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Analysing the Effect of Inflation on Economic Growth in Türkiye's Industrial Sector

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Abstract: This paper examines the effect of inflation on economic growth of the industrial sector in Türkiye from 1998:Q1 to 2022:Q4. To achieve this objective, the producer price index is used as a measure of industrial inflation and industrial production index as a measure of the growth of industrial sector. Also, the study captures the effect of exchange rate and unemployment rate. Using a Vector Autoregressive model and Block Exogeneity Granger Causality test, the empirical results suggest that a shock in inflation causes economic growth in the industrial sector to decrease in the short run, increase slightly towards the long run but later drop continually until it becomes stabilized. Also, a shock in economic growth of industrial sector causes a slight increase in the short run and keeps fluctuating in the long run. A shock in unemployment rate causes growth to increase in the short run but fluctuate in the long run. A shock in exchange rate causes growth to decrease in the short run but in the long run it is observed to decrease. The implication of these results is that, in Türkiye inflation causes the economic growth to drop in the short run but eventually stabilizes in the long run. Furthermore, economic growth Granger causes inflation while inflation does not Granger cause economic growth. Based on these findings, policymakers should not over-jealously promote growth that exerts huge inflationary pressures in the economy. Therefore, policymakers need to put anti-inflationary policies in the forefront of economic policies in Türkiye.

Keywords: Industrial Inflation, Industrial Economic Growth, Exchange Rate, Unemployment Rate, Türkiye

JEL Classification: O47

1. Introduction

Inflation and economic growth are two critical factors for the health and stability of an economy. Inflation generally refers to a continuous increase in the price level, which means consumers need to pay more and can reduce their purchasing power. Economic growth, on the other hand, is the increase in a country's Gross Domestic Product (GDP), which can result in increased production and job opportunities. In developing countries

like Türkiye, the relationship between inflation and economic growth has significant effects, particularly on the industrial sector. The industrial sector plays a crucial role in the economy of any country and can be directly affected by the relationship between inflation and economic growth. Understanding what inflation is and how it is measured is essential. The Consumer Price Index (CPI) is commonly used to measure inflation. The CPI represents how much consumers pay for specific goods and services during a certain period. Rising CPI rates indicate higher levels of inflation (Akın, 2022: 4-8). Economic growth, as mentioned earlier, refers to an increase in a country's GDP. This increase can lead to growth in production and job opportunities. One indicator commonly used to measure economic growth is the annual real growth rate. A high real growth rate indicates that an economy is expanding rapidly. In this study, we focus on the long-term relationship between inflation and economic growth to examine their impacts on Türkiye's industrial sector. We analyse historical data to shed light on Türkiye's industrial sector performance (Unsal, 2017: 85-89).

The industrial sector in Türkiye can be affected by the relationship between inflation and economic growth. For instance, high inflation rates can increase costs, which can then be reflected in production expenses. As a result, companies may raise prices or reduce worker salaries to maintain their profits. The impact of economic growth on the industrial sector can be seen as increased employment opportunities and production. With economic growth, demand also increases, leading to a greater need for production. This can create new job opportunities in the industrial sector. When examining the state of Türkiye's industrial sector, the importance of the relationship between inflation and economic growth becomes evident. High inflation rates increase costs, while economic growth can offer employment and production opportunities. Therefore, Türkiye needs to both control inflation and promote economic growth to sustain its economic health (Mercan and Kızılkaya, 2014: 140-141).

This study aims to investigate the long-term relationship between inflation and economic growth to examine the effects on Türkiye's industrial sector. Inflation represented by producer price index and economic growth by production index. This study will be based on Türkiye's data and seek to shed light on the performance of the industrial sector in Türkiye. The industrial sector plays a significant role in the economic growth of a country. Therefore, inflation and growth rates in the industrial sector are considered as indicators of overall economic health. These include the Producer Price Index, unemployment rate, nominal exchange rate, and Industrial Production Index. The

Producer Price Index is a measure of changes in the prices of intermediate goods used in the production process. This index is used to track price fluctuations in the industrial sector. The unemployment rate is an important data that reflects the employment situation in a country and serves as an indicator of economic conditions. A high unemployment rate can indicate economic problems, while a low unemployment rate can indicate stronger economic performance. The nominal exchange rate is crucial for international trade and for export-oriented countries like Türkiye. Fluctuations in the exchange rate can affect export prices and therefore impact industrial sector growth. The exchange rate determines competitiveness in foreign trade. The industrial production index measures production activities in the industrial sector of a country. This index helps monitor growth or contraction in the industrial sector. An increase in industrial production generally indicates economic growth, while a decrease may indicate contraction. To examine the relationship between these four variables – Producer Price Index, Unemployment Rate, Exchange Rate, and Industrial Production Index – the Vector Autoregressive (VAR) model including Impulse Response Functions and Variance Decompositions have been used.

The remainder of this study is organized as follows: Section 2 is the review of related literature. Section 3 provides the description of data and methodology employed. Section 4 provides the results and discussion, while Section 5 is the conclusion and recommendations.

2. Literature Review

The industrial sector plays a crucial role in the economic growth and employment of a country. Therefore, understanding the performance of Türkiye's industrial sector is important in examining the long-term relationship between inflation and economic growth. In this study, we will conduct a literature review to explore the effects of inflation on Türkiye's industrial sector.

Turan's study (2010) investigated the relationship between inflation and economic growth in the Turkish economy. Regression analysis and cointegration tests were employed for this research. The analysis revealed that in Türkiye's economic structure, there is a short-term negative effect of current inflation on growth but a positive effect of a one-period lag, which balance each other out resulting in neutrality. Similar results were observed in long-term forecasts, indicating that inflation does not have any impact on growth. This suggests that the persistent issue of high inflation in the Turkish

economy over the years has negatively affected economic growth by creating uncertainty. In a separate investigation conducted by Berber and Artan in 2004, the Granger causality analysis method was employed to analyze Turkish data spanning from 1987 to 2003. The results of this study demonstrated an inverse relationship, indicating that an increase in inflation within a 10% range leads to a decline of 1.9% in economic growth. Terzi (2004) examined the causal relationship between inflation and economic growth in the Turkish economy using Granger causality analysis with data encompassing the period from 1924 to 2002. The analysis revealed a negative link from inflation to economic growth.

Artan (2006) conducted an econometric analysis in his study, which covered the period from the beginning of 1987 to the third quarter of 2003, to investigate the relationship between inflation, inflation uncertainty, and economic growth in Türkiye. The results revealed that the negative effects of inflation uncertainty on economic growth were higher compared to the effects of inflation itself. Specifically, a 1% increase in inflation uncertainty was found to lead to a decrease of 3.95% in economic growth, while a 1% increase in inflation resulted in a reduction of 0.56% in growth.

In a study conducted by Şentürk and Akbaş (2014), the mutual relationship between economic growth, unemployment rates, and inflation rates in Türkiye from 2005:01 to 2012:07 was examined. The stationarity of the series was assessed using PP and KPSS unit root tests. The Zivot-Andrews (1992) structural break unit root test was also applied to identify any breaks in the series. Toda-Yamamoto (1995) tests were employed to determine the causal relationship between the variables. The results of the study revealed a bidirectional causal relationship between the industrial production index and both inflation rate and unemployment rate. Çiftci's study (2015) provided a theoretical explanation of the relationship between inflation and economic growth in the Turkish economy during the period of 1980-2014, followed by an empirical investigation. Annual data from 1980 to 2014 were used to examine the relationship between inflation and economic growth in Türkiye through time series analysis. Granger causality and regression analyses were utilized as methods. The Granger causality analysis indicated a unidirectional causal relationship from inflation to economic growth. According to the findings, inflation affects economic growth in Türkiye. The regression analysis showed an estimated coefficient of -0.6 for inflation, indicating a negative relationship between growth and inflation. This suggests that a 1-unit increase in inflation leads to a decrease of 0.6 units in economic growth. Contrary to the previous authors, Saçkan's study (2006)

utilized quarterly data from 1987:2 to 2005:3 to examine the relationship between inflation and economic growth in the Turkish economy using the VAR model and Granger causality test. The findings indicated that there was no causal relationship between the variables and no long-term effects among them.

In summary, literature studies examining the relationship between inflation and growth in Türkiye mostly utilize macroeconomic data to analyses the interaction between these two factors. However, it should be noted that the results of these studies can vary depending on the country's economic conditions, periods, and policies. Our study, as mentioned in the literature review above, will be analysed within the framework of Granger Causality Test and Johansen Cointegration Test.

3. Data and Methodology

3.1. Data

Variables used in this study Producer Price Index for inflation as the independent variable, Industrial Production Index for economic growth as the dependent variable, Unemployment rate and nominal exchange rate as controlled variables. The data spans from 1998:Q1 to 2022:Q4. Table 1 illustrates the variables employed in this study.

Table 1. Variables and Measurements

VARIABLE	SYMBOL	Measurement
Producer Price Index	PRI	2003=100
Unemployment Rate	UR	Percentage
Nominal Exchange Rate	EXR	Buying Rate of Turkish Lira/USD
Industrial Production Index	IPI	2015=100

Source: *Turk Stat and US Dollar data from CBRT-EVDS.*

3.1.1. Time Series Plots of Variables

In this test we examine the time series plots of variables in this study by checking the existence of trends, drifts, seasonality, and breaks caused by structural changes in the variables. Based on the time series plots of the variables as shown in Figure 1, the unemployment rate exhibits no clear-cut of an upward or downward trending at all the period of analysis. In the case of industrial production index (LIP), production price index (LPP) and US dollar currency buying (LUSD) there is an upward trending. The trend is clearer in the case of LIP and LUSD.

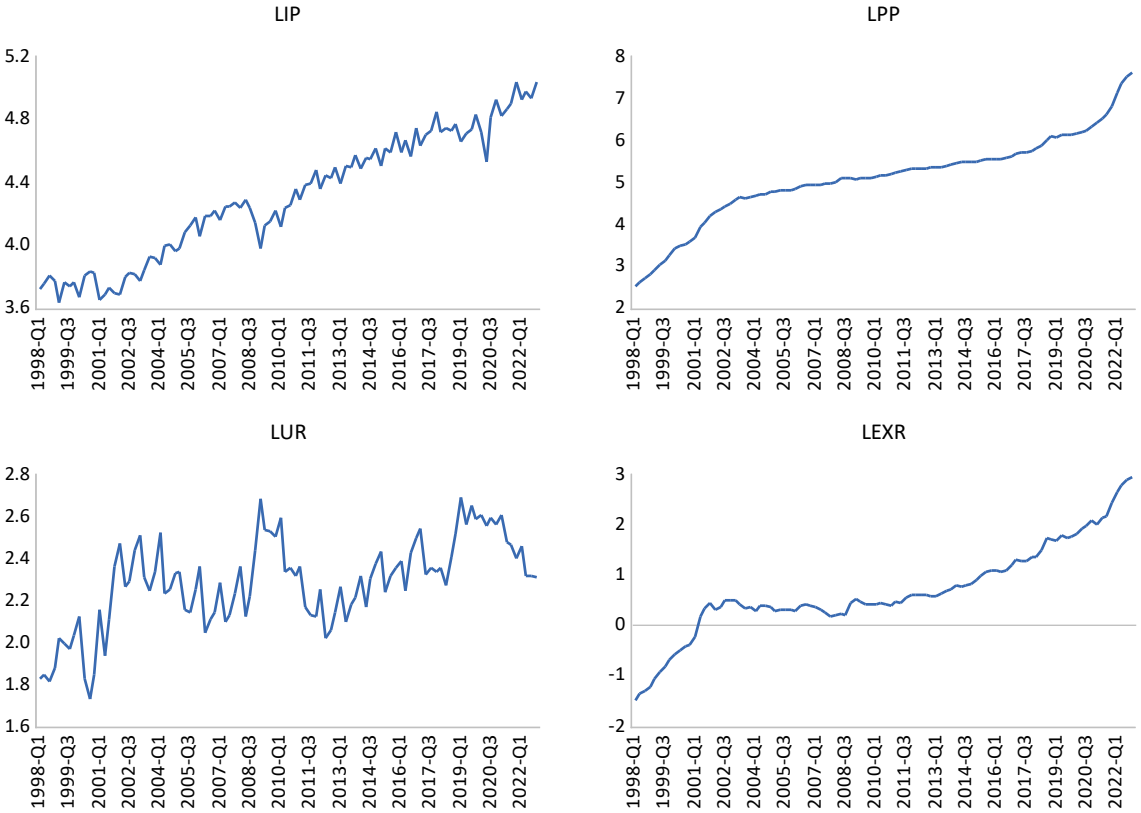

Figure 1. Graphs of the trends of variables used in this study from 1998:Q1 to 2022:Q4

3.2. Methodology

Descriptive statistics and correlation are first carried out, then ADF and PP unit root test are conducted to know the eligibility of employing the vector autoregressive model (VAR model). Block Exogeneity Granger Causality Test is also used to determine causal relationships between the variables. An appropriate lag criterion is selected before conducting the VAR and causality tests.

3.2.1. Vector Autoregressive Model

$$Y_t = \beta_0 + \sum_{j=1}^{p} \phi_j Y_{t-j} + \varepsilon_t \quad (1)$$

Since in VAR there are only endogenous variables, one general equation is used to represent all the variables. Y_t is vector for all variables of interest in this paper which include the dependent variable, i.e. industrial production index, and explanatory variables which include producer price index--a measure of inflation in the manufactory

industry, exchange rate, and unemployment rate. ϕ_j represents a vector for all the autoregressive coefficients, β_0 is vector for all intercepts and ε_t is the vector for all error terms.

3.2.2. Block Exogeneity Granger Causality

The traditional granger causality developed by Granger (1969) only permits stationary variables which for this case there are I (1) variables hence it cannot work. Firstly, we need to establish a simple autoregressive model, called a VAR (Vector Auto Regression) model. Assuming we have two variables: $Y$and X. We can specify our VAR model as follows: Y represents the dependent variable Producer Production Index and the independent variable is represented by X.

$$Y(t) = a_0 + \sum_{i=n}^{n} a_i Y_{(t-i)} + \sum_{i=1}^{n} b_i X_{(t-i)} + e_{Y(t)} \quad (2)$$

$$X(t) = c_0 + \sum_{i=n}^{n} c_i X_{(t-i)} + \sum_{i=1}^{n} d_i Y_{(t-i)} + e_{X(t)} \quad (3)$$

In these formulas: $Y(t)$ and $X(t)$ represent the variables $Y$and X at time t. a_0 and $c_0$are constants. a_i, b_i, c_i, and $d_i$are coefficients for the respective lagged variables, n represents the number of lags. $e_{Y(t)}$ and $e_{X(t)}$ are error terms. The causality test is carried out with a hypothesis test.

Firstly, we look at whether the null hypothesis $H_0: b_i: c_i = 0$, i.e., X has no effect on Y is rejected or not and compare it with the alternative we look at the alternative $H_0: b_i: c_i \neq 0$. If H_0 is rejected, then we can say that X Granger causes Y. Likewise, we look in the other direction (whether Y Granger causes X). In this case, the null hypothesis is taken as $H_0: a_i: d_i = 0$ and tested and the alternative $H_0: a_i: d_i \neq 0$. The outcome of testing is determined by looking at the p-value. Generally, if the p-value is less than 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted. Statistical software is used to apply this formula and interpret the results correctly (Kasapoğlu, 2007).

4. Results and Discussion

4.1. Descriptive Statistics results

According to Table 2, the variable highest mean value is LPPI (5.082064) then LIP (4.297673) with a value of LEXR (0.669775) also the result showed is negative. Furthermore, all the finding showed the deviation of the variables and the exception of LPPI (1.039009) they are all close to zero. This denotes that all the variables show less volatility, resulting in a low level of fluctuation, except for LPPI. The findings also

demonstrate that although the remaining variables, apart from LEXR, which has a value of 0.187078, all have values near to zero in absolute terms, while the LEXR has a positive skewness. Except for LEXR, which has a leptokurtic distribution and all of the kurtosis values being positive, all of the variables show indications of platykurtic distribution. then, the results of the Jarque-Bera statistics do not allow the null hypothesis of the normal distribution of variables to be rejected.

Table 2. Descriptive Statistics

	LIP	LPPI	LUR	LEXR
Mean	4.297673	5.082069	2.279557	0.669775
Median	4.273830	5.155464	2.311048	0.464543
Maximum	5.032896	7.610589	2.685805	2.923054
Minimum	3.629242	2.491854	1.722767	-1.498521
Std. Dev.	0.399854	1.039009	0.213330	0.905367
Skewness	-0.021150	-0.350926	-0.398628	0.187078
Kurtosis	1.805285	3.502634	2.787498	3.426016
Jarque-Bera	5.954721	3.105160	2.836562	1.339512
Probability	0.050927	0.211701	0.242130	0.511833
Sum	429.7673	508.2069	227.9557	66.97749
Sum Sq. Dev.	15.82842	106.8745	4.505449	81.14916
Observations	100	100	100	100

4.2. Correlation Matrix

Furthermore, in this test utilized the pairwise correlation matrix of the variables, when it's shown in Table 3 to test for multi-collinearity in the variables. The Correlation Matrix showed there is strong relationship between LIP and LPP (0.9104) and there is a weak relationship between LIP and LUR (0.4985), The Correlation Matrix showed there is strong relationship between LPP and LEXR (0.96334) and there is a weak relationship between LPP and LUR (0.6698) , The Correlation Matrix showed there is strong relationship between LUR and LEXR (0.6808) and there is a weak relationship between LUR and LIP (0.4985) and The Correlation Matrix showed there is strong relationship between LEXR and LPP (0.9633) also there is a weak relationship between LEXR and LUR (0.6808). Finally, the findings indicate that, in most instances, there is a strong and positive association between the factors.

Table 3. Correlation matrix

Variable	LIP	LPP	LUR	LEXR
LIP	1	0.9104	0.4985	0.8701
LPP	0.9104	1	0.6698	0.96334
LUR	0.4985	0.6697	1	0.6808
LUSD	0.8701	0.9633	0.6808	1

4.3. Unit Root Test ADF Test and PP Test

Table 4. ADF Unit Root Test Results

ADF UNIT ROOT TEST				
Variables	Level		First Difference	
	C	C&T	C	C&T
LIP	-3.5178 [0.9119]	-3.3074 [0.0713]	-5.1027 [0.0000*]	-5.0532 [0.0004*]
LPP	-0.206750 [0.7622]	-1.658346 [0.9329]	-3.933345 [0.0026**]	-3.8987 [0.0156**]
LUR	-2.6821 [0.0811]	-3.4560 [0.0505]	-3.70254 [0.0056*]	-3.8805 [0.0169**]
LEXR	-0.262179 [0.9254]	-1.334725 [0.8733]	-7.021274 [0.0000*]	-6.992032 [0.0000*]

Note: The values not in parentheses are t-statistic while those in [] are P-values. Asterisk *, ** show the level of significance at 1% and 5% respectively.

4.3.1. ADF Unit Root Test

The results of the ADF unit root test by Dicky AND Fuller (1979) for the fourth variables are shown in Table 4. The results reveal that all the variables are not stationary in levels at 5% level of significance and then become stationary after their first difference. This indicates that the variables are typically exhibiting I(1) process.

Table 5. PP Unit Root Test Results

PP UNIT ROOT TEST				
Variables	Level		First Difference	
	C	C&T	C	C&T
LIP	-0.0570 [0.9502]	-6.2860 [0.0000*]	-32.1358 [0.0001*]	-32.2606 [0.0001*]
LPP	-0.7158 [0.8371]	-1.8694 [0.6628]	-3.8299 [0.0037*]	-3.7857 [0.0214**]
LUR	-3.4105 [0.0128**]	-3.4560 [0.0505]	-4.3967 [0.0035*]	-20.1062 [0.0001*]
LEXR	-0.4456 [0.8959]	-1.4339 [0.8450]	-7.0213 [0.0000*]	-6.9920 [0.0000*]

Note: The values not in parentheses are t-statistic while those in [] are P-values. Asterisk *, ** show the level of significance at 1%, 5%respectively.

4.3.2. PP Unit Root Test

Furthermore, the PP unit root test by Phillips & Perron (1988) is also applied (See Table 5). The results show that the variables are non-stationary at level even at 5% level of significance except for LUR. After taking their first difference, the variables become stationary. This implies that the variable such as LIP, LPP, and LEXR are stationary of I(1).

Table 6. Lag Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	410.221765 78854	NA	1.56e-09	-8.927951	-8.817583	-8.883425
1	474.723880 2798224	121.9161	5.37e-10	-9.993931	-9.442094*	-9.771299
2	505.702735 2198059	55.83002	3.87e-10	-10.32314	-9.329830	-9.922400
3	540.022391 788635	58.83370	2.60e-10	-10.72577	-9.290990	-10.14692
4	570.832601 3909634	50.10891*	1.90e-10*	-11.05127*	-9.175019	-10.29432*
5	586.718428 1061634	24.43973	1.93e-10	-11.04876	-8.731040	-10.11370
6	599.652345 8801041	18.76129	2.12e-10	-10.98137	-8.222184	-9.868210
7	615.797520 2826695	22.00002	2.19e-10	-10.98456	-7.783905	-9.693296
8	629.930387 7142204	18.01552	2.38e-10	-10.94353	-7.301399	-9.474154

*shows the preferred number of lags, Aikake Information Criterion (AIC), Schwarz Creterion Hannan Quinn (HQ)

4.4. Lag Criteria

One of the pre-requisite qualifications for estimate a VAR model is the fact that the series must not only be integrated at level or take the first difference of variables the optimum lag selection is very important. From Table 6, the optimal lag order selected for this study is 4 as suggested by AIC, SC, and HQ.

4.5 Impulse Response Functions (IRFs)

Basically, the coefficient of the VAR model is not reliable for policymaking (see Usman et al. 2022). To this extent, we report the results of the Impulse Response Functions (IRFs) and Variance Decompositions (VDs). From Figure 2, the effect of an innovation in producer price index which represents inflation in the manufacturing sector in the study shows to have a fluctuating effect on Industrial Production Index (economic growth). It causes it to gradually decrease in the short run from period one and slightly increase in

period two. In the long run from period 8, it increases gradually then sharp decrease in period ten. An innovation of inflation causes unemployment rate to significantly rise in the short run and then falls afterwards. In the long run it is observed to fall and eventually rise in the 10th quantile. Finally, an innovation of inflation will cause EXR to appreciate rapidly in the short run and maintains stability in the long run. A general comment could be that a change in inflation causes fluctuation on economic growth and unemployment rate while the value of EXR appreciates hence a fall for local currency.

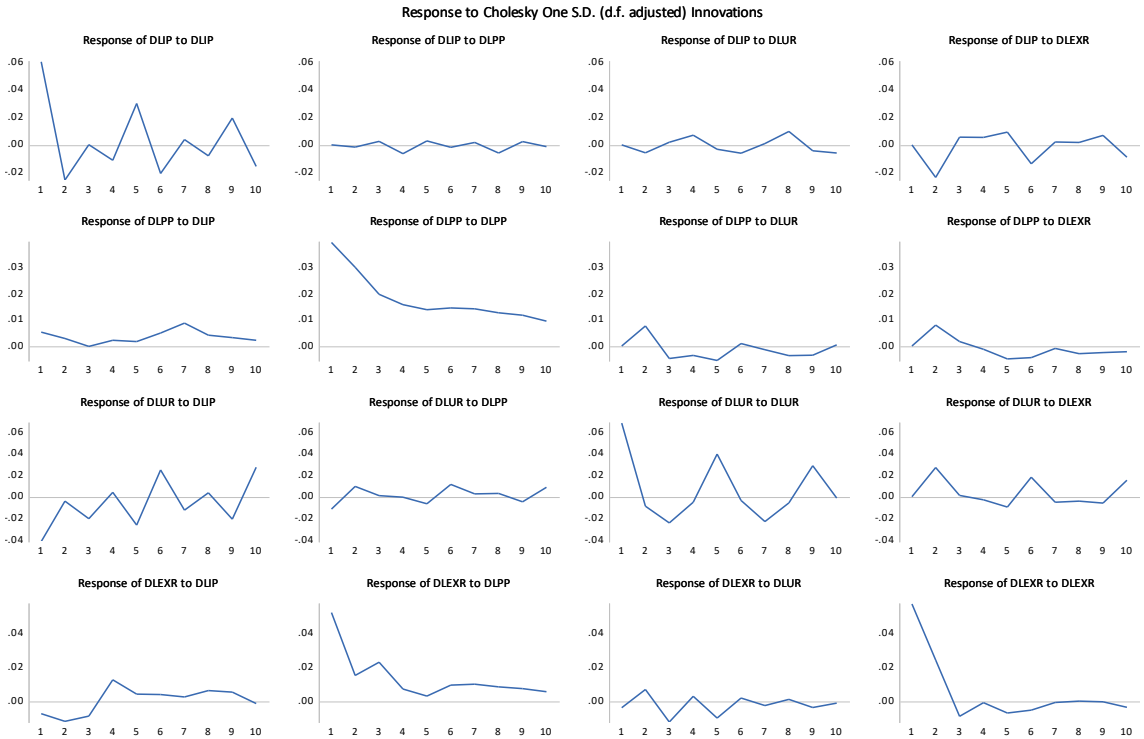

Figure 2. Impulse response graph for all the variables

4.6. Variance Decompositions (VDs)

The variance decomposition results are presented in Figure 3. The results explain the contribution of one variable in forecasting the other variable. For the interest of this study which investigates the relationship between inflation and growth, it is observed that inflation (DLPP) had a 100% contribution in furcating growth in the short run, but it slightly decreases in the long run to below 100% but above 80%. But when it comes to unemployment rate (DLUR) and exchange rate (DLEXR) the contribution of inflation in forecasting is below 20%. This implies that inflation has little contribution on unemployment and exchange rate but has a big contribution in the short run-in forecasting growth. Furthermore, a significant large percentage is observed when growth

is predicting growth that moves from 100% in the short run and slowly decreases over the long run to around 80%. The opposite is true for growth forecasting inflation which is observed to fall below 20%. Showing in this context

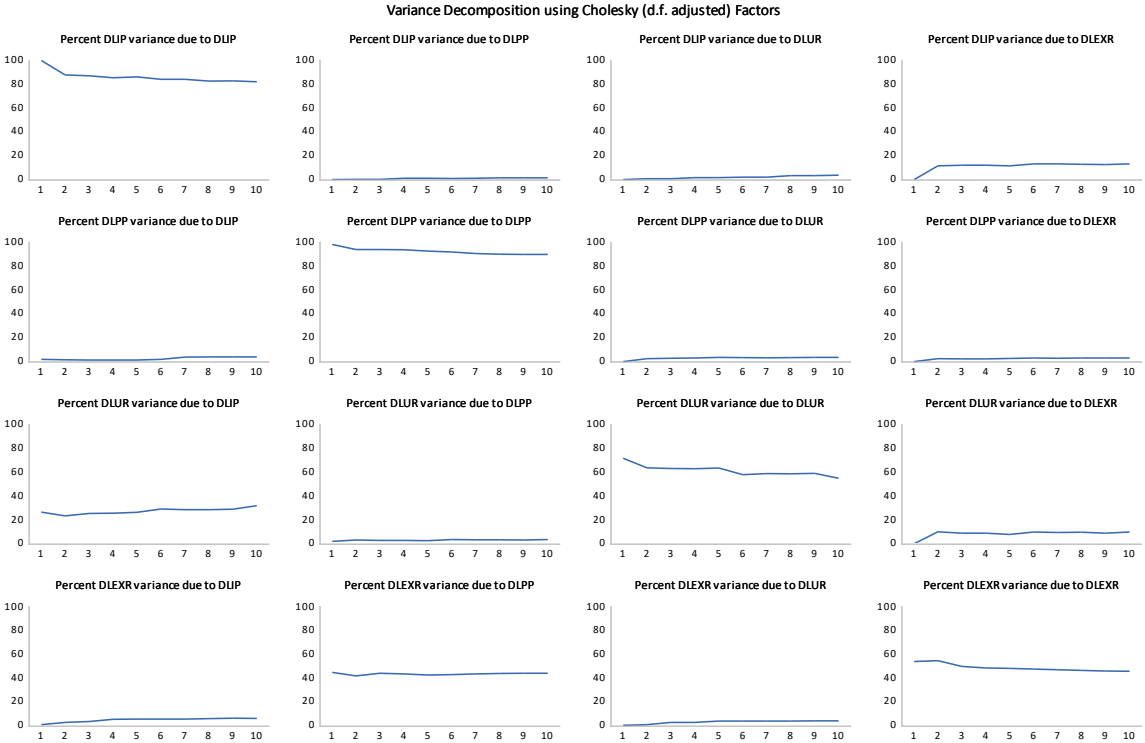

Figure 3. Variance decomposition showing the contribution of each variable

4.7. Block Exogeneity Granger Causality

Table 7. Granger Causality Test Results

Variables	LIP	LPP	LUR	LEXR
LIP	…. ….	8.8061*** (0.0661)	14.108*1 (0.0070)	8.4750*** (0.0756)
LPP	4.8991 (0.2978)	…. ….	2.8458 (0.5839)	10.4585** (0.0334)
LUR	3.5229 (0.4744)	16.0451** (0.0030)	…. ….	7.4436 [0.1142]
LEXR	13.5752*** (0.088)	6.3979*** (0.1713)	10.9452** (0.0272)	…. ….

Note: Asterisk *, **, *** show the level of significance at 1%, 5% and 10%. The values in parenthesis are probability values. The null hypothesis is that independent variable does not Granger causes the dependent variable.

From Table 7, the results provide that there is a uni-directional causal relationship from Industrial Production Index to Producer Price Index at 10% level significant but there is no causality relationship from Producer Price Index and Industrial Production Index. A uni-directional causality is observed from Industrial Production Index to unemployment rate at 1% level significant. But a bi-directional causality is causality from Industrial Production Index to EXR at 10% level of significance and from EXR to Iindustrial Production Index at 1% level of significance. There is a uni-directional causality relationship from unemployment rate to Producer Price Index. There is causality relationship from Producer Price Index to EXR at 5% level significant but there is no causality from EXR to Producer Price Index. There is no causality relationship between unemployment rate and EXR. but there is unidirectional causality from EXR to unemployment rate at 5 % level significant.

The results depict that it is observed that economic growth granger causes inflation, but inflation does not granger cause growth. This implies that growth predicts inflation, but inflation does not predict economic growth. Hence policy makers should consider measurements control inflation from growth side and mild inflation might not cause growth.

5. Conclusion and Policy Recommendations

This study aims to examine the effect of inflation and economic growth in the industrial sector of Türkiye. Variables such as Producer Price Index, Unemployment Rate, Exchange Rate, and Industrial Production Index are used in the study, and analytical methods like Block Exogeneity Granger causality and VAR tests are applied. The variables are all I(1) hence a normal causality cannot be used but instead Block Exogeneity Granger Causality in the VAR model is employed. The variables are logged and differenced in order to achieve the pre-requite requirements for estimating a VAR model.

The results of the impulse response function show that an innovation to economic growth causes a slight increase in the short run then keeps on fluctuating in the long run. Also, an innovation of inflation causes growth to decrease in the short run then increases slightly but drops in the long run and consequently becomes stable. This implies that in Türkiye, inflation will cause the economic growth to drop in the short run but eventually stabilizes in the long run. Furthermore, the results show that economic growth Granger causes inflation while inflation does not Granger cause economic growth. This is crucial in policymaking, keeping in mind that an increase in economic growth will lead to inflation. Based on these findings, the study recommends that

policymakers should not to over-jealously promote growth that exerts huge inflationary pressures in the economy. While promoting economic growth, there is a need to put in place strong policies and strategies to mitigate the inflationary effect of economic growth.

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