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Macroeconomic Drivers of Inflation in a Commodity-Exporting Economy: Evidence from Kazakhstan

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ABSTRACT

Inflation remains a central macroeconomic challenge for emerging economies, as persistent price instability undermines economic growth, distorts income distribution, and weakens the effectiveness of monetary policy. This study aims to assess the relationships between inflation, the policy rate, the exchange rate, oil prices, and National Fund transfers in Kazakhstan using annual data for 2000–2025 and an Autoregressive Distributed Lag (ARDL) model. The initial data consist of annual time series for 2000–2025, including 26 observations for each indicator, compiled from statistics from the Bureau of National Statistics, the National Bank of Kazakhstan, the World Bank, and the Ministry of Finance of the Republic of Kazakhstan. Descriptive statistics, correlation analysis, the Dickey–Fuller test, and the ARDL autoregressive distributed lag model were used. The coefficient for the lagged exchange rate was −0.0733 (p = 0.0274), and for the current logarithm of the oil price, it was 6.9936 (p = 0.0048), while the current and lagged coefficients for the interest rate and the logarithm of National Fund transfers are statistically insignificant at the 5% level. The model is characterized by a determination coefficient of R^2 = 0.6546 and overall statistical significance (F = 1.159; p = 0.0239), however, the bounds test did not confirm the presence of a long-term relationship between the variables (F = 2.4282; p = 0.3762). These results contribute to a deeper understanding of the factors influencing inflation in Kazakhstan and can inform monetary and macroeconomic policy.

KEYWORDS: Inflation, Interest Rate, Refinancing Rate, Fiscal Strategy, Monetary Policy, Macroeconomics, Resource-Dependent Economy

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Макроэкономические факторы инфляции в сырьевой экспортно-ориентированной экономике: на примере Казахстана

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АННОТАЦИЯ

Инфляция остается одной из главных макроэкономических проблем для стран с формирующимся рынком, поскольку постоянная нестабильность цен подрывает экономический рост, искажает распределение доходов и снижает эффективность денежно-кредитной политики. Целью данного исследования является оценка взаимосвязи между инфляцией, учетной ставкой, обменным курсом, ценами на нефть и трансфертами в Национальный фонд в Казахстане с использованием годовых данных за 2000-2025 годы и модели авторегрессии с распределенным лагом (ARDL). Исходные данные представляют собой годовые временные ряды за 2000–2025 годы, включающие 26 наблюдений по каждому показателю, сформированные на основе статистики Бюро национальной статистики, Национального банка Казахстана, Всемирного банка и Министерства финансов Республики Казахстан. Использованы описательная статистика, корреляционный анализ, тест Дики–Фуллера, модель авторегрессии с распределёнными лагами ARDL. Коэффициент при валютном курсе с лагом составил −0,0733 (p = 0,0274), а при текущем логарифме цены нефти — 6,9936 (p = 0,0048), тогда как текущие и лаговые коэффициенты процентной ставки и логарифма трансфертов Национального фонда по отдельности статистически незначимы на уровне 5%. Модель характеризуется коэффициентом детерминации R^2 = 0,6546 и общей статистической значимостью (F = 3,159; p = 0,0239), однако тест границ не подтвердил наличие долгосрочной связи между переменными (F = 2,4282; p = 0,3762). Полученные результаты способствуют более глубокому пониманию факторов инфляции в Казахстане и могут быть использованы при формировании денежно-кредитной и макроэкономической политики.

КЛЮЧЕВЫЕ СЛОВА: инфляция, процентная ставка, ставка рефинансирования, фискальная стратегия, денежно-кредитная политика, макроэкономика, ресурсозависимая экономика

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INTRODUCTION

Inflation is defined as a sustained increase in the general price level of goods and services in an economy, accompanied by a decline in the purchasing power of the national currency. In simple terms, inflation means the same amount of money can buy fewer goods and services over time. In Kazakhstan, inflation is officially measured using the Consumer Price Index (CPI).

Inflation is an important indicator of macroeconomic stability because persistent price increases reduce households' purchasing power, increase business uncertainty, and complicate long-term investment and economic planning. For Kazakhstan, inflation matters because the economy remains sensitive to external commodity prices and exchange rate movements. Since 2015, the National Bank of Kazakhstan has implemented an inflation-targeting regime combined with a floating exchange rate. The effectiveness of this framework depends not only on monetary policy but also on external shocks and the economy's structural characteristics.

Since independence, Kazakhstan has experienced considerable fluctuations in inflation. These changes have been driven by both domestic and external factors, including changes in global oil prices, exchange rate movements, domestic demand, and major external shocks. The decline in global oil prices in 2015, the COVID-19 pandemic in 2020-2021, and the geopolitical shock in 2022 were accompanied by significant changes in price dynamics. For a commodity-exporting economy such as Kazakhstan, oil prices matter because they affect export revenues, the exchange rate, fiscal revenues, and domestic economic activity.

The relationship between oil prices and inflation can operate through several channels. Changes in energy prices can directly affect consumer prices and production costs. Oil price movements can also influence the exchange rate by changing export revenues and foreign currency inflows. In addition, changes in oil revenues may affect domestic demand through fiscal policy and transfers from the National Fund. Therefore, oil prices may affect inflation beyond the direct impact of energy costs.

The concept of greenflation also emphasizes the relationship between changes in energy markets and price pressures. The transition toward a low-carbon economy may increase the costs of energy production and carbon-intensive goods during periods of adjustment. For this study, however, this issue is considered only as broader context for understanding energy-related inflationary pressures. The empirical analysis focuses on global oil prices as the main external energy-related variable.

Previous studies of inflation in Kazakhstan have identified exchange rate movements, oil prices, monetary conditions, and external price shocks as important determinants of inflation. However, these factors may affect inflation differently across periods and methods. In particular, fiscal transfers from the National Fund represent an important feature of Kazakhstan's economic system because they provide a channel through which oil-related revenues can enter the domestic economy.

This study aims to assess the relationships between inflation, the policy rate, the exchange rate, oil prices, and National Fund transfers in Kazakhstan using annual data for 2000–2025 and an Autoregressive Distributed Lag (ARDL) model. The study uses the Augmented Dickey–Fuller (ADF) test to determine the integration properties of the variables and the ARDL bounds testing approach to examine the presence of a long-run relationship. The analysis also considers short-run dynamics and applies diagnostic and stability tests to assess the model's adequacy. The study examines monetary, external, and fiscal factors within a single empirical framework. Including National Fund transfers allows the study to assess whether this fiscal channel is associated with inflation alongside global oil prices, the exchange rate, and the policy interest rate.

LITERATURE REVIEW

Inflation is a key macroeconomic factor affecting purchasing power, economic stability, and long-term development. Economic literature explains inflation through several interconnected channels, including monetary conditions, exchange-rate movements, global commodity prices, expectations, and fiscal policy. The relative importance of these factors differs across countries and periods, particularly during episodes of large external shocks. For a small, open, commodity-exporting economy such as Kazakhstan, monetary policy, the exchange rate, global oil prices, and fiscal conditions are especially relevant because domestic price dynamics depend

on both internal policies and developments in international markets.

The monetary explanation of inflation has a strong theoretical foundation. Friedman and Schwartz (1963) associate sustained inflation with monetary expansion, while Friedman (1968) emphasized the role of inflation expectations and their importance for monetary policy. More recent empirical research generally confirms the relevance of monetary conditions but shows that their effects depend on the economic environment and the selected indicators. Ujkani and Gara (2023), using panel data for 40 countries, find a positive relationship between money supply growth and inflation. Acar and Orhan (2023), focusing on OECD economies during and after the COVID-19 pandemic, show that monetary and fiscal expansion was associated with stronger inflationary pressures. Although these studies use different samples and explanatory variables, they suggest that monetary factors remain an important part of inflation dynamics and should be considered together with other macroeconomic conditions.

The monetary transmission mechanism is particularly important for emerging economies, where policy-rate changes may affect inflation with a considerable lag. Evidence for Kazakhstan also suggests that the structure of the domestic economy influences this relationship. Hledik et al. (2018), using a semi-structural quarterly model, examine monetary-policy transmission in Kazakhstan and emphasize the role of external conditions and oil prices in shaping it. More recent evidence from Kazakhstan suggests that the interest-rate channel may be weak. Impavido (2025), using monthly data from August 2016 to February 2025, analyzes monetary conditions together with fiscal policy, inflation expectations, and external price pressures. The study finds that monetary policy has only partly contained domestic and external inflationary pressures and points to weaknesses in the interest-rate transmission mechanism. These findings suggest that the effect of monetary policy on inflation should be considered dynamically, not only through contemporaneous changes in the policy rate.

Exchange-rate movements represent another major source of inflation, especially in economies that depend heavily on imported consumer and intermediate goods. Currency depreciation can raise the domestic price of imports and increase production costs, which may subsequently be transmitted to consumer prices. Taylor (2000) argues that the strength of exchange-rate pass-through depends partly on the inflation environment, while McCarthy (2007) provides empirical evidence that exchange-rate and import-price shocks affect domestic consumer prices. For oil-exporting CIS economies, Rahimov et al. (2017) examine Azerbaijan, Kazakhstan, and Russia using a VAR approach and find significant but incomplete exchange-rate pass-through. Their findings indicate that exchange rate changes affect inflation, although these changes are not immediately passed through in full to consumer prices.

Recent micro-level evidence strengthens this argument for Kazakhstan. Kim et al. (2024) examine exchange-rate pass-through using retail scanner data covering more than 1,400 consumer products. Unlike studies based on aggregate price indices, their approach allows a comparison of price responses between imported and domestically produced goods. Using local projections, the authors find substantial but incomplete exchange-rate pass-through, with approximately half of an exchange-rate shock transmitted to retail prices within one year. They also identify asymmetric and nonlinear responses to exchange-rate movements. The findings complement earlier macroeconomic evidence and indicate that the exchange-rate channel remains important for explaining inflation in Kazakhstan, although its magnitude may depend on the direction and size of currency movements.

A third group of studies focuses on global commodity and oil-price shocks. The theoretical and empirical literature shows that oil-price changes can affect inflation through energy and production costs, aggregate demand, and broader macroeconomic adjustments (Hamilton, 2003, 2009; Kilian, 2009). Recent studies have expanded this analysis in response to the major global disruptions of the 2020s. Kilian and Zhou (2023) examine how energy-price shocks transmit to inflation using a structural VAR approach, while Pan et al. (2024) provide evidence of asymmetric interdependence between global commodity prices and inflation. Abu Asab (2025) similarly identifies oil and food prices, together with supply-chain disruptions, as important supply-side drivers of inflation. Despite differences in samples and methods, these

studies show that commodity shocks can generate significant price pressures, while their magnitude and persistence depend on the economy's structure and the nature of the shock.

The oil-price channel is particularly important for Kazakhstan because oil is a major source of export and fiscal revenues. As a result, changes in global oil prices may influence domestic conditions through several mechanisms, not only through energy costs. Hasanov et al. (2017) examine oil-exporting CIS economies and show that oil-price movements are related to exchange-rate dynamics. Akhmedov (2019), focusing specifically on Kazakhstan and applying a VAR model, finds that world oil-price shocks affect several domestic macroeconomic indicators. These results indicate that changes in global oil markets can be transmitted to Kazakhstan through broader macroeconomic channels. At the same time, the literature does not provide uniform evidence on the magnitude or timing of the inflation response to oil-price changes, providing a basis for testing this relationship directly.

Fiscal policy constitutes the fourth channel considered in the literature. Expansionary fiscal measures may contribute to inflation by increasing aggregate demand, particularly when the supply response is limited. The relationship received renewed attention following the large fiscal interventions during the COVID-19 period. Acar and Orhan (2023) show that fiscal expansion, together with monetary measures, was associated with higher inflation in OECD economies. However, the effect of fiscal policy likely depends on the institutional structure of public finance, suggesting that general cross-country findings may not fully explain the experience of resource-exporting economies.

This issue is particularly relevant for Kazakhstan because the National Fund creates an institutional link between oil revenues and the state budget. Transfers from the Fund provide fiscal resources that can support government expenditure and domestic demand. Therefore, they represent a more specific fiscal mechanism than general measures such as total government expenditure or the overall fiscal balance. Recent Kazakhstan-specific research confirms the importance of broader fiscal conditions. Impavido (2025), for example, identifies fiscal policy as an important source of domestic inflationary pressure, while distinguishing it from external and imported inflation. However, the study represents fiscal conditions through the broader fiscal stance rather than National Fund transfers as an independent explanatory variable. Consequently, its findings do not directly establish whether transfers themselves are associated with inflation after accounting for monetary, exchange-rate, and oil-price factors.

Other recent Kazakhstan-specific studies emphasize additional aspects of the inflation process. Imanbayev et al. (2024) consider both domestic and external sources of inflation, including imported inflation and changes in global commodity prices. Jarzhanov et al. (2024) focus on household inflation expectations and emphasize their importance for monetary-policy effectiveness under inflation targeting. These studies broaden the understanding of inflation in Kazakhstan by showing that observed price dynamics are shaped not only by conventional monetary variables but also by expectations and external conditions.

Atamanchuk et al. (2025) provide a broader regional perspective by examining inflation in the Caucasus and Central Asia using three complementary approaches: an augmented Phillips curve, panel VAR, and local projections. Rather than focusing on a single transmission channel, the study considers domestic demand conditions and inflation expectations alongside external factors, including exchange rates and global food and oil prices. The results indicate that external factors play a major role in regional inflation dynamics, although domestic factors also contribute. The authors also find a statistically significant effect of monetary policy and show that it can moderate the impact of external shocks. This regional evidence is useful for Kazakhstan because it demonstrates that inflation in Central Asian economies reflects the interaction of several domestic and external forces rather than a single dominant determinant.

Comparison of the existing literature reveals important differences in both methodology and variable selection. Studies based on VAR models generally focus on dynamic interactions and responses to exchange-rate or oil-price shocks (Akhmedov, 2019; Kilian & Zhou, 2023; Rahimov et al., 2017), while semi-structural models examine broader monetary transmission mechanisms (Hledik et al., 2018). More recent research employs Phillips-curve specifications and local projections

to distinguish domestic and external inflation drivers and assess the responses to specific shocks (Atamanchuk et al., 2025; Impavido, 2025; Kim et al., 2024). Despite methodological differences, the literature broadly indicates that inflation in Kazakhstan and comparable economies reflects a combination of monetary conditions, exchange-rate movements, global commodity shocks, and domestic fiscal factors. At the same time, differences in data frequency, sample periods, country coverage, and model specification lead to variation in the estimated magnitude and timing of these effects.

This comparison also identifies a more specific research gap. Previous studies have examined monetary transmission, exchange-rate pass-through, commodity-price shocks, inflation expectations, and broader fiscal conditions in Kazakhstan, but National Fund transfers have received limited attention as a separate inflation determinant. In particular, the reviewed literature does not directly estimate the relationship between National Fund transfers and inflation while simultaneously accounting for the monetary policy interest rate, the KZT/USD exchange rate, and global oil prices. Thus, the research gap does not imply that previous research has ignored fiscal policy or National Fund operations. Rather, it concerns the limited empirical evidence on National Fund transfers as a distinct fiscal variable within a joint dynamic specification of inflation determinants.

The explanatory variables in the present study follow directly from these four channels. The monetary policy interest rate represents monetary conditions, while the KZT/USD exchange rate captures exchange-rate pass-through. Brent crude oil prices represent external commodity shocks and Kazakhstan's exposure as an oil-exporting economy. National Fund transfers capture the specific fiscal mechanism through which accumulated oil revenues are transferred to the state budget. Other variables, including money supply, import prices, food prices, inflation expectations, the output gap, and broader government expenditure, may also influence inflation. Their exclusion does not imply that they are unimportant; the present study focuses on the four channels directly related to its research objectives.

The study therefore complements the existing literature by examining these monetary, exchange-rate, commodity-price, and fiscal factors within a single dynamic framework for Kazakhstan from 2000 to 2025. The empirical analysis applies the ARDL approach and the bounds-testing procedure developed by Pesaran et al. (2001). The ARDL framework incorporates lagged responses and provides a formal test for a possible long-run relationship among variables with appropriate orders of integration. In this way, the study builds on previous research while placing particular emphasis on National Fund transfers as a separate fiscal variable.

Based on the theoretical arguments and empirical findings discussed above, the following hypotheses are proposed:

H1: The monetary policy interest rate significantly affects inflation in Kazakhstan.

H2: Exchange rate movements significantly affect inflation in Kazakhstan.

H3: Global oil prices significantly affect inflation in Kazakhstan.

H4: National Fund transfers significantly affect inflation in Kazakhstan.

METHODOLOGY

This study examines the macroeconomic determinants of inflation in Kazakhstan over the period 2000-2025, with particular attention to monetary, exchange rate, commodity price, and fiscal factors. Inflation is the dependent variable, while the monetary policy interest rate, KZT/USD exchange rate, Brent crude oil price, and National Fund transfers to the state budget are explanatory variables.

The empirical analysis proceeds in several stages. First, the dataset is constructed, and variables are transformed as needed. Second, the stationarity properties of the time series are examined using the ADF unit root test. Given the identified orders of integration, an ARDL model is estimated to be following the methodological framework of Pesaran and Shin (1999) and Pesaran et al. (2001). The ARDL bounds testing procedure is then applied to test for a long-run relationship among the variables. Finally, diagnostic and stability tests assess the model's adequacy and robustness.

Table 1 presents the variables used in the empirical analysis, their units of measurement, and data sources.

Table 1. Model variables and sources

Variable	Definition	Source
Inflation	Annual average inflation rate measured by the consumer price index (CPI), %	Bureau of National Statistics of Kazakhstan
Rate	Monetary policy interest rate, % per annum; official refinancing rate for 2000-2014 and NBK base rate for 2015-2025, measured at the end of the year	National Bank of Kazakhstan
FX	Annual average nominal exchange rate, KZT per USD	National Bank of Kazakhstan
lnOil	Natural logarithm of the annual average Brent crude oil price, measured in USD per barrel before transformation	World Bank Commodity Price Data (Pink Sheet)
ln Transfers	Natural logarithm of annual National Fund transfers to the state budget, measured in trillion KZT before transformation	Ministry of Finance of the Republic of Kazakhstan

Note: compiled by the authors based on Bureau of National Statistics (2025), World Bank (2025), National Bank (2025)

The choice of the ARDL framework is motivated by both the statistical properties of the data and the dynamic nature of inflation. Inflation may respond to monetary, exchange-rate, commodity-price, and fiscal shocks with different time lags rather than adjusting instantaneously. The ARDL framework incorporates current and lagged values of the dependent and explanatory variables in a single dynamic specification and provides a basis for distinguishing short-run dynamics from a potential long-run relationship.

The methodological foundation follows Pesaran and Shin (1999) and Pesaran et al. (2001). An important advantage of the ARDL bounds-testing approach is its applicability when the variables are integrated of different orders, I(0) and I(1), provided that none of the variables is integrated of order two, I(2). This property is particularly relevant to the present study because the variables exhibit mixed orders of integration.

The empirical specification is also informed by previous studies that use ARDL-type models to examine inflation dynamics through monetary, exchange-rate, and commodity-price channels. For example, Anderl and Caporale (2023) employ a linear ARDL model as a benchmark for examining inflation in developed and emerging economies, incorporating the policy interest rate, exchange rate, and oil-price-related factors. Mirza et al. (2023) use a nonlinear ARDL framework to investigate exchange-rate pass-through and energy-price shocks in inflation-targeting economies. These studies demonstrate the usefulness of distributed-lag specifications for capturing delayed and potentially heterogeneous responses of domestic prices to monetary and external shocks.

This framework is particularly relevant for Kazakhstan, where inflation dynamics may be influenced simultaneously by domestic monetary conditions and external factors associated with exchange-rate and commodity-price movements. This study builds on this empirical literature by jointly considering the monetary policy rate, the KZT/USD exchange rate, Brent oil prices, and National Fund transfers. Including National Fund transfers extends the specification by adding a fiscal factor alongside the monetary and external determinants of inflation.

The empirical analysis begins with descriptive statistics to summarize the main characteristics of the variables. The analysis then examines the time series' stationarity using the Augmented Dickey-Fuller (ADF) unit root test. The results indicate that inflation is stationary at level, I(0), whereas the interest rate, exchange rate, logarithm of oil prices, and logarithm of National Fund transfers become stationary after first differencing, I(1). None of the variables is integrated of order two, which satisfies an important prerequisite for applying the ARDL bounds-testing approach.

Given the relatively small annual sample of 26 observations, the maximum lag length is restricted to one to preserve degrees of freedom and reduce the risk of overparameterization. Within this restriction, the lag structure is selected using the Akaike Information Criterion (AIC), resulting in an ARDL (1,1,1,1,1) specification. The empirical model is expressed as follows (1):

$$INF_t = \beta_0 + \beta_1 INF_{t-1} + \beta_2 Rate_t + \\ + \beta_3 Rate_{t-1} + \beta_4 FX_t + \beta_5 FX_{t-1} + \\ \beta_6 lnOil_t + \beta_7 lnOil_{t-1} + \\ \beta_8 \ln Transfers_t + \beta_9 \ln Transfers_{t-1} \quad (1)$$

where:

INF_t – the inflation rate;

$Rate_t$ – the monetary policy interest rate;

FX_t – the KZT/USD exchange rate;

$\ln Oil_t$ – the natural logarithm of the Brent crude oil price;

$\ln Transfers_t$ – the natural logarithm of National Fund transfers;

ϵ_t – the error term;

t – the period;

t-1 – a one-period lag;

β_0 – the constant term;

$\beta_1, \ldots, \beta_9$ – the estimated coefficients of the corresponding variables.

The ARDL bounds testing procedure proposed by Pesaran et al. (2001), building on the ARDL framework of Pesaran and Shin (1999), was used to test for the existence of a long-run relationship among the variables. The null hypothesis assumes no long-run level relationship, whereas the alternative hypothesis assumes one. The calculated F-statistics are compared with the lower I(0) and upper I(1) critical bounds. If the F-statistics exceed the upper bound, reject the null hypothesis; if it falls below the lower bound, you cannot reject the null hypothesis; and if it lies between the two bounds, the result is inconclusive. The bounds' testing approach is appropriate when the variables are a mixture of I(0) and I(1), provided that none is integrated of order two, I(2).

Given the small annual sample of 26 observations, finite-sample considerations are particularly relevant. Narayan (2005) demonstrates that critical values may differ in small samples and reports finite-sample critical values for sample sizes ranging from 30 to 80 observations. Since the present sample contains only 26 observations, these values are not applied mechanically but are considered when interpreting the bounds-test results cautiously.

The adequacy of the estimated model was examined using a set of diagnostic tests. The Breusch-Godfrey LM test tested for serial correlation, the Breusch-Pagan test assessed heteroskedasticity, and the Jarque-Bera test examined residual normality. The Recursive CUSUM and CUSUM of Squares (CUSUMSQ) tests evaluated the stability of the estimated parameters.

RESULTS

The analysis of the results begins with examining the dynamics of inflation and the interest rate in Kazakhstan for the period 2000–2025. During this period, the country's economy faced fluctuations in world oil prices, changes in the exchange rate, and external shocks. Comparing the two indicators makes it possible to identify periods of acceleration and deceleration of inflation, trace changes in the interest rate, and assess how well they coincided in time. This examination provides an initial understanding of the dynamics of the indicators before conducting econometric analysis, but on its own does not establish a causal relationship between them. The dynamics of inflation and interest rates are presented in Figure 1.

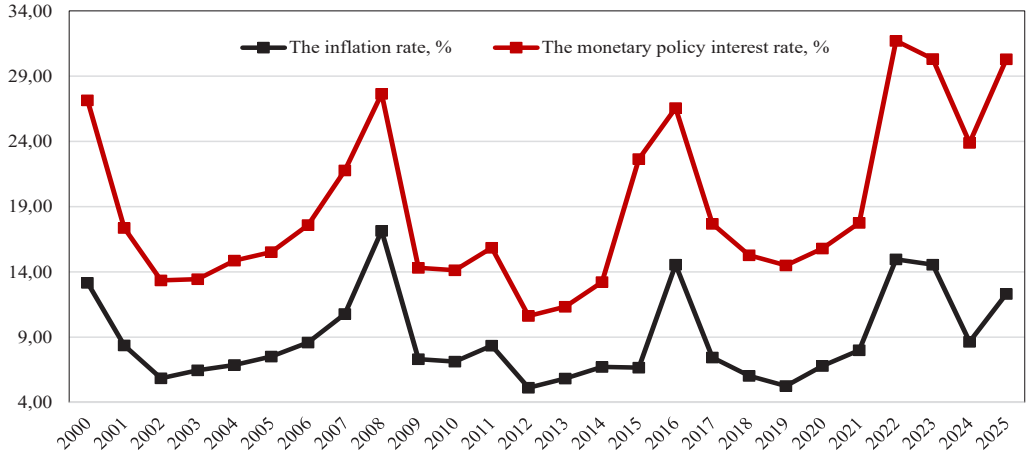


Figure 1. Dynamics of inflation and monetary policy rate in Kazakhstan for 2000-2025

Figure 1 illustrates several distinct episodes in the dynamics of inflation and the monetary policy interest rate in Kazakhstan over 2000-2025. One of the most pronounced inflationary episodes occurred in 2007–2008. Average annual inflation increased from approximately 10.8% in 2007 to about 17.0% in 2008. The National Bank of Kazakhstan reported that the acceleration of inflation in the second half of 2007 was driven primarily by a substantial increase in food prices. During the first half of 2008, Kazakhstan also faced a sharp rise in global prices for food, raw materials and other commodities. The subsequent easing of global commodity prices and weakening economic activity contributed to the moderation of inflationary pressures (National Bank of Kazakhstan, 2025).

A second important structural episode occurred in 2015-2016. In August 2015, Kazakhstan moved to an inflation-targeting monetary policy framework with a floating exchange rate. According to the National Bank, the transition took place against the background of falling global oil prices and depreciation pressures associated with weakening currencies of major trading partners. These developments increased the importance of the exchange-rate channel for domestic price formation. The sharp tightening of monetary conditions visible in Figure 1 during this period therefore coincided with a major adjustment in Kazakhstan's monetary and exchange-rate framework (National Bank of Kazakhstan, 2025).

The next major inflationary cycle began after 2020. Inflationary pressures intensified during 2021 amid elevated external food prices, supply-demand imbalances in individual markets, disruptions in global and domestic supply chains, and persistently high inflation expectations. These factors created a difficult inflationary environment even before the additional external shocks that followed.

Before estimating the ARDL model, descriptive statistics were calculated to provide an overview of the distribution and variability of the variables included in the analysis. Table 2 reports the mean, median, minimum, maximum, and standard deviation of the model variables over the study period, with oil prices and National Fund transfers expressed in natural logarithms.

Table 2. Descriptive statistics of the variables

Variable	Mean	Median	Minimum	Maximum	Std_Dev
Inflation	8.662	7.365	5.118	17.148	3.360
Rate	10.163	9.125	5.500	18.000	3.640
FX	244.325	153.280	120.210	518.450	135.962
lnOil	4.052	4.079	2.954	4.741	0.492
lnTransfers	0.969	0.875	0.182	1.723	0.439

Note: compiled by the authors

The descriptive statistics indicate substantial variation in Kazakhstan's macroeconomic conditions over the sample period. Average inflation was 8.662%, with values ranging from 5.118% to 17.148%, while the policy rate averaged 10.163% and varied between 5.500% and 18.000%. The exchange rate averaged 244.325 KZT/USD, ranging from 120.210 to 518.450, with a standard deviation of 135.962. Its relatively large standard deviation (135.962) reflects substantial exchange-rate variation over the study period. The logarithmic oil-price variable had a mean of 4.052 and a standard deviation of 0.492, whereas lnTransfers averaged 0.969 with a standard deviation of 0.439. Overall, the descriptive statistics reveal considerable variation in inflation, monetary conditions, the exchange rate, oil prices, and fiscal transfers over the period analyzed, providing an appropriate empirical basis for examining their dynamic relationships within the ARDL framework.

Following the descriptive analysis, Pearson correlation coefficients were calculated to provide a preliminary assessment of the relationships among the variables included in the model and to identify potential multicollinearity concerns. Table 3 presents the Pearson correlation matrix for inflation, the policy rate, the exchange rate, and the natural logarithms of oil prices and National Fund transfers.

Table 3. Correlation analysis

Variable	Inflation	Rate	FX	lnOil	lnTransfers
Inflation	1.000	0.522	0.167	0.055	0.274
Rate	0.522	1.000	0.644	0.051	0.703
FX	0.167	0.644	1.000	0.228	0.822
lnOil	0.055	0.051	0.228	1.000	-0.089
lnTransfers	0.274	0.703	0.822	- 0.089	1.000

Note: compiled by the authors

The correlation analysis indicates a moderate positive and statistically significant association between inflation and the policy rate ($r = 0.522$, $p = 0.006$). In contrast, the contemporaneous correlations of inflation with FX ($r = 0.167$), lnOil ($r = 0.055$), and lnTransfers ($r = 0.274$) are relatively weak and statistically insignificant. Among the explanatory variables, the strongest positive correlation is observed between FX and lnTransfers ($r = 0.822$, $p < 0.001$). The policy rate is also positively correlated with FX ($r = 0.644$, $p < 0.001$) and lnTransfers ($r = 0.703$, $p < 0.001$).

Given the relatively high pairwise correlation between the exchange rate and National Fund transfers, an additional variance inflation factor (VIF) test was conducted to assess potential multicollinearity. The VIF values were 2.046 for the policy rate, 4.332 for the exchange rate, 1.413 for oil prices, and 4.835 for National Fund transfers. Since all values remained below the threshold of 5, the diagnostic results do not indicate severe multicollinearity among the explanatory variables. Nevertheless, the relatively high correlation between FX and lnTransfers should be taken into account when interpreting their individual coefficients. It should also be noted that the correlation coefficients represent contemporaneous pairwise associations and do not account for lagged adjustments or the dynamic structure of inflation. Therefore, the weak unconditional correlations between inflation and some explanatory variables do not preclude dynamic relationships in the subsequent ARDL analysis.

The dynamics of the variables included in the empirical model over the period 2000-2025 are presented in Figure 2.

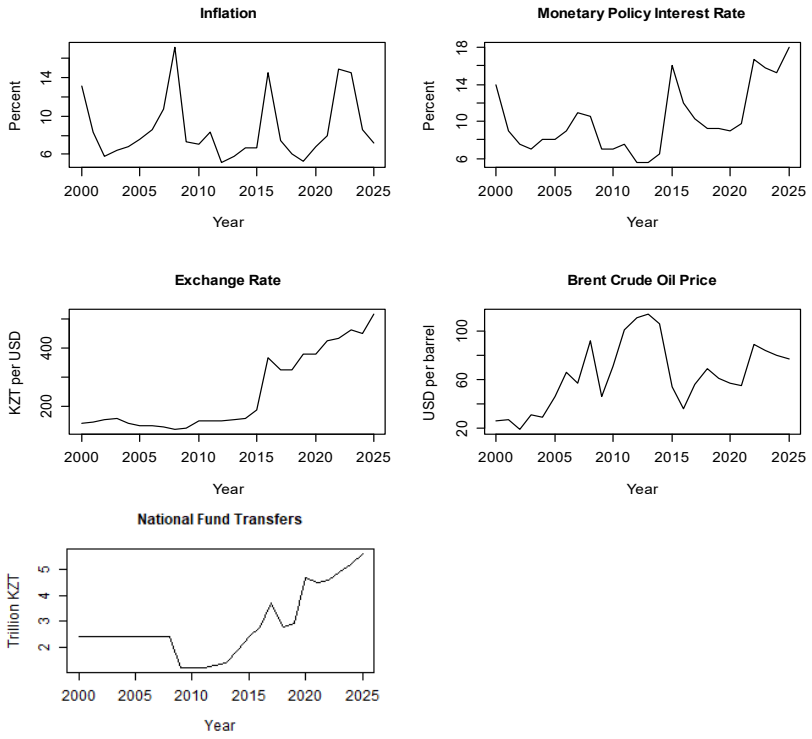


Figure 2. Time series dynamics of inflation, interest rate, exchange rate, oil prices and transfers for 2000-2025

The graphical representation provides an overview of changes in inflation, the monetary policy interest rate, the exchange rate, Brent crude oil prices, and National Fund transfers during the study period. Inflation and the monetary policy interest rate exhibit noticeable fluctuations, while the KZT/USD exchange rate shows a pronounced upward trend, particularly after 2014. Brent crude oil prices demonstrate substantial volatility, whereas National Fund transfers vary considerably across the sample period and increase in the later years. These differences in the dynamics of the variables indicate the need to examine their time-series properties before estimating the ARDL model.

Before estimating the ARDL model, the integration orders of the variables were assessed using the ADF unit root test. The results are presented in Table 4.

Table 4. ADF unit root test results

Variable	ADF statistic (level)	5% critical value	ADF statistic (1st difference)	5% critical value	Integration order
Inflation	-3.5463	-3.00	-	-	I(0)
Rate	-1.4087	-2.93	-4.2301	-3.00	I(1)
FX	0.7615	-2.93	-3.7274	-3.00	I(1)
lnOil	-2.0819	-2.93	-3.7868	-3.00	I(1)
lnTransfers	-0.5801	-2.93	-3.1544	-3.00	I(1)

Note: compiled by the authors

The ADF test results show that inflation is stationary at level, I(0), whereas Rate, FX, lnOil, and lnTransfers become stationary after first differencing and are therefore integrated of order one, I(1). None of the variables is integrated of order two, which supports the application of the ARDL approach.

Since the ADF test confirmed that the variables are integrated of order I(0) and I(1), with none integrated of order I(2), the ARDL approach was applied. Given the relatively small annual sample, the maximum lag length was restricted to one to preserve degrees of freedom and avoid overparameterization. Within this restriction, the lag structure was selected using the Akaike Information Criterion (AIC), resulting in an ARDL (1,1,1,1,1) specification.

Following the lag selection and bounds testing procedure, the ARDL (1,1,1,1,1) model was estimated to examine the dynamic relationship between inflation and the selected macroeconomic factors. The estimated coefficients are presented in Table 5.

Table 5. Results of ARDL estimation for 2000-2025

Variable	Estimate	Std. Error	t-value	p-value
Constant	−11.1068	6.6476	−1.671	0.1155
Inflation (-1)	0.5461	0.4158	1.313	0.2088
Rate	0.2245	0.2559	0.877	0.3942
Rate (-1)	−0.1242	0.4934	−0.252	0.8047
FX	0.0433	0.0273	1.588	0.1332
FX (-1)	−0.0733	0.0300	−2.443	0.0274**
lnOil	6.9936	2.1124	3.311	0.0048***
lnOil (-1)	−3.8113	1.9353	−1.969	0.0677*
lnTransfers	5.8977	4.0665	1.450	0.1676
lnTransfers (-1)	1.5340	3.1416	0.488	0.6324
*Coefficients are statistically significant at ***1%, **5%, *10% level of significance.*				

Note: compiled by the authors

The estimation results show that the ARDL model is statistically significant overall ($F = 3.159$, $p = 0.0239$) and explains approximately 65.5% of the variation in inflation ($R^2 = 0.6546$). At the 5% significance level, the lagged exchange rate and the current oil price are statistically significant. The coefficient of the lagged exchange rate is negative ($\beta = -0.0733$, $p = 0.0274$), indicating a significant

lagged relationship between exchange rate movements and inflation. The current coefficient of lnOil is positive and statistically significant (β = 6.9936, p = 0.0048), indicating a significant relationship between global oil prices and inflation in Kazakhstan. The lagged oil price is significant only at the 10% level (p = 0.0677). In contrast, the current and lagged coefficients of the monetary policy interest rate are statistically insignificant at the 5% level. The coefficients of National Fund transfers and their first lag are also statistically insignificant. Overall, the results indicate that exchange rate movements and global oil prices have the most pronounced statistical relationships with inflation within the estimated ARDL specification.

The ARDL bounds test was applied to examine whether a long-run relationship exists between inflation and the explanatory variables. Table 6 reports an F-statistic of 2.4282 and a p-value of 0.3762.

Table 6. Results of cointegration test

Model	Test statistic	p-value	Decision
ARDL (1,1,1,1,1)	2.4282	0.3762	No evidence of cointegration

Note: compiled by the authors

The null hypothesis of no level relationship cannot be rejected. The bounds-test results therefore do not provide evidence of a long-run relationship between inflation and the explanatory variables over the study period.

The estimation results were also used to evaluate the research hypotheses formulated in the literature review. H1, which assumed a significant relationship between the monetary policy interest rate and inflation, was not supported, as both the current and lagged coefficients of the interest rate were statistically insignificant. H2 was supported, as the lagged exchange rate coefficient was statistically significant at the 5% level (p = 0.0274). H3 was also supported, with the current oil price coefficient being statistically significant at the 1% level (p = 0.0048). H4 was not supported, as the current and lagged coefficients of National Fund transfers were statistically insignificant. However, joint tests of the current and lagged coefficients are needed to assess the overall significance of each explanatory variable.

To assess the adequacy of the estimated ARDL model, several diagnostic tests were performed. The results are presented in Table 7.

Table 7. Diagnostic tests for the ARDL Model

Diagnostic	Test statistic	P-value	Result
Serial correlation	0.0203	0.8886	No evidence of first-order serial correlation
Heteroskedasticity	14.386	0.1092	No evidence of heteroskedasticity
Jarque-Bera	0.1091	0.9469	Normality not rejected

Note: compiled by the authors

The diagnostic tests indicate that the estimated model satisfies the main residual assumptions. The Breusch-Godfrey LM test shows no evidence of first-order serial correlation (p = 0.8886), while the Breusch-Pagan test indicates no evidence of heteroskedasticity (p = 0.1092). In addition, the Jarque-Bera test does not reject the null hypothesis of residual normality (p = 0.9469).

The stability of the estimated ARDL model was examined using the Recursive CUSUM and OLS-based CUSUM tests. These tests are used to identify possible parameter instability over the estimation period. The results are presented in Figure 3.

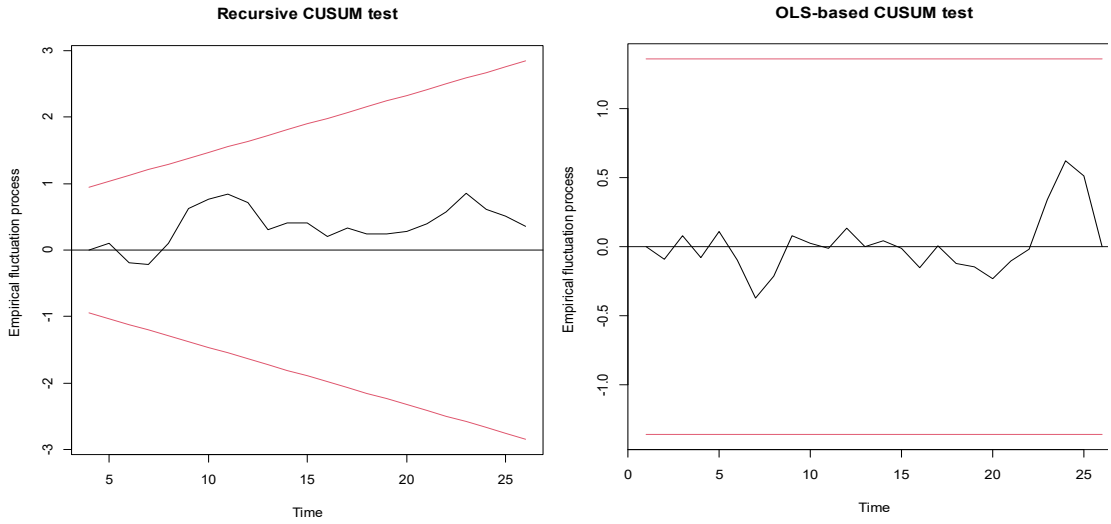


Figure 3. Recursive CUSUM and OLS-based CUSUM stability tests

As shown in Figure 3, the Recursive CUSUM statistic remains within the 5% critical bounds throughout the estimation period. Similarly, the OLS-based CUSUM statistic does not cross the corresponding critical boundaries. Thus, both tests provide no evidence of parameter instability and indicate that the estimated ARDL specification remains stable over the study period.

A noticeable upward shift around 2014-2015 suggests a change in volatility dynamics, however, this change does not exceed the critical bounds and therefore does not violate variance stability. The 2014-2015 shift corresponds to the oil price shock and exchange rate regime change in Kazakhstan, which increased short-term volatility without causing structural instability. Thus, the model demonstrates acceptable stability properties, supporting the reliability of the estimated long-run and short-run coefficients.

CONCLUSION

This study examined the relationships between inflation and selected macroeconomic factors in Kazakhstan using annual data for 2000-2025 and an ARDL model. The analysis included the monetary policy interest rate, the KZT/USD exchange rate, global oil prices, and National Fund transfers.

The empirical results show that the lagged exchange rate and current global oil prices are statistically significant in the estimated model. The lagged exchange rate has a negative coefficient ($\beta = -0.0733$, $p = 0.0274$), indicating an inverse lagged relationship with inflation within the estimated specification. This finding should be interpreted cautiously and does not imply a general negative effect of exchange rate depreciation on inflation. In contrast, the coefficient on current lnOil is positive and statistically significant ($\beta = 6.9936$, $p = 0.0048$), indicating a positive association between oil prices and inflation within the estimated model.

The current and lagged coefficients of the policy interest rate and lnTransfers are individually insignificant at the 5% level. These results should not be interpreted as evidence that monetary policy and National Fund transfers have no relationship with inflation. Joint coefficient tests and further analysis of indirect transmission channels are needed to assess their roles more fully.

The ARDL bounds test does not provide evidence of a long-run cointegrating relationship among the variables ($F = 2.4282$, $p = 0.3762$). Therefore, the estimated coefficients are interpreted as dynamic relationships within the ARDL specification rather than as long-run equilibrium effects. The diagnostic and stability tests indicate that the estimated model satisfies the main residual assumptions and provides no evidence of parameter instability.

The findings suggest that external macroeconomic conditions, particularly exchange rate dynamics and global oil prices, should be considered when assessing inflation developments in Kazakhstan. At the same time, the insignificant coefficients of the policy interest rate and National Fund transfers

indicate the need for further investigation of their transmission mechanisms rather than conclusions about their ineffectiveness. Based on the empirical results, several policy implications can be identified. Given the statistically significant association between inflation and the lagged exchange rate, greater attention should be paid to exchange rate developments when assessing inflationary risks. The significant positive relationship between global oil prices and inflation also supports the inclusion of external commodity price developments in inflation monitoring and forecasting. At the same time, the statistically insignificant coefficients of the monetary policy interest rate and National Fund transfers should not be interpreted as evidence of policy ineffectiveness; rather, they indicate the need for further analysis of their transmission mechanisms. Therefore, monetary and fiscal policy decisions should be supported by continued assessment of how external shocks and domestic policy variables are transmitted to inflation.

Future research could examine these mechanisms using higher-frequency data and models that explicitly identify the transmission channels between oil prices, fiscal policy, exchange rate movements, monetary policy, and inflation. The findings are subject to the small annual sample, the limited lag structure, and the exclusion of other potential inflation drivers. Future research could use higher-frequency data, assess sensitivity to alternative specifications, and examine the transmission channels linking oil prices, fiscal policy, exchange rates, monetary policy, and inflation.

AUTHOR CONTRIBUTIONS

Conceptualization and theory: ZY; research design: ZY; data collection: ZY, NA and AZ; analysis and interpretation: ZY, NA and AZ; writing draft preparation: ZY; supervision: ZY, NA and AZ; correction of article: ZY, NA and AZ; proofread and final approval of article: ZY, NA and AZ. All authors have read and agreed to the published version of the manuscript.

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