No. 130/24, 7–21
ISSN 2657-6988 (online)
ISSN 2657-5841 (printed)
DOI: 10.26408/130.01

Submitted: 24.11.2023
Accepted: 19.05.2024
Published: 28.06.2024

ANALYSING THE IMPACT OF EXPORT VOLUME ON INFLATION BY USING CONTAINER TRAFFIC: EVIDENCE FROM TURKEY

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Abstract: Inflation has been the subject of many studies as a principal factor that rapidly decreases social welfare, especially in developing countries. For this reason, determining which factors affect inflation is important for the effectiveness of the policies implemented in the fight against inflation. In this study, we aimed to determine whether an increase in exports affects inflation based on exported container traffic, which mostly includes high value-added cargoes. We applied a two-way Granger causality analysis because the opposite relationship between the variables could theoretically be possible. We used 228 monthly observations covering the period between January 2004 and December 2022. The results showed that there is a unidirectional causality between export container traffic and inflation. A positive shock in exports generates a negative shock in inflation, and this shock remains in the system for about 10 months, while the change in inflation is mostly caused by its own past values. This situation shows that exports are effective in reducing inflation by providing foreign currency to the country, but the expectations of an increase in inflation must be broken to a considerable extent for the reducing policies to be effective.

Keywords: inflation, export, container throughput, causality.

1. INTRODUCTION

Trade connects world economies to each other by generating bonds, meaning countries need to be open to foreign markets. Being open to foreign markets, through exporting goods and services produced in domestic markets, contributes to a country's economy. Therefore, trade plays a significant role in economic changes, and it can affect and be affected by many elements [Erokhin 2020].

Inflation is one of the top problems that countries face, especially developing economies [Sachs 1989], defined as an increase in the general price level of goods and services in an economy. Although there are many factors that trigger inflation, it can be considered in general from two different Keynesian perspectives.

The factors affecting it essentially also support these two perspectives: the cost-push effect and the demand-pull effect. According to the cost-push effect, since the increase in costs will increase the production costs, there is an increase in the general level of prices. These costs may relate to inputs, intermediate goods, labour and taxes. On the other hand, according to the demand-pull effect, more demand for goods generates a new equilibrium in the supply-demand balance, causing prices to move upwards [Comley 2015]. The reason for this can be shown as the need for more production factors due to the increasing demand and therefore moving away from the optimum production level that minimizes the unit cost.

One of the factors affecting both the costs and demands of products is exchange rates [Bigman and Taya 2003]. Since the prices of raw materials, intermediate goods, and production equipment used in production are based on dollars in the international market, an increase in exchange rates naturally causes an increase in production costs and triggers domestic inflation. In addition, since the prices of the goods in the country are determined by the exchange rate, an increased exchange rate increases the international demand for the country's relatively cheaper goods and increases inflation. In this respect, every factor that affects the exchange rate can also affect inflation. The main determinants of exchange rates can be counted as interest policies [MacDonald 2007], economic policies [Steinberg 2015], the country's reputation [Levy-Livermore 2019], and foreign trade balance [Harvey 2009]. One of the most influential factors is undoubtedly the foreign trade balance, while the export performance of the country has a significant impact on this balance. However, since the monetary values used in the measurement of foreign trade are also exposed to inflationary pressures, different measurement variables are also needed. These can be the indicators of the country's physical good export performance.

In this study, we aimed to determine whether changes in container transport, which is used extensively in the export of products with high value-added [Ducruet and Itoh 2021], contribute to the inflation of the country. The increased export volume with high-value-added goods may also increase the foreign currency inflow to the country, slowing the rate of increase in the exchange rate [Joshi and Klein 2018] and generating a negative effect on the rate of increase in inflation [Nas 2008], as the changes in exchange rates affect container traffic in the ports as well as in international trade [Açık, Sağlam and Tepe 2019]. Significant foreign exchange inflows are provided in Turkey, where exports by sea are 56% in terms of value [TÜİK 2023]. The results obtained showed that there is a one-way significant causality relationship from export container traffic in ports to the Turkish inflation index. In addition, a positive shock in container traffic has a negative effect on inflation rates. However, although this shock remains in the system for a long time, the extent of this effect remains limited. The change in inflation is largely due to its own historical values, which indicates the importance of adaptive and rational expectations rather than other factors in the formation of inflation. Our study shows that export container traffic in ports is a leading indicator for domestic inflation and

that export-supportive policies should be followed to reduce the rate of increases in inflation.

In the second part of the study, the relevant literature is reviewed and the current study is positioned. In the third part, the dataset and method to be used in the analysis are introduced. The fourth part covers estimating the models and presenting the results. The introduction includes some background information, such as theories, prior work, and hypotheses.

2. LITERATURE REVIEW

It is known that increases in foreign demand mean that exports will also increase. If there is not enough domestic production, then foreign demand increases the domestic prices, i.e., through inflation. On the other hand, if there is an increase in the amount of the exchange rate for things entering the country, this will partially suppress inflation. The interaction between foreign trade and inflation is also described in the Keynesian demand function, as exports raise total demand and imports reduce total demand. Thereby, a rise in exports in liberal economies will raise local revenues and thus total demand. Raising total demand will cause a rise in local prices, leading to inflation. On the other hand, an increase in imports causes a part of the national income to leak to foreign countries, thereby decreasing total demand and decreasing inflation.

In the literature, the domestic price level in an open economy is affected by exchange rate changes and international prices, through goods and services subject to foreign trade. There has been much research related to the interactions between exchange rates, inflation, exports, and imports for Turkey and the world economy. However, these studies have shown different results in different time periods. First, therefore, we need to compile some studies in the world and some studies carried out in Turkey.

In the first of the world-specific studies, Afshan and Batul [2014] examined the interactions between exchange rates, inflation, exports, and imports and tested the variables in Pakistan and India using econometric techniques. The purpose of this was to analyse the short and long-term interactions between selected variables. The findings indicated that significant movements in the exchange rate seriously affected the inflation rate of a developing country like Pakistan, and export rates would be negatively affected as it could not compete with the global market due to high inflation. Ulfa and Abbas [2018] analysed the effect of exports and imports on inflation in Indonesia for the period 1990–2016 using multiple linear regressions. The results obtained in the study showed that, in this period, exports did not affect inflation in Indonesia, while imports had a significant and positive effect on inflation. Sahoo and Sethi [2020] investigated the interaction between inflation, exports, imports, and foreign direct investment in India between 1975 and 2017. They found

a unidirectional causality between exports to inflation, one-way causality between inflation and imports, and two-way causality between exports and foreign investments. Kiganda et al. [2017] studied the interactions between exports and inflation in Kenya by conducting some time series analyses, such as correlation, co-integration, causality, impulse response, and variance decomposition. The findings indicated that the interaction between total exports and inflation was significant and had long-run characteristics. In addition, there was a one-way causality from total exports to inflation. The findings of the study indicated that total exports were determined as a significant factor affecting the inflation of the country.

In the first of the studies carried out in Turkey, Göçer and Gerede [2016] tested the effects of foreign trade on inflation in Turkey. The monthly dataset between January 1989 and December 2015 was used, and the import, export, and inflation variables were analysed using causality tests. As a result of this, it was determined that there was a bidirectional causality relationship between inflation, exports, and imports. In the test made using the Toda-Yamamoto method, while bidirectional causality was determined between exports and inflation, one-way causality was determined from imports to inflation. Öksüzler [2019] examined the causality relationship between inflation, unemployment, and foreign trade in Turkey using monthly data for the 2014–2019 period. In this study, neither a causal relationship between imports and inflation nor between exports and inflation were found. According to the findings of Baylan et al. [2021], exports generate inflation in Turkey. This situation makes it important to increase domestic production in order to reduce inflation in Turkey, which implements inflation targeting, and to eliminate excess demand arising from exports.

In this context, it is important to maintain producer incentives and to focus on policies that provide cheap inputs to the industrial sector. In addition, it is thought that making structural changes in the economy to reduce the dependence of exports on imports, then the domestic production of intermediate and capital goods demanded from abroad should positively affect both growth and inflation. In a study by Açık and İnce [2022] that models Turkish inflation, exchange rates, commodity prices, container freight rates, and dry cargo freight rates are used as factors likely to affect inflation. While the exchange rate may affect the costs and the demand for goods within the country, other variables may cause an increase in the general level of prices as they affect the production and transportation costs. The results show that inflation is mostly affected by its historical values, and the next biggest effect is due to the exchange rate. Izgi [2021] examined the relationship between inflation and foreign trade in Turkey, and the ADF unit root test was used in the study. Afterwards, the Granger causality test and the Toda and Yamamoto causality test were used to determine the relationships between the variables. According to the results of the study, there is a one-way causal relationship between exports and inflation, there is no causal relationship between exports and imports, and there is no causal relationship between imports and inflation.

To summarize the literature in general, the results of studies examining the relationship between foreign trade and inflation differ from country to country, from method to method, and from data set to data set. There are also studies that found significant results between exports and inflation, which is our research question. The basis of our study is that we used the amount of physical goods, based on the fact that monetary values can be misleading due to inflationary and political reasons. On average, the amount of an exported container is a relatively more concrete measurement tool, even though the monetary value of the goods inside is unknown. For this reason, we hope that the results obtained in this study are relatively more comprehensive than other studies.

3. DATA AND METHODOLOGY

In our research, we used the monthly inflation index published by the Central Bank of the Republic of Turkey (CBRT) [2023] as the inflation measurement variable. The related variable was calculated by indexing 2003 to 100. The exported container variable is published by the Ministry of Transport and Infrastructure of the Republic of Turkey (MTIRT) [2023] and calculates the amount of TEU (Twenty-Foot Equivalent Unit) containers sent as exported cargo from Turkish ports. The dataset used in the study consists of 228 monthly observations and covers the period between January 2004 and December 2022.

Descriptive statistics of the variables are presented in Table 1. According to the data, an average of 261,500 TEU export containers handled per month was realized in this period. The average inflation index was 288.

However, since the inflation index is a cumulative index based on 2003, it may be wrong to interpret this average. Instead, it would be more accurate to interpret the average inflation change. Considering the monthly geometrical averages in the period under consideration, export container volume increased by 0.3%, while inflation increased by 1%.

In addition, the maximum increases within 1 month in the period under consideration were 24.6% for exported containers and 13.1% for inflation. The highest shrinkage rates were 25.1% for containers and 1.6% for inflation. As can be seen, inflation seldom shows a downward trend. This situation was also reflected in the distribution characteristics of the variables. While the amount of containers showed features close to the normal distribution, inflation showed a right-skewed distribution feature. In other words, the effect of positive shocks was very high inflation.

Table 1. Descriptive statistics of the raw and return variables

	Export	Inflation	Δ ln Export	Δ ln Inflation
Mean	261533.5	288.8018	0.005869	0.010492
Median	258533.0	221.9800	0.003928	0.008371
Maximum	442359.0	1128.450	0.246631	0.131164
Minimum	95442.50	104.8100	-0.251655	-0.016751
Std. Dev.	90852.15	203.9842	0.073347	0.014177
Skewness	0.107744	2.153513	-0.035526	4.675815
Kurtosis	1.832364	7.998113	3.524726	33.58460
Jarque-Bera	13.39318	413.5503	2.651981	9674.651
Probability	0.001235	0.000000	0.265540	0.000000
Observations	228	228	227	227

Source: [CBRT 2023; MTIRT 2023].

Figure 1 presents the movements of the number of exported containers at Turkish ports and the inflation index in the period under consideration.

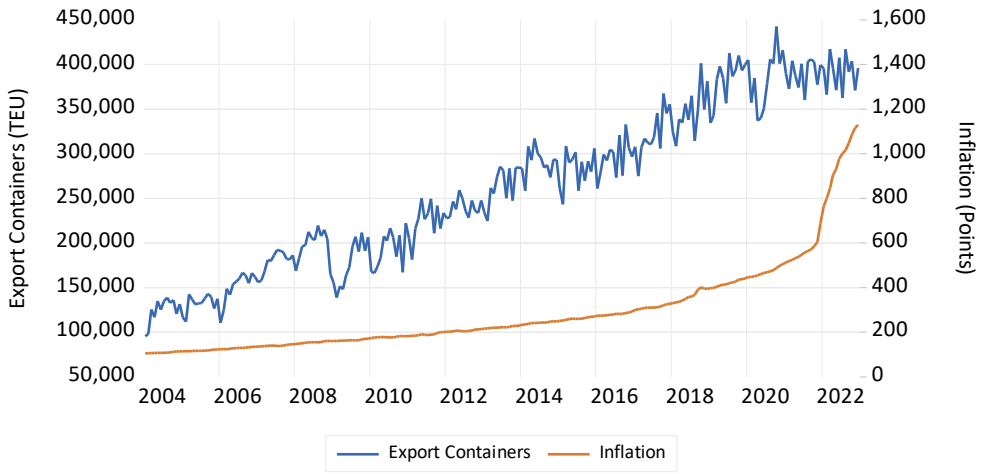

Fig. 1. Graphical display of the variables

Source: [CBRT 2023; MTIRT 2023].

In general, it can be said that their trends acted together and that their relations were positive. However, it was necessary to test which one affected the other, and in what direction the relationship was statistically. Since the increased container traffic increased the foreign exchange inflow to the country, it may have had a negative effect on inflation. Since an increase in the demand for foreign currency increases inflation, there may have been an increase in the foreign exchange supply

in the country due to the increased exports. On the other hand, increasing inflation may have had a positive effect on export container traffic, as it leads to the relative cheapening of the country's goods. The cheaper the country's goods, the more demand may be generated. Theoretically, both cases may be valid, but they need to be statistically proven.

Both export container and inflation data may contain seasonal movements. Factors such as the demand for some products more in certain seasons or the change in costs according to the seasons may generate temporary seasonal changes in the series. The use of non-seasonally adjusted variables in the time series analysis may make it difficult to find significant relationships. For this reason, we applied an STL decomposition to adjust for seasonal effects in the series. We also visualized the seasonal effects in the series in Figure 2. As can be seen, except for the general trend of export container traffic, it decreased, especially in January and February. In other months, the seasonal effects were relatively low. The inflation variable, on the other hand, decreased between June and September, while it increased in other months. All these variations can be effective in the results of the time series analysis.

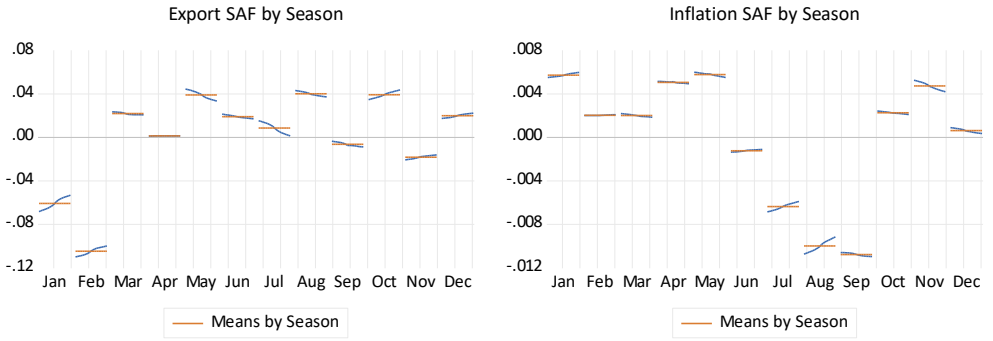

Fig. 2. Seasonal adjustment factors of variables

We preferred to use the Granger [1969] causality test in our research. The exported container amount and inflation index variables, which are the subject of our analysis, can be affected both by their own historical values and by the historical values of the other variables. Changes a few periods ago may impact the present values. Thanks to the vector autoregressive (VAR) models estimated in the Granger causality analysis, the effects of the past and other variables can also be included in the model. Thus, it can be determined that there was a flow of information from one variable to another variable [Kirchgässner and Wolters 2007]. As a result of the estimated VAR model, assuming that X is the independent variable and Y is the dependent variable if the past and present values of X contribute to explaining the present values of Y in a meaningful way, while the variable X is expressed as the Granger cause of the variable Y [Yu et al. 2015].

The results of the Granger causality analysis are sensitive to the unit root and co-integration conditions of the series [Nazlioglu 2019]. The unit root inclusion of the series shows that their distributions are time-dependent, with mean and variances changing over time. Therefore, the series for which VAR models are estimated should not contain unit roots [Brooks 2014]. For this, unit root and stationarity tests were used: the Augmented Dickey-Fuller (ADF) [1979] and Phillips-Perron (PP) [1988] unit root tests. The null hypothesis of these tests indicated that the nonstationary [Zivot and Wang 2003] and the null hypothesis must be rejected in order to call the series stationary. If the unit root hypothesis cannot be rejected at this level, the unit root test is applied to the first differenced series. If the hypothesis is rejected in the first differenced series, the first differenced series is used in the Granger causality test.

While estimating VAR models, information criteria are used to determine which lag is better. The number of lags that minimize the information criterion value is determined as the optimum one [Kočenda and Černý 2015].

Example VAR models consisting of 2 variables and estimated for 1 lag are presented in equations 1 and 2:

$$y_t = \beta_{10} + \beta_{11} y_{t-1} + \propto_{11} x_{t-1} + u_{1t} \tag{1}$$

$$x_t = \beta_{20} + \beta_{21} x_{t-1} + \propto_{21} y_{t-1} + u_{2t} \tag{2}$$

After estimating the VAR equation with optimum lag, AR roots are checked and expected to be less than 1, and included inside the unit circle [Bo and Zing 2011].

Then, by confirming that the root condition is met, the Granger causality test is applied. The null hypothesis for the test is $H_0 = X\ does\ not\ Granger\ cause\ Y$. The rejection of the null hypothesis indicates a significant causality and information flow between the variables.

When significant relationships are determined, the causality test results can be enriched with impulse-response and variance decomposition analysis. In particular, impulse-response analysis is important in determining how a shock in one variable affects the other endogenous variable, and how long this effect persists in the system.

Causality analysis is performed in the next section.

4. RESULTS

To apply Granger causality analysis, the series must first be stationary. Time series analyses with non-stationary series can produce erroneous results if the method is not robust to possible unit roots. The fact that the series contains unit roots shows that they do not tend to return to the mean overall and that shocks have a permanent effect. We analysed whether the inflation and export container variables we used in

our study were stationary or not with ADF and PP tests, see Table 2. These tests were developed to test the unit root, and their null hypothesis indicates a unit root. The results show that the null hypothesis for the inflation variable at the level cannot be rejected in both tests. On the other hand, the null hypothesis for the export container variable was rejected in the trend & intercept option. In this case, it was decided that the first difference should be taken to clear the series from the trend effect. As a result, since it was decided that both variables were I (1), it was deemed appropriate to use the first differences of both variables. In addition, this situation indicates that the shocks in both variables have permanent effects, and the series does not show a tendency to return to the mean eventually.

Table 2. Unit root test results

Test	Variable	Level		First Difference	
		Intercept	Intercept & Trend	Intercept	Intercept & Trend
ADF	**Export**	-1.92	-4.19***	-25.85***	-25.88***
	Inflation	3.39	2.21	-4.40***	-7.66***
PP	**Export**	-2.07	-7.09***	-33.74***	-34.84***
	Inflation	4.12	3.76	-6.84***	-7.62***

Notes: (1) CVs for tests are -3.45 for ***1%, -2.87 for **5%, -2.57 for *10% at the Intercept, and -3.99 for ***1%, -3.42 for **5%, -3.13 for *10% at the Intercept & Trend. (2) Lag lengths were determined automatically by the Schwarz information criterion. (3) The Barlett kernel spectral estimation method and Newey-Est Bandwidth were selected in PP.

In causality analysis, the information criteria are used to determine the most appropriate lag for the VAR models to be estimated. For this, information criteria were examined for the cases with a maximum lag of 15 due to the use of monthly data, with the results presented in Table 3. The results show that the optimal lag is 5 according to the LR, FPE, and AIC information criteria, and 1 according to the SC and HQ criteria. In this case, it was decided to estimate the VAR models for both suggested lag numbers and to interpret the results according to the final causality test results.

Table 3. Lag length selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	847.5287	NA	1.18e-06	-7.976685	-7.945020	-7.963887
1	937.1063	176.6200	5.25e-07	-8.784022	-8.689024*	-8.745626*
2	938.5127	2.746492	5.38e-07	-8.759554	-8.601224	-8.695561
3	945.6564	13.81558	5.22e-07	-8.789211	-8.567550	-8.699621
4	949.3067	6.990703	5.24e-07	-8.785912	-8.500919	-8.670725
5	954.8189	10.45248*	5.17e-07*	-8.800179*	-8.451854	-8.659394
6	958.3943	6.712240	5.19e-07	-8.796173	-8.384516	-8.629791

cont. Table 3

7	960.4532	3.826352	5.29e-07	-8.777860	-8.302871	-8.585881
8	964.5065	7.456583	5.28e-07	-8.778363	-8.240043	-8.560786
9	966.9925	4.526456	5.36e-07	-8.764080	-8.162428	-8.520907
10	967.7265	1.322568	5.53e-07	-8.733269	-8.068285	-8.464498
11	970.1767	4.368669	5.61e-07	-8.718648	-7.990332	-8.424279
12	975.2004	8.862657	5.56e-07	-8.728306	-7.936658	-8.408340
13	976.6527	2.534649	5.70e-07	-8.704271	-7.849291	-8.358708
14	977.3616	1.223788	5.89e-07	-8.673222	-7.754911	-8.302062
15	979.0226	2.836399	6.02e-07	-8.651157	-7.669514	-8.254400

Notes: Suggested lags are shown by *. LR: Likelihood Ratio, FPE: Final Prediction Error, AIC: Akaike Information Criterion, SC: Schwarz Information Criterion, HQ: Hannan-Quinn Information Criterion.

Another requirement of causality analysis is that the AR roots in the predicted VAR models should be less than 1. The model estimated for 1 lag has 2 roots, and the model estimated for 5 lags has 10 roots.

Figure 3 presents charts showing the state of the roots using the unit circle. The findings showed that all AR roots are within the unit circle and therefore are less than absolute 1.

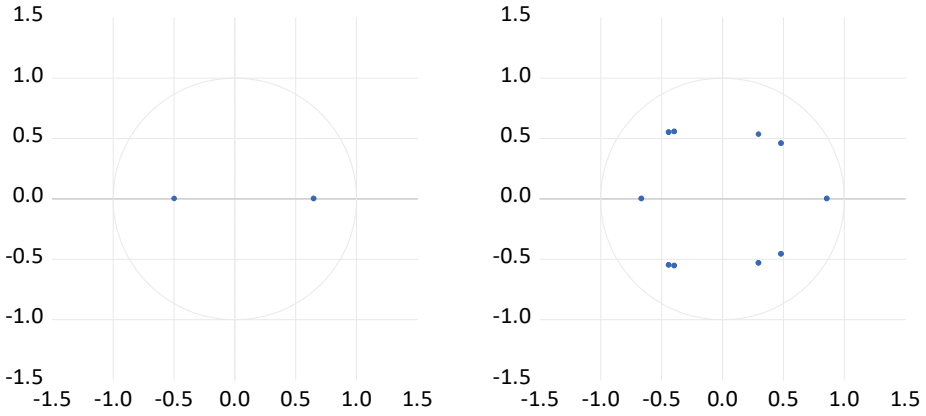

Fig. 3. Inverse roots of AR characteristic polynomials

Two-way estimated Granger causality test results for 1 and 5 lags are presented in Table 4. The null hypothesis for this test is that the causal relationship between the variables is insignificant. Since the null hypothesis could not be rejected, no significant relationship was detected in the model estimated for 5 lags. In the model estimated for 1 lag, a one-way causality relationship was determined from the number of exported containers to inflation. This shows that the change in export container traffic at ports has a significant effect on Turkish inflation.

In other words, there is a significant flow of information from current and past container traffic to inflation.

Table 4. Granger causality test results

Null Hypothesis	Chi-Square Statistics	Degree of freedom	Probability
Export does not cause Granger Causality Inflation	5.7263	1	0.0167**
Inflation does not cause Granger Causality Export	0.0771	1	0.7811
Export does not cause Granger Causality Inflation	7.7142	5	0.1727
Inflation does not cause Granger Causality Export	4.1829	5	0.5234

Notes: (1) **Null of non-causality was rejected at 5%.

Since the direction of the relationship is determined from export container volume to inflation in the causality analysis, we examined the reaction of inflation to exported containers in the impulse & response analysis. According to the relationship presented in Figure 4, it has been determined that the unexpected 1 standard deviation shock in exports has a negative effect on inflation and that this effect remains in the system for about 9 months. This situation can be interpreted as an increase in exports having a negative effect on inflation by earning foreign currency for the country and causing an increase in the coverage ratio of exports to imports.

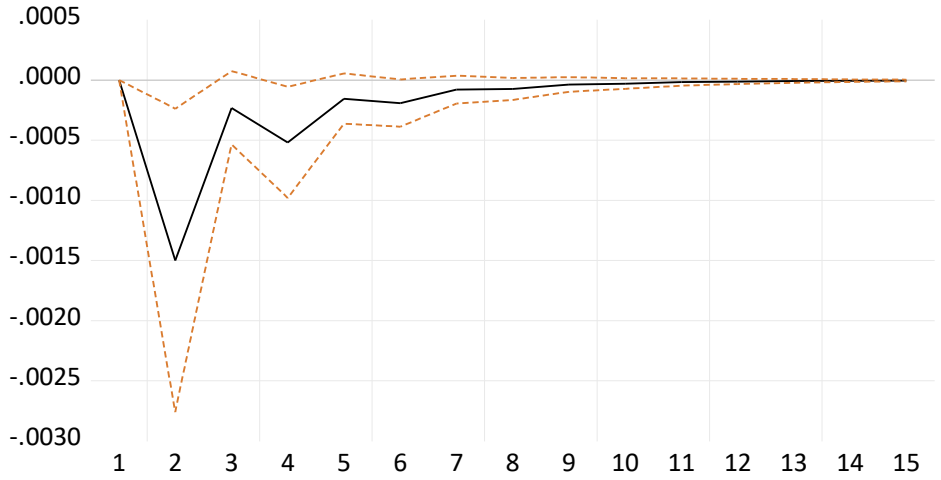

Fig. 4. Response of inflation to export containers
Notes: (1) Response to Cholesky One S.D. (d.f. adjusted) Innovations ±2 S.E.

Since our affected variable in the causality test was determined as inflation, we decomposed inflation for 6 periods in the variance decomposition analysis, as shown in Table 5. The results show that although the change in the number of exported containers has a significant effect on inflation, this effect is limited. After a certain period, approximately 98% of the change in inflation is due to its historical values. The permanent effects of inflation are outweighed.

Table 5. Variance decomposition analysis of the variables

Period	S.E.	DLNEXPSA	DLNINFSA
1	0.063947	0.000000	100.0000
2	0.071426	1.342257	98.65774
3	0.073135	1.222409	98.77759
4	0.073554	1.303020	98.69698
5	0.073655	1.290746	98.70925
6	0.073681	1.298577	98.70142

The estimated VAR equations to test for Granger causality can also be used to predict the future. Since the test results show us that the flow of information is from the number of exported containers to the inflation index, we aimed to forecast the inflation variable. Using our data starting in January 2004 and ending in December 2022, we estimated the inflation until December 2023 and presented it graphically in Figure 5. The estimation results obtained show that the inflation index will increase in the following periods, but the rate of increase will slow down.

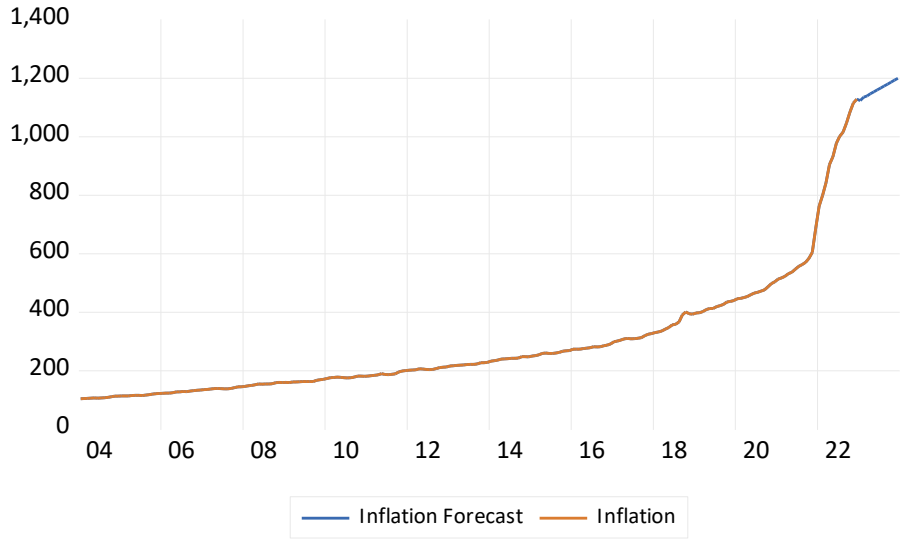

Fig. 5. Inflation forecast until December 2023 by using the VAR equation

5. CONCLUSIONS

Inflation and the understanding of inflation are important, as consumer spending, business investment, employment rates, government programs, tax laws, and interest rates are all impacted by inflation. Moreover, understanding inflation is important in investments as it can diminish the value of the investment returns. For instance, the price fluctuation height increases with each increase in the average inflation rate. This causes many consumers, entrepreneurs, investors, and other actors in the economy to be unable to see their way.

The exports of a country affect many dynamics in the economy, and it is also affected by many other dynamics as well. Exports and inflation are considered related to each other, yet this relationship can change from period to period and country to country. Therefore, it is important to understand the relationship between the selection and the implications of the economic policies affecting these dynamics. A two-way relationship can be expected theoretically between exported containers and inflation. Since the increased inflation is caused by the increase in the exchange rates, a process may occur that results in the country's goods becoming cheaper and the foreign demand increasing. On the other hand, as foreign exchange inflows increase due to increased exports, exchange rates may be suppressed, and the rate of inflation may decrease.

In our study, we preferred Granger causality analysis based on VAR modelling as a method. In this type of analysis, the dependence of the dependent variable on its own past values may be considered. Previous studies in the literature have shown that inflation can also be highly dependent on its historical values. For this reason, other methods that included the independent analysis of only two variables from their past values were not preferred. Our results show that increases in exports have a negative impact on the inflation of Turkey. This is probably due to the increased foreign exchange inflow along with exports. Referring to studies determining that the biggest reason for the increase in Turkish inflation, according to its historical values, is the changes in the exchange rate [Turna and Özcan 2021; Açık and İnce 2022; Yiğit 2022] and conditions that suppress the exchange rate, which then affect the cost of each product and also suppress the increase in inflation. In addition, our results show that the major cause for a change in inflation is its own historical values. This may be evidence of the effect of adaptive and rational expectations. People can anticipate future inflation by looking at past inflation, and this can generate stickiness in the inflation level. Although exports have a reducing effect, this situation is limited, and negative expectations need to be broken to implement effective reduction policies.

In future studies, other possible variables affecting inflation can also be included in the model. In addition, by forming panel data sets, generalizable results can be revealed by analysing a certain number of other countries, not just Turkey.

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