Analysis of the Relationship between External Debt Stock, Inflation and Economic Growth for Turkiye: Vector Autoregressive Models- Granger Causality Test and Toda-Yamamoto for the Period 1970-2020

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Abstract

In a sense, in the same sense as an important external problem for developing countries as well. In cases where domestic consumption is appropriate, payments are made in foreign purchases because of low income from consumption. Although it is expressed negatively, it is possible to achieve the domestic economic balance with a good shopping external debt process. In particular, economic growth is discussed in theoretical education. The prices listed for this are among the subjects that benefit from the resources taken from the resources benefited from. Whether the economies for this environment are negative or positive from the economic point of view, it will be from the economic budget and the management. In this study, Turkiye's economic 1970-2020 foreign debt, inflation and growth were tested with VAR, Granger Causality Test and Toda-Yamamoto Analysis. From the external outlook of real GDP and rollback of inflation, from the stock used to evaluate the choice of GDP and from the control of inflation, from the choice of GDP, from the buy-back of real GDP, from the external stock of real GDP and from the control of inflation from the evaluation of the choice of GDP from the external debt analysis and Select GH from external debt in the analysis of the conductivity of inflation in the choice of GDP. That's because GDP is the Granger cause. In the Toda-Yamamoto test, on the other hand, it is obtained because there is causality from external debt stock to GDP and inflation, from GDP to external debt stock and inflation, and from inflation to external debt stock and GDP.

Key Words: External Debt Stock, Inflation, Economic Growth, VAR, Granger Causulity Test, Toda-Yamamoto Test

Dış Borç Stoku, Enflasyon ve Ekonomik Büyüme ilişkisinin Türkiye Açısından Analizi: 1970-2020 Dönemi için Vektör Otoregresif Model - Granger Nedensellik Testi ve Toda-Yamamoto

Özet

Gelişmekte olan ülkeler için dış borçlanma hem önemli bir sorun hem de neredeyse kaçınılmaz bir süreçtir. İç tasarrufların yetersizliği, ödemeler dengesi açığı ya da ihracat gelirlerinin düşüklüğü gibi pek çok neden ülkeleri dış borçlanmaya itmektedir. Her ne kadar olumsuz bir adım olarak ifade edilse de, iyi yönetilen bir dış borç süreci ile iç makro ekonomik denge açısından olumlu adımlar atılması mümkündür. Özellikle ekonomik büyüme açısından dış borçlanma süreçleri ve dış borç stoku teoride ve literatürde sıklıkla tartışılmaktadır. Bunun yanı sıra fiyat istikrarının sağlanması hususunda da dış borç stokunun etkileri sıkça araştırılan konular arasında yer almaktadır. Bu bağlamda gelişmekte olan ülkeler açısından makro ekonomik denge için negatif mi yoksa pozitif mi etki yapacağı hem dış borç sürecinin yönetim usulüne hem de mevcut koşullarda dış borçların makro ekonomik süreçlerdeki yansımalarına bağlı olmaktadır. Bu çalışmada Türkiye açısından 1970-2020 döneminde dış borç stoku, enflasyon ve ekonomik büyüme ilişkisi VAR, Granger Nedensellik Testi ve Toda-Yamamoto Analizleri ile sınanmıştır. Gerçekleştirilen analizlerden VAR testinde GSYH değişkeninin dış borç stokundan ve enflasyonun GSYH değişkeni ile dış borç stokundan etkilendiği sonucu elde edilirken, Granger Nedensellik Analizinde dış borç stokunun GSYH'nın granger nedeni olduğu, GSYH'nın diğer değişkenlerin Granger nedeni olduğu ve enflasyon ile dış borç değişkeninin de GSYH'nın Granger nedeni olduğu sonucu elde edilmiştir. Toda-Yamamoto testinde ise dış borç stokundan GSYH'ya ve enflasyona, GSYH'dan dış borç stokuna ve enflasyona, enflasyondan da dış borç stokuna ve GSYH'ya nedensellik ilişkisi olduğu sonucu elde edilmiştir.

Anahtar Kelimeler: Dış Borç Stoku, Enflasyon, Ekonomik Büyüme, VAR, Granger Nedensellik Testi, Toda-Yamamoto Testi

1. Introduction

When it comes to external borrowing, it is understood that the processes of the states to generate income through external resources. It is a method frequently used by developing countries to achieve growth and development goals or due to unsustainable balance of payments deficits. Because for these countries, domestic savings or export revenues are not always sufficient to bring the macroeconomic structure of the country into balance at the desired level and to provide the desired growth rate and price stability. One of the biggest reasons for this situation is that the balance of payments deficit is far from sustainability. In this case, it may cause the process of seeing external debt as a source of income in developing countries.

It is not possible to reach a definite conclusion about the disappearance of these reasons, as these reasons lead countries to external debt. So much so that it is not possible to make a definite judgment about whether the countries that go to external debt will be able to use their income or incomes effectively. Finally, with the effective use of external debt, it is possible for countries to reach their growth and price stability targets. However, in case of an ineffective use problem, external debt cannot go beyond being a burden for national economies.

In this regard, econometric studies are frequently mentioned in the literature. The number of studies evaluating the effects of both external debt stock and economic growth and external debt stock on macroeconomic factors is quite high. In order to investigate the relationship between external debt stock, economic growth and inflation, the 1970-2020 period data for Turkiye were obtained from the World Bank Data website in this study. In the study, it was aimed to test the relationship in question by applying different econometric models. For this purpose, firstly the VAR (Vector Autoregressive Model), then the Granger Causality Test and finally the Toda-Yamamoto test were applied to examine the relationship between the variables. The reason for examining Turkiye as a sample is that Turkiye has previously resorted to external borrowing due to the savings gap, the need for foreign currency or different reasons.

The study consists of 4 chapters, in the continuation of the introduction, there is the second chapter, which includes examples of the literature examining the relationships of these variables. Then, in the third section, econometric methods are explained and analyzes are carried out, and in the last section, there is a conclusion section that includes the findings obtained from both the literature review and econometric analyzes.

2. The Literatur Review

The external debt stock is extremely important especially for developing countries. It is seen as an income method that developing countries inevitably resort to for various reasons. For this reason, there are many studies in the literature examining the relationship between external debt stock and macroeconomic variables. According to these studies external debt stock effects economic growth, development, income distribution and the external debt stock (Yıldız (2022); Adıyaman (2006)).

Table 1: The Literatur Review

Author	Scope	Term	Method	Results
Lin and Sosin (2001)	77 countries	1970-1992	Regression Analysis	In Latin American countries that have achieved industrialization, the relationship between external debt and economic growth is negative but statistically insignificant; They found that it was negative and statistically significant in African countries.
Aristovnik (2007)	MENA countries	1992-2006	Dynamic Panel Data Analysis	It has been determined that external debts have a reducing effect on the current account deficit.
Karagöz (2007)	Turkiye	1980-2004	Regression	It has been determined that the effect of the change in public expenditures on external debt is statistically insignificant, but the balance of payments deficit, domestic savings and the amount of domestic debt have a significant effect on the amount of external debt.
Çiçek and others (2010)	Turkiye	1990Q1–2009Q3	Unit root testing, Structural break testing and Regression analysis	Positive effect of the increase in the domestic debt stock on GDP However, it has been determined that the increase in the external debt stock has a negative effect on GDP.

Table 1: The Literatur Review (continue)

Butts and others (2012)	Thailand	1970 - 2003	ADF and PP unit root test ARDL limit test Granger causation analysis	A reciprocal relationship has been identified between GDP and external debt. There is cointegration
Akan and Kanca (2015)	Turkiye	1980-2012	VAR	economic growth increases external debt and inflation, and It is concluded that the change in external debt affects inflation.
Kamacı (2016)	Azerbaijan, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Turkmenistan and Turkiye	1995-2014	Panel Data Analysis	As a result of the analysis, it has been determined that there is a one-way causality relationship from foreign debt to economic growth and there is no relationship between external debt and inflation.
Ushahemba and others (2016)	Nigeria	1981 - 2014	ADF and Ng-Perron unit root test Johansen cointegration granger causation	They found cointegration among the variables and determined the effect from external debt stock to GDP.
Suidarma and Yasa (2021)	Indonesia	2011-2020	Error Correction Method	It has been determined that external debt makes a significant contribution to growth in the long run.

3. Methodology

Time series data is affected by historical and/or random shocks and changes in other series, and multivariate analyzes instead of univariate analyzes provide more effective results. In this context, it would be correct to use a system of equations for models containing more than one time series. For this reason, the vector autoregressive VAR(p) model was used primarily in the study. (Sevüktekin and Çınar, 2017, p.495).

3.1 Vector Autoregressive Models and Granger Causulity Test

VAR is a dynamic model that detects relationships between variables. It is a system of equations and estimates are made by taking into account the delayed values of all variables determined internally in the system, as well as the lagged values of other variables. In this way, after estimating all the equations separately or as a whole and measuring the responses of the variables to the shocks one by one, impact response analysis is performed. Causality analysis can be performed with VAR models. With this analysis, the direction of the relationship between the variables can be determined (Yerdelen Tatoğlu, 2020, p.5). With causality analysis, short-term relationships can be determined, but if there is a cointegrated relationship between the variables, it is possible to make long-term interpretations. All variables used for analysis must be stationary.

$$Y_t = \alpha_{10} + \sum_{i=1}^{p} \alpha_{11i} Y_{t-i} + \sum_{i=1}^{p} \alpha_{12i} X_{t-i} + u_{1t} \qquad H_0: \alpha_{12i} = 0 \qquad H_1: \alpha_{12i} \neq 0$$

$$\begin{bmatrix} Y_t \\ X_t \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \alpha_{11i} & \alpha_{11i} \\ \alpha_{11i} & \alpha_{11i} \end{bmatrix} \cdot \begin{bmatrix} Y_{t-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}$$

When VAR analysis is performed, impulse-response function and variance decomposition are applied instead of model parameters, and impulse response function determines the response of internal variables in the VAR model to random shocks in the error term. In impulse response functions, the response of the endogenous variable is measured in response to a unit random shock given the error term. Variance decomposition analysis, on the other hand, determines the ratio between the movements of a variable caused by its own shocks and the changes caused by the shocks of other variables. If the ratio of the error variance of the first variable to the error variance of the other variable is zero in all periods, it can be concluded that the second variable is an exogenous variable, and in the opposite case, if the rate of error variances is different from zero, it is determined that the second variable is an internal variable (Sevüktekin & Çınar, 2017, p. 510-515).

3.2 Findings

In this study, the relationship between External debt stock (ex), inflation and economic growth for Turkiye is analyzed. The time series of the variables included in the econometric model are shown in the figure 1.

Figure 1: Graph of Variables

EX

GDP

INF
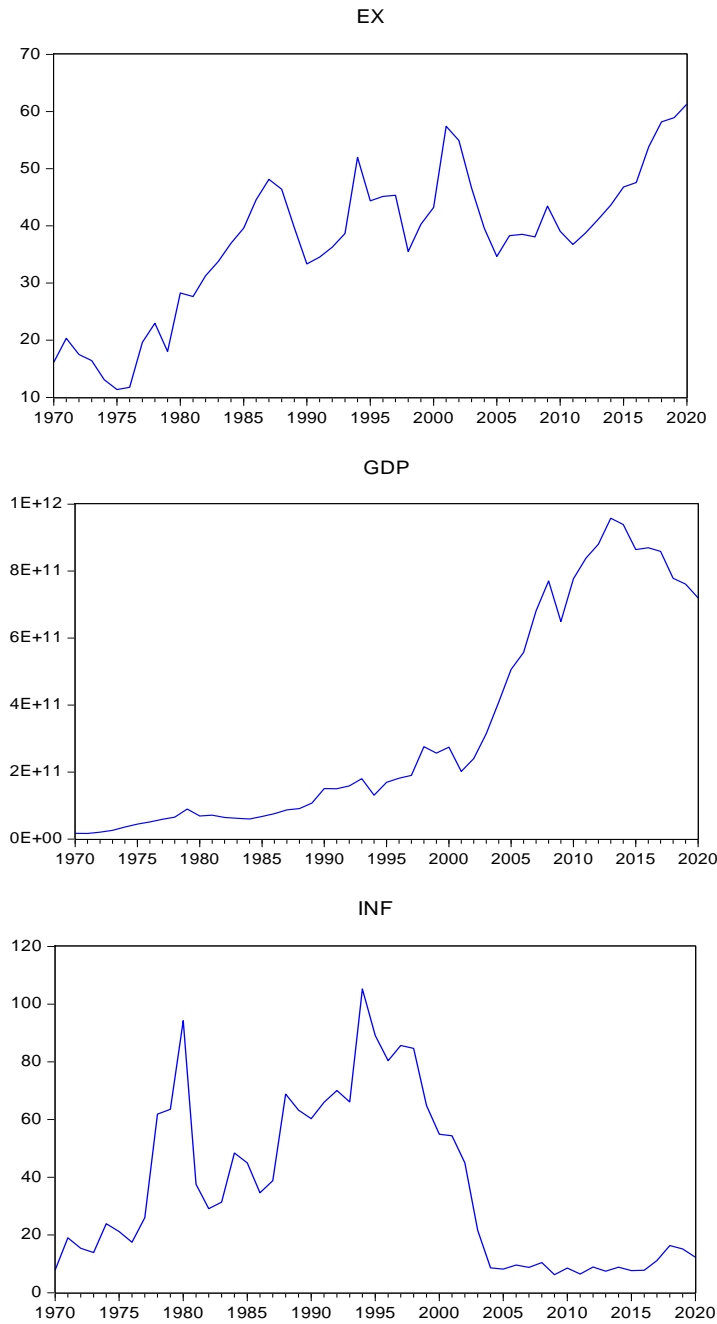
In this study the time series analysis was performed to explain the relationship between ex, inf, and GDP variables. Descriptive statistics of the variables are given in Table 2.

Table 2: Descriptive Statistics of Variables

	Mean	Median	Max	Min	Standard deviation	Skewness	Kurtosis	Normality
Ex	37.44	38.76	61.29	11.37	12.79	-0.37	2.55	1.62 (0.44)
Lngdp	25.92	25.91	27.58	23.51	1.20	-0.17	1.94	2.61 (0.27)
Lninf	3.24	3.25	4.65	1.83	0.90	-0.05	1.51	4.72 (0.09)
Gdp	3.31E+11	1.80E+11	9.58E+11	1.63E+11	3.22E+11	0.76	1.94	7.39 (0.02)
inf	36.71	25.98	105.21	6.25	28.82	0.65	2.15	6.12 (0.07)

Note: The value in parentheses is the probability value.

In the descriptive statistics of the variables, the logarithms of the data of the GDP and external debt stock variables were added to the research. In time series analysis, the series must be stationary in order to detect significant relationships between variables. Augmented Dickey Fuller (ADF) unit root test, Phillips Perron (PP) unit root test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests were carried out to examine whether the series are stationary or not. The test results are given in Table 3.

Table 3: Results of Unit Root Tests

ex	ADF		PP		KPSS	
	Fixed	Fixed and Trending	Fixed	Fixed and Trending	Fixed	Fixed and Trending
Test Statistics	-1.36	-1.80	-1.34	-2.37	0.70	0.14
1%	-3.544063	-4.124265	-3.544063	-4.118444	0.739000	0.216000
5%	-2.910860	-3.489228	-2.910860	-3.486509	0.463000	0.146000
10%	-2.593090	-3.173114	-2.593090	-3.171541	0.347000	0.119000
LnGDP	ADF		PP		KPSS	
	Fixed	Fixed and Trending	Fixed	Fixed and Trending	Fixed	Fixed and Trending
Test Statistics	-1.92	-1.77	-1.89	-2.05	0.93	0.06
1%	-3.560019	-4.140858	-3.544063	-4.118444	0.739000	0.216000
5%	-2.917650	-3.496960	-2.910860	-3.486509	0.463000	0.146000
10%	-2.596689	-3.177579	-2.593090	-3.171541	0.347000	0.119000
LnInf	ADF		PP		KPSS	
	Fixed and Trending	Fixed	Fixed and Trending	Fixed	Fixed and Trending	Fixed and Trending
Test Statistics	-1.61	-2.50	-1.66	-2.50	0.37	0.18
1%	-3.560019	-4.140858	-3.544063	-4.118444	0.739000	0.216000
5%	-2.917650	-3.496960	-2.910860	-3.486509	0.463000	0.146000
10%	-2.596689	-3.177579	-2.593090	-3.171541	0.347000	0.119000

H0: The serial unit is rooted.
H1:: The series is stationary.

When Table 3 is examined, it has been determined that all variables have unit roots at the level. For this reason, calculations were made by taking the first differences of the series.

Table 4: Linear Unit Root Tests – First Differences

Ex	ADF	PP	KPSS
Test Statistics	-4.85	-6.50	0.07
1%	-2.605442	-2.604746	0.739000
5%	-1.946549	-1.946447	0.463000
10%	-1.613181	-1.613238	0.347000
LnGDP	ADF	PP	KPSS
Test Statistics	-3.14	-5.83	0.21
1%	-2.606911	-2.604746	0.739000
5%	-1.946764	-1.946447	0.463000
10%	-1.613062	-1.613238	0.347000
LnInf	ADF	PP	KPSS
Test Statistics	-7.04	-7.04	0.29
1%	-2.606911	-2.604746	0.739000
5%	-1.946764	-1.946447	0.463000
10%	-1.613062	-1.613238	0.347000

When Table 4 is examined, it is seen that both variables are stationary in the first order. After both variables were determined as first-order stationary, the lag lengths of the model were determined in order to determine the order of the VAR model.

Table 5: Lag Length of the Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-281.4654	NA	36.28112	12.10491	12.22300	12.14935
1	-94.18784	342.6780*	0.018430*	4.518632*	4.991010*	4.696391*
2	-87.75418	10.95092	0.020669	4.627837	5.454499	4.938916
3	-80.86013	10.85445	0.022906	4.717452	5.898398	5.161850

As seen in Table 5, the lag length of the model was determined as 1.

Table 6: Residual of the Model

Component	Jarque-Bera	df	Probability Values
1	0.222615	2	0.8947
2	1.179053	2	0.5546
3	1.889919	2	0.3887
Joint	3.291587	6	0.7715

H0 = Residues are normally distributed.
H1 = Residues are not normally distributed.

Since 0.8947 is bigger han 0.05, the null hypothesis is accepted, and the residuals in the model are normally distributed. The normal distribution of the model is important for constructing F statistics and confidence intervals.

If the model is determined at which order, it is expected that there will be no autocorrelation at that order. At this point, the results of the LM tests are examined.

H0 = No autocorrelation.
H1 = There is autocorrelation.

Table 7: LM Test

Lags	LM-Stat	Prob
1	9.480315	0.3942
2	7.931116	0.5411
3	9.801557	0.3668

As can be seen in Table 7, the null hypothesis was accepted since the probability value in the 1rd order was 0.3942>0.05. There is no autocorrelation in the model.

In order to establish a VAR model, there should be no problem of varying variance in the model.

H0 = There is constant variance.
H1 = There is varying variance.

Table 8: Joint Test

Chi-sq	df	Probability Values
77.61019	72	0.3046

The probability value is greater than 0.3046 > 0.05 and

H0 is accepted. The model has constant variance.

In order to ensure the stationarity and stability condition of the VAR model, the model must be in the unit circle and the inverses of all AR roots must be less than 1.

Figure 2: Unit Circle View of Characteristic Roots of the VAR Model

Inverse Roots of AR Characteristic Polynomial
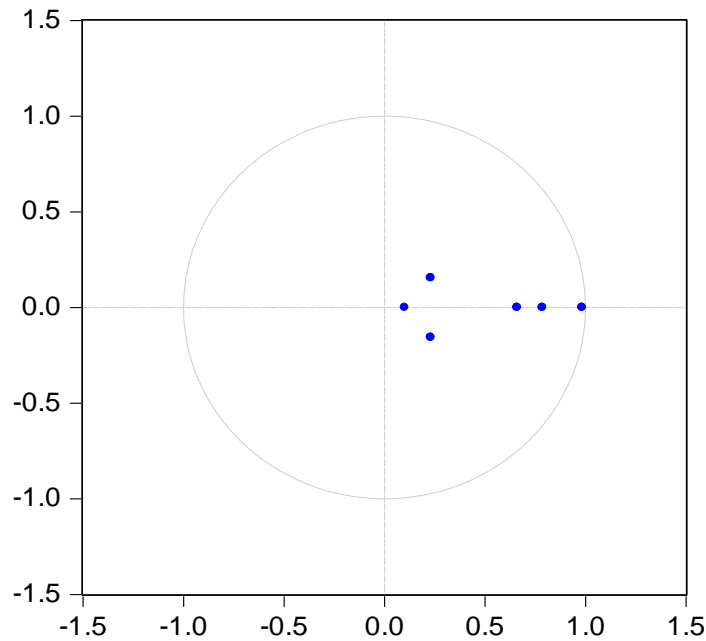
The inverses of all AR roots lie within the unit circle.

Table 9: Stability of the VAR Model

Root	Modulus
0.983017	0.983017
0.785603	0.785603
0.660061	0.660061
0.230256 - 0.156175i	0.278223
0.230256 + 0.156175i	0.278223
0.100191	0.100191

It has been determined that the VAR model can be used because the model provides all the conditions. First, variance decomposition is performed.

Table 10: Variance Decomposition

EX				
Period	S.E.	EX	LNGDP	LNINF
1	4.687674	100.0000	0.000000	0.000000
LNGDP				
Period	S.E.	EX	LNGDP	LNINF
1	0.150220	74.80676	25.19324	0.000000
LNINF				
Period	S.E.	EX	LNGDP	LNINF
0.331517	7.921646	0.192435	91.88592	0.331517

In Table 10, the sources of the change in the variable are determined. The external debt stocks variable is 100% affected by itself, and gdp variable is affected by 74.80% external debt stock and 25.19% itself. Inflation variable is affected by 91.88% gdp and 0.19% external.

Table 11: Granger Causality Test

Dependent variable: EX			
Excluded	Chi-sq	df	Prob.
LNGDP	11.07979	2	0.0039
LNINF	4.379793	2	0.1119
All	12.36990	4	0.0148
Dependent variable: LNGDP			
Excluded	Chi-sq	df	Prob.
EX	4.808748	2	0.0903
LNINF	4.993281	2	0.0824
All	6.424576	4	0.1696
Dependent variable: LNINF			
Excluded	Chi-sq	df	Prob.
EX	6.713744	2	0.0348
LNGDP	5.127120	2	0.0770
All	8.770114	4	0.0671

Since the external debt stock variable is 0.0039<0.05, it is the granger cause of the gdp variable. Gdp variable is the granger cause of other variables with 10% probability (0.09 and 0.08<0.10). If the inflation variable is again with a probability of 5% (0.03<0.05), and the external variable with a probability of 10% (0.07<0.10), it is the granger cause of the gdp variable.

3.3. Toda-Yamamoto Analysis

For model estimation, the lag length (k) value should be added to the highest level of stationarity (dmax) included in the variables.

VAR (k+dmax) = k + dmax = 2

Hypotheses in Toda-Yamamoto analysis;

H0 = There is no causal relationship
H1 = There is causal relationship

Table 12: Toda-Yamamoto Causality Test Results

Basic Hypothesis	Chi-Square Test Statistic	Probability Value	Relationship and Direction
Ex → GDP	12.92643	0.0016	H1 admit, there is causulity
Ex → Inf	5.109758	0.0777	H1 admit, there is causulity
GDP → ex	5.610206	0.0605	H1 admit, there is causulity
GDP → Inf	5.825494	0.0543	H1 admit, there is causulity
Inf → ex	7.832701	0.0199	H1 admit, there is causulity
Inf → GDP	5.981640	0.0505	H1 admit, there is causulity

Considering the chi-square test statistics and probability values, it has been determined that there is a causal relationship from external debt stock variable to GDP and inflation, from gdp to external debt stock and inflation, and from inflation to external debt stock and gdp.

4. Conclusion

It is possible to define the concept of external debt simply as the income of the states by borrowing from external resources. The concept in question is not just a type of debt for countries. It often refers to a process preferred by developing countries in order to give direction to their basic macroeconomic elements. Sustainability of balance of payments deficits, adequacy of export revenues, foreign exchange stocks and price stability concept are extremely important for countries. These factors are among the determinants of the macroeconomic balance of countries. For this reason, especially developing countries can see external borrowing as a source of income in order to achieve the targeted growth rate and level or to ensure the sustainability of their balance of payments deficits. Sometimes this situation results in positive results, but sometimes it results in more serious economic problems. In this context, in cases where external borrowing is inevitable, a supportive process can be provided for developing countries in achieving growth and price stability targets by using the borrowed resource effectively. However, the processes that are considered theoretically and applied do not always coincide.

In this context, the relationship between the economic growth and inflation levels of developing countries and their external debt stocks is frequently examined in the literature. When the studies in the literature are examined, according to Kamacı (2016) and Suidarma and Yasa (2021), the external debt stock has an effect on GDP. The level of the said effect differs from country to country due to the policies applied. From this point of view, in this study, the relationship between external debt stock, inflation and economic growth variables was tested for Turkiye. The GDP variable representing economic growth is included in the analysis. Data for the period 1970-2020 were tested by applying VAR, GRANGER causality Analysis and Toda-Yamamoto Analysis.

In the study, time series analysis was performed to explain the relationship between variables. Augmented Dickey Fuller (ADF) unit root test, Phillips Perron (PP) unit root test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests were used out to examine that the series are stationary or not. Calculations were made by taking the first differences of the series because all variables have unit roots at the level. Since 0.8947 is > than 0.05, the residuals in the model are normally distributed. VAR model is be used because the model provides all the conditions. As the result of Granger Analysis; the external debt stock variable is $0.0039<0.05$, it is the granger cause of the gdp variable. Gdp variable is the granger cause of other variables with 10% probability (0.09 and $0.08<0.10$). If the inflation variable is again with a probability of 5% ($0.03<0.05$), and the external variable with a probability of 10% ($0.07<0.10$), it is the granger cause of the gdp variable. As the result of Toda-Yamamoto Analysis; there is a causal relationship from external debt stock variable to GDP and inflation, from gdp to external debt stock and inflation, and from inflation to external debt stock and gdp. The relationship between external debt stock, economic growth and inflation has also been proven for Turkiye in the 1970-2020 period with econometric analyzes. According to these results, considering the relationship of external debt stock with inflation and economic growth, it is possible to increase economic growth with the effective use of external debt, as mentioned before in this study. External debt stock has a great importance for developing countries. For this reason, the application of different econometric analysis methods in the studies that will be carried out in the future periods for the subject examined in this study will also contribute to the literature.

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