MULTIDIMENSIONAL ANALYSIS OF INFLATION DYNAMICS IN TURKEY: A BAYESIAN VAR AND MARKOV MODELS APPROACH

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Abstract

This study aims to examine in detail how the industrial production index, financial services confidence index, weighted average cost of funding, the average interest rates applied by banks on consumer loans, and household transfers affect inflation and the relationships among these series in Turkey. A comprehensive time series analysis was conducted using monthly data from the period 2012:07 to 2024:11. During the analysis process, the stationarity levels of the series were determined using ADF and PP unit root tests, and the results indicated that all series were stationary at the first difference, following an I(1) process. The Markov Regime Switching Model was employed to model different periods, and a Bayesian Vector Autoregression (BVAR) model was constructed to analyze the impulse response functions of the series. The findings reveal that increases in the interest rates applied to consumer loans and the industrial production index lead to higher inflation by creating demand and cost pressures. Additionally, the joint implementation of monetary and fiscal policies is found to be highly significant. This study provides a comprehensive time series analysis to deepen the understanding of the interaction between inflation and macroeconomic variables. It also concludes that avoiding high interest rates, which restrict household expenditures and increase production costs, can play a significant role in reducing price increases.

Keywords: Inflation, Markov regime switching model, Vector autoregression, Impulse-Response analysis

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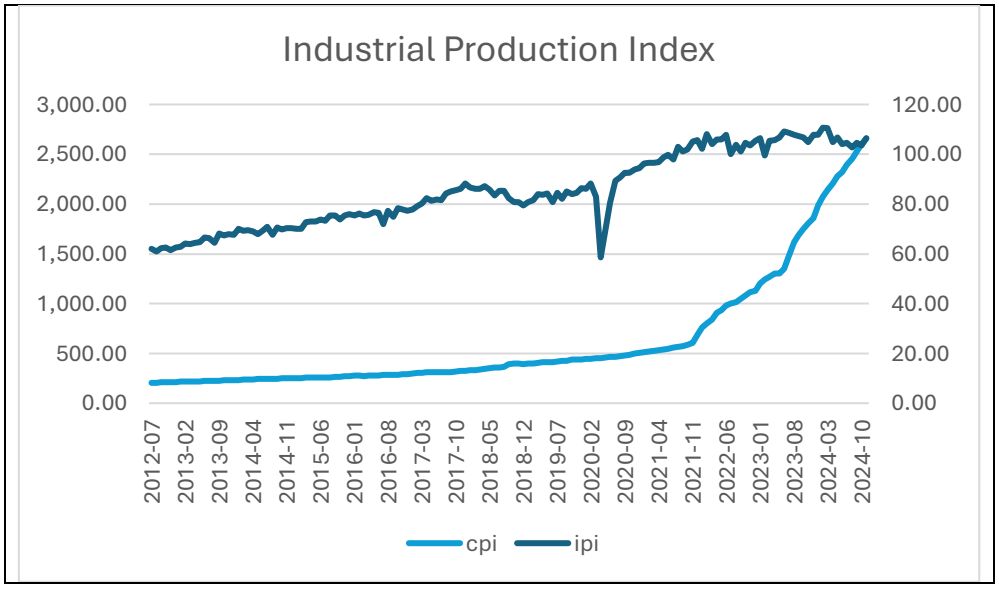
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1. Introduction

Inflation is recognised as an important macroeconomic indicator for the economic stability of a country. High inflation adversely affects economic growth and leads to fluctuations in domestic demand and investments. Recent developments in the Turkish economy require a closer examination of the relationship between inflation and monetary policy.

Between 2012 and 2024, the Turkish economy experienced various crises due to global developments, domestic political fluctuations and economic policy changes. In 2013, the unrest and social instability caused by the Gezi Park protests had a negative impact on investment confidence and led to a decline in economic activity. In 2016, Turkey experienced a failed military coup attempt. This failed attempt raised concerns about the rule of law and led to an economic slowdown. In 2018, high inflation, a large deficit and concerns about the independence of the central bank led to a currency crisis, causing uncertainty in the economy and negatively affecting both businesses and consumers. In 2019, the Covid-19 pandemic, which affected the world, caused disruptions in various sectors and significantly affected the Turkish economy.

Table 1: Industrial Production Index and Consumer Prices Index Graphs



As one of the main indicators of economic growth, the industrial production index reveals changes in production activities. The December 2020 industrial production index reveals that Turkey's transition to the Presidential Government System in 2018 and the diplomatic crisis with the US caused sudden fluctuations in the exchange rate. The rapid depreciation of the Turkish Lira caused inflation rates to rise, industrial production to decline and domestic demand and investments to weaken. This process continued in 2019. In 2020, the emergence of the COVID-19 pandemic led to a sharp decline in industrial production in Turkey, as in global economic activity. However, a rapid economic recovery was observed in 2021. Industrial production started to rise again with the increase in domestic and foreign demand. In 2022 and beyond, high inflation, increases in interest rates and geopolitical uncertainties caused fluctuations in industrial production and economic growth.

Consumer loans are a type of repayable loan obtained from financial institutions used for purchasing or spending on goods and services other than housing. Consumer loans allow individuals to use their future income. This facility has an impact on macroeconomic variables. By making spending easier, consumer loans support economic growth by increasing consumption. However, excessive borrowing can lead to financial instability and trigger crises.

The Central Bank of the Republic of Turkey (CBRT) uses various tools to ensure and maintain price stability. One of the most important indicators among these tools is the CBRT Weighted Average Funding Cost (WAFC). WAFC refers to the weighted average interest rate of the funds provided by the CBRT to banks. It is used to determine the impact of the interest rate policies implemented by the CBRT on market interest rates. During the period between 2012-2015, the CBRT tried to keep the cost of funding low in the market. The recovery from the 2008 financial crisis was continuing, and economic difficulties caused interest rates to remain at certain levels. The low funding cost continued. After 2015, due to the depreciation of the Turkish lira, the CBRT opted to increase interest rates. During this period, the WAFC began

to rise. Due to the pandemic experienced in 2019, the CBRT went for an interest rate cut, and accordingly, the WAFC decreased. In 2023-2024, interest rates were increased, and it has been observed that the WAFC rose rapidly during this period.

Ensuring economic stability, fairness in income distribution and increasing social welfare are important for a country. Transfers to households are of great importance in achieving this objective. Transfers to households are payments made to individuals or families by the state or institutions. These payments include various benefits such as pensions, unemployment pensions, orphan and orphan pensions, scholarships paid to students, agricultural supports and health supports. Depending on the economic developments in 2012-2024, transfers to households increase. The COVID-19 pandemic between these years and the high inflation after 2022 have led to significant increases in transfers to support households.

Confidence indices are used to measure the confidence in financial markets. One of these is the Financial Services Confidence Index. This index is developed by the answers given to the Financial Services Survey Questions applied to business people. Between 2012 and 2017, the index was above 100, indicating that the sector had a good period. In 2018, there was a sharp decline due to the currency crisis. The COVID-19 pandemic in 2020, the currency crisis in 2022 and the earthquake in 2023 had a negative impact on the Turkish economy. In 2024, although the recovery continued, volatility continued.

2. Literature Review

Durmuş and Şahin (2019) examined the relationship between consumer loans and selected macroeconomic variables in Turkey using quarterly data from 2006:Q1 to 2018:Q2. The causality relationship between variables was analyzed using the Toda-Yamamoto approach-based Granger causality test. The test results indicate a bidirectional causality between interest rates and loans, as well as a unidirectional causality from money supply to loans. It was

observed that macroeconomic variables such as economic growth, employment and unemployment rates, interest rates, inflation rates, exchange rates, public and private sector expenditures, savings rates, and monetary aggregates have adverse effects on consumer loans, particularly during economic cycles or crisis periods.

Shinwari and Özdemir (2022) aimed to investigate the dynamics between selected macroeconomic variables, such as the Consumer Price Index (CPI) and Industrial Production Index (IPI), and housing prices in Turkey between 2010 and 2020. The relationship between Turkey's hedonic housing price index, CPI, and IPI was analyzed using ARDL boundary tests and Toda-Yamamoto causality tests with monthly data from the 2010-2020 period. Although the findings do not confirm the existence of a long-term relationship between the housing price index, CPI, and IPI, a negative short-term interaction was observed. Empirical results obtained through the application of the Autoregressive Distributed Lag (ARDL) model and boundary tests provide evidence that increases in the CPI or IPI negatively impact Turkey's hedonic housing price index in the short term.

Kalkay and Tunalı (2024) examined the relationship between unconventional monetary policies implemented by the Central Bank of the Republic of Turkey (CBRT) after the 2008 financial crisis and selected macroeconomic indicators. The Bayesian Vector Autoregression (B-VAR) method, which allows for the assumption of prior conditions, was used in the model. The model estimation covered one-month, three-month, and six-month datasets from the period 2010:1-2021:12. The findings indicate that, following 2014, there is no strong evidence of a significant impact between the unconventional monetary policy tools implemented by the CBRT and macroeconomic indicators.

Telatar et all (2003) investigated whether the term structure contained useful information regarding future inflation for Turkey during the 1990-2000 period, a time characterized by high inflation and large budget deficits. The study analyzed the relationship

between interest rate types and inflation fluctuations using a Markov-switching heteroskedastic model and a time-varying parameter model. These models provide a reasonable explanation of the relationship between variables during periods of economic turbulence and help to better understand economic dynamics. During this period, frequent changes occurred in monetary and fiscal policies due to political instability, leading to shifts in stabilization regimes. This situation made models that account for regime changes and endogenous parameter variations particularly appealing for analyzing the Turkish economy. The study emphasizes the importance of such modeling approaches in examining Turkey's economic dynamics and forecasting future inflation expectations.

Kayhan et all (2013) analyzed the behavior of the CBRT between 2002 and 2011 by constructing a forward-looking monetary policy reaction function incorporating individuals' expectations within the framework of the model developed by King (1996). The study examined the presence of asymmetric behavior in the CBRT's policy decisions using the Markov-Switching Vector Autoregression (MS-VAR) model. The analysis, conducted using monthly data from the 2002-2011 period when the inflation-targeting strategy was implemented, indicates that the Turkish economy experienced continuous expansion phases throughout this time frame.

Tüzün ve Kahyaoğlu (2015) The study aims to analyze the impact of the macroprudential monetary policy implemented by the Central Bank of the Republic of Turkey (CBRT) to ensure financial stability without deviating from its price stability objective, using monthly data from the 2008-2013 period. This analysis is conducted using the Bayesian VAR (B-VAR) method. The findings support the CBRT's decision to select capital mobility and credit expansion as indicators for maintaining financial stability without compromising price stability. Accordingly, financial stability policies should be implemented in a stable manner while considering price stability.

Albayrak ve Abdioğlu (2015) In this study, the validity of the Taylor rule was tested using monthly data for the period 2002-2014. According to which variable the CBRT shaped its monetary policy in the 2002-2007 and 2008-2014 periods, Taylor (1993) model and its extended versions were examined. According to the results, it is seen that the Central Bank targets price stability and directs interest rates steadily. The fact that the interest smoothing parameter is significant shows that financial stability is also taken into account. In the post-crisis period of 2008-2014, there is no significant difference between the forward and backward Taylor rule.

İlhan (2022) This study examines the impact of loans in different regimes on monetary policy reactions in Turkey. For this purpose, the credit gap and the extended Taylor rule were estimated using the Markov regime switching model with data for the 2006-2019 period. According to empirical findings, it defines two regimes: low and high interest rates. While the low interest rate regime reflects the priority of growth, the high interest rate regime has a significant impact on inflation and the interest rate of the loan. This shows that despite macroprudential tools after the global financial crisis, credit conditions are effective in tightening monetary policy in Turkey.

Yağcıbaşı ve Yıldırım (2019) In the study, alternative specifications of monetary policy rules were examined in the inflation targeting regime in Turkey, using monthly data for the period 2003-2017. The original Taylor rule and the exchange rate-augmented Taylor rule were estimated with Markov regime switching models. According to the findings, it shows that the Turkish economy operates in high and low interest rate regimes, and 2009 was the most prominent year of this transition. In a high interest rate regime, the response to inflation is greater and the response to the output gap is more aggressive, which means that, according to the Central Bank, output gap stability is more important than inflation stability.

Kılınç ve Tunc (2019) In this study, the asymmetric effects of monetary policy on economic activity in Turkey for the period 2006-2017 were examined using GDP and industrial production data. Markov Switching Model was applied. According to the findings, monetary policy shocks show stronger effects in contraction periods and weaker effects in expansion periods. Additionally, when credit cycles are used, asymmetric effects become more pronounced.

3. Method and Dataset

In this study, a time series analysis is performed using monthly data covering the period 2012:07-2024:11. R programme was used in this analysis. The consumer price index, industrial production index and interest rate applied to consumer loans variables used in the analysis are taken from the Electronic Data Distribution System (EDDS).

Table 2: Variables

Variables	Symbol	Unit	Source
Consumer Prices Index	cpi	%	EVDS
Industrial Production Index	ipi	%	EVDS
Consumer Loan Interest Rate	int	%	EVDS
Weighted Average Funding Cost	wafc	LCU	EVDS
Transfers to Households	thl	LCU	EVDS
Financial Services Confidence Index	fsci	%	EVDS

In this study, as a first step, the graphs of the series are analysed to test the presence of seasonal effects. After determining that there are seasonal effects in the graphs, the variables are seasonally adjusted using the TRAMO-SEATS method. In another step of the analysis, ADF and PP unit root tests were used to test the stationarity of the series. After determining the stationarity of the series, the regression model was estimated. In another step, Markov regime switching model was constructed and potential regime changes of the series were analysed. Bayesian VAR (BVAR) model was established in order to model the uncertainties of the

parameters and to make flexible and more reliable forecasts. In addition, the Classical VAR model was also established to provide a more comprehensive analysis.

Johansen cointegration analysis was performed to examine the relationships between the variables. In addition, Granger causality test was used to test the relationship between the model parameters. Impulse-Response analysis was applied as the last stage of the analysis.

The model used to make these analyses is constructed as follows:

$$cpi_t = \beta_0 + \beta_1 ipi_t + \beta_2 int_t + \beta_3 wafc_t + \beta_4 thl_t + \beta_5 fsci_t + \mu_t \qquad (1)$$

In the model, inflation rate is selected as the dependent variable and industrial production index, interest rate applied to consumer loans, weighted average cost of funding, transfer expenditures to households and financial services confidence index are selected as independent variables. In order to solve the autocorrelation problem, one lagged version of the error terms is added to the model.

Table 3: Descriptive Statistics

	CPI	THL	FSCİ	INT	IPI	WAFC
Mean	6.135	12.981	162.163	24.177	85.288	15.451
S.d	0.722	1.0604	13.112	15.868	14.860	11.660
Minimum	5.319	11.745	119.850	10.274	60.365	4.647
Maximum	7.885	15.321	188.078	80.845	109.893	53.068
Median	5.968	12.719	165.097	17.152	83.993	11.602

TRAMO-SEATS method is used to seasonally adjust the inflation rate, industrial production index, interest rate on consumer loans, weighted average cost of funding, transfer expenditures to households and financial services confidence index variables. The graphs of the variables are as follows:

Table 4: Seasonally Adjusted Industrial Production Index and Consumer Loan Interest Rate

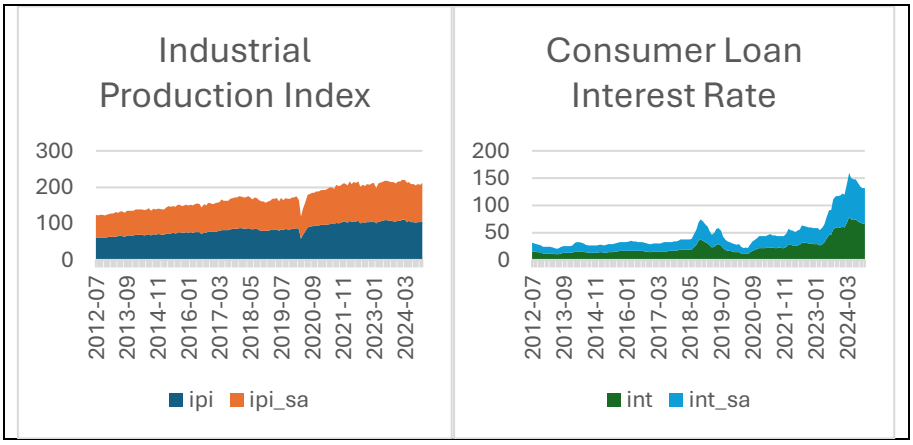


Table 5: Seasonally Adjusted Weighted Average Funding Cost and Financial Services Confidence Index

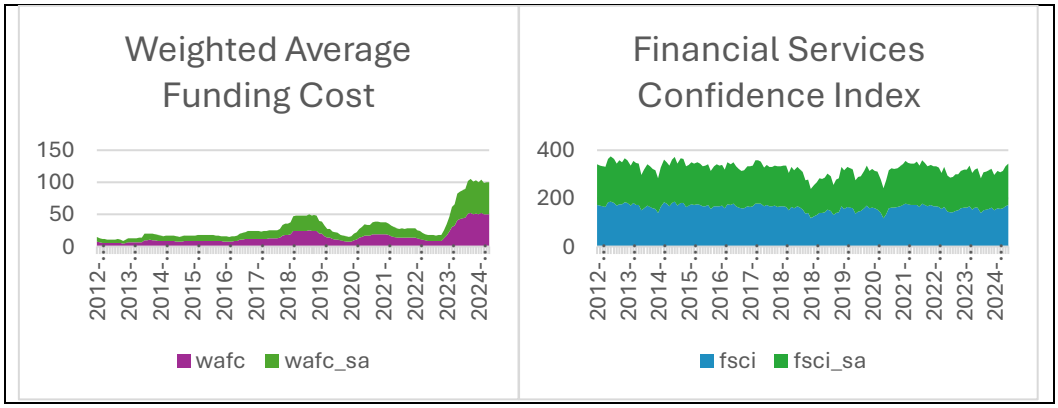
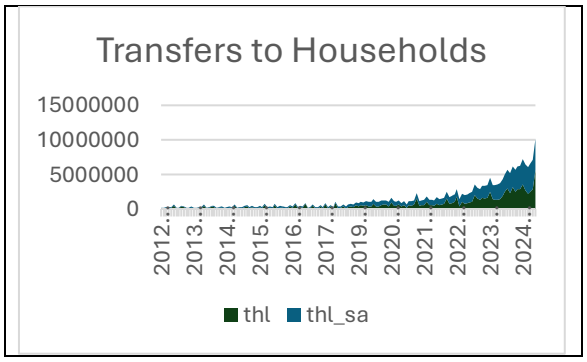


Table 6: Seasonally Adjusted Transfers to Households



The first step in a time series analysis is to test the stationarity of the variables. In this study, the stationarity levels of the variables were determined by Augmented Dickey Fuller and Philips and Perron unit root tests.

3.1. Augmented Dickey-Fuller Unit Root Test

The Augmented Dickey-Fuller (ADF) unit root test lays the groundwork for other unit root tests. The ADF test by Dickey and Fuller is based on the assumption that error terms are independent and constant variance (Dickey and Fuller, 1979). Unit-rooted series are those containing an AR component. This test is based on the estimation of the first order autoregressive process equation. In other words, since the AR(1) model has one characteristic root, the ADF test takes into account the presence of a single unit root. AR(1) model,

$$Y_t = \rho Y_{t-1} + \varepsilon_t \qquad (2)$$

It is expressed as. In order to perform unit root test in the established equation, firstly, Y_{t-1} is subtracted from both sides of the equation and the first order equation

$$\Delta Y_t = (\rho - 1) Y_{t-1} + \varepsilon_t \qquad (3)$$

It transforms into. When expressed here as $\rho - 1 = \delta$,

$$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t \qquad (4)$$

The final form of the equation will be as follows. To test for the existence of a unit root, the hypothesis $\delta = 0$ $[or\ (\rho - 1) = 0]$ is tested. Three different models are used to calculate the unit root test:

$$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t \qquad (5)$$

$$\Delta Y_t = \mu + \delta Y_{t-1} + \varepsilon_t \qquad (6)$$

$$\Delta Y_t = \mu + \beta T + \delta Y_{t-1} + \varepsilon_t \qquad (7)$$

Equation number five is the model without constant and trend, equation number six is the model with constant and equation number seven is the model with both constant and trend.

For all equations above, $\varepsilon_t \sim IID(0, \sigma^2)$ is assumed. The test statistic for these models is calculated as follows:

$$\tau_\delta = \frac{\hat{\delta}}{s_{\hat{\delta}}} \qquad (8)$$

The main alternative hypotheses for the test statistic will be as follows:

$$H_0: \delta = 0 \; ise \; the \; series \; is \; stationary$$

$$H_1: \delta < 0 \; ise \; the \; series \; is \; not \; stationary$$

Equation number six is used in this study. In other words, the unit root test model with constant is used (Güriş, Çağlayan Akay, & Güriş, 2020, p. 170).

3.2. Phillips-Perron Unit Root Test

Another unit root test used in the time series analysis conducted in this study is the nonparametric unit root test developed by Phillips and Perron (1988). According to the Dickey-Fuller unit root test, error terms are assumed to be independent and have constant variance. Phillips and Perron (1988) argued that the DF test method would give erroneous results. They added a correction factor to the Dickey-Fuller test statistics. In this context, a new method was introduced by adding a correction factor to the DF test statistic when autocorrelation is detected in the error terms.

When we express this definition mathematically,

$$(Y_t - \mu) = \alpha(Y_{t-1} - \mu) + \varepsilon_t, \; t = 1,2,3, \dots, n \quad (9)$$

Based on the AR(1) model,

$$Y_t = \alpha_0 + \alpha Y_{t-1} + \varepsilon_t, \; t = 1,2,3, \dots, n \quad (10)$$

It can be expressed as. In the above equation, error terms are shown as ε_t. The error terms, $\Psi(B)e_t = 1 + \beta_1 B + \beta_2 B^2 + \cdots + \beta_q B^q$, can be expressed as $\varepsilon_t = \Psi(B)e_t$. A correction factor is added to the Dickey-Fuller test statistic. The error terms from the regression of Y_t on Y_{t-1} are $\hat{\varepsilon}_t$. When we define the autocovariances of the residual squares by $\hat{\gamma}(h)$,

$$\lambda^2 = \hat{\gamma}(0) + 2\sum_{j=1}^{q}\left[1 - j/(q+1)\right]\hat{\gamma}(j) \quad (11)$$

The new equation takes the form of equation number eleven. The mean squared error from the regression of Y_t on Y_{t-1} is as follows:

$$S_n^2 = \frac{1}{n-2}\sum_{t=1}^{n}\hat{\varepsilon}_t^2 \quad (12)$$

Phillips-Perron unit root test statistics,

$$Z_\mu = \left[\sqrt{\frac{\hat{\gamma}(0)}{\hat{\lambda}^2}}\right]\hat{t}_u - \left\{\frac{1}{2}\left(\hat{\lambda}^2 - \hat{\gamma}(0)\right)(ns_{\hat{\alpha}}/S_n)\right\}\hat{\lambda}^{-1} \quad (13)$$

It is expressed as. In this study, the stationarity degrees of the series were determined by using the constant model (Akdi, 2012, p. 261-280).

3.3. Markov Regime Switching Model

Unlike linear time series, Markov regime switching model has a non-linear structure that shows different behaviours in different periods. This model assumes that a time series can have different regimes. This assumption is determined by the Markov chain. The process consisting of at least two regimes is combined with a variable that acts as a regime variable, a dummy variable. In this context, it offers the opportunity to evaluate periods with different characteristics (Evci, 2016, p.69). Markov regime switching models have been discussed by Hamilton (1989, 1990, 1994, 1996), Kim and Nelson (1998), Krolzing (1997, 1998, 2000, 2001) in order to analyse business cycles. Hamilton (1989) constructed a two-regime Markov regime switching model as follows:

$$Y_t = \begin{cases} \phi_{1,0} + \phi_{1,1}Y_{t-1} + \cdots + \phi_{1,p}Y_{t-p} + \varepsilon_t, \ eğer \ (s_t = 1) \\ \phi_{2,0} + \phi_{2,1}Y_{t-1} + \cdots + \phi_{2,p}Y_{t-p} + \varepsilon_t, \ eğer \ (s_t = 2) \end{cases} \quad (16)$$

$$Y_t = \phi_{0,st} + \phi_{1,st}Y_{t-1} + \cdots + \phi_{p,st}Y_{t-p} + \varepsilon_t \ (17)$$

It is constructed as follows. In the model, $\phi_{1,j}$ and $\phi_{2,j}$ are the autoregressive lag parameters for each regime, s_t is the value of each regime, p is the autoregressive degree of the model, $\varepsilon_{it} \sim IID(0, \sigma^2)$ and $\sigma_i^2 < \infty$ (Mohd and Zaidi, 2006: 57; Fallahi and Rodriguez, 2007: 5), (Kayhan, S., Bayat, T., & Koçyiğit, A. (2013)).

Regimes depend on their previous values and transformation probabilities. A regime change is characterised by an unobservable state variable. This state variable is modelled as a Markov chain with different regimes:

$$P(S_t = j | S_{t-1} = i) = p_{ij}, i, j = 1,2, \ldots, k \ (18)$$

In the eighteen numbered equation above, p_{ij} is the transition probability from regime i to regime j. The transition probability matrix P containing transition probabilities:

$$P = \begin{bmatrix} P_{11} & \cdots & P_{1k} \\ \vdots & \ddots & \vdots \\ P_{k1} & \cdots & P_{kk} \end{bmatrix}, ve \ \sum_{j=1}^{k} p_{ij} = 1 \ (19)$$

The conditional probability density function of Y_t in each regime is expressed as follows:

$$f(Y_t | S_t = j) = \frac{1}{\sqrt{2\pi\sigma_j^2}} \exp\left(-\frac{(Y_t - X_t\beta_i)^2}{2\sigma_j^2}\right) \ (20)$$

In the Markov regime-switching model, this equation allows both the dynamics of the series in different regimes and the transition probabilities between regimes to be modelled together.

3.4. Bayesian Vector Autoregression (B-VAR)

Litterman (1986) played an important role in the development of the Bayesian VAR model in order to solve the over-fitting and over-parameterisation problems of the classical VAR model, to make the forecasts more reliable and to reduce the uncertainties compared to the classical VAR model. The Bayesian VAR (BVAR) model adjusts parametric uncertainties with prior distributions such as Minnesota and calculates posterior distributions to fit the generated data set. The Minnesota prior allows for more consistent forecasts by preventing excessive bias of the forecasts.

The classical VAR model equation makes data-driven forecasts. Larger data sets are required compared to the Bayesian VAR model. Looking at the components of the classical VAR model:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t,\ \varepsilon_t \sim N(0, \Sigma) \quad (21)$$

In this equation, $Y_t$represents the vector of variables, $A_i$represents the parameter matrices to be estimated and ε_t represents the error terms.

Looking at the components of the Bayesian VAR model:

$$p(\Theta|Y) \propto p(Y|\Theta)p(\Theta) \quad (22)$$

In the Bayesian approach for $\Theta = \{A_1, A_2, \ldots A_p, \Sigma\}$ the prior $p(\Theta)$ and the data-driven probability $p(Y|\Theta)$ denote the posterior probability $p(\Theta|Y)$ of the parameters.

The posterior distribution is calculated as follows:

$$p(\Theta|Y) = \frac{p(Y|\Theta)p(\Theta)}{\int p(Y|\Theta)p(\Theta)} \quad (23)$$

Bayesian VAR (BVAR) model is used in this study. The two models are compared by constructing a classical VAR model.

4. Results

4.1. Unit Root Tests

In order to determine the stationarity of the variables used in the study, Augmented Dickey-Fuller, Phillips-Perron unit root test and Zivot-Andrews unit root test with structural breaks were used to test the stationarity of inflation rate, industrial production index, transfers to households, interest rate applied to consumer loans, weighted average cost of funding and financial services confidence index. According to the findings, it is concluded that the variables used in the model are not stationary at the level values of the series. In this context, the series were made stationary by taking the first difference. In other words, it is concluded that the series are first order integrated I (1). The results obtained are as follows:

Table 7: ADF and PP Unit Root Test

	ADF				PP			
	t- statistic	**%1**	**%5**	**%10**	**t- statistic**	**%1**	**%5**	**%10**
Cpi	-3.57	-3.46	-2.88	-2.57	-3.03	-3.47	-2.88	-2.57
İpi	-14.03	-3.46	-2.88	-2.57	-14.70	-3.46	-2.88	-2.57
İnt	-7.35	-3.46	-2.88	-2.57	-7.25	-3.46	-2.88	-2.57
Wafc	-6.68	-3.46	-2.88	-2.57	-6.87	-3.46	-2.88	-2.57
Thl	-11.63	-3.46	-2.88	-2.57	-11.71	-3.46	-2.88	-2.57
Fsci	-14.55	-3.46	-2.88	-2.57	-15.40	-3.46	-2.88	-2.57

Note: All variables are stationary at 1%, 5%, 10% significance levels

4.2. Markov Regime Switching Model

After determining the stationarity degrees of the variables, three different Markov regime switching models were constructed. For the Markov regime switching model, a model

with two regimes (Regime 1 and Regime 2) was preferred. The results of the analyses are shown in the table below.

Table 8: Markov Regime Switching Model Test Results

Variables	**Model A**		**Model B**		**Model C**	
	Regime 1					
THL	0.06***(0.000)		0.0005***(0.000)		0.0004***(0.000)	
Fsci	0.4831(0.3831)		-0.3440*(0.03082)		-	
Wafc	-8.6662 ***(0.000)		-11.8201***(0.000)		-9.8309***(0.000)	
Int	9.2151***(0.000)		10.8558***(0.000)		9.7748***(0.000)	
Ipı	-0.4002(0.6577)		-		2.0617***(0.000)	
C	33.9811(0.6727)		157.0814***(0.000)		-26.2999(0.3446)	
	Regime 2					
THL	0.06***(0.000)		0.0005***(0.000)		990.3796***(0.000)	
Fsci	0.2039 (0.188073)		3.6362***(0.000)		-	
Wafc	-1.8538**(0.004459)		-3.9650**(0.007938)		15.7086***(0.000)	
Int	0.9741(0.114635)		8.5776***(0.000)		-6.7937*(0.0373)	
Ipi	3.8145***(0.000)		-		-5.1604***(0.000)	
C	-149.1142***(0.000)		-502.5410***(0.000)		-12389.6***(0.000)	
	Transition Probabilities Matrix					
	Regime 1	Regime 2	Regime 1	Regime 2	Regime 1	Regime 2
Regime 1	0.94734529	0.02310197	0.93800724	0.07248532	0.94954935	0.06870972
Regime 2	0.05265471	0.97689803	0.06199276	0.92751468	0.05045065	0.93129028

Table 9: Model A

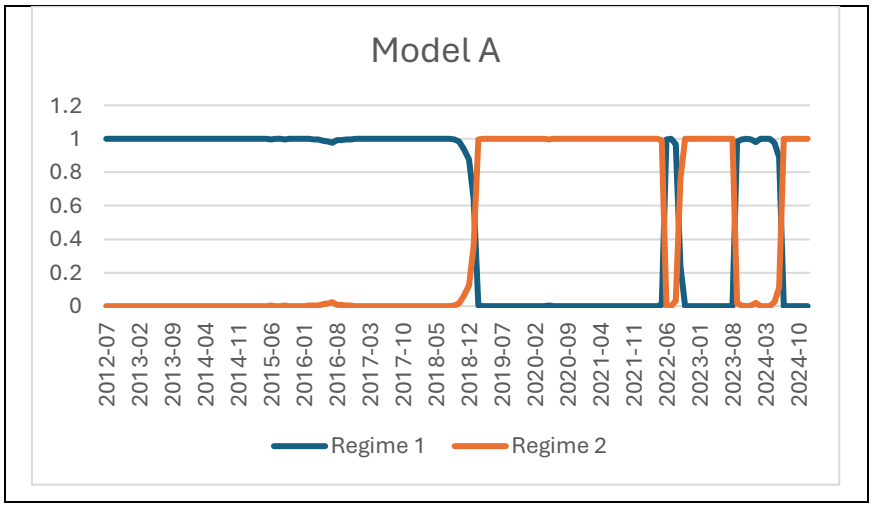


Table 10: Model B

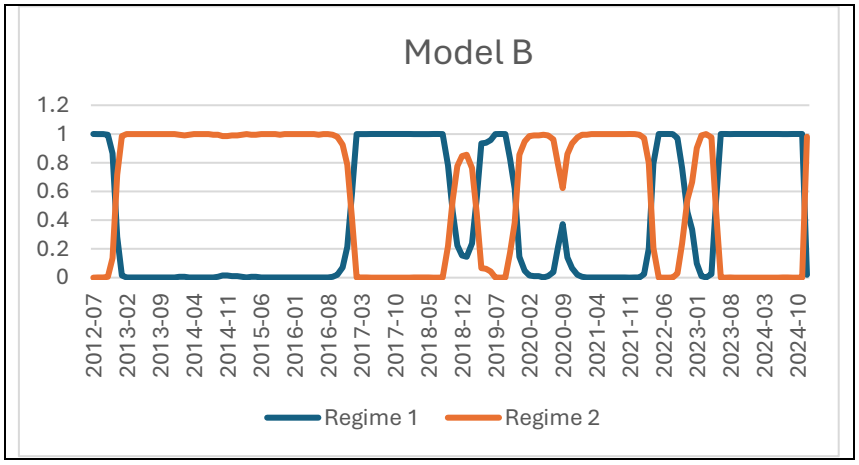
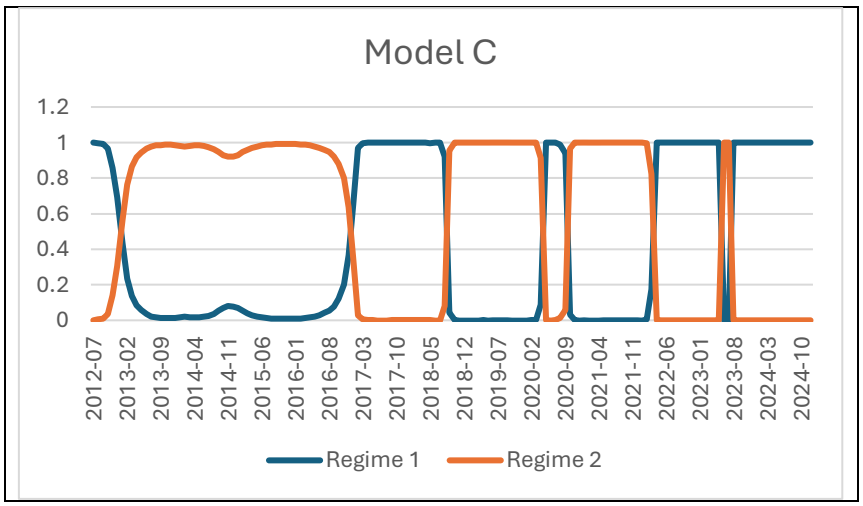


Table 11: Model C



In this study, Markov regime switching models with two regimes, namely Model A, Model B and Model C, were established. The findings of the Markov regime switching models are presented in Table 8. Regime 1 represents the low inflation period and Regime 2 represents the high inflation period. When the results for Regime 1 in Table 8 are analysed, it is seen that Regime 1 refers to growth periods with generally lower inflation rates. In this regime, there is a positive interaction of transfer expenditures to households on inflation. This indicates that transfers increase consumption demand and exert an upward pressure on the general price level. Similarly, industrial production exerts a limited pressure on inflation in this regime. In this context, the increase in production accompanies the increase in demand and supports the price level to remain under control. The positive impact of consumer loan interest rates suggests that

increased access to credit stimulates spending and may increase demand-side inflationary pressures. On the other hand, the negative effect of the weighted average cost of funding implies that the increase in financing costs restrains the increase in the price level by limiting credit utilisation. This regime covers a period of controlled inflation and economic growth.

Regime 2 represents the contractionary period observed in high inflationary environments. Looking at the results of Regime 2 in Table 8, the positive effect of transfer expenditures to households on inflation is more evident. Increased expenditures of households may lead to a rapid increase in price levels by strengthening demand-side pressure. The positive effect of the financial services confidence index contributes to inflationary dynamics by supporting economic recovery. Another parameter, the positive effect of the weighted average cost of funding on the inflation rate, indicates that the implementation of liquidity enhancing policies may further push inflation upwards. The negative effect of consumer loan interest rates indicates that high interest rates aim to restrain price increases by reducing demand. The negative effect of industrial production, on the other hand, indicates that prices may increase uncontrollably due to the decline in production during contraction periods, rising interest rates on raw materials and equipment and supply-side problems in production. This regime refers to a period of intense demand and cost-driven inflationary pressures.

4.3. Bayesian Vector Autoregression (B-VAR)

Bayesian Vector Autoregressive Model (BVAR) model was established as the last stage of the analysis. After determining the optimal lag length suitable for the model, impulse-response graphs were created. In order to control the complexity of the model and the overfitting problem, the lambda value was set as 0.44179. The iteration value, known as the warm-up phase of the model, was accepted 4772 out of 10000 iterations. The accepted traction rate was determined as 94.4%.

Table 12: Determination of Optimal Lag Length

Criterion	1	2	3	4	5	6
AIC	**8.219981**	8.325922	8.378456	8.281790	8.274060	8.167733
HQ	**8.524493**	8.934945	9.291990	9.499835	9.796617	9.994801
SC	**8.969346**	9.824651	10.62655	11.27924	12.02088	12.66392
FPE	**3715.554**	4139.567	4388.237	4029.670	4075.801	3772.698

Note: According to AIC, HQ, SC and FPE critical values, the appropriate lag length is 1.

In this study, Bayesian Vector Autoregression (BVAR) and Vector Autoregression (VAR) models are used to examine the differences between the two models. Impulse-Response analysis results are presented in Table 13 and Table 14. When the impulse response graphs of the Bayesian VAR model are analysed, it is observed that the inflation rate's response to its own shock creates a high positive effect for a short period, while it is dampened towards the last periods. The inflation rate shows a resilient structure against exogenous effects. A one-unit shock in the transfers to households variable has a positive effect on the inflation rate until the third period. After the third period, there is a decline until the fifth period. When the last periods are approached, it is observed that the line is dampened. When the effect of financial services confidence index on inflation is analysed, it is observed that it has a positive effect until the fourth period and the curve approaches zero towards the last periods. A shock in the weighted average funding cost has a positive effect on the inflation rate. A one-unit shock in the interest rate applied to consumer loans and the industrial production index reveals that it has an increasing effect on inflation. A one-unit shock in the inflation rate has a strong negative effect on the transfers to households variable in the first period. Later on, this effect is observed to be a rapid decline in the THL variable after the shock. In the short run, a shock in the inflation rate has a negative effect on the THL variable. A one-unit shock in the financial services confidence index is found to have a strong negative effect on transfers to households in the short run. An increase in the financial services confidence index puts pressure on household expenditures. A shock in the weighted average cost of funding has a strong negative impact on transfers to households. In the first periods, transfers to households tend to decrease significantly. An

increase in the weighted average cost of funding depresses transfers to households in the short run. A one-unit shock in the industrial production index has a positive effect on transfers to households. A shock in the inflation rate has a negative effect on the financial services confidence index in the initial periods. It is determined that transfer expenditures to households have a negative interaction on the financial services confidence index in the initial periods. It is observed that the curve is dampened towards the last periods. It is concluded that a one unit shock in the weighted average funding cost has a negative effect on the financial services confidence index. A one-unit shock in consumer loans has a sharp negative trend on the financial services confidence index.

Table 13: BVAR Impulse-Response Graphs

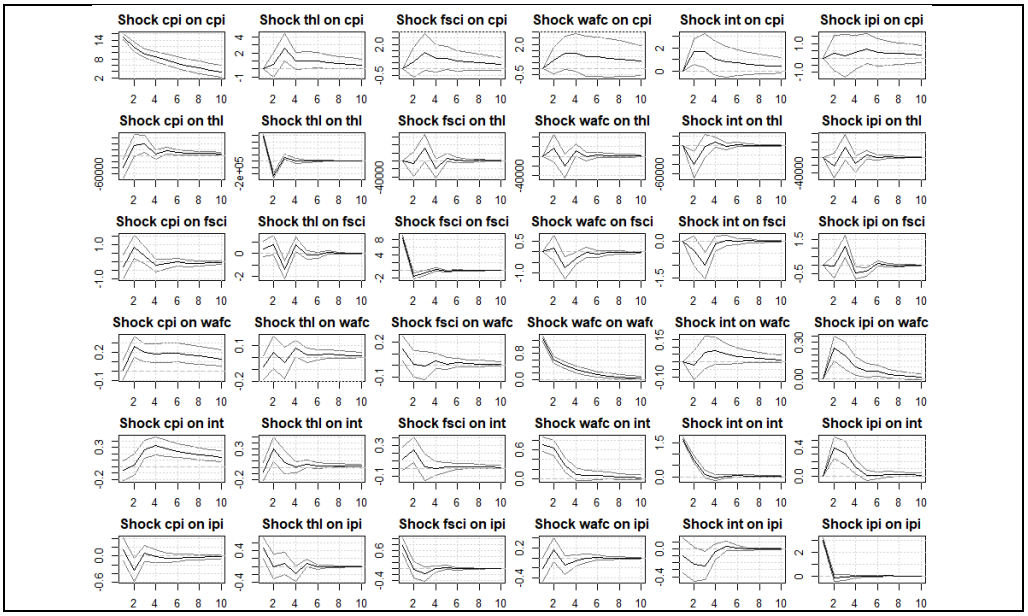
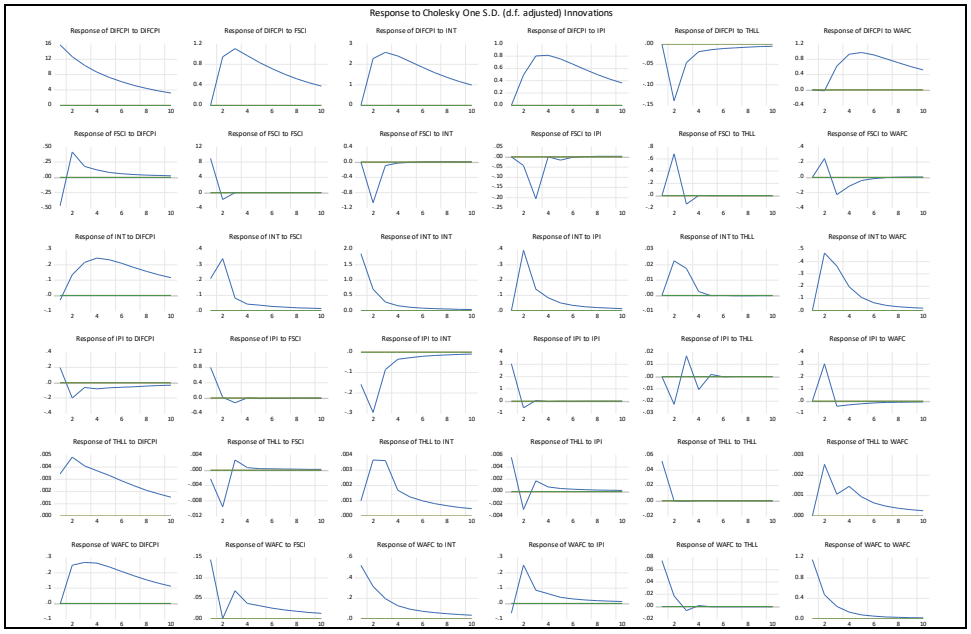


Table 14: Classical VAR Model



5. Conclusion

This study aims to analyse the effects of transfer expenditures to households, industrial production index, weighted average cost of funding, average interest rate applied to consumer loans and financial services confidence index variables on the inflation rate and the relationships between the variables.

Markov regime switching model is used to analyse the regime transitions between variables. Regime 1 covers the period when the inflation rate is low. According to the results of regime 1, it is concluded that transfers to households increase the consumption demand of households. In this context, it is determined that it has an increasing effect on the inflation rate. Increases in the industrial production index are found to have a suppressive effect on the inflation rate. In other words, increases in industrial production also increase aggregate demand. Increases in demand support a controlled increase in prices. Increases in interest rates applied to consumer loans are found to have a positive relationship on transfers to households. According to the results, the increase in interest rates has an incentive effect on households. This increases demand-side inflationary pressures. The negative impact of the weighted average

cost of funding on inflation limits the consumer credit utilised by households. This situation suppresses the inflation rate by controlling price increases and reducing consumption demand. Regime 1 represents a period of more balanced economic activity.

Regime 2 represents the contractionary effects of periods of high inflation. According to the results of Regime 2, when the effect of the weighted average cost of funding on inflation is analysed, an increase in the weighted average cost of funding decreases the inflation rate. This increases loan rates. With increasing loan rates, banks tend to be more selective in lending. In this context, it reduces consumers' willingness to borrow and tends to reduce inflation. Decreases in the weighted average funding cost, on the other hand, increase the borrowing status of consumers and increase consumer demand. Economic activity increases with low interest rates. As a result, inflationary pressures may increase. The positive effect of transfers to households on inflation increases consumer demand. With the increase in the interest rate applied to consumer loans, households and enterprises face high costs. This situation is reflected in price increases and cost inflation is realised. When the positive effect of the industrial production index on inflation is analysed, the positive increase in the industrial production index indicates the growth status of a country, as the inflation variable is a cyclical variable. Regime 2 covers the period of intense demand and cost-driven inflationary pressures.

According to the results of the impulse-response analysis, the inflation rate shows a structure that is resistant to exogenous shocks. This shows that the inflation rate will increase steadily according to a certain level. Increases in the interest rate applied to consumer loans and the industrial production index increase inflation. This situation leads to demand and cost pressures. Weighted average funding cost increases inflation. It is also found to have a negative impact on transfers to households. According to these results, the increase in borrowing cost reduces the consumption demand of households.

When the interrelationships among the variables of inflation rate, interest rate applied to consumer loans, industrial production index, weighted average cost of funding, financial services confidence index and transfers to households are analysed, it is seen that stronger monetary policy arrangements are required for a developing country like Turkey. In addition, it is very important to conduct fiscal policy together with monetary policy. Transfers to households should be focussed on the right groups. The negative effect of financial services confidence index increases uncertainties. This situation should be eliminated by strengthening the supervision mechanisms and a more secure and transparent financial system should be created.

6. References

Albayrak, N., & Abdioğlu, Z. (2015). Estimating the backward and forward-looking monetary policy reaction functions: Taylor rule. *Süleyman Demirel University Journal of Economic and Administrative Sciences*, 20(4).

Akdi, Y. (2012). *Time Series Analysis* (3rd ed.). Gazi Kitabevi.

Bayat, T., Kayhan, S., & Koçyiğit, A. (2013). Examining the asymmetric behavior of unemployment in Turkey with a regime-switching model. *Journal of Business and Economic Research*, 4(2), 7-20.

Durmuş, S., & Şahin, D. (2019). Analyzing the causality relationship between inflation, exchange rates, and consumer loans in Turkey. *International Journal of Economic and Administrative Studies*, (23), 95-112.

Gültekin, H., & Taştan, B. (2022). The impact of Covid-19 and inflation on the industrial production index. *Cumhuriyet University Journal of Economics & Administrative Sciences*, 23(3).

Güriş, S., Çağlayan Akay, E., & Güriş, B. (2020). *Basic Econometrics with R*. Der Kitabevi.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica*, 57, 357-384.

Hamilton, J. D. (1990). Analysis of time series subject to regime changes. *Journal of Econometrics*, 45, 39-70.

Hamilton, J. D. (1994). *Time Series Analysis* (Chapter 22). Princeton University Press: Princeton, New Jersey.

Hamilton, J. D. (1996). Specification testing in Markov-switching time-series models. *Journal of Econometrics*, 70(1), 127-157.

İlhan, A. (2022). Examining the effect of credit on monetary policy with Markov regime switching: Evidence from Turkey. *Economics and Business Review*, 22(4), 68-87.

İskenderoğlu, Ö., & Akdağ, S. (2017). Examining the validity of financial services confidence index: The case of Turkey. *International Economic Research Journal*, 3(4), 625-633.

Kalkay, D., & Tunalı, H. (2024). Analysis of the relationship between unconventional monetary policies and selected macroeconomic indicators using B-VAR model. *Journal of Accounting and Finance*, (103), 135-154.

Kartal, M., & Mangır, F. (2019). The relationship between stock market index and industrial production index in BRICS-T countries: Panel Fisher causality test. *International Journal of Social and Humanities Sciences Research (JSHSR)*, 6(47), 4313-4318.

Kayhan, S., Bayat, T., & Koçyiğit, A. (2013). Learning process and asymmetry in inflation targeting regimes: A Markov-switching approach. *Eskisehir Osmangazi University Journal of Economic and Administrative Sciences*, 8(1), 191-212.

Kılınç, M., & Tunc, C. (2019). The asymmetric effects of monetary policy on economic activity in Turkey. *Structural Change and Economic Dynamics*, 51, 505-528.

Kim, C.J., & Nelson, G. (1998). *State-Space Models with Regime-Switching: Classical and Gibbs-Sampling Approaches with Applications*. MIT Press.

King, M. (1996). How should central banks reduce inflation? Conceptual issues. *Federal Reserve Bank of Kansas City Economic Review*, Fourth Quarter.

Krolzig, H.M. (1997). *Markov Switching Vector Autoregressions: Modelling, Statistical Inference, and Application to Business Cycle Analysis*. Springer.

Krolzig, H.M. (1998). *Econometric Modelling of Markov-Switching Vector Autoregressions Using MSVAR for Ox*. Oxford University Press.

Krolzig, H.M. (2000). Predicting Markov-Switching Vector Autoregressive Processes. Working Paper 2000W31, Oxford University Press.

Krolzig, H.M. (2001). Estimation, structural analysis, and forecasting of regime-switching models with MSVAR for Ox. Oxford University Press.

Koyuncu, T., & Meçik, O. (2020). Sectoral and inter-sectoral impacts of the Covid-19 pandemic on economic growth in Turkey. *Journal of Management and Economics Research*, 18(4), 112-131.

Mohd, T.I., & Zahid, I. (2006). Modelling exchange rates using regime switching models. *Sains Malaysiana*, 35(2), 55-62.

Oktar, S., & Dalyancı, L. (2011). Analysis of the relationship between monetary policy and inflation in the Turkish economy. *Marmara University Journal of Economic and Administrative Sciences*, 31(2), 1-20.

Öcal, F. M. (2013). Econometric analysis of the relationship between industrial production index and manufacturing industry trend indicators in Turkey. *Celal Bayar University Journal of Social Sciences*, 11(2), 242-258.

Pekçağlayan, B. (2021). Determinants of the industrial production index in Turkey: ARDL model. *Istanbul Economics Journal*, 71(2), 435-456.

Shinwari, S., & Özdemir, D. (2023). The effect of industrial production and consumer price index on housing price index in Turkey: ARDL bounds testing analysis. *Çukurova University Journal of Economic and Administrative Sciences*, 26(1), 61-82.

Telatar, E., Telatar, F., & Ratti, R. A. (2003). On the predictive power of the term structure of interest rates for future inflation changes in the presence of political instability: The Turkish economy. *Journal of Policy Modeling*, 25(9), 931-946.

Tunalı, H., & Kalkay, D. (2024). Foreign exchange-protected deposit account application as a macroprudential monetary policy tool. *PressAcademia Procedia*, 18(1), 63-68.

Turkish Statistical Institute (TÜİK).

Tüzün, O., & Kahyaoğlu, H. (2015). Financial stability as a macroprudential monetary policy objective: An application for Turkey. *Finance, Politics and Economic Reviews*, (603), 25-45.

Yağcıbaşı, F. Ö., & Yıldırım, O. M. (2019). Estimating Taylor rules with Markov switching regimes for Turkey. *Romanian Journal of Economic Forecasting*, 22(3), 83-96.

Appendix

Table 15: Durbin-Watson Autocorrelation Test

DW	p- Value
2.2742	0.8915

Table 16: Variable Variance Test Results

Chi-square	DF	p-Value
0.2018268	1	0.65325

Table 17: Error terms Graph

