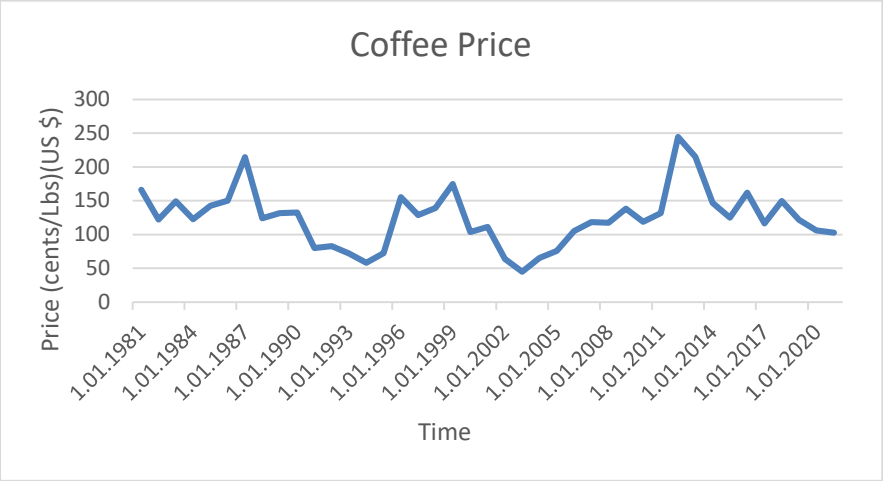
Table 1. Data Period, Variables, and Source by Countries

Countries	Data Period	Variables	Source
Brazil	1981-2021	GDP	World Bank Database
Colombia	1981-2021	GDP	World Bank Database
Kenya	1981-2021	GDP	World Bank Database
Ethiopia	1981-2021	GDP	World Bank Database

Four coffee producer countries' GDP are used in annual frequency in analysis. World coffee prices used in the analysis are US coffee C Futures in US Dollar Graph 1 shows fluctuations in world coffee prices during the given period. In the graph, the horizontal axis shows the date;

vertical axis shows the price of coffee. In the financial market, coffee prices closed 2021 at around 160 US cents/lbs, as given in Graph 1.

Graph 1. Global (World) Coffee Prices



Source: Created by authors.

4. ANALYSIS

In this part of the study, Engle-Granger cointegration analysis, Error Correction Model and Toda Yamamoto Causality Analysis were used for empirical analysis between coffee prices and the economic growth of the selected countries.

4.1. Engle- Granger Co-integration Analysis and Error-Correction Model

After Granger (1981) discovered the relationship between cointegration and error correction models, Engle and Granger developed estimation methods, tests, and empirical examples in their article. Based on the article of Granger and Weiss (1983), the relationships of moving averages, autoregression, and error correction for cointegration were revealed (Engle and Granger, 1987, p. 251).

A long-term relationship is estimated with the Engle-Granger cointegration test. The relevant equation is as follows (Enders, 2015, p. 361):

$$Y_t = \beta_0 + \beta_1 z_t + e_t \quad (1)$$

If there is a long-term relationship between the variables, the error correction model is estimated. The related equation is as follows (Enders, 2015, p. 362):

$$\Delta y_t = \alpha_1 + \alpha_y [y_{t-1} - \beta_1 z_{t-1}] + \sum_{i=1} \alpha_{11}(i) \Delta y_{t-i} + \sum_{i=1} \alpha_{12}(i) \Delta z_{t-i} + \varepsilon_{yt} \quad (2)$$

$$\Delta z_t = \alpha_1 + \alpha_z\left[y_{t-1} - \beta_1 z_{t-1}\right] + \sum_{i=1} \alpha_{21}(i)\Delta y_{t-i} + \sum_{i=1} \alpha_{22}(i)\Delta z_{t-i} + \varepsilon_{zt} \quad (3)$$

Engle-Granger Cointegration tests were performed to determine the long-term relationship. Engle-Granger Cointegration test results for each country are given in the tables below.

Table 2. Engle-Granger Cointegration Results for Brazil

Brazil				
Dependent Variable	tau-statistic	Prob.*	z-statistic	Prob.*
ln_GDP	-2.790747	0.0550	-13.17371	0.0616
ln_coffe_price	-2.814862	0.0522	-13.30028	0.0595

Table 3. Engle-Granger Cointegration Results for Colombia

Colombia				
Dependent Variable	tau-statistic	Prob.*	z-statistic	Prob.*
ln_GDP	-2.805685	0.0532	-13.30539	0.0594
ln_coffe_price	-2.833291	0.0501	-13.44228	0.0572

Table 4. Engle-Granger Cointegration Results for Kenya

Kenya				
Dependent Variable	tau-statistic	Prob.*	z-statistic	Prob.*
ln_GDP	-4.167128	0.0370	-23.65075	0.0388
ln_coffe_price	-3.506219	0.1368	-15.53298	0.2526

Table 5. Engle-Granger Cointegration Results for Ethiopia

Ethiopia				
Dependent Variable	tau-statistic	Prob.*	z-statistic	Prob.*
ln_GDP	-3.448389	0.0121	-121.2935	0.0000
ln_coffe_price	-3.507990	0.0104	-121.3168	0.0000

In the tables above, a long-term relationship has been determined between coffee prices and GDP in all countries. Accordingly, in the long run, the increase in world coffee prices will increase the GDP of Brazil, Colombia, Kenya, and Ethiopia.

Table 6. Error-Correction Model by Countries

Countries	Error Correction Coefficient	Standard Error	t-statistics
Brazil	-0.232718	(0.07475)	[-3.11326]
Colombia	-0.179374	((0.05888)	[-3.04636]
Kenya	-0.085565	(0.06093)	[-1.40423]
Ethiopia	-0.018270	(0.06915)	[-0.26421]

The Error Correction Model's results as seen in Table 13, in which the short-term relationship is found, the model works for Brazil and Colombia. Accordingly, the system reaches equilibrium in approximately 4.30 periods (1/0.232718) in Brazil and 5.57 periods (1/0.179374) in Colombia.

4.2. Toda-Yamamoto Causality

One of the main studies to reveal the causal relationship between the variables was done by Granger (1969). On this subject, causality analysis by Toda-Yamamoto (1995) has been frequently used in studies in recent years. In Toda-Yamamoto's (1995, pp. 225-250) causality test, the fact that the series is stationary or cointegrated at the same level does not affect the validity of the test. It is an advantage of this test that it prevents data loss if the series is made stationary by taking the difference as in the Granger causality test. This has resulted in the frequent use of this analysis in determining causality.

For the Toda-Yamamoto causality test, unit root tests should be performed in order to determine the maximum stationarity (d_{max}). Table 2 below shows the results of the Augmented Dickey-Fuller unit root test and Phillips-Perron unit root test.

In the study, ADF (Augmented Dickey-Fuller) and PP (Phillips-Perron) unit root tests determined whether the series were stationary. When the results of both tests were taken together, I(1) was chosen. According to the unit root test analysis, the series was considered stationary at I(1). After determining the lag length of each series, 1 will be added to the lag length and the appropriate lag length for the VAR models to be used for each country will be calculated.

In the first step of the Toda Yamamoto approach, the lag length and the maximum degree of integration (d_{max}) of the variables are calculated. In the next step, the VAR (k+d_{max}) model

is created by adding d_{max} to the standard VAR (k) model with delay included. Accordingly, the model to be created will be as follows (Tarı et al., 2019, p. 445):

$$Y_t = \mu + A_{11}Y_{t-1+\ldots+}A_{1k}Y_{t-k} + \sum_{l=k+1}^{k+d_{\max}} A_{il} + \upsilon_t \qquad t=1,2,\ldots,T \qquad (4)$$

Table 7. ADF and PP Test Results on I(0)

I(0)				
	ADF Unit Root Test		Philips- Perron Unit Root Test	
Variables	Constant	Constant and Trend	Constant	Constant and Trend
ln_coffee_price	0,0647	0,2061	0,0480*	0,1637
ln_gdp_brasil	0,7147	0,3247	0,7325	0,5514
ln_gdp_colombia	0,8375	0,8495	0,8246	0,6339
ln_gdp_kenya	0,9963	0,4605	0,9919	0,4289
ln_gdp_ethiopia	0,9815	0,8934	0,9951	0,9509

Not: *It represents stationary according to %5 significance level.

Table 8. ADF and Phillips-Perron Unit Root Test Results on I(1)

I(1)				
	ADF Unit Root Test		Philips- Perron Unit Root Test	
Variables	Constant	Constant and Trend	Constant	Constant and Trend
ln_coffee_price	0,0000*	0,0000*	0,0000*	0,0000*
ln_gdp_brasil	0,0010*	0,0059*	0,0010*	0,0061*
ln_gdp_colombia	0,0006*	0,0038*	0,0006*	0,0038*
ln_gdp_kenya	0,0006*	0,0024*	0,0008*	0,0038*
ln_gdp_ethiopia	0,0081*	0,0177*	0,0094*	0,0206*

Not: *It represents stationary according to %5 significance level.

With respect to test results, all variables are stationary at I(1).

After the establishment of the VAR model, the lag length must be determined to apply the Toda-Yamamoto causality test. The tables below show the criteria by which the lag length of the estimated VAR models for Brazil, Colombia, Kenya, and Ethiopia is determined, respectively.

Table 9. Lag Length for GDP of Brazil and Coffee Price Model

BRAZIL					
Lag	LR	FPE	AIC	SC	HQ
0	NA	0.050860	2.697039	2.785916	2.727720
1	**115.5853***	0.001727	-0.686431	**-0.419800***	**-0.594390***
2	7.134704	**0.001716***	**-0.695683***	-0.251298	-0.542282
3	5.365157	0.001794	-0.658725	-0.036585	-0.443962
4	2.327765	0.002087	-0.519683	0.280211	-0.243559
5	0.724281	0.002598	-0.321289	0.656358	0.016194
6	0.601082	0.003276	-0.120040	1.035362	0.278804

Not: *It represents the optimal number of lags in the relevant information criteria.

The lag order selected 1 according to LR, SC, and HQ criteria for the GDP of Brazil and coffee price. As calculated k=1 comes from the VAR lag order, and $dmax$ comes from the unit root test, which is equal to 1. In total, the lag for the model is 2.

Table 10. Lag Length for GDP of Colombia and Coffee Price Model

COLOMBIA					
Lag	LR	FPE	AIC	SC	HQ
0	NA	0.063425	2.917827	3.006704	2.948507
1	**137.1652***	**0.001097***	**-1.140014***	**-0.873382***	**-1.047972***
2	4.291858	0.001199	-1.054504	-0.610119	-0.901102
3	7.805169	0.001148	-1.104689	-0.482549	-0.889926
4	6.200304	0.001151	-1.114590	-0.314697	-0.838467
5	1.315195	0.001398	-0.940819	0.036829	-0.603335
6	4.149014	0.001500	-0.900839	0.254563	-0.501994

Not: *It represents the optimal number of lags in the relevant information criteria.

The lag order selected one according to all criteria for the GDP of Colombia and coffee prices. As calculated k=1 comes from the VAR lag order, and $dmax$ comes from the unit root test, which is equal to 1. In total, the lag for the model is 2.

Table 11. Lag Length for GDP of Kenya and Coffee Price Model

KENYA					
Lag	LR	FPE	AIC	SC	HQ
0	NA	0.101132	3.384392	3.473269	3.415073
1	151.3893	0.001122	-1.117953	-0.851322*	-1.025912*
2	8.222301	0.001075	-1.163458	-0.719073	-1.010056
3	2.161520	0.001260	-1.012084	-0.389944	-0.797321
4	**12.87256***	**0.000977***	**-1.278611***	-0.478717	-1.002488
5	0.816174	0.001212	-1.084046	-0.106399	-0.746563
6	0.328960	0.001547	-0.870428	0.284974	-0.471583

Not: *It represents the optimal number of lags in the relevant information criteria.

The lag order selected four according to LR, FPE, and AIC criteria for the GDP of Kenya and coffee price. As calculated, k=1 comes from the VAR lag order, and $dmax$ comes from the unit root test, which equals 1. In total, the lag for the model is 5.

Table 12. Lag Length for GDP of Ethiopia and Coffee Price Model

ETHIOPIA					
Lag	LR	FPE	AIC	SC	HQ
0	NA	0.103964	3.412013	3.500890	3.442693
1	146.3819	0.001349	-0.933850	**-0.667219***	-0.841809
2	9.490513	**0.001239***	**-1.021629***	-0.577244	**-0.868228***
3	1.306839	0.001497	-0.839731	-0.217592	-0.624968
4	**10.49598***	0.001272	-1.014851	-0.214957	-0.738728
5	1.559251	0.001529	-0.851248	0.126399	-0.513764
6	0.529028	0.001935	-0.646723	0.508678	-0.247879

Not: *It represents the optimal number of lags in the relevant information criteria.

The lag order selected two according to FPE, AIC, and HQ criteria for the GDP of Ethiopia and coffee price. As calculated, k=1 comes from the VAR lag order, and $dmax$ comes from the unit root test, which is equal to 1. In total, the lag for the model is 3.

Table 13. Toda Yamamoto Analysis Results

Countries	**Aspect of Causality**	**x^2 Test Statistics**	**Probability Value**	**Decision**
Brazil	Coffee Price=> GDP	8.678525	0.0339	There is a causal relationship between Coffee Price to GDP.
Colombia	Coffee Price => GDP	3.612677	0.1643	There is a causal relationship between Coffee Price to GDP.
Kenya	Coffee Price => GDP	24.63482	0.0002	There is a causal relationship between Coffee Price to GDP.
Ethiopia	Coffee Price ≠> GDP	4.521762	0.2104	There is no causal relationship between Coffee Price to GDP.

According to Toda-Yamamoto, Causality results between Coffee Prices and Real GDP, as shown in Table 13; for Brazil, Colombia, and Kenya, Coffee Price is the cause of Real GDP. There is unidirectional causality from coffee price to GDP in Brazil, Colombia, and Kenya. However, there is no causal relationship between coffee prices to Ethiopia's GDP.

It is observed from the results of the analysis that world coffee prices affect the GDP of the coffee producers Brazil, Colombia, and Kenya. However, it has been found that world coffee prices do not affect the GDP of another coffee producer Ethiopia.

5. CONCLUSIONS

Increasing coffee consumption and the fact that coffee is a popular beverage raise the global trade volume of this commodity. So that; as explained by the ICO (International Coffee Organization), coffee is the second commodity with the highest trade volume after oil. However, the economic and financial literature on coffee is scarce.

This study has been used the Engle-Granger Co-integration model for long-term relationship testing, especially the Toda-Yamamoto causality analysis. The Error Correction Model was used for short-term relationship testing. First of all, according to the findings obtained from the Toda-Yamamoto causality analysis, unidirectional causality was found between the world coffee price and the GDPs of coffee producers Brazil, Colombia, and Kenya. Accordingly, the world coffee price for Brazil, Colombia, and Kenya is a cause of GDP. That is, there is unidirectional causality between coffee prices and GDP. On the other hand, there is no causality

between world coffee prices and the GDP of Ethiopia, another coffee producer. In the long run, according to the Engle-Granger co-integration test results, a relationship was determined between world coffee prices and GDPs in all chosen countries. Accordingly, the effect of world coffee prices on the GDPs of Brazil, Colombia, Kenya, and Ethiopia, in the long run, has been determined. The findings are similar or close to other studies except the Oviedo-Gomez and Viafara (2022) study in the literature review section. In the results of the Error Correction Model used to determine the short-term relationship, a relationship was found between the world coffee price and the GDP of Brazil and Colombia. However, it has been seen that there is no short-run relationship between the GDPs of Kenya and Ethiopia and the price of coffee.

In light of the empirical findings in this study, it is estimated that the economic importance of coffee commodities for coffee-producing countries will increase in the coming years. It cannot be wrong to comment that the increase in coffee prices will significantly contribute to these countries' GDP, at least in the long run.

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