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Oil Prices and Inflation: Empirical Evidence from Turkey

Petrol Fiyatları ve Enflasyon: Türkiye'den Ampirik Kanıtlar

ABSTRACT

The nexus between oil prices and inflation has piqued the curiosity of policymakers, business leaders, and academics alike since oil price fluctuations have an impact on the inflation rates and accordingly on the entire economy. In this paper, we tried to investigate the relationship between oil prices and inflation in Turkey during the period from 1995 to 2022, utilizing the Bounds Cointegration test. The dependent variable is Inflation, consumer prices (annual %). The independent variables are Gross national expenditure (% of GDP), Broad money growth (annual %), and Oil prices - Crude oil prices. The results of this test confirm the long-run cointegration between inflation and oil prices during the studied interval. It's imperative for policymakers to contemplate amplifying economic tenacity by expanding the avenues of national revenue and targeting self-sufficiency in energy or a diverse energy landscape.
Keywords: Oil Prices, Inflation, Bounds Cointegration test, Turkey
Jel codes: E31, Q43.

ÖZET

Petrol fiyatları ile enflasyon arasındaki ilişki, petrol fiyat dalgalanmalarının enflasyon oranlarına ve dolayısıyla tüm ekonomiye olan etkisi nedeniyle politika yapıcıları, iş dünyası liderlerini ve akademisyenleri eşit derecede ilgilendirmiştir. Bu çalışmada, 1995-2022 döneminde Türkiye'de petrol fiyatları ile enflasyon arasındaki ilişkiyi Sınırlı Eş-bütünleşme testini kullanarak incelemeye çalıştık. Bağımlı değişken Tüketici Fiyatları ile Enflasyondur (yıllık %). Bağımsız değişkenler ise Gayri Safi Yurtiçi Harcama (%GSMH), Geniş Para Arzı Büyümesi (yıllık %) ve Ham Petrol Fiyatlarıdır (cari ABD doları). Bu testin sonuçları, incelenen dönemde enflasyon ile petrol fiyatları arasında uzun dönemli eş bütünleşmeyi doğrulamaktadır. Politika yapıcılarının ulusal gelirin kaynaklarını genişleterek ekonomik dayanıklılığı artırmayı ve enerjide kendi kendine yetme ya da çeşitli bir enerji portföyü hedeflemeyi düşünmeleri esastır.
Anahtar kelimeleri: Petrol fiyatları, enflasyon, Eş-bütünleşme testi, Türkiye
Jel sınıflandırması: E31, Q43.

1. INTRODUCTION

The topics related to the price fluctuations of natural resources in the global markets provoke extensive debates on account of their notable effects. Given that oil is the dominant energy source worldwide, any increase in oil prices is bound to cause an unavoidable increase in local price levels as a result of energy costs. Literature shows that oil price fluctuations hurt economic performance. Furthermore, high inflation ratios can worsen the impacts of extreme oil price upsurges. This poses a fundamental source of economic volatility. Research investigations have confirmed the credibility of the spillover effect theory, which posits that fluctuations in oil prices have an impact on multiple macroeconomic factors such as economic growth, inflation, interest rates, and the financial sector's development. In theory, oil price fluctuations affect inflation directly from the demand side and indirectly from the supply side. In this research paper, we aim to study the relationship between oil prices and inflation in the Turkish economy over the period from 1995 to 2022 using the ARDL (Autoregressive Distributed Lag) model. This work is made up of four sections: The first section includes the introductory part. The second section summarized the related literature. The third section entails data and methodology. The fourth section includes the empirical implementation. The fifth section is about evaluating the results and conclusions.

2. LITERATURE REVIEW

Many central banks are endeavoring to achieve stability by ensuring that inflation remains within manageable levels. That is to say, they aim to maintain stable prices. Price instability negatively affects the evolution of the economy through decision-making distortions that lead to inefficiencies in resource allocation (Nusair, 2019). The realm of economics has been engaged in continuous debate and policy implementation concerning the comprehension and regulation of inflation. The "neo-quantity theory" or Fisherian theory claims that inflation is likely to occur when the amount of money circulating in the economy increases, and vice versa. The Fisher equation can be computed as follows: $M \times V = P \times T$, where: M= money supply, V= velocity of money, P= average price level, and T= volume of transactions in the economy. Under the assumption that V is constant and T is stable vis-à-vis M, any change in M has a direct and important impact on P. That is to say, increases in money supply result in a corresponding increase in the average price level and the inverse is also true. It is anticipated that this will have no important impact on actual economic performance. On the flip side, the Keynesian school posits that inflation is associated with demand-pull factors such as consumer spending, investment, and government expenditure; and cost-push factors such as increases in production costs. Monetarists put forth that inflation is the result of a rapid increase in the money supply, causing more money to be in circulation within the economy. The purchasing power parity will increase when the amount of money that can be spent grows. In other words, the demand for goods and services will increase resulting in increasing prices and accordingly inflation if the increased demand couldn't be associated with a corresponding rise in the production of goods and services. According to the structural school, the limitations that influence the economy (such as food shortages and scarcity of foreign exchange) have an impact on inflation in developing countries (Diouf 2008). Based on the above-mentioned discussion, major supply shocks (related to energy for example) are an essential catalyst of inflation worldwide.

In this context, extensive theoretical and applied research closely scrutinize the causes and effects of inflation, including the impacts of oil prices' fluctuations on prices at the local level. Baba and Lee (2022) scrutinizes the repercussions of oil price upheavals on consumer price, wages, inflation, and inflation expectations, proposing that the impact hinges on current inflation levels, inherent aspects of an economy, and economic activity cycles. Throughout periods of escalating inflation, the pass-through impacts are amplified in emerging economies. However, when central banks effectively stabilize expectations of inflation, the pass-through impacts will be lower. Furthermore, the results revealed that the ramifications of shocks in oil price on both inflation and the expectations of it are in sync with their impacts on wages. Gagliardone and Gertler (2023) examined the recent abrupt and enduring surge in inflation, underlining the part played by oil shocks and permissive monetary policy. The results revealed that even in the context of demand shocks and labor market strain, the increase resulted from the oil price shocks. European Central Bank (2017) study investigated if macroeconomic reactions to oil prices experience episodic variations. The study uncovers two regimes marked by different qualitative trajectories in terms of economic activity and inflation subsequent to oil price shocks in the euro area. Under the normal regime, oil price shocks instigate only limited and ephemeral adjustments in these variables. In stark contrast, under the adverse regime, oil price shocks induce major and persistent macroeconomic shifts, with both inflation and economic activity moving in unison with the oil price. The results revealed that the reactions of inflation expectations and wage growth indicate that second-round effects may be directing the dynamics inherent to the adverse regime. The systematic reaction of monetary policy attempts to mitigate these second-round effects under the adverse regime, but it's not sufficient to wholly nullify them. Ider et al. (2023) revealed that contractionary monetary policy dims both energy prices and the leading price level in the Eurozone. Ibrahim Anyars and Adabor (2023) revealed that to maintain inflation stability, policies aimed at bolstering the transport sector should be implemented to dampen the impact of oil price shocks. Aka (2020) revealed one-way relationship running from oil prices to economic evolution, consumer price index, producer price index and industrial firms' stocks in Turkey. Sek, Teo, and Wong (2015) revealed that while oil price fluctuations directly affect domestic inflation in the low oil dependency group, they indirectly affect high oil dependency groups through alterations in the exporter's production costs. Furthermore, their study showed that the key factors influencing domestic inflation in the high oil dependency group are the real exchange rate and exporter's production cost. Moreover, the factors influencing domestic inflation in the low oil dependency group are domestic output and exporter's production cost. Kelesbayev et al. (2022) revealed that the surge in oil prices provokes inflation. Furthermore, one of the indirect impacts of the increase in oil prices on inflation is the interest rate decline stemmed from the expansionary monetary policies. Xuan and Cuong (2016) also revealed between the petroleum price change and various types of CPI. Klepacz (2021) revealed that price variations are more likely to be more scattered and occur infrequently; indicating that prices are less inclined to align in their movement. The author claimed that an uptick in aggregate volatility doesn't significantly undermine the potency of monetary policy in spurring output. Sarmah and Bal

(2021) revealed that in India, crude oil prices have a positive impact on inflation rate but have a negative impact on the evolution of the economy. Similar conclusions have been revealed when the oil prices are split into their positive and negative segments. The study suggests that lessening crude oil consumption and prioritizing renewable energy can help shield the domestic economy from the volatility of international oil prices, restrain inflation, and attain environmental ambitions. Kilian and Zhou (2022) found that there is a significant impact of gasoline price fluctuations on households' one-year inflation expectations, explaining 42% of the fluctuations in these expectations. An abrupt rise in gasoline prices during the period from 2009 to 2013, explained the aggregate increase in household inflation expectations. Furthermore, the results gave no support to connecting escalation in gasoline prices with the alignment of the Phillips curve with household inflation expectations. Topan et al. (2020) reveal that roughly half of the fluctuation in overall inflation changes can be linked to oil price shocks driven by the energy aspect of inflation.

3. DATA and METHODOLOGY

We investigated the nexus between Inflation, consumer prices, gross national expenditure, broad money growth, and oil prices. In this context, Equation 1 estimates inflation in Turkey depending on previously cited factors.

$$NF_t = f(GNE_t, MG_t, OP_t) \quad \textbf{(1)}$$

We employed these variables in their logarithmic form. Logarithmic forms enable direct elasticity interpretations and typically provide more effective results than merely using the functional format of a rudimentary linear equations (Ehrlich, 1996). Equation (2) presents the empirical model:

$$LNF_t = \beta_0 + \beta_{GNE} LGNE_t + \beta_{MG} LMG_t + \beta_{OP} LOP_t + \mu_t \quad \textbf{(2)}$$

Where NF indicates inflation, consumer prices (annual %), GNE denotes gross national expenditure measured as % of GDP, MG denotes broad money growth measured as annual %, OP denotes oil prices - Crude oil prices measured in current US$, and μ is the residual or error term. Every datum point discussed were sourced from the World Development Indicators (World Bank) for Turkey between 1990 and 2020, except for OP data which obtained from Our World in Data (OWID). About cointegration assessment, we utilize the ARDL bounds testing methodology crafted by Pesaran et al. (2001) to investigate the relationship between the dependent variable (inflation) and independent variables. Unlike other traditional approaches, the ARDL bounds testing technique's main assets are its capability to scrutinize long-term equilibrium relationships among series integrated of different degrees, its consistency in providing results against autocorrelation and endogeneity issues, and its facility to differentiate the short-term adjustment procedure from the long-term association between variables (Pesaran and Shin, 1999). The ARDL method unfolds in a duo of steps. First, the ARDL unrestricted model is gauged, as demonstrated in Equation 3:

$$\Delta LNF_t = \beta_0 + \beta_{GNE} LGNE_{t-1} + \beta_{MG} LMG_{t-1} + \beta_{OP} LOP_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta LNF_{t-i} + \sum_{k=0}^{m} \beta_{3k} \Delta LGNE_{t-k} + \sum_{l=0}^{n} \beta_{4l} \Delta LMG_{t-l} + \sum_{r=0}^{o} \beta_{5r} \Delta LOP_{t-r} + \mu_t \quad \textbf{(3)}$$

The null and alternative hypotheses are shown below:

$\boldsymbol{H_0}$: There is no cointegration if $\beta_{NF} = \beta_{GNE} = \beta_{MG} = \beta_{OP} = 0$.

$\boldsymbol{H_1}$: There is cointegration if no fewer than one β_k is not zero ($\beta_k \neq 0$).

When the derived F-statistic surpasses the critical value, drawn from comparing it with both the lower and higher critical values, it provides the statistical substantiation of a cointegrating nexus amidst the factors. If the ascertained F-statistic doesn't surpass the critical limit, we can't reject the proposition of the null hypothesis, asserting the absence of cointegration. The optimal lag had been selected to handle the sensitivity of the results to the lag order. If the null hypothesis had been rejected, then the short- and long-term nexus will be defined. the ARDL model encompasses the error correction term (ECT_{t-1}) for the short-run scenario as shown in equation (4).

$$\Delta LNF_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\Delta LNF_{t-i} + \sum_{k=0}^{m} \alpha_{3k}\Delta LGNE_{t-k} + \sum_{l=0}^{n} \alpha_{4l}\Delta LMG_{t-l} + \sum_{r=0}^{o} \alpha_{5r}\Delta LOP_{t-r} + \lambda ECT_{t-1} + \epsilon_t \quad \textbf{(4)}$$

In Equation 4, The λ coefficient denotes the adjustment parameter, denoting the velocity at which the model reaches enduring stability, and it is predicted to be negative and to demonstrate statistical significance. Finally, it is necessary to employ more diagnostic tests to confirm the accurate specification of the model, akin to the Breusch-Godfrey method for serial correlation using Lagrange multipliers, the ARCH technique for heteroskedasticity, the Jarque-Bera approach for normality testing, the Ramsey RESET tool, and stability analysis via CUSUM/CUSUMSQ methods.

4. EMPIRICAL IMPLEMENTATION

The first step is to conduct the stationarity tests. A precondition intrinsic to the ARDL method is the entirety of factors are integrated to a topmost order of I (1). Hence, demonstrating that the entirety of variables is of the I (0) or I (1) order is vital, and the Dickey-Fuller test is employed to validate that the variables are cohesive at the order I (1) to the highest extent. The inferences drawn from Table (1) hint that except for LGNE which is stationary at level, all the rest variables have unit roots at the level but are stationary at their first level.

Table 1: Time Series Properties of the Variables (ADF)

Variable	Test	Level (Constant)	Level (Constant & Trend)	Level (w/o Both)	1st Diff. (Constant)	1st Diff. (Constant & Trend)	1st Diff. (w/o Both)
LNF	t-Stat	-1.2907	0.7269	-0.4866	-2.5333	-3.6497	-2.6632
	Prob.	***0.6189***	***0.9994***	***0.4956***	***0.1196***	***0.0465***	***0.0098***
LGNE	t-Stat	-3.7702	-3.754	-0.125	-7.3718	-7.284	-7.5389
	Prob.	***0.0085***	***0.0356***	***0.6314***	***0.0000***	***0.0000***	***0.0000***
LMG	t-Stat	-2.0844	0.3812	-0.6339	-7.4076	-6.1158	-7.5287
	Prob.	***0.2520***	***0.9980***	***0.4333***	***0.0000***	***0.0002***	***0.0000***
LOP	t-Stat	-1.4598	-1.8168	0.9675	-4.53	-4.4134	-4.4474
	Prob.	***0.5382***	***0.6684***	***0.9070***	***0.0014***	***0.0088***	***0.0001***

In the subsequent stage, we will apply the ARDL bound test to confirm the enduring connection between the variables. The optimal lag for variables was determined since the results are prone to be impacted by opting for the lag order. Based on VAR Lag Order Selection Criteria, the optimal lag order is 4. Grounded on the best model selected, we conduct the bounds test. It has been verified that the variables share a cointegration nexus since we negate the null postulate and acknowledge the alternative hypothesis for the reason that the derived F-statistic outpaces the threshold value of the upper limit. F-statistic is (9.171611) in case 2 with rest. constant, and table (2) represents that this value is greater than the critical value of the upper limit.

Table 2: Consequences of The Bounds Assessment of the Chosen Model: ARDL (4,2,2,4)

	Bounds	Values	Asymptotic
10%	I(0)	2.676	2.370
	I(1)	3.586	3.200
5%	I(0)	3.272	2.790
	I(1)	4.306	3.670
1%	I(0)	4.614	3.650
	I(1)	5.966	4.660

* I(0) and I(1) are respectively the stationary and non-stationary bounds.

Moreover, we implemented diagnostic analyses to authenticate the accuracy of the model. Starting with the outset on Breusch-Godfrey serial correlation LM test, table (3) revealed that the probability of F-statistic is greater than 0.01, demonstrating the absence of the autocorrelation problem in the structured model. Secondly, we conduct the autoregressive conditional heteroskedasticity (ARCH) test, table (3) revealed that since the p-value is greater than 0.01, then there is no heteroscedasticity problem in the structured model. Thirdly, we conduct Ramsey RESET test and table (3) revealed that since p-value of F-statistic is greater than 0.01, then the correct functional form had been selected.

Table 3: Diagnostics Tests

Test	F-statistics	P-value
Breusch-Godfrey Serial Correlation LM Test	0.000752	0.9789
Heteroskedasticity Test: ARCH	0.470375	0.5003
Ramsey RESET Test	1.78634	0.2232

Fourthly, we conduct the Jarque-Bera normality test, figure (1) revealed that since that the probability is greater than 0.01; then the error terms exhibit a Gaussian distribution; means that the model has satisfied the assumption of normality.

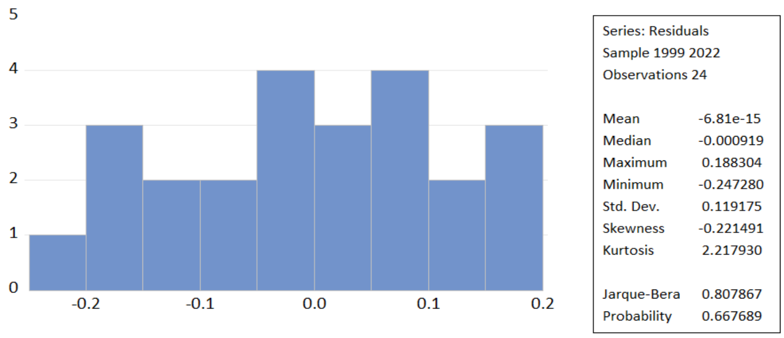

Figure 1: Normality Test

Fifthly, we conduct the stability tests both CUSUM and CUSUM of squares. Figure (2) revealed that the blue line is oscillate between the red dashed bands.

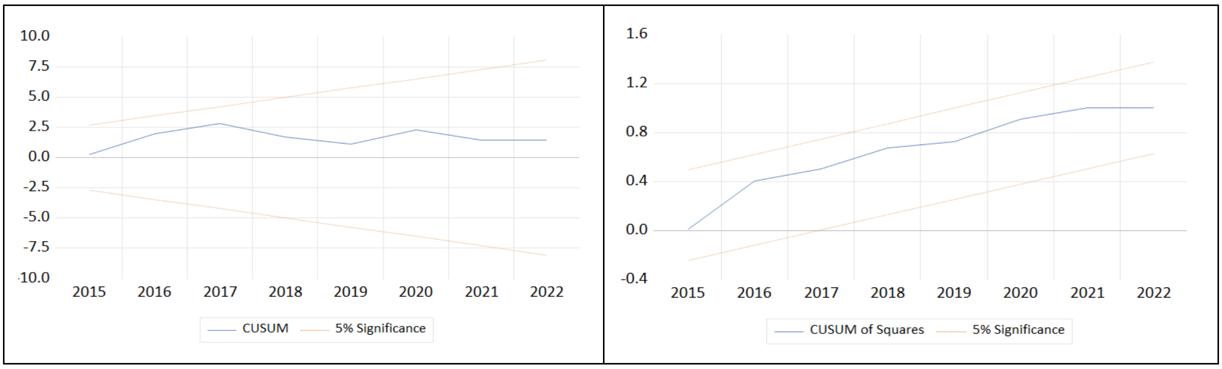

Figure 2: CUSUM and CUSUM Of Squares

The long-run metrics are reported in Table (4). In the long run, a one-unit surge in LGNE is allied with a decline of roughly 10.803 units in LNF. The nexus is statistically meaningful at the 5% level (p=0.0360). Furthermore, a unit increase in LMG leads to an approximate surge of 1.185 units NF. This impact is highly statistically momentous, with a p-value of 0.0005. Moreover, a one-unit rise in LOP corresponds to an increase of 1.213 units in NF. This relationship holds statistical significance at around the 1% level (p=0.0106). The short-run estimates are reported in Table (5). In the short run, a unit increase in LGNE causes a decrease of 5.53 units in NF. This nexus is statistically momentous at the 1% level (p=0.0099). Furthermore, a unit increase in LMG is associated with an increase of 0.37 units in NF. This impact is statistically weighty at about the 1% level (p=0.0022). Moreover, a unit change in LOP leads to an increase of 0.72 units in NF. This nexus is highly statistically substantial with a p-value of 0.0005. COINTEQ* denotes the error correction term. A coefficient of -0.45 designates that after a shock, about 44.74% of the disequilibrium is corrected in each period. Given the statistical significance at the 1% level (p=0.0000), it confirms the occurrence of a cointegrating nexus and proposes that deviations from the long-term equilibrium are adjusted in the short run.

Table 4: Long-Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNF(-1)*	-0.447382	0.271995	-1.644816	0.1386
LGNE(-1)	-10.80352	4.293762	-2.516096	0.0360
LMG(-1)	1.185435	0.210680	5.626715	0.0005
LOP(-1)	1.213443	0.365787	3.317350	0.0106
C	40.29470	18.98640	2.122293	0.0666
R-squared	0.926704	Mean dependent var		-0.006562
Adjusted R-squared	0.789275	S.D. dependent var		0.440197
S.E. of regression	0.202072	Akaike info criterion		-0.125666
Sum squared resid	0.326664	Schwarz criterion		0.659703
Log likelihood	17.50800	Hannan-Quinn criter.		0.082692
F-statistic	6.743126	Durbin-Watson stat		1.914712
Prob(F-statistic)	0.005178			
* p-values are incompatible with t-bounds distribution.				

Table 5: Short-Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-0.447382	0.053942	-8.293798	0.0000
D(LNF(-1))	-0.156449	0.145985	-1.071679	0.3049
D(LNF(-2))	-0.075795	0.133942	-0.565883	0.5819
D(LNF(-3))	-0.368022	0.155837	-2.361587	0.0359
D(LGNE)	-5.526850	1.807749	-3.057310	0.0099
D(LGNE(-1))	-2.098667	1.596259	-1.314741	0.2132
D(LMG)	0.366951	0.094909	3.866334	0.0022
D(LMG(-1))	-0.395533	0.118117	-3.348649	0.0058
D(LOP)	0.718584	0.153926	4.668376	0.0005
D(LOP(-1))	-0.521612	0.158234	-3.296465	0.0064
D(LOP(-2))	-0.697417	0.202834	-3.438356	0.0049
D(LOP(-3))	-0.623086	0.174511	-3.570461	0.0038
R-squared	0.926704	Mean dependent var		-0.006562
Adjusted R-squared	0.859517	S.D. dependent var		0.440197
S.E. of regression	0.164991	Akaike info criterion		-0.459000
Sum squared resid	0.326664	Schwarz criterion		0.130027
Log likelihood	17.50800	Hannan-Quinn criter.		-0.302731
F-statistic	13.79276	Durbin-Watson stat		1.914712
Prob(F-statistic)	0.000037			
* p-values are incompatible with t-Bounds distribution.				

5. CONCLUSION

The nexus between oil prices and inflation has piqued the curiosity of policymakers, business leaders, and academics alike since that oil price fluctuations have an impact on the inflation rates and accordingly on the entire economy. The rise in oil prices directly raises production costs, a matter that triggers inflation by increasing the prices of goods and services. Furthermore, the fluctuations in the oil prices have an indirect impact that may lead to inflation, that is increasing the costs of transportation. Moreover, anticipating increasing oil prices can lead to an increase in the expectations of future inflation. Considering these repercussions, it is understandable that central banks are vigilant with oil prices. Nevertheless, their response depends on supply and demand factors that cause oil price increases. For these reasons, comprehending the nexus between oil prices and inflation is crucial for central banks to handle monetary policy and for businesses and consumers to make informed choices. In this study we tried to investigate the relationship between oil prices and inflation in Turkey during the period from 1995 to 2022, utilizing the Bounds Cointegration test. The dependent variable is Inflation, consumer prices (annual %). The independent variables are Gross national expenditure (% of GDP), Broad money growth (annual %), and Oil price - Crude prices since 1861 (current US$). The results of this test confirm the long run cointegration between inflation and oil prices during the studied interval. Our results are satisfied with those obtained by Peker and Mercan (2011). The positive nexus between oil price (OP) and inflation is expected that because that oil prices frequently impact the cost structure in several economies. Bearing this in mind, it's advisable for policymakers to chalk out schemes that mitigate the erratic nature of oil prices. Measures might encompass expanding energy diversification, capitalizing on investments in alternative and sustainable energy, and mulling over the establishment of vital oil depots to avert short-run oil price leaps. Furthermore, policymakers ought to steer clear of impulsive responses to transient variations and concentrate on foundational and long-term strategies. Observing an adjustment rate at around 44.74% per interval, it suggests a system primed for quick adaptation, inferring that enacted strategies may begin to manifest their promises in a brief span. Furthermore, it's imperative for policymakers to contemplate amplifying economic tenacity by expanding the avenues of national revenue and targeting self-sufficiency in energy or a diverse energy landscape. Such strategies would provide a safeguard for the economy against unforeseen external upheavals, up to a point. Further research needs to be conducting to understand inflation dynamics utilizing different variables such as private sector savings which significantly correlated with inflation as revealed by Telek and Miçooğulları (2022), and the regulatory impact of institutional quality variables (Miçooğulları, 2022) which positively affects inflation.

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