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RESEARCH ARTICLE

The Hybrid New Keynesian Phillips Curve: An Application For Türkiye

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ABSTRACT

Inflation is a continuous structural problem in the history of Türkiye's economy. High increases in inflation cause unpredictability and worries about the future. This situation negatively affects the pricing behavior of economic agents. The question that comes to the fore at this point is to what extent this change in the formation of expectations is reflected in the pricing behavior and inflation dynamics. In this paper, the effects of the output gap, import prices, and expectations on inflation between the 2013-2022 period in Türkiye were examined. Vector Autoregressive Model / VAR was the preferred method for analysis. According to the variance decomposition results of the study, inflation, changes in import prices, expected inflation, expected increases in USD/TL exchange rates, interest rate expectations and the output gap help explain a significant part of the total change in inflation.

The results of the Impact-Response analysis and the effect of inflation on itself indicated inflation inertia. This showed that despite the policies implemented by the decision makers, economic agents adjusted their pricing behavior according to past inflation rather than future inflation expectations. For this reason, the measures taken by the decision-makers was not completely successful. However, the analysis did not show that the inflation-targeting regime was successful in anchoring the expectations of economic agents.

If the central bank or the economic authority reduces inflation uncertainty and develops policies based on expectations, it will have a positive effect on inflation. This will bring remarkable results for policymakers, especially for price stability and inflation targeting.

Keywords: *Monetary Policy, New Keynesian Phillips Curve, Inflation, Expectations, Output GAP.*

JEL Kodu / JEL Code: B22, B41, E31

Introduction

The most important task of central banks is to control inflation, which is the average rate at which prices for goods and services rise. Keeping inflation at its target level is important because high, low, or unstable inflation imposes significant costs, particularly for households and businesses. Unstable movements or inflationary shocks cause people to rethink their inflation expectations for the future. These factors keep current and forecast inflation increasing over time. In this respect, a reliable and transparent monetary policy is important to deliver on expectations (Yellen, 2015:3).

Inflation is a permanent structural problem in Türkiye's economic history. In the early 2000s, single-digit inflation was achieved, and that process continued until 2016. Inflationary pressure, which manifested itself worldwide with the the pandemic during the last period, brought inflation in Türkiye to 60%. High inflationary rises are a source of unpredictability and concern for the future. High inflation pushes up inflation costs by distorting price formation and resource allocation, making long-term contracts risky. According to Milton Friedman (1977), this distorted macroeconomic performance measures such as investment, consumption, jobs and economic growth. This distortion resulted in economic decisions that were uncertain.

The Central Bank of the Republic of Türkiye, whose primary goal of monetary policy is price stability, has grappled with inflation for many years. In Türkiye, since 2001, the Central Bank's main objective was amended to ensure price stability. This change was an important step in securing the Bank's independence. One of the biggest advantages of an inflation target is that it helps to reduce uncertainty about future inflation (Hartmann, Herwartz & Ulm, 2020:1). A strategy for implicit inflation targeting was implemented in Türkiye from 2002 to 2005. Explicitly targeting inflation was introduced in 2006. Since the beginning of 2000, inflation rates in Türkiye were close to 10%. While the targeted rates were not met with the explicit inflation targeting regime

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introduced in 2006, excessively volatile rates were not observed. The rise in the exchange rate after 2010 and the depreciation of the Turkish lira again made inflation a major problem. Turkish currency, the lira, depreciated by 27 per cent between January 1, 2022, and October 31, 2022. The lira depreciation caused inflation expectations to rise due to the knock-on effect of the exchange rate on prices (Kara and Orak, 2008:37-43; Binal-Yılmaz, 2012:56).

As the price for imported goods increased as the lira depreciated, the cost of production increased. Consequently, rising costs were reflected in the prices. At the same time, the relatively low price of exported goods offered a competitive advantage. It was also a political decision. However, due to the competitive advantage in countries with high foreign dependency, the inflow of foreign currency did not always meet the foreign exchange that came out due to the increased cost of imported goods. That was because of the composition of imports in the Türkiye economy. The composition of imports, the weight of energy, raw materials and intermediate products was more significant. These developments reflected excessive public spending and external shocks such as the strong deterioration in trade (Agenor and Hoffmaister, 1997:4).

Motivation of the Study: Do import prices have a significant effect on inflation? Has the sensitivity of the output gap to inflation decreased? Do expectations have an explanatory effect on the inflation rate? The Hybrid New Keynessian Phillips Curve (NKPC) model was used for the research questions of this paper.

This paper investigated the effects of inflation expectations for 12 months, which were measured by CBRT's expectations survey, the expected policy interest rate, the expected depreciation in TL, the GAP: output gap and import prices on inflation. The fact that the expected exchange rate rise was considered a variable rather than the exchange rate (Dollar/TL) in the study made it different from other studies. The behavior of economic units that wanted to protect their capital because of the rise in exchange rate inflation is important. This paper examined the period from 2013 to 2022.Although the analysis is recent, there was sufficient time and data available. In inflation research, an interesting topic is to examine the effect of managing expectations on inflation. This research offers important clues to understanding future-oriented rational behavior.

Theoretical Framework, and Literature

An article, published in 1958, aroused great interest and initiated discussions that continue to this day. William Phillips found a negative and nonlinear relationship in his study of the rate of change of money wages and the unemployment rate in the United Kingdom from 1861 to 1957 with long-term data. In the original Phillips curve, the rate of change of money wages is on the Y-axis and the unemployment rate is on the X-axis. It is shown as a negative, concave curve. An increase in the rate of change of money wages (inflation) reduces unemployment and vice versa (Phillips, 1958: 283-299). This study, which was a milestone in the development of macroeconomics, is defined in the equation below.

$$\pi t = \alpha + \beta ut + \epsilon_t, \beta < 0. \tag{1}$$

In Equation (1), πt; rate of change of money wages, u_t; the current unemployment rate, $epsilon_t$, is the error term. and $\beta < 0$. Accordingly, a rise in the unemployment rate means an increase in the labor supply, which puts downward pressure on wages.

This model assumed that prices were determined by a constant increase in price above the unit labor cost and were therefore adjusted in proportion to wages. This assumption, formulated by Solow and Samuelson (1960), transformed the PC (Phillips Curve) from a wage exchange relation to a price exchange relation which was more beneficial for policymakers (Samuelson and Solow, 1960: 177-194).

The PC was accepted as an integral part of the Keynesian economy in the sixties. The common Keynesian interpretation of the Phillips curve was reversed by new ideas in the 1960s and by the events of the 1970s (Snowdon and Vane, 2005: 155). During the 1970s, unemployment and salary increases were very high. With the emergence of this condition known as stagflation, the validity of the Phillips curve was questioned (Abel et al., 2017: 489).

Phelps (1967) and Friedman (1968) argued that there was no simple trade-off between inflation and unemployment. According to Friedman (1968), based on the adaptive expectations hypothesis, PC depended on both expected inflation and deviation from the natural rate of unemployment. We expressed PC generated by the adaptive expectations hypothesis as the following regression.

$$\pi_t = \pi_t^e + a(\mu_t - \mu_t^*) + \epsilon_t \tag{2}$$

In Equation 2; π_t, inflation, π_t^e, expected inflation, μ_t, unemployment, μ_t^*, NAIRU; It is the unemployment rate that does not accelerate inflation. ϵ_t, is the error term. In this context, employees form their inflation expectations based on past estimation

Table 1. Literature Review

STUDY	SAMPLE	METHOD	FINDINGS
Gali, Gertler & Lopez-Salido, (2001).	1970–1998	Baseline and Structural Model	The new Phillips Curve is valid.
Leigh & Rossi (2002)	1994–2002	VAR	The effect of the exchange rate on the prices lasted for one year and most of the effect occurred in the first four months and was reflected in the prices.
Rudd, & Whelan, (2007).	1960–2004	GMM	There was insufficient evidence for the New Phillips Curve.
Peker & Görmüş (2008)	1987–2006	VAR	The study determined that exchange rate fluctuations were the main determinant of inflation.
Fanelli, (2008)	1971–1998	VAR	Fanelli revealed that inflation expectations were not important in determining the inflation rates of the European Region. The NKPC was invalid.
Eren & Çiçek (2009)	1987–2007	TVPP – Kalman Filtresi	This study observed the sensitivity of the domestic inflation rate to the national output gap decreased over time. The effect of the national output gap on the domestic inflation rate was that it decreased over time.
Korkmaz, (2010)	1997–2006	2AEKK	in Türkiye is determined according to the expectations for the future period. Firms made their pricing behavior prospectively.
Kara & Öğünç (2011)	2002–2011	VAR	Import prices were as important as the exchange rate on inflation.
Kara, Öğünç & Sarıkaya, (2017)	2006–2016	Baseline Model	The effect of import prices on inflation decreased, and the effect of the exchange rate continued stably.
Terzioğlu, (2017)	1987–2015	VAR–MVEGARCH	In the pre-2003 period, the effect of output uncertainty on inflation was positive, while its effect on output and exchange rate change was negative. In the low inflation period after 2003, the increase in output uncertainty had an increasing effect on growth and exchange rate and a decreasing effect on interest rates.
Bozdağlıoğlu & Yılmaz (2017)	1994–2004	VAR	Increases in the nominal exchange rate affected inflation.
Ogunc, Ozmen, & Sarikaya (2018)	2005–2016	BVAR	The pass-through of exchange rate and import price shocks to inflation was quite strong.
Terzioğlu, (2018)	1987–2015	MGARCH	The effects of inflation uncertainty on real and nominal indicators differed in periods of high and low inflation.
Kaygısız, (2018)	2002–2016	VAR	Twenty percent of the change in inflation was explained by the exchange rate.
Chin, (2019)	1960–2015	GMM	There was insufficient evidence for the NKPC prediction.
Çiçek & Alkan (2019)	2004–2019	BEKK–GARCH	When a shock occurred to the actual (or expected) inflation, the effect of this shock spreads to the expected (or actual) inflation and continued for some time.
Duğru, (2020)	1981–2018	ARDL	The negative relationship between unemployment and income per capita was valid both in the short and long run.
Wardhono, Nasir, Qori'ah & Indrawati (2021)	2005–2018	GMM	The NKPC was valid in the ASEAN region.
Zobl & Ertl (2021)	2003–2019	GMM	In Central and Eastern Europe, the NKPC was valid under the assumption of an open economy.
Kara & Sarıkaya (2021)	2006–2021	VAR	After 2017, inflation inertia and the exchange rate pass-through were quite high.
Tombak, (2021)	2003–2019	NARDL	A long-term cointegration relationship was found between inflation, output gap, inflation expectation, real effective exchange rate, and the M2 money supply in Türkiye. The findings concluded that positive increases in output gap increased inflation in the short and long term.
Yasar & Terzioglu (2020)	1987–2020	FIVAR – VARFI	When changes in the money supply affected investment through interest rates, they also affected the size of output and the sustainability of stability (during a crisis).
Aytekin, Bayrakdar & Aksoy, (2023)	2004–2021	ARDL-Toda Yamamoto	A bidirectional causality relationship was found between inflation and the exchange rate.

The results of the analysis and the literature will be evaluated in the conclusion.

errors. The expression $\alpha(\mu_t - \mu_t^*)$, represents the gap between real and nominal wages. Under the assumption that workers have congruent expectations, expected inflation becomes a weighted average of past inflation rates.

Phelps (1969) and Friedman (1977) independently argued that the original Phillips curve contradicted the rational expectations hypothesis and criticized the concept of a stable (long-run) Phillips curve.

According to rational expectations theory, people believe that they will not make mistakes because they form their expectations based on available information along with past experiences (Muth, 1961: 321-327). According to Lucas, when economic agents act only with backward expectation estimation, they make systematic errors because the available information is missing (Snowdon and Vane, 2005: 200). Therefore, future inflation expectations are included in the equation to represent forward-looking information. Lucas and Rapping suggested that the Phillips curve varied with time (Lucas and Rapping, 1969: 345-348).

$$\pi_t = y\pi_{t+1}^e + \alpha(\mu_t - \mu_t^*)\epsilon_t \tag{3}$$

In Equation 3; $y\pi^{e}_{t+1}$, inflation expectations for the next period are included. According to the rational expectations hypothesis, individuals who used the available information in the best way did not allow inflation-output trade-offs by accurately predicting the results of systematic policies (Lucas, 1973:326-327). The random error term has a mean of zero and has no causal relationship with the information set available when generating expectations. Accordingly, if there is no lack of information, the estimation error of rationally formed expectations is random and will not contain systematic deviations (Snowdon, Vane and Wynarczyk, 1996: 191).

The NKPC (New Keynesian Phillips Curve) is an important tool for monetary policymakers. The NKPC depicts an output-inflation trade-off, much like the traditional PC does. But it is based on micro foundations. In this sense, NKPC differs from Friedman's theory of adaptive expectations. Instead of an unemployment gap, the output gap is included in the PC analysis as a measure of the excess demand (Claus, 2000: 4).

The NKPC argues that current inflation is affected by expected future inflation and that these expectations are rational. In Gali and Gertler's (1999) improved NKPC equation, current inflation was determined by an expected future inflation and output gap or marginal cost. While the output gap is useful in measuring the demand pressure in an economy, it is preferred to measure the cost pressure with the marginal cost on the production side.

$$\pi_t = yf\pi^{e}_{t+1} + \lambda y_t \tag{4}$$

The New Keynesian Phillips Curve is an equation where output is at potential when unemployment is at the natural rate; When unemployment is above the natural rate, the output is below potential and vice versa. At equilibrium, inflation is as expected, and output is at full employment (or potential) - the output gap is zero. In Equation 4, the inflation rate, π t, depends on the expected inflation rate for the next period, π^{e}_{t+1}, and an output gap measure denoted by y_t (Nason and Smith, 2008: 363).

Gali and Gertler (1999) put forward the Hybrid New Keynesian Model, which combined expected and past inflation values (Chowdhury and Sarkar, 2017: 428). Thus, past values of inflation are also included in the model.

$$\pi_t = yf\pi^{e}_{t+1} + \lambda y_t + (1-y)\pi_{t-1} \tag{5}$$

For the hybrid New Keynesian Phillips curve, equation 4 was expanded as in equation 5 by adding the past inflation rate. In Equation 5, the parameter y lies between 0 and 1 (Nason and Smith, 2008: 363).

Studies that examined the Phillips curve approach and inflation dynamics in national and international literature are listed in Table 1 below.

Econometric Method, and Data Sets

It was important to test the stationarity among the variables to determine the appropriate econometric model. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, which are the most widely used unit root tests, were preferred for the econometric model (Makridakis et al., 1998:329).

ADF test equation form is shown in equation 6.

$$\Delta y_t = a_0 + a_1 + yY_{t-1} + \Sigma^{k}_{i=1}\beta_i \delta y_{t-i} + u_t \tag{6}$$

ADF test hypotheses:
H_0: γ=0 There is a unit root.
H_1: γ<0 No unit root.

When the alternative hypothesis is rejected, according to Dickey and Fuller (1981: 1057-1072), the difference is applied to make the series stationary.
The PP test equation form is shown in equation 7.

$$\delta y_t = a y_{t-1} + x'_t \delta + u_t \tag{7}$$

PP test hypotheses:
H_0: a=0 There is a unit root.
H_1: a<0 No unit root.
The Phillips-Perron test statistic is similar to the ADF test statistic. Therefore, the test statistic is compared with the MacKinnon critical values. (Phillips and Perron, 1981: 335-346).

The Vector Autoregressive Model (VAR) developed by Sims (1980) is a multivariate form of the univariate autoregressive (AR) model. The model not only explains the dynamic behavior of the relationship between endogenous and exogenous variables or the relationship between endogenous variables but also explains it with the impulse-response function of the variable or a series of variables. According to Johansen (1995), the VAR model is represented in equation (8):

$$y_t = A_i y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \varepsilon_t \quad (8)$$

y_t; in Equation (8); While denoting the px1 variable vector, x_t; Expresses dx1-dimensional deterministic variables.A_i; pxp dimensional matrices, and ϵ_t; is the vector of error terms.

In the VAR approach, the endogenous variables in the system are treated as a function of the lagged values of all the endogenous variables in the system, unlike basic regression or time series analysis. The basic VAR model has the following form (Lütkepohl, 2005: 13).

$$y_t = A_1 + y_{t-1} + \cdots + A_p y_{t-p} + C_{X_t} + u_t \quad (9)$$

In equation 9 above,$y_t = (y_{1t}, \ldots . y_{Kt})'$, is the vector of observable endogenous variables (K×1),
$X_t = (x_{1t}, \cdots .x_{dt})', (d \times 1)$dimensional vector of exogenous variables,
$A_1, \cdots, A_p, (K \times K)$ dimensional, coefficients matrices for lagged variables,
Coefficients matrix of C,k×d dimensional exogenous variables,

$u_t = (u_{1t}, \cdots, u_{Kt})'; E = (u_t) = 0, E(\mu_t \mu_t) = \sum_u andE(\mu_t u_s') = 0(t \neq s)$ is the error vector showing the $(k \times 1)$ dimensional clean sequence feature.

If the bivariate VAR model is rewritten as k=2 and p=1 (Mert and Çağlar 2019: 2016-228); $y_{1t} = a_{11} y_{1t-1} + a_{12} y_{2t-1} + c_1 + u_{1t}$ It is expressed as $y_{2t} = a_{21} y_{1t-1} + a_{22} y_{2t-1} + c_2 + u_{2t}$

Impact Response analysis is an important step in econometric analysis using vector autoregressive models. It describes the evolution of the variables of a model in response to a shock in one or more variables. Impact Response analysis measures the time cross-section of the impact of shocks at a certain time point on the (expected) future values of the variables (Mert and Çağlar 2019: 2016-229).

Variance decomposition is a useful method to evaluate the transmission of external shocks to each economic variable (Mert and Çağlar 2019: 2016-230). In Table 2, the variables to be used in the econometric analysis are introduced.

Motivation of the Study: Do import prices have a significant effect on inflation? Has the sensitivity of the output gap to inflation decreased? Do expectations have an explanatory effect on the inflation rate? The Hybrid New Keynesian Phillips Curve model was used for the research questions of this study.

The quarterly data of the economy of Türkiye for the period 2013:Q2-2022:Q2 are shown in Table 2 as explicit and implicit.

Table 2. Symbolic and Explicit Representation of Data for 2013:Q2-2022:Q2 Periods [1],[2]

Variable	Definition	Source
π_t	Consumer Price Index[1] (TUFE-B)	CBRT
π_t^e	Expected Consumer Price Index (After 12 Months) (TUFE-B)	CBRT
$erate$	Expected Interest Rate (After 12 Months)	CBRT
bdk	Expected Increase in Dollar/Tl Exchange Rate	CBRT
gap_t	Output Gap[2]	CBRT
$\mathrm{imp_t}$	Import Unit Value İndex	CBRT

In this context, the seasonally adjusted, logarithmic difference (quarterly inflation rate) of the consumer prices excluding unprocessed food and alcoholic beverages-tobacco (CPI-B) price index as of the end of the quarter was preferred to form the

[1] For consumer prices, the CPI indicator, excluding unprocessed food and alcoholic beverages-tobacco, was preferred.
[2] It was obtained by decomposing the GDP Calculated with the Chained Volume Index into its components with the HP Filter (Hodrick and Prescott, 1997).

inflation variable. Market participants' survey results were used in the formation of the expected inflation variable (Probability Distribution of Expectations for Annual Consumer Inflation After 12 Months). The expected increase in $/TL rate: Expectation of exchange rate after 1 year and $/TL rate in the survey period were used. The logarithmic difference (quarterly import price change rate) of the import unit value index as of the end of the quarter was preferred. The output gap variable was obtained by decomposing the GDP Calculated with the Chained Volume Index into its components using the HP Filter (Hodrick and Prescott, 1997). Interest rate expectation (8C. (Arithmetic Average) CBRT Weighted Average Funding Cost Expectation After 12 Months) was obtained from the market participants' survey results. It is the logarithmic difference of all variables. In 2013, the year when the Fed reduced its bond purchasing program, was decisive for the model. The model established for analysis is as follows.

The model created with the above data is as follows.
Model
2013:Q2-2022:Q2

$$\pi_t = \alpha_0 + \beta_0 \pi_t^e + \beta_1 erate + \beta_2 bdk + \beta_3 gap_t + \beta_4 imp + \varepsilon_t$$

*α; is the constant parameter. β; refers to the coefficient in front of the variables. ϵ_t, is the error term. Figure 1 shows the Expected Increase (%) in the $/TL Rate in the above model.

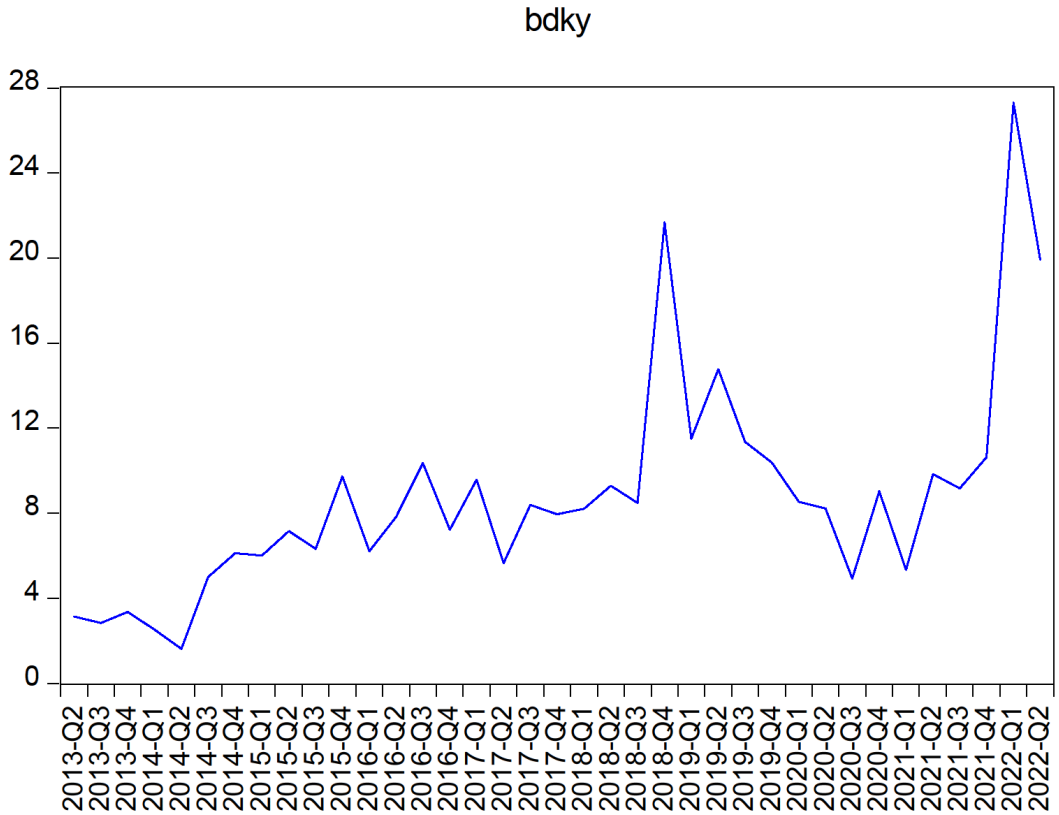


Figure 1. Expected Increase in $/TL Rate (%)

Source: CBRT www.evds.com.tr

Output gap (GAP), defined as the logarithmic difference of GDP from its potential level, was obtained using the HP Filter with the Eviews 10.0 package program as in Figure 2 below. Lambda=1600 was taken as quarterly series were used.

In Figure 2, the trend represents potential revenue. Final seasonally adjusted series represents the real production level. The cycle, which shows the difference between the two, represents the output gap. It is shown as an output gap (GAP) in Figure 3.

According to Figure 3, the part above the zero line represents the positive output gap and the part below the negative output gap. In Figure 3, there was a negative output gap in the economy of Türkiye during the global economic crisis and pandemic that occurred in 2020.

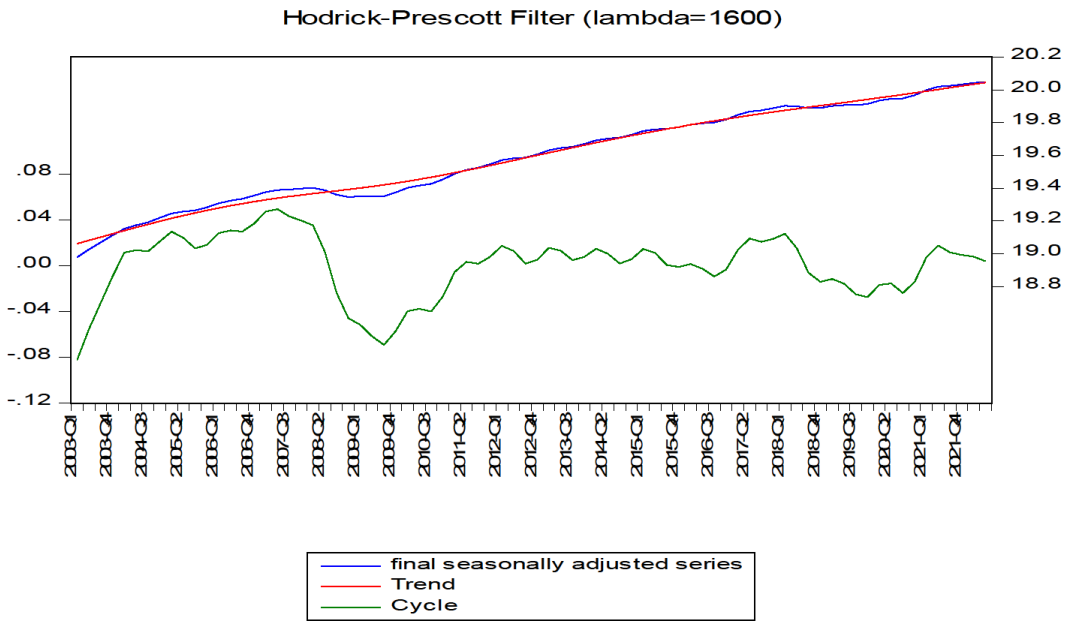


Figure 2. Differentiation of GDP Series into Components with the Hodrick-Prescott Filter

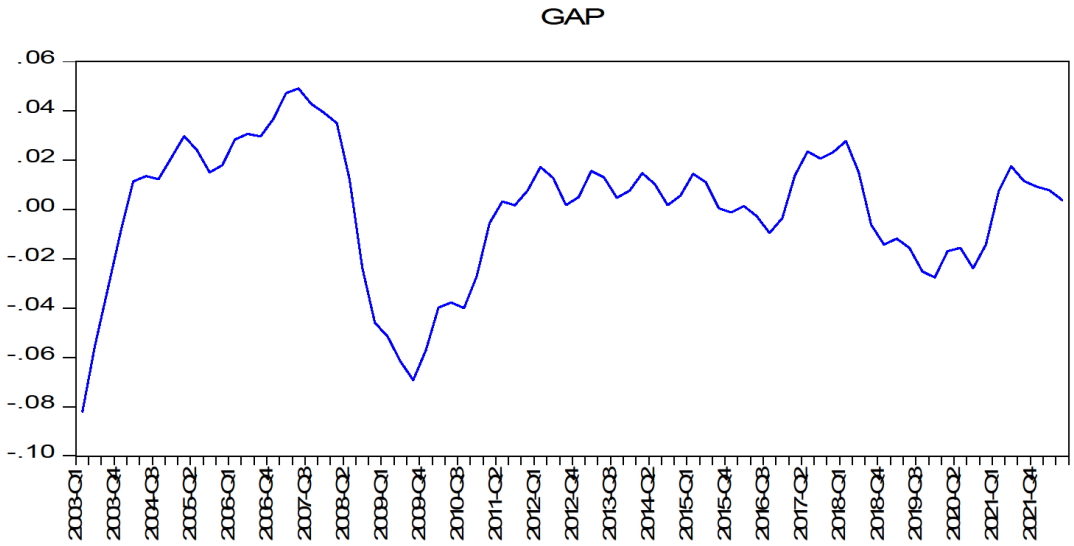


Figure 3. Graph of Output Gap

The literature states that the output gap is generally used as the explanatory variable in the Hybrid New Keynesian Phillips Curve Model and that the output gap has a positive effect on inflation. After estimating the expected increase in the $/TL exchange rate and the output gap, it was included in the model as an independent variable for econometric analysis. The results of the econometric analysis are given under the heading of findings.

Empirical Results

The data regarding the variables were obtained from the EVDS of the Central Bank of the Republic of Türkiye on 15.11.2022. The test results in which unit root analysis of the variables were made are shown in Table 3.

It was concluded that the test statistic calculated for the variables in the table is less than all critical values at the 10% significance level, and since the null hypothesis was rejected, it does not contain a unit root, that is, the series is stationary. Since no cointegrated

Table 3. Unit Root Test Results

		UNIT ROOT TEST TABLE (PP)				
	At Level					
		EINF	ERATE	GAP	IMP	INF
With Constant	t-Statistic	-4.0985	-4.2088	-5.5732	-2.7292	-2.6778
	Prob.	***	***	***	**	**
With Constant & Trend	t-Statistic	-4.3539	-4.2939	-5.4991	-2.5527	-3.2583
	Prob.	***	***	***	*	*
Without Constant & Trend	t-Statistic	-3.6675	-4.1590	-5.4669	-2.4200	-1.6448
	Prob.	***	***	***	**	*
		UNIT ROOT TEST TABLE (ADF)				
	At Level					
		EINF	ERATE	GAP	IMP	INF
With Constant	t-Statistic	-4.0985	-4.4537	-5.5715	-2.7474	-2.7081
	Prob.	***	***	***	**	**
With Constant & Trend	t-Statistic	-4.2813	-4.3796	-5.4971	-2.5808	-3.4704
	Prob.	***	***	***	*	*
Without Constant & Trend	t-Statistic	-3.7667	-4.0825	-5.4646	-2.4903	-1.7525
	Prob.	***	***	***	**	*

*Notes: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant *MacKinnon (1996) one-sided p-values.*

relationship was found, the study examined the relationship between inflation and GAP, import prices, and expectations between 2013:Q2–2022:Q2 using the VAR analysis method.

Table 4. VAR Lag Order Selection Criteria

Endogenous variables: INF EINF ERATE BDK GAP IMP
Exogenous variables: C
Sample: 1 37
Included observations: 35

Lag	LogL	LR	FPE	AIC	SC	HQ
0	7.798688	NA	3.64e-08	-0.102782	0.163849*	-0.010741*
1	50.03668	67.58079	2.63e-08	-0.459239	1.407179	0.185048
2	92.50876	53.39347*	2.20e-08*	-0.829072*	2.637132	0.367461

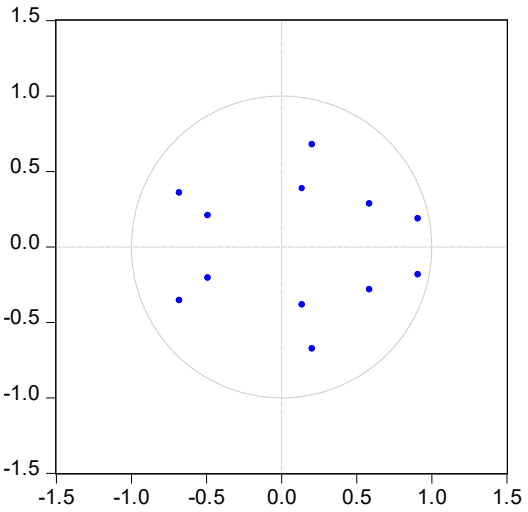
** Indicates lag order selected by the criterion*
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
**As can be seen from the table, lag length 2 was preferred according to LR, FPE, and AIC criteria.*

The roots of the characteristic polynomial are given in the table below.

The VAR (2) model, which was created as a result of the diagnostic tests; the stability condition, absence of serial correlation, constant variance, and normality conditions are at 0.01 error level. All diagnostic tests for the VAR model provide evidence that the model is meaningful.

In Figure 4, there are thirty-six impulse-response graphs related to the VAR (2) model. The graph in the upper left corner shows the response of inflation to itself. According to the graph, a shock to inflation affects itself positively for nine quarters. In addition, the response of inflation to the shock is significant because the zero line is not within the first-period confidence interval. The

Table 5. Roots of Characteristic Polynomial



Roots of Characteristic Polynomial
Endogenous variables: INF EINF ERATE BDK GAP IMP
Exogenous variables: C
Lag specification: 1 2

Root	Modulus
0.910374 - 0.185428i	0.929067
0.910374 + 0.185428i	0.929067
-0.677724 - 0.355331i	0.765226
-0.677724 + 0.355331i	0.765226
0.206980 - 0.676052i	0.707027
0.206980 + 0.676052i	0.707027
0.587874 - 0.284217i	0.652974
0.587874 + 0.284217i	0.652974
-0.487969 - 0.206696i	0.529941
-0.487969 + 0.206696i	0.529941
0.138681 - 0.384590i	0.408830
0.138681 + 0.384590i	0.408830

No root lies outside the unit circle.
VAR satisfies the stability condition.

It is understood from the graph and the table that all characteristic roots are in the unit circle and the VAR model satisfies the stability condition.

Table 6. Diagnostic Tests

LM Test						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
4	38.95014	36	0.3384	1.095413	(36, 51.1)	0.3772
White Test						
Chi-sq	df	Prob.				
507.2118	504	0.4515				
Normality Test						
Component	Chi-sq	df	Prob.			
Joint	11.96966	6	0.0626			

**Original tables of the LM Test, White Test, and Normality Test are in the appendices.*

response of the expected inflation to the inflation shock was positive for four quarters. The response of the expected interest rate to a shock to inflation was negative throughout all periods. The response of the expected increase in the exchange rate to a shock to inflation was positive throughout all periods. Given a shock to inflation, the response of the output gap was positive but downward for five periods. The response of inflation to a shock to import prices was positive throughout all periods. The response of import prices to a shock to inflation was positive for four quarters and then negative until the twelfth quarter.

Table 7 below shows how much the independent variables affected the dependent variable in the face of the shock given to the variables.

Twelve periods for each series were followed in the variance decomposition results in Table 7. When the variance decomposition results for the inflation variable are examined, the total change in the first-period inflation (100.00) is explained by itself. In the second quarter, 55% of the change in inflation is its own shocks. Thirty-eight percent of inflation in the second quarter is explained by expected inflation. About 3% of inflation in the second quarter is explained by the expected increase in the exchange rate. About 2% of inflation in the second quarter is explained by the expected interest rate. About 0.5% of inflation in the second quarter is explained by the import unit value index. About 0.5% of inflation in the second quarter is explained by the output gap.

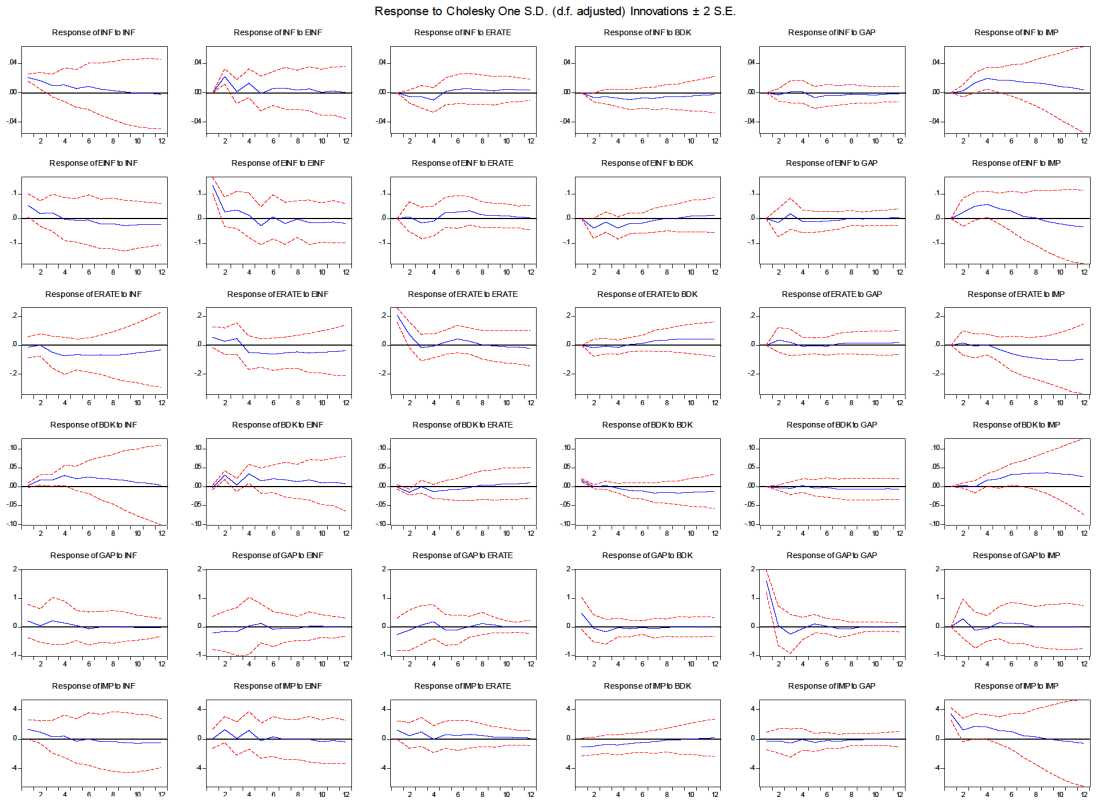


Figure 4. Impulse Response

Table 7. Variance Decomposition of Inflation

Variance Decomposition of INF: 2013Q2-2022Q2							
Period	S.E.	INF	BDK	ERATE	GAP	EINF	IMP
1	0.021034	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.036063	55.30864	2.951177	1.700607	0.529786	38.93471	0.575080
3	0.040647	49.69539	3.956031	2.943017	0.543090	30.82766	12.03481
4	0.050000	37.70001	4.678908	5.765232	0.448241	27.41806	23.98955
5	0.054471	32.97117	6.733048	4.998133	1.704562	23.12745	30.46564
6	0.058844	30.55336	7.141533	5.116512	1.782459	20.85196	34.55418
7	0.061989	28.20964	7.892366	5.403641	1.943466	19.86932	36.68157
8	0.064131	26.60054	8.025601	5.522377	1.887739	18.98956	38.97418
9	0.065860	25.28077	8.294001	5.425834	1.899158	18.70149	40.39874
10	0.066864	24.52920	8.433916	5.805621	2.010715	18.16544	41.05511
11	0.067539	24.04394	8.494797	6.121918	2.035574	17.95215	41.35162
12	0.067908	23.87197	8.522707	6.458547	2.063413	17.76330	41.32006

In the third quarter, the self-explanatory rate of inflation decreased to approximately 50%. In the third quarter, the inflation explanation rate of expected inflation decreased to approximately 30%. Approximately 12% of the change in inflation in the third quarter is explained by the import unit value index. About 4% of inflation in the third quarter is explained by the expected increase in the exchange rate. About 3% of inflation in the third quarter is explained by the expected interest rate.

At the end of the first year, the inflation rate self-explanation dropped to about 37%. The inflation disclosure rate of the import unit value index rose to 23%. The inflation disclosure rate of the expected interest rate was approximately 5.7%. The expected increase in the exchange rate was approximately 4.6%. At the end of the second year, approximately 38% of the change in inflation is explained by the import unit value index. Eight percent of inflation is explained by the expected increase in the exchange rate.

At the end of the third year, approximately 41% of the total change in inflation is explained by the import unit value index. Eight and a half percent (8.5%) is explained by the expected increase in the exchange rate.

The variance decomposition results are given graphically below.

Figure 5. Variance Decomposition

In the first chart from the left, a significant part of inflation is explained by the import unit value index and expected inflation. Inflation is then explained by the expected increase in the exchange rate and the expected interest rate. In the first chart, it is understood that a significant part of inflation is explained by expectations. In the second chart, a significant part of the expected inflation is explained by the current inflation and the import unit value index. According to the variance decomposition results of the expected interest rate, a significant part of it is explained by current inflation, expected inflation, and the import unit value index. A significant part of the expected interest rate is explained by the expected inflation, current inflation, and the import unit value index. According to the variance decomposition of the output avalanche, the most explanatory variable is the expected

increase in the Dollar/TL exchange rate. According to the variance decomposition graph of the import unit value index, current inflation, expected inflation, expected interest rate and expected increase in USD/TL exchange rate explain IMP.

According to these results, the main causes of inflation in Türkiye are, respectively, inflation itself, changes in import prices, inflation expectation, expected increases in Dollar/TL exchange rate, interest rate expectation, and the output gap. Therefore, the pass-through effect of exchange rate variability on prices was realized at a very high rate with its effect on import prices. Therefore, the exchange rate should be considered a very important policy variable in explaining the causes of inflation in Türkiye and the fight against inflation.

CONCLUSION

The fact that inflation stays above the targets for many years causes the targets to weaken as anchors. The rise in inflation rates brought with it the increasing importance attributed to past inflation and exchange rate developments in the formation of expectations. The question that comes to the fore at this point is to what extent this change in the formation of expectations is reflected in the pricing behavior and thus in the inflation dynamics. This research paper tested the hybrid model in price determination to understand the behavior of inflation and macroeconomics. The Motivation of the Study: Do import prices have a significant effect on inflation? Has the sensitivity of the output gap to inflation decreased? Do expectations have an explanatory effect on the inflation rate? The Hybrid NKPC model was used for the research questions of this study.

Do import prices have a significant effect on inflation? In the literature, Kara & Öğünç (2011), Analyzed the years between 2002 and 2011, and emphasized that import prices are as important as the exchange rate on inflation. In the sample taken, both Türkiye's 2001-2002 banking crisis and the 2008 global financial crisis effected import prices. In the study conducted by Kara, Öğünç & Sarıkaya (2017) between 2006 and 2016 in Türkiye, the effect of import prices on inflation decreased, and the exchange rate effect continued in a stable manner. In the history of Türkiye's economy, inflation reached single-digit figures in 2000 and this continued until 2016.

According to the results of the impulse-response analysis graphs of this study, the response of inflation to a shock to import prices is positive throughout all periods. The response of import prices to a shock to inflation is positive for four quarters and then negative until the twelfth quarter. According to the variance decomposition results of the study, the effect of import prices on inflation increased for 12 quarters for the period between 2013-2022. The impact of import prices was not diminished. After 2016, the crisis in the exchange rate caused import prices to increase. Between January 2, 2006, and December 30, 2016, the depreciation[3] of the lira was approximately (minus) 61%. Between January 2, 2017, and October 31, 2022, the depreciation[4] of the lira was approximately (minus) 80%. This explains the result. Therefore, do import prices have a significant effect on inflation? The answer to that question is Yes.

Has the sensitivity of the output gap to inflation decreased? Eren and Çiçek (2009) between 1987 and 2007, analyzed the effect of the national output gap on the domestic inflation rate by the Kalman Filter Method, and the change in the coefficients estimated in the model over time was monitored. It was determined that the coefficient decreased over time. This proved that the Phillips curve flattened in Türkiye. Eren and Çiçek (2009) stated that the inflation process in Türkiye changed and the use of national resources, which the CBRT tries to determine with short-term interest rates, may be insufficient in the fight against inflation. For this reason, they argued that global demand conditions should also be included in inflation models. Tombak, (2021), in the analysis made between 2003 and 2019, found a long-term relationship between inflation, output gap, inflation expectation, real effective exchange rate, and the M2 money supply in Türkiye. The findings concluded that positive increases in output gap increased inflation in the short and long term.

When we looked at the literature, the output gap was generally used as the explanatory variable in the Hybrid New Keynesian Phillips Curve Model and this gap has a positive effect on inflation. In the results of the impulse-response analysis graphs of this study, when a shock is given to the inflation variable, the response of the output gap was positive but decreased for five periods. According to the variance decomposition results, the output gap explained the change in inflation by 0.05% in the second quarter and 0.4% in the fourth quarter for the period 2013-2022. At the end of the second year, the output gap explained 1.8% of the total change in inflation, and at the end of the third year, 2.06% of the total change in inflation. It found that the coefficient decreased over time. This result indicated that the Phillips curve flattened in Türkiye. Therefore, the findings showed that the sensitivity of the output gap to inflation decreased.

The issue of which factors affect economic units while determining prices has always been among the topics worth researching

[3] On January 2, 2006, it was $/TL= 1.3506 (1/1.3506 =0.74041166888) and on December 30, 2016, it was $/TL=3.5255 (1/3.5255= 0.28364770954). Depreciation of the lira= ((0.28364770954-0.74041166888)/ 0.74041166888)*100= - % 61.6906232949

[4] On January 2, 2017, it was $TL= 3.5402 (1/3.5402 =0.28246991695) and on October 31, 2022, it was $/TL= 18.6250 (1/18.6250= 0.05369127516). Depreciation of the lira= ((0.05369127516-0.28246991695)/ 0.28246991695)*100= - % 80.9922147676

for economists. Macro analyses based on micro-fundaments revealed that inflation expectations have an extremely important role in price determination decisions. From the studies on Türkiye, Çiçek and Alkan (2019) conducted between 2004-2019, it was discovered that when a shock occurs to the realized (or expected) inflation, the effect of this shock spreads to the expected (or actual) inflation and this effect continues for a while.

In the results of the impulse-response analysis graphs of this study, the response of inflation to a shock to expected inflation was positive for eleven periods. Then, the response of inflation disappeared in the twelfth period. The response of expected inflation to a shock to inflation was positive for one year and negative for the following periods. In the variance decomposition results, expected inflation explained about 39% of inflation in the second quarter. Even though this effect decreased towards the end of the year, it explains approximately 17.7% of the total change in inflation at the end of the third year. This finding supported that the CBRT could not be fully successful in shaping inflation expectations during the periods when inflation started to rise in Türkiye.

In results of the impulse-response analysis graphs of this study, the response of inflation to a shock to the expected interest rate (ERATE) was negative for five periods and then the effect was positive until the ninth period. After the ninth period, the effect disappeared. The expected interest rate (ERATE) response to a shock to inflation was meaningless because the zero line and response curve was inside the confidence interval. In the variance decomposition results, the expected interest rate (ERATE) explained approximately 6.45% of the total change in inflation. This effect increased throughout all periods.

According to the results of the impulse-response analysis graphics of this study, the response of inflation to a shock to the expected increase in the Dollar/TL exchange rate (BDK) has been negative for ten periods. Then the effect disappears after the tenth period. The response of the expected increase in the Dollar/TL exchange rate (BDK) to a shock to inflation is positive throughout all periods. In the variance decomposition results, the expected increase in the USD/TL exchange rate (BDK) explains approximately 8.52% of the total change in inflation. This effect tends to increase throughout all periods.

Therefore, do the expectations have an explanatory effect on the inflation rate? The answer to that question is Yes.

In their analysis between 2006-2021, Kara and Sarikaya (2021) stated that inflation inertia and exchange rate pass-through were quite high after 2017. According to the results of the impulse-response analysis graphics of this study, the response of inflation to a shock to inflation was positive for nine periods, and then the effect disappeared. In the variance decomposition results, inflation explained 100% of the change in the first quarter. the inflation self-explanation rate was 55% in the second quarter and 49% in the third quarter. Although the rate of explaining the change in inflation itself decreased, it explained approximately 24% of the total change at the end of the third year.

This shows that despite the policies implemented by decision makers, economic agents adjusted their pricing behavior according to past inflation more than inflation expectations. For this reason, the measures taken by decision-makers could not be fully successful. For the steps to be effective, behavioral transformation throughout society is also important, while strengthening communication channels plays a critical role in addition to structural policies.

As stated by Kara and Sarıkaya (2021) in their study, it was important for the central bank to re-establish the trust factor to break the inflation inertia. In addition, as stated in the central bank law, the primary objective of monetary policy is to protect the value of the lira.

According to the results of the analysis, the inflation-targeting regime was not successful in anchoring the expectations of economic agents. Developing policies based on expectations by reducing inflation uncertainty by the central bank or economic authority could have a positive effect on inflation. These are remarkable results for policymakers, especially for price stability and inflation targeting.

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ATTACHMENTS

Table 8. Vector Autoregression Estimates

Vector Autoregression Estimates
Date: 11/28/22 Time: 16:11
Sample (adjusted): 3 37
Included observations: 35 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	INF	EINF	ERATE	BDK	GAP	IMP
INF(-1)	0.346384	0.404812	-0.182941	0.093346	-2.655078	6.034022
	(0.21525)	(1.48375)	(2.21366)	(0.18219)	(17.8184)	(41.5020)
	[1.60920]	[0.27283]	[-0.08264]	[0.51236]	[-0.14901]	[0.14539]
INF(-2)	-0.056654	-0.967926	-2.907827	0.552921	20.00228	-17.29203
	(0.31427)	(2.16626)	(3.23192)	(0.26599)	(26.0146)	(60.5924)
	[-0.18027]	[-0.44682]	[-0.89972]	[2.07869]	[0.76889]	[-0.28538]
EINF(-1)	0.172713	0.169297	0.078152	0.256323	-0.714713	8.968886
	(0.03293)	(0.22699)	(0.33866)	(0.02787)	(2.72594)	(6.34918)
	[5.24478]	[0.74583]	[0.23077]	[9.19633]	[-0.26219]	[1.41260]
EINF(-2)	0.005084	0.566131	0.698465	-0.051096	-2.086037	1.354594
	(0.05683)	(0.39176)	(0.58449)	(0.04810)	(4.70470)	(10.9580)
	[0.08945]	[1.44508]	[1.19501]	[-1.06218]	[-0.44339]	[0.12362]
ERATE(-1)	-0.030298	-0.027590	0.354352	-0.077036	-0.994940	0.002688
	(0.02091)	(0.14417)	(0.21509)	(0.01770)	(1.73129)	(4.03246)
	[-1.44866]	[-0.19137]	[1.64749]	[-4.35182]	[-0.57468]	[0.00067]
ERATE(-2)	-0.043179	-0.258196	-0.264581	0.041464	0.670414	-0.542115
	(0.02285)	(0.15750)	(0.23498)	(0.01934)	(1.89144)	(4.40549)
	[-1.88971]	[-1.63932]	[-1.12596]	[2.14400]	[0.35445]	[-0.12305]
BDK(-1)	-0.269043	-1.562479	-1.369957	0.081993	1.276644	-29.90310
	(0.14507)	(0.99997)	(1.49190)	(0.12279)	(12.0087)	(27.9703)
	[-1.85458]	[-1.56252]	[-0.91827]	[0.66777]	[0.10631]	[-1.06910]
BDK(-2)	0.274124	0.414612	0.067552	0.613631	-8.582993	27.85196
	(0.12917)	(0.89036)	(1.32835)	(0.10933)	(10.6923)	(24.9041)
	[2.12225]	[0.46567]	[0.05085]	[5.61282]	[-0.80273]	[1.11837]
GAP(-1)	-0.001503	-0.008800	0.023803	-0.001551	0.039777	-0.087249
	(0.00258)	(0.01778)	(0.02652)	(0.00218)	(0.21349)	(0.49726)
	[-0.58266]	[-0.49501]	[0.89743]	[-0.71042]	[0.18632]	[-0.17546]
GAP(-2)	0.003911	0.015008	0.001959	0.001979	-0.138063	-0.162166
	(0.00253)	(0.01745)	(0.02603)	(0.00214)	(0.20951)	(0.48797)
	[1.54511]	[0.86024]	[0.07528]	[0.92367]	[-0.65899]	[-0.33233]
IMP(-1)	0.000790	0.007406	0.004825	0.000960	0.084234	0.364631
	(0.00119)	(0.00817)	(0.01219)	(0.00100)	(0.09812)	(0.22855)
	[0.66687]	[0.90645]	[0.39583]	[0.95682]	[0.85845]	[1.59543]
IMP(-2)	0.002688	0.012710	-0.005934	-0.002001	-0.055850	0.343577
	(0.00125)	(0.00861)	(0.01284)	(0.00106)	(0.10338)	(0.24080)
	[2.15248]	[1.47638]	[-0.46201]	[-1.89311]	[-0.54022]	[1.42683]
C	0.024885	0.152896	0.215218	0.005574	-0.131438	0.611047
	(0.01348)	(0.09292)	(0.13863)	(0.01141)	(1.11586)	(2.59903)
	[1.84610]	[1.64548]	[1.55247]	[0.48858]	[-0.11779]	[0.23511]
R-squared	0.844239	0.482766	0.284406	0.922223	0.111060	0.516945
Adj. R-squared	0.759278	0.200638	-0.105918	0.879799	-0.373817	0.253460
Sum sq. resids	0.009734	0.462489	1.029438	0.006973	66.69812	361.8401
S.E. equation	0.021034	0.144990	0.216316	0.017803	1.741187	4.055525
F-statistic	9.936805	1.711160	0.728641	21.73829	0.229047	1.961954
Log likelihood	93.61869	26.05057	12.04801	99.45542	-60.94735	-90.54030
Akaike AIC	-4.606782	-0.745747	0.054399	-4.940310	4.225563	5.916589
Schwarz SC	-4.029081	-0.168046	0.632100	-4.362609	4.803264	6.494289
Mean dependent	0.040416	0.061334	0.041139	0.091313	-0.265432	0.754142
S.D. dependent	0.042871	0.162169	0.205697	0.051351	1.485529	4.693756

Determinant resid covariance (dof adj.)	3.31E-09
Determinant resid covariance	2.04E-10
Log likelihood	92.50876
Akaike information criterion	-0.829072
Schwarz criterion	2.637132
Number of coefficients	78

Table 9. Variance Decomposition

Variance Decomposition of INF:							
Period	S.E.	INF	EINF	ERATE	BDK	GAP	IMP
1	0.021034	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.036063	55.30864	38.93471	1.700607	2.951177	0.529786	0.575080
3	0.040647	49.69539	30.82766	2.943017	3.956031	0.543090	12.03481
4	0.050000	37.70001	27.41806	5.765232	4.678908	0.448241	23.98955
5	0.054471	32.97117	23.12745	4.998133	6.733048	1.704562	30.46564
6	0.058844	30.55336	20.85196	5.116512	7.141533	1.782459	34.55418
7	0.061989	28.20964	19.86932	5.403641	7.892366	1.943466	36.68157
8	0.064131	26.60054	18.98956	5.522377	8.025601	1.887739	38.97418
9	0.065860	25.28077	18.70149	5.425834	8.294001	1.899158	40.39874
10	0.066864	24.52920	18.16544	5.805621	8.433916	2.010715	41.05511
11	0.067539	24.04394	17.95215	6.121918	8.494797	2.035574	41.35162
12	0.067908	23.87197	17.76330	6.458547	8.522707	2.063413	41.32006
Variance Decomposition of EINF:							
Period	S.E.	INF	EINF	ERATE	BDK	GAP	IMP
1	0.144990	13.57276	86.42724	0.000000	0.000000	0.000000	0.000000
2	0.156976	13.24108	76.68105	0.204200	6.170916	1.038286	2.664472
3	0.172784	12.78739	67.42540	1.227566	5.736702	2.065960	10.75699
4	0.187381	10.88267	57.87387	1.349708	8.944070	2.129705	18.81998
5	0.197016	9.988547	54.49364	2.918103	9.008474	2.360160	21.23108
6	0.202330	9.562483	51.78759	4.445979	9.376603	2.478975	22.34837
7	0.207296	10.23393	50.23148	6.516839	9.054650	2.487510	21.47559
8	0.208908	11.03202	49.46775	6.953168	8.916325	2.460601	21.17013
9	0.212228	12.52230	48.46054	7.104768	8.655608	2.394732	20.86205
10	0.215917	13.45716	47.43425	7.137143	8.571617	2.320175	21.07966
11	0.219920	14.17285	46.07832	6.960138	8.490260	2.249749	22.04869
12	0.225042	14.59203	44.70568	6.674769	8.523914	2.194199	23.30940
Variance Decomposition of ERATE:							
Period	S.E.	INF	EINF	ERATE	BDK	GAP	IMP
1	0.216316	0.317646	6.874162	92.80819	0.000000	0.000000	0.000000
2	0.235012	0.278497	7.327024	88.76485	0.554129	2.570919	0.504581
3	0.245822	3.962979	10.39456	81.52741	0.547519	3.070752	0.496775
4	0.261891	11.27311	12.87721	71.86845	0.741027	2.766879	0.473332
5	0.277225	15.34584	15.17860	64.77818	0.708370	2.480839	1.508167
6	0.300954	18.13285	16.99679	57.10131	0.802293	2.148782	4.817979
7	0.324722	19.63525	17.14250	49.82985	1.631265	1.991264	9.769866
8	0.348566	20.82218	16.51406	43.27118	2.533827	1.943785	14.91497
9	0.374321	20.96011	16.39770	37.53326	3.489175	1.872192	19.74758
10	0.397041	20.36200	15.92491	33.42558	4.311093	1.828649	24.14777
11	0.417617	19.45537	15.55114	30.30875	4.985144	1.804414	27.89519
12	0.434036	18.53116	15.06708	28.28317	5.564617	1.861316	30.69266
Variance Decomposition of BDK:							
Period	S.E.	INF	EINF	ERATE	BDK	GAP	IMP

Table 10. VAR Residual Serial Correlation LM Tests

VAR Residual Serial Correlation LM Tests
Date: 11/28/22 Time: 16:13
Sample: 1 37
Included observations: 35

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	31.15890	36	0.6980	0.823514	(36, 51.1)	0.7276
2	34.36270	36	0.5466	0.931566	(36, 51.1)	0.5834
3	32.86612	36	0.6184	0.880459	(36, 51.1)	0.6524
4	38.95014	36	0.3384	1.095413	(36, 51.1)	0.3772

Table 11. VAR Residual Heteroskedasticity Tests (Levels and Squares)

VAR Residual Heteroskedasticity Tests (Levels and Squares)
Date: 11/28/22 Time: 16:13
Sample: 1 37
Included observations: 35

Joint test:

Chi-sq	df	Prob.
507.2118	504	0.4515

Table 12. Normality Test

Component	Kurtosis	Chi-sq	df	Prob.
1	3.703394	0.721529	1	0.3956
2	5.285862	7.620031	1	0.0058
3	3.960506	1.345418	1	0.2461
4	2.738945	0.099385	1	0.7526
5	4.204667	2.116365	1	0.1457
6	2.785764	0.066933	1	0.7959
Joint		11.96966	6	0.0626