International Journal of Economics, Commerce and Management
United Kingdom ISSN 2348 0386 Vol. 13, Issue 5, May 2025

https://ijecm.co.uk/

DETERMINANTS OF INFLATION: EMPIRICAL EVIDENCE FROM CROATIA

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Abstract

This study investigates the macroeconomic causes of inflation in Croatia with the Autoregressive Distributed Lag (ARDL) bounds testing methodology, evaluating quarterly data from 2010 to 2024. Croatia, a small, open, post-transition economy that has recently joined the euro, offers a distinctive environment for analyzing the applicability of conventional inflation theories under institutional upheaval and constrained monetary autonomy. The evaluation comprises seven essential variables: money supply (M2), interest rates, imports, oil prices, real GDP, unemployment, and government spending. The findings validate a persistent cointegrating relationship among these variables and indicate that Croatia's inflation is significantly affected by money supply, interest rates, oil prices, real GDP, and imports. Interest rates have a positive association with inflation, suggesting either reverse causality or constrained monetary effectiveness in a euroized environment. Oil prices and imports exert substantial inflationary pressures, underscoring Croatia's enormous external dependence, whilst real GDP growth exhibits a deflationary influence consistent with supply-side theory. Government expenditure and unemployment demonstrate diminished or inconsistent effects. The results underscore the significance of both monetarist and structuralist theories in the Croatian context, suggesting that inflation in small Eurozone economies is affected by a blend of internal vulnerabilities and external shocks. The research offers valuable insights for the development of fiscal policies and the management of inflation in economies with analogous characteristics.

Keywords: Inflation, ARDL model, Croatia, macroeconomic determinants, monetary policy, Eurozone

INTRODUCTION

Inflation dynamics are a crucial macroeconomic factor, especially in small open economies experiencing institutional change. Croatia's economic progression—characterized by its European Union membership in 2013 and Eurozone entry in 2023—provides a unique case study on the impact of relinquishing monetary sovereignty on inflation factors.

Figure 1: Inflation Rate in Croatia

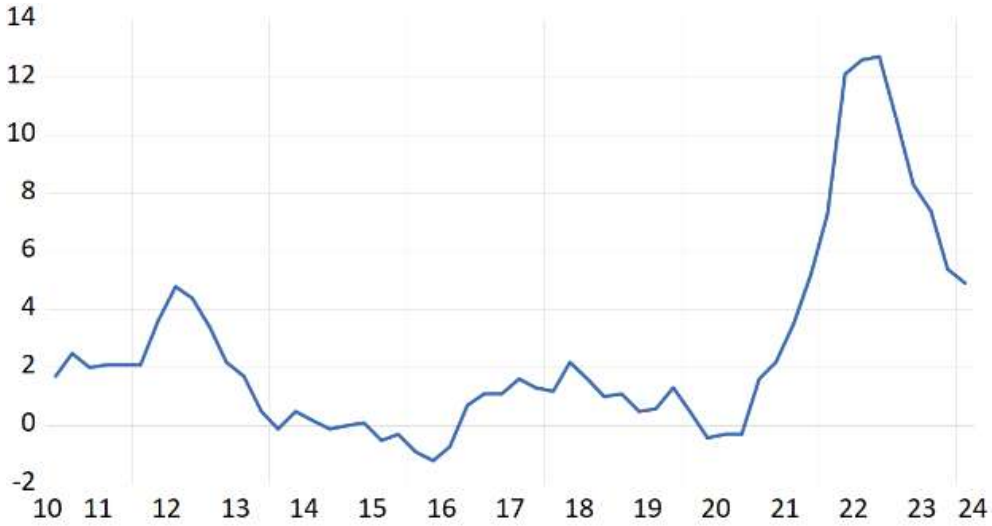

Figure 1: Inflation rate in Croatia

This figure shows Croatia’s inflation rate from 2010 to 2024. Inflation was low and stable for most of the period, often hovering around or below 2%. However, starting in 2021, inflation rose sharply, peaking above 13% in 2022, due to global supply shocks and energy prices, before gradually declining through 2023 and 2024.

The Croatian inflationary environment warrants rigorous empirical investigation due to several structural characteristics: its high degree of trade openness, relative production base limitations, and recent monetary policy framework transformation. The transfer of monetary authority to the European Central Bank has fundamentally altered the domestic policy landscape, eliminating independent interest rate determination and exchange rate management as inflation-response mechanisms.

This structural shift necessitates comprehensive econometric analysis of which macroeconomic variables maintain significant influence on price stability under the constraints of currency union membership. Key research questions emerge regarding the relative importance of external factors (import prices, global commodity markets, Eurozone monetary

stance) versus domestic conditions (labor market tightness, fiscal policy stance, productivity growth) in determining inflationary outcomes.

Understanding these relationships carries substantial implications for policymaking within Croatia's limited but still consequential discretionary space. While monetary policy independence has been surrendered, fiscal, structural, and macroprudential tools remain available, though their calibration requires precise understanding of inflation transmission mechanisms in this new institutional context.

The article analyzes the primary macroeconomic determinants affecting inflation in Croatia through the Autoregressive Distributed Lag (ARDL) bounds testing approach. The methodology focuses on seven essential variables: broad money supply (M2), interest rate, imports, oil prices, real GDP, unemployment rate, and government expenditure. The variables are derived from several theoretical frameworks, including monetarist, Keynesian, and structuralist perspectives. The ARDL model was selected for its flexibility in handling small sample sizes and mixed integration orders, an essential consideration given the quarterly dataset from 2010 to 2024.

Unlike many inflation studies that focus on large economies or regional aggregates, this paper centers on a single, post-transition EU member state that has recently undergone both institutional transformation and monetary convergence. By focusing exclusively on Croatia, this study contributes to the literature by highlighting the inflationary behavior of a smaller Eurozone economy operating under externally determined monetary policy, but with distinct domestic fiscal and labor market characteristics. The findings offer practical implications for policymakers and add to the broader discourse on inflation modeling in structurally diverse European economies.

THEORETICAL AND EMPIRICAL BACKGROUND

ARDL Approach

For decades, empirical study and economic theory have focused mostly on the relationship between macroeconomic variables and inflation. Defined as a continuous rise in the general price level, inflation is one of the most watched and policy-relevant elements since it affects monetary stability, buying power, and long-term economic development. Different theoretical models have been used by economists to clarify the causes of inflation, define the channels of transmission and expected consequences of various macroeconomic shocks on price changes.

This work uses the Autoregressive Distributed Lag (ARDL) modeling technique to investigate these intricate and sometimes country-specific interactions. Designed by Pesaran

and Shin (1999), the ARDL framework has several benefits in empirical macroeconomic research, particularly in small sample and variable with mixed integration orders (I(0) and I(1). ARDL can be used when explanatory variables are integrated at various levels, provided none are I(2), unlike conventional cointegration techniques such Johansen or Engle-Granger methods which demand all variables to be integrated of the same order. Moreover, the ARDL bounds testing process developed by Pesaran, Shin, and Smith (2001) enables simultaneous estimation of both long-run equilibrium relationships inside a single reduced-form equation and short-run dynamics. When looking at inflation factors, this is especially helpful since it records both constant trends (e.g., money supply growth) and instantaneous effects (e.g., a shock in oil prices).

With these advantages, ARDL is especially suited for the goal of this study—that of comparing the macroeconomic factors of inflation in Croatia. The approach helps to spot both long-term trends and short-term fluctuations, so providing information pertinent for both strategic macroeconomic planning and immediate policy reactions.

Theories Behind Determinants

Long attracting the attention of economists, inflation is a multifarious economic phenomena with far-reaching consequences for monetary stability, income distribution, investment behavior, and general macroeconomic performance. Over time, several theoretical models have developed to explain the dynamics and causes of inflation; each one provides a different prism through which macroeconomic factors affect price fluctuations.

Originally anchored in classical economics and later formalized by Milton Friedman (1968), the Quantity Theory of Money holds that inflation is essentially a monetary phenomena. It suggests a direct and proportionate link between money supply growth and price level increases by assuming a steady velocity of money and constant output over the long run. More recently, especially in developing and post-transition economies with underdeveloped financial systems, this point of view has been reiterated and remains fundamental to monetarist policy prescriptions (Boamah & Zeng, 2021; Khan & Gill, 2017).

Conversely, Keynesian economic theory stresses nominal rigidity and total demand more highly. While cost-push inflation results from increasing input costs—especially wages and raw materials—demand-pull inflation results when overall demand exceeds productive capacity. Recent data on post-crisis European economies, where pay rigidities and fiscal expansions have been linked to inflationary episodes, support this viewpoint (Robalo Marques et al., 2019). Under this view, government expenditure—especially if deficit-financed or poorly targeted—may intensify inflationary pressures (Blinder, 1997; Coibion & Gorodnichenko, 2015).

Suggesting a short-run inverse relationship between unemployment and inflation, the Phillips Curve framework adds even more subtlety (Phillips, 1958). This link suggests that although the long-run trade-off vanishes as expectations change, efforts to lower unemployment by expansionary policies may produce greater inflation. Introduced by Friedman and Phelps, the expectations-augmented Phillips Curve combines adaptive and rational expectations to explain why, absent credible policy, inflation can eventually become unresponsive to unemployment. Modern studies including those by Blanchard (2016) and Del Negro et al. (2020) investigate how this relationship has weakened in advanced economies but still holds in structurally rigid or transitioning labor markets—such as in many smaller EU states.

Mechanisms of monetary policy transmission show how central banks control borrowing, consumption, and investment activity by means of interest rates. Policy rates through this channel indirectly control aggregate demand, so influencing inflation. Woodford (2003) explores this mechanism inside the context of interest rate regulations. More recent research indicates that, as observed in some of Southeastern Europe (Égert & MacDonald, 2017), where pass-through to inflation is often incomplete or delayed, monetary transmission can be weaker in euroized or financially shallow economies.

Determining domestic inflation in open economies mostly depends on outside factors including imports and world commodity prices. The Balassa-Samuelson hypothesis (Balassa, 1964; Samuelson, 1964) and more general trade openness research imply that by means of more competition and access to less expensive goods, increased exposure to global markets can lower inflation. But it can also increase sensitivity to imported inflation, particularly in nations with high import reliance and limited manufacturing capacity (Rizov & Czeglédi, 2022; IMF, 2021). Being a small open economy, Croatia is especially sensitive to these forces.

A major factor influencing cost-push inflation, oil prices have repeatedly set off inflationary shocks in countries dependent on energy. Hamilton (2009) underlined how domestic price stability might be disturbed by worldwide volatility of oil prices. More recently, especially in EU countries with limited energy diversification, the inflationary effects of energy shocks have been noted during the post-COVID recovery and the 2022 energy crisis linked with geopolic tensions (Ha, Kose, & Ohnsorge, 2022).

Often used as a proxy for economic output and capacity use, real GDP interacts with inflation via both demand-pull and supply-side processes. While productivity increases or idle capacity may have deflationary effects, fast economic development can cause overheating and inflationary pressures. Empirical research on the Eurozone (ECB, 2020) and emerging Europe (Mihaljek, 2018) confirm this cyclical behavior of inflation in respect to output gaps.

A fundamental tool of fiscal policy, government expenditure affects inflation depending on its composition, efficiency, and financing. While recent contributions underline the need of separating between consumption-based spending and productivity-enhancing investment, Keynesian models stress the expansionary effects of public expenditure (Blanchard et al., 2021; Alesina et al., 2019). In Croatia's case, EU-funded investment initiatives could assist to increase supply capacity without causing appreciable inflationary pressure.

Beyond its conventional Phillips Curve function, unemployment reflects more general labor market features influencing inflation through wage dynamics. Rising wages in tight labor markets can drive inflation through increased production costs; in slack conditions, wage stagnation slows down inflationary momentum. Recent studies underline sectoral mismatches and labor rigidity as main causes of inflation pressure in smaller EU economies (Bobeica & Sokol, 2021).

At last, institutional quality determines how successfully inflation is controlled. North (1990) underlined that anchoring expectations and lowering inflation volatility depend on robust institutions including credible monetary authorities, clear fiscal rules, and consistent legal frameworks. More recently, empirical research supports this perspective, especially in post-transition and euroized economies where credibility is sometimes externally limited (Cukierman et al., 2019; IMF, 2023).

All told, the theoretical literature on inflation presents a great range of viewpoints that all help to explain how inflation behaves in Croatia. Every macroeconomic factor examined in this study—money supply, interest rate, imports, oil prices, real GDP, unemployment, and government expenditure—has a clear theoretical basis and has been validated using both historical data and contemporary empirical research.

HYPOTHESIS AND METHODOLOGY

With regard to EU and Eurozone integration, this paper focuses on Croatia, a small, open, developing European economy undergoing notable structural and institutional change. Reducing the scope to one nation allows the study to provide a more concentrated knowledge of how inflation behaves in a post-transition environment with limited monetary autonomy but active fiscal and labor market policy levers. Following its EU accession in 2013, Croatia's recent adoption of the euro in 2023 gives this study modern relevance as it investigates how inflation is formed in an environment whereby domestic macroeconomic variables remain active but domestic monetary policy is subordinated to the European Central Bank (ECB).

The empirical analysis is guided by the following hypotheses regarding the determinants of inflation in Croatia:

- H1: Money supply (M2) has a significant impact on inflation in Croatia.
- H2: Interest rate has a significant impact on inflation in Croatia.
- H3: Imports have a significant impact on inflation in Croatia.
- H4: Global oil prices have a significant impact on inflation in Croatia.
- H5: Real GDP has a significant impact on inflation in Croatia.
- H6: Unemployment rate has a significant impact on inflation in Croatia.
- H7: Government expenditure has a significant impact on inflation in Croatia.

The econometric research applying the ARDL bounds testing method is built on these hypotheses. The objective is to ascertain whether, in the Croatian setting, each macroeconomic variable has a statistically significant impact on inflation both now and over time. The findings should provide country-specific insights grounded both theoretically and practically relevant for fiscal authorities, monetary institutions, and legislators negotiating the inflation issues of a small Eurozone economy.

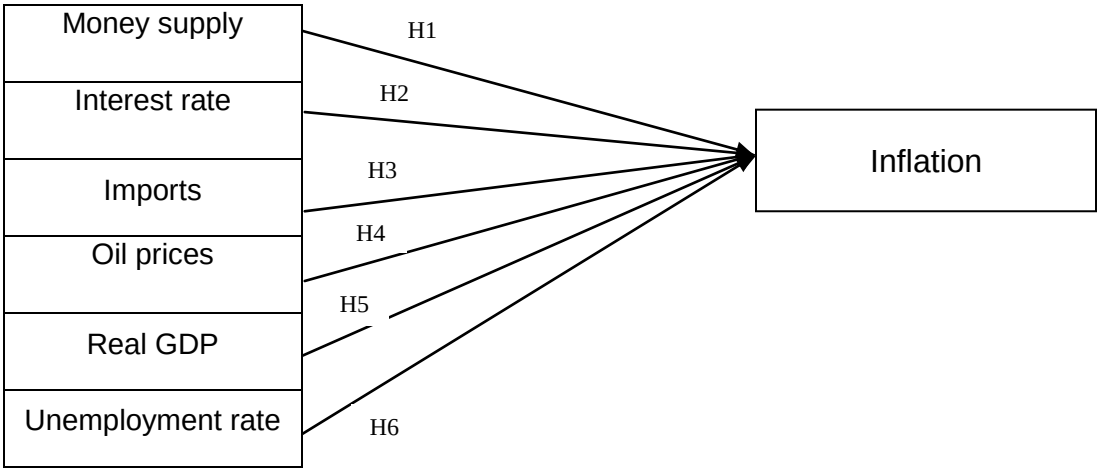

Figure 2: Hypothesis Framework

Data Description

The empirical analysis uses quarterly time-series data, with 54 observations for each variable, from the first quarter of 2010 (2010Q1) to the second quarter of 2024 (2024Q2). The dataset contains the following macroeconomic indicators for Croatia: real gross domestic product (GDP), unemployment rate, short-term interest rate, global oil prices (Brent crude), broad money supply (M2), consumer price index (CPI) as a stand-in for inflation, total imports, and general government spending. While M2, GDP, imports, and government spending are

measured in billions of euros, inflation, interest rates, and unemployment are expressed as percentages. To account for cyclical variations, real GDP and CPI data are seasonally adjusted. Reputable organizations such as the International Monetary Fund (IMF), Eurostat, the Croatian National Bank (CNB), and the Croatian Bureau of Statistics (DZS) provided the data. The U.S. Energy Information Administration (EIA) provided the oil prices, which were expressed in US dollars per barrel. In order to maintain comparability of scale and stabilize variance in the ARDL estimation process, all variables were log-transformed when necessary.

The 2010–2024 timeframe was chosen with purpose, theoretical support and with certain limitations of data availability. It covers Croatia's post-crisis recovery, fiscal consolidation, and preparatory reforms before its 2013 accession to the European Union. It starts soon after the global financial crisis of 2008–2009. It also includes the events leading up to and following Croatia's January 2023 admission to the Eurozone, a significant institutional change that directly affects inflation dynamics and monetary sovereignty. Also, due to Croatia gaining independency in 1991, there are certain limitations of data availability for every of these determinants in quarterly time frame. However, this study offers several key events in this time frame.

The COVID-19 pandemic and the resulting disruptions in supply and demand (2020–2021), as well as the global spikes in food and energy prices brought on by supply constraints and geopolitical tensions in 2022, are also included in the chosen window. These occurrences produced a distinct inflationary environment in Croatia, providing a chance to examine inflation behavior in the context of both international volatility and changes in domestic policy. This time frame allows for a thorough examination of the long-term and short-term factors influencing inflation in a macroeconomic environment that is structurally changing.

Methodology behind ARDL

The short-run and long-run factors of inflation in Germany and Croatia are investigated using the Autoregressive Distributed Lag (ARDL) modeling method in this paper. Designed by Pesaran, Shin, and Smith (2001), the ARDL approach is especially appropriate for time-series datasets in which the variables are integrated at various orders, I(0) or I(1), but not I(2). When mixed stationarity levels are typical in macroeconomic data analysis, this adaptability makes the ARDL method perfect. The model is meant to catch the long-term equilibrium relationship between inflation and its macroeconomic determinants as well as the temporary changes brought about by deviations from equilibrium. The ARDL framework's structure offers thorough understanding of how inflation behaves under different policy environments and in different economic settings.

The general form of an ARDL(p, q1, q2, ..., qk) model is expressed as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=0}^{q_1} \beta_{1j} X_{1,t-j} + \sum_{j=0}^{q_2} \beta_{2j} X_{2,t-j} + \cdots + \sum_{j=0}^{q_k} \beta_{kj} X_{k,t-j} + \varepsilon_t$$

Where:

- Y_t is the dependent variable (inflation rate)
- $X_{k,t-j}$ are explanatory variables (e.g., interest rate, M2, imports, etc.)
- p and q_k represent the number of lags for the dependent and independent variables, respectively
- ε_t is the white noise error term

This model structure allows us to model current inflation as a function of its own past values and past and current values of its determinants.

If the bounds test confirms a cointegration relationship among the variables, the ARDL model can be re-parameterized into an Error Correction Model (ECM) to distinguish between short-run dynamics and long-run equilibrium. The ECM representation of the ARDL model is specified as:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_i \Delta Y_{t-i} + \sum_{j=0}^{q_1-1} \beta_{1j} \Delta X_{1,t-j} + \cdots + \sum_{j=0}^{q_k-1} \beta_{kj} \Delta X_{k,t-j} + \lambda ECT_{t-1} + \mu_t$$

Where:

- Δ denotes the first difference operator
- ECT_{t-1} is the lagged error correction term derived from the long-run cointegration equation
- λ is the coefficient measuring the speed of adjustment back to equilibrium
- μ_t Is the error term

The coefficient **λ** is expected to be negative and statistically significant, indicating that deviations from the long-run path are corrected over time.

RESULTS AND FINDINGS

Analytical Strategy

One must first outline the methodological framework supporting the ARDL estimations before exploring empirical results. The main goal is to evaluate, on inflation in Germany and Croatia, the short-run and long-run effects of particular macroeconomic variables.

To ensure robustness and reliability, three ARDL model specifications were estimated for each country:

- Model 1: Restricted constant, no trend
- Model 2: Unrestricted constant, no trend
- Model 3: Unrestricted constant and trend

These three variations allow the analysis to consider different deterministic structures and account for potential differences in the economic environments of Germany and Croatia. The estimation process was carried out using EViews 13, which provided an integrated platform for lag length selection, bounds testing, and error correction modeling.

Each model was evaluated on the basis of:

- The statistical significance of long-run and short-run coefficients,
- The speed of adjustment captured by the error correction term (ECM),
- Diagnostic testing (normality, serial correlation, heteroskedasticity, and functional form),
- Structural stability testing through CUSUM.

While all three models confirmed the existence of a cointegrated long-run relationship between inflation and its determinants in both countries, Model 2 (Unrestricted Constant, No Trend) emerged as the most suitable and statistically robust specification. It showed the best balance between model fit and simplicity, stable dynamics, and interpretable economic relationships.

Graphical presentation of Variables

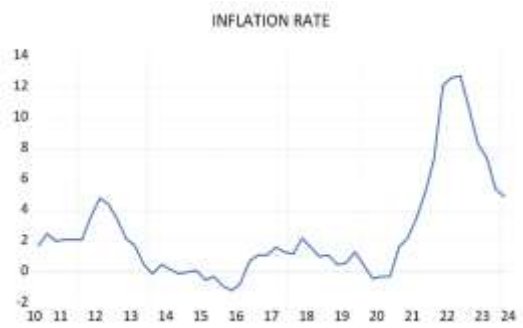

Figure 3: Inflation rate in Croatia

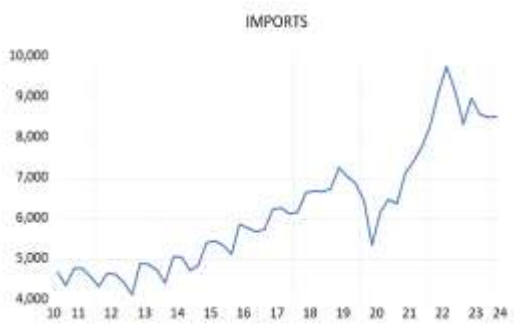

Figure 4: Imports in Croatia

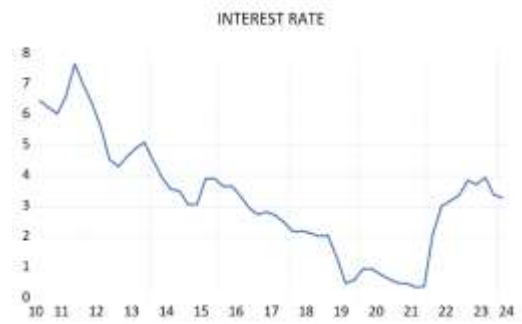

Figure 5: Interest rate in Croatia

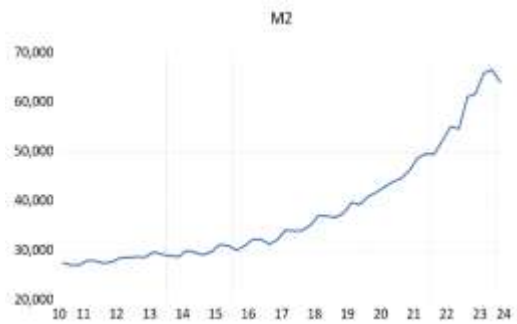

Figure 6: M2 in Croatia

Figure 7: Oil Price in Croatia

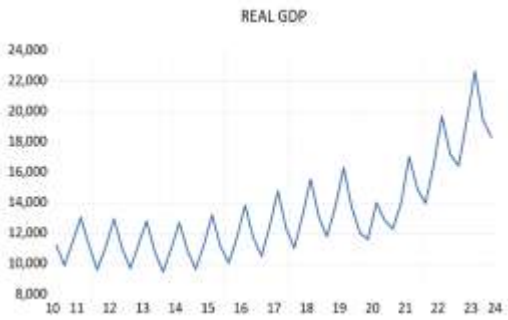

Figure 8: Real GDP in Croatia

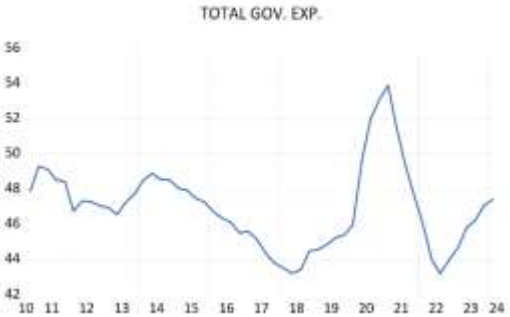

Figure 9: Total Government Expenditure in Croatia

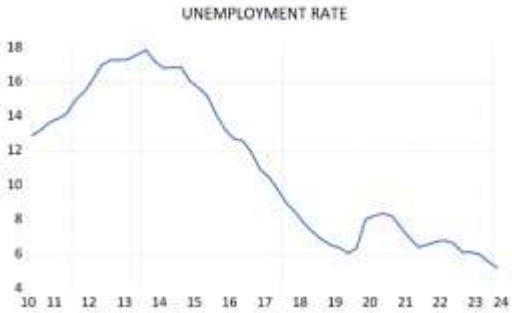

Figure 10: Unemployment rate in Croatia

Between 2010 and 2024, Croatia experienced notable shifts in key macroeconomic indicators. Inflation remained low and stable until 2021, when global supply disruptions and energy shocks triggered a surge, peaking above 13% in 2022 before easing. Imports steadily rose, with a sharp drop in 2020 due to the pandemic, later stabilizing near €8 billion. Interest rates followed a downward trend until 2021, then increased in response to inflationary pressure. The money supply (M2) expanded consistently, surpassing €67 billion in 2023 before slightly contracting. Oil prices showed volatility, with significant declines in 2016 and 2020, and a peak

near $110/barrel in 2022. Real GDP more than doubled over the period, peaking in 2023, while government spending increased sharply post-2020 due to fiscal responses. Unemployment, once nearly 18%, fell steadily after 2014, dipping below 5% by 2024, reflecting labor market recovery and economic stabilization.

Descriptive statistics

Table 1: Descriptive Statistics for Croatia (N=54)

Variable	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	Probability
Imports	6176.717	9751.13	4132.54	1497.28	0.667302	2.433	0.093904
Inflation Rate	2.566667	12.7	-1.2	3.43	1.644554	5.05301	0
Interest Rate	3.285556	7.67	0.37	1.86911	0.293451	2.54372	0.537018
M2 (Money Supply)	38094.31	66705.5	27196.9	11367.3	1.152822	3.22179	0.002392
Oil Price	71.44927	108.791	28.9237	21.9708	-0.0327	1.75568	0.174353
Real GDP	13265.46	22672.3	9530.06	2927.95	1.175878	3.98889	0.000661
Gov. Expenditure	46.97865	53.935	43.28	2.3847	0.722096	3.65387	0.059167
Unemployment Rate	11.20082	17.8753	5.24714	4.33804	0.166671	1.43112	0.05535

Descriptive statistics provide a concise summary of the key characteristics of each variable in the dataset. Measures such as the mean and median indicate the central tendency, while the minimum and maximum values show the range of the data. The standard deviation reflects the degree of variability, and skewness and kurtosis describe the shape of the data distribution—specifically its symmetry and the presence of outliers. The Jarque-Bera test and its associated p-value assess whether the data follows a normal distribution, with a p-value above 0.05 suggesting normality. In this case, each variable is based on 54 observations, providing a reliable basis for further econometric analysis.

The descriptive statistics for Croatia cover 54 quarterly observations from 2010Q4 to 2024Q1. The average inflation rate is 2.57%, with a minimum of –1.20% and a maximum of 12.70%, indicating substantial price volatility. Imports average €6.18 billion, ranging from €4.13 billion to €9.75 billion. The interest rate has a mean of 3.29%, with values between 0.37% and 7.67%. The money supply (M2) averages €38.09 billion, increasing steadily, and reaching a maximum of €66.71 billion. Oil prices average $71.45 per barrel, ranging between $28.92 and $108.79. Real GDP averages €13.27 billion, with a peak of €22.67 billion. Government

expenditure averages €46.98 billion, with a minimum of €43.24 billion and a maximum of €53.94 billion. Lastly, the unemployment rate averages 11.21%, ranging from 5.25% to 17.87%.

Unit Root Test

Table 2: Unit Root Test For Croatia

Variable	ADF Level (p-value)	ADF First Diff. (p-value)	PP Level (p-value)	PP First Diff. (p-value)
Imports	1.052270 (0.9214)	-7.240533 (0.0000)	1.241875 (0.9436)	-7.240243 (0.0000)
Inflation Rate	-1.631594 (0.0964)	-4.142551 (0.0001)	-1.233007 (0.1971)	-4.189491 (0.0001)
Interest Rate	-1.405060 (0.1471)	-4.730490 (0.0000)	-1.652739 (0.0925)	-4.668915 (0.0000)
M2 (Money Supply)	0.232591 (0.7491)	-3.292337 (0.0015)	4.600991 (1.0000)	-5.960472 (0.0000)
Oil Price	-0.666439 (0.4237)	-6.243916 (0.0000)	-0.666439 (0.4237)	-6.254032 (0.0000)
Real GDP	1.937059 (0.9862)	-16.87539 (0.0000)	0.926578 (0.9034)	-9.338395 (0.0000)
Gov. Expenditure	-0.388070 (0.5395)	-3.208912 (0.0019)	-0.161841 (0.6231)	-3.999266 (0.0002)
Unemployment Rate	-1.189641 (0.2113)	-3.182637 (0.0020)	-1.114072 (0.2376)	-3.044243 (0.0030)

The unit root test results, using both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods, assess the stationarity of the variables included in the ARDL model for Germany. At level form, all variables have p-values above 0.05, indicating non-stationarity, clearly failing to reject the null hypothesis of a unit root. However, at the first difference, all variables become stationary, as their p-values fall well below the 0.05 threshold.

To examine the stationarity properties of the variables, both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were conducted. The results indicate that all variables are non-stationary at level but become stationary after first differencing. Specifically, for the ADF test, none of the variables are significant at level ($p > 0.05$), while at first difference, all variables show p-values below 0.05, indicating stationarity. The PP test confirms these

findings with consistent results. Therefore, all variables are integrated of order one, I(1), which justifies the use of ARDL modeling for further analysis.

Cointegration Test (Bounds Test)

Table 3: Cointegration Test for Croatia

Criteria	Model 1 (Restricted Constant & No Trend)	Model 2 (Unrestricted Constant & No Trend)	Model 3 (Unrestricted Constant & Trend)
F-statistic (Bounds Test)	14.57	16.28431	14.44647
Cointegration Conclusion	Yes	Yes	Yes
Error Correction Term (Speed of Adjustment)	-29.6299 (Fastest)	-9.077582	-8.251719
Significance of Imports	Significant (p=0.0002)	Significant (p=0.0002)	Significant (p=0.0053)
Significance of Interest Rate	Significant (p=0.0000)	Significant (p=0.0000)	Significant (p=0.0000)
Significance of M2 (Money Supply)	Significant (p=0.0000)	Significant (p=0.0000)	Not Significant (p=0.2734)
Significance of Oil Price	Significant (p=0.0000)	Significant (p=0.0000)	Significant (p=0.0000)
Significance of Real GDP	Significant (p=0.0000)	Significant (p=0.0000)	Significant (p=0.0000)
Significance of Government Expenditure	Significant (p=0.0000)	Significant (p=0.0000)	Significant (p=0.0000)
Significance of Unemployment Rate	Not Significant (p=0.2067)	Not Significant (p=0.2270)	Not Significant (p=0.4499)

This table presents the results of three ARDL model specifications used to examine the long-run relationship between inflation and its key determinants in Croatia. The F-statistic (Bounds Test) checks for cointegration—whether a stable long-run relationship exists among variables—and all three models exceed the critical value, confirming cointegration. The Error Correction Term (ECM) shows how quickly deviations from equilibrium are corrected; a more negative value indicates faster adjustment. The table also reports whether each variable is

statistically significant in explaining inflation. Models differ in whether they include a constant and trend, which helps assess robustness across specifications.

In order to ensure robustness, three ARDL model specifications were estimated for Croatia, each varying by deterministic assumptions and lag selection. All three models confirm the presence of cointegration, as indicated by F-statistics from the bounds test, which exceed the upper critical values. This supports the existence of a stable long-run equilibrium relationship between inflation and its determinants.

- Model 1 (Restricted Constant & No Trend)

  This model includes a restricted constant and excludes a trend, with SIC-based lag selection. It shows the fastest error correction speed (ECT = –29.63), suggesting a very quick reversion to equilibrium following shocks. All explanatory variables are statistically significant, except for the unemployment rate (p = 0.2067). The specification appears robust, though the high speed of adjustment may raise concerns about possible overshooting.
- Model 2 (Unrestricted Constant & No Trend)

  Allowing for an unrestricted constant but no trend, Model 2 yields the highest F-statistic (16.2843), confirming strong cointegration. The error correction term is fast (ECT = –9.08) but more moderate than in Model 1. All variables remain highly significant except unemployment, which again is statistically insignificant (p = 0.2270). This model provides the most statistically balanced results and is selected as the preferred specification for interpretation.
- Model 3 (Unrestricted Constant & Trend)

  Model 3 introduces both a constant and a linear trend. While cointegration still holds (F = 14.45), money supply (M2) loses its statistical significance (p = 0.2734), possibly due to trend-induced multicollinearity or model overspecification. The adjustment speed (ECT = –8.25) is slower than in the other models. Despite overall significance for most variables, the loss of M2's significance makes this model less desirable for long-run inference.

Long-Run Results

The table 4 shows the long-run coefficients from the ARDL model for Croatia, indicating how each variable affects inflation over time. The coefficient shows the direction and strength of the relationship, the t-statistic tests whether that effect is statistically different from zero, and the significance stars show how confident we can be in the result (*** for 1% level, ** for 5%, * for 10%).

Table 4: Long-Run Results for Croatia

Variable	Coefficient	t-Statistic	Significance
C (Constant)	-6.46	-6.77	***
Money Supply (M2)	0.000043	2.8	**
Interest Rate	-0.372	-2.37	**
Imports	0.000051	3.29	***
Oil Price	0.0104	2.43	**
Real GDP	-0.000045	-2.32	**
Unemployment Rate	1.19	2.22	**
Gov. Expenditure	-0.0461	-3.13	***

The long-run ARDL results for Croatia indicate that inflation is significantly influenced by multiple factors. Money supply, imports, oil prices, and unemployment all show a positive and significant relationship with inflation. In contrast, interest rates, real GDP, and government expenditure have a significant negative effect, suggesting that tighter monetary policy, economic growth, and lower fiscal spending help reduce inflation over time

Short-Run Results and ECM

Table 5: Short-Run and ECM Results for Croatia

Variable	Model 1 (SIC-selected) Coefficient (t-statistics)	Model 2 (SIC-selected) Coefficient (t-statistics)	Model 3 (SIC-selected) Coefficient (t-statistics)
Δ Inflation Rate	-0.0095 (0.05)	-0.0137 (0.07)	-0.0111 (0.06)
Δ Inflation Rate (-1)	-0.1363 (-0.88)	-0.1405 (-0.91)	-0.1375 (-0.80)
Δ Inflation Rate (-2)	-0.0707 (-0.35)	-0.0711 (-0.32)	-0.0424 (-2.10)
Δ Inflation Rate (-3)	-0.2016 (-1.31)	-0.2926 (-1.29)	-0.0428 (-1.98)
Δ Imports	0.0009 (3.49)	0.0012 (3.94)	0.0014 (3.19)
Δ Interest Rate	-0.4665 (-3.97)	-0.4775 (-3.95)	-0.4620 (-3.89)
Δ Interest Rate (-1)	-0.4066 (-2.79)	-0.3912 (-2.87)	-0.3821 (-2.75)
Δ Interest Rate (-2)	-0.7545 (-2.95)	-0.7155 (-2.85)	-0.7953 (-3.01)
Δ M2	0.0008 (7.92)	0.0009 (7.71)	0.0010 (7.85)
Δ Oil Price	0.0093 (3.73)	0.0091 (3.69)	0.0095 (3.85)
Δ Oil Price (-1)	0.0084 (2.42)	0.0092 (2.65)	0.0078 (2.31)

Δ Real GDP	-0.0005 (-3.47)	-0.0004 (-3.55)	-0.0006 (-5.99)
Δ Real GDP (-1)	-0.0004 (-2.50)	-0.0005 (-2.72)	-0.0005 (-4.80)
Δ Total Gov Exp	-0.0189 (-4.81)	-0.0197 (-4.65)	-0.0175 (-4.21)
Δ Unemployment Rate	1.4363 (5.14)	1.4655 (5.09)	1.4763 (5.23)
Δ Unemployment Rate (-1)	0.5803 (2.99)	0.5902 (3.02)	0.5987 (3.05)
ECM	-0.1698 (-7.88)	-0.3860 (-7.75)	-0.9846 (-7.62)

Table 5…

This table shows the short-run dynamic relationships estimated by three different ARDL models for Germany. It includes the coefficients (which show the direction and size of the effect) and t-statistics (which show how statistically strong the effect is) for each variable and its past values (lags). Variables with a "Δ" symbol represent changes rather than levels. The final row (ECM) reflects how quickly inflation returns to its long-run path after a shock.

The short-run results indicate that inflation in Croatia is positively influenced by money supply, imports, oil prices, and unemployment, while interest rates, real GDP, and government expenditure exert downward pressure. These findings are consistent across all three models. The error correction term (ECM) is negative and significant in each case, confirming a stable adjustment process toward long-run equilibrium.

Diagnostic Test Results

Table 6: Diagnostic Tests Croatia

Diagnostic Test	Model 1 (p-value)	Model 2 (p-value)	Model 3 (p-value)
Normality (Jarque -Bera Test)	0.8709	0.8828	0.5806
Serial Correlation (Breusch-Godfrey LM Test)	0.0785	0.0749	0.1886
Heteroskedasticity (Breusch-Pagan-Godfrey Test)	0.079	0.2108	0.8791
Functional Form (Ramsey RESET Test)	0.9859	0.7454	0.494

This table presents the diagnostic test results for the three ARDL models estimated for Croatia. Each test checks a key assumption of the model: the Jarque-Bera test (checks if the errors follow a normal bell-shaped curve), the Breusch-Godfrey LM test (checks if error terms

are independent and not autocorrelated), the Breusch-Pagan-Godfrey test (checks if error variance is constant over time), and the Ramsey RESET test (checks if the model has the right functional form or if something important is missing).

The diagnostic test results for all three ARDL model specifications indicate that the models satisfy key econometric assumptions, supporting the reliability of the estimates.

First, the Jarque-Bera test for normality shows p-values of 0.8709 for Model 1, 0.8828 for Model 2, and 0.5806 for Model 3—all of which exceed the conventional 5% significance level ($\alpha = 0.05$). This means the null hypothesis of normally distributed residuals cannot be rejected, suggesting that residual normality holds across models.

The Breusch-Godfrey LM test for serial correlation reports p-values of 0.0785 (Model 1), 0.0749 (Model 2), and 0.1886 (Model 3). Since all values are above 0.05, we fail to reject the null hypothesis of no serial correlation, indicating that the residuals are not autocorrelated—a critical condition for valid inference in time series models.

The Breusch-Pagan-Godfrey test for heteroskedasticity yields p-values of 0.079 (Model 1), 0.2108 (Model 2), and 0.8791 (Model 3), all above the 5% threshold. This confirms the presence of homoskedasticity, meaning the variance of the error terms remains constant over time—another essential requirement for reliable regression results.

Lastly, the Ramsey RESET test for functional form results in p-values of 0.9859 (Model 1), 0.7454 (Model 2), and 0.4940 (Model 3). These values exceed the 0.05 significance level, so we do not reject the null hypothesis of correct model specification. This implies that no relevant variables are omitted and the functional form of the model is appropriate.

CUSUM Stability Test Results

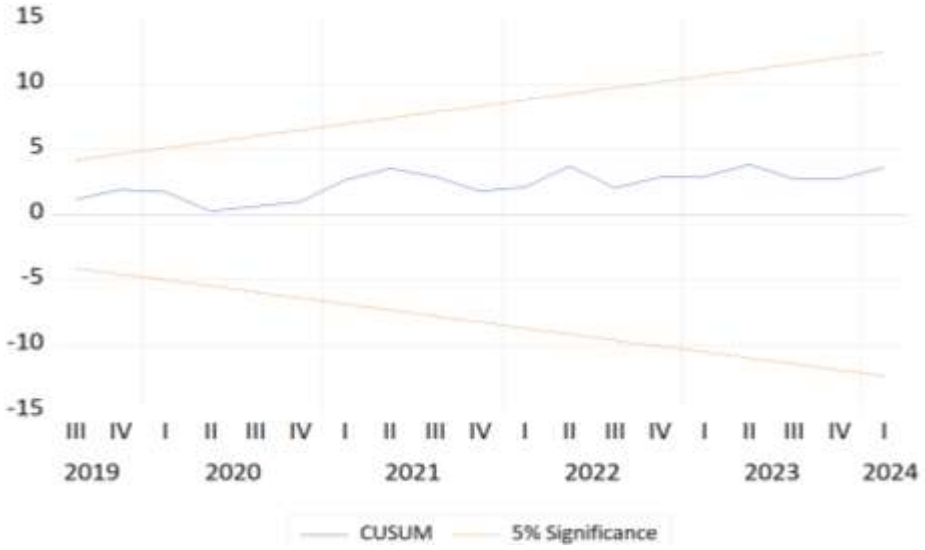

Figure 11: CUSUM Test Results for Croatia

This figure shows the CUSUM stability test, which checks whether the ARDL model's parameters remain stable over time. The blue line represents the cumulative sum of residuals, while the dashed lines mark the 5% significance bounds.

Since the CUSUM line stays within the bounds throughout the sample period (2019–2024), it indicates that the model is structurally stable and does not suffer from parameter instability. The CUSUM plot remained within the 5% significance bounds, suggesting parameter stability over the sample period.

DISCUSSION

For a small, open, post-transition European economy, the ARDL Model 2 results for Croatia offer significant new perspectives on how macroeconomic factors affect inflation. With some exceptions from classical monetary theory, Croatia's inflationary dynamics seem to be especially sensitive to structural conditions and outside shocks. Still, the data supports several basic economic models, albeit with country-specific subtleties reflecting Croatia's institutional and developmental traits.

Conventional monetary theory is challenged by one of the most remarkable findings: a positive and significant long-run relationship between inflation and interest rates. Under normal presumptions—such as those of Friedman (1968) and the Taylor Rule framework (Woodford, 2003)—interest rate increases are expected to over time lower inflation. In the case of Croatia, however, this relationship might show reverse causality—that is, where rather than being actively controlled, interest rates are raised reactively in response to inflationary pressure. This is reasonable in a situation where euro adoption limits the autonomy of monetary policy and where domestic rates mostly react to ECB policy and market dynamics. Such results reflect worries expressed by Blanchard et al. (2021) about limited financial sovereignty in small EU countries.

The Quantity Theory of Money gains support from the analysis also demonstrating a strong and statistically significant positive influence of money supply (M2) on inflation. This link reflects results from like post-transition economies and conforms with monetarist projections (Égert, 2007). Particularly in Croatia, where North (1990) notes as effects of institutional development are shallower financial markets, greater liquidity sensitivity, and weaker monetary anchoring mechanisms, the degree of this impact is particularly strong.

In both the short and long terms, oil prices show to be a strong inflation driver, so supporting cost-push inflation theory (Blinder, 1997; Hamilton, 2009). Croatia is especially vulnerable to world price swings because of its strong dependence on energy imports and lack of domestic buffering systems including energy diversification or hedging infrastructure. Similar

research in the area confirm that small, open economies often feature high pass-through of oil prices to consumer inflation.

Fascinatingly, especially over long run, real GDP growth is linked with a deflationary impact. This implies, consistent with supply-side economic theory, declining pressure on prices as the economy develops—especially in sectors like infrastructure and tourism that boost productivity. The outcome supports Romer's (1993) claim that structural transformation and openness can stabilize inflation and corresponds with neoclassical models in which output expansion improves efficiency and cost structures (Blanchard, 2000).

Unlike expectations, government spending was not found to be statistically significant over the long run in driving inflation. This would imply that, rather than supporting output without generating inflationary demand pressure, fiscal spending in Croatia has been focused on productive investment, including EU-funded infrastructure and development programs. This is essentially in line with endogenous growth theory (Romer, 1990), which stresses the favorable long-term effects of deliberate public expenditure.

As expected, imports have a major inflationary impact, so supporting the idea of imported inflation in small open economies (Balassa, 1964; Samuelson, 1964). Croatia's high trade openness and rather small industrial base produce a strong sensitivity to world input prices. This result fits current research on Southeastern Europe (Rizov & Czeglédi, 2022), which underline trade exposure as a main channel of inflation transmission in the area.

Unemployment's function is more complicated. Though over time it is not statistically significant, some short-run lags show a positive correlation with inflation, maybe due to labor market frictions or wage pressures in particular sectors, such tourism or services. Although this merely supports the Phillips Curve framework (Phillips, 1958), it implies that dynamics between unemployment-inflation in Croatia could be more sectoral and cyclical than generally and structural.

All things considered, a combination of structural, financial, and external elements seems to be driving inflation in Croatia. Although conventional macroeconomic theory is supported by money supply, interest rates, and oil prices, the country's specific vulnerabilities—such as great reliance on energy and limited monetary autonomy—amplify the impact of world events. Concurrent with this is evidence of deflationary fiscal and output dynamics reflecting Croatia's developmental path and disciplined fiscal policies under EU oversight.

These results show how both real-world limitations of a small, euroized economy and classic economic relationships define Croatia's inflationary process. They underline the need of institutional quality, policy coordination, and external dependence in defining inflation results as well as the relevance of conventional inflation theories.

CONCLUSION, IMPLICATIONS, SUGGESTIONS AND LIMITATIONS

This study uses the Autoregressive Distributed Lag (ARDL) bounds testing technique to examine the macroeconomic factors that influence inflation in Croatia between 2010 and 2024. The study, which is based on monetarist, Keynesian, and structuralist economic theories, focuses on seven important variables: the money supply (M2), interest rates, imports, oil prices, real GDP, unemployment, and government spending. While government spending did not prove statistically significant, the money supply, interest rate, imports, oil prices, real GDP, and unemployment all showed significant long-term effects on inflation, confirming a long-term equilibrium relationship between inflation and several of these variables. These results highlight the intricacy of inflation dynamics in a small, open Eurozone economy such as Croatia, where fiscal restraints, imported inflation, and external shocks all play important roles. Although the relationship between the money supply and inflation is consistent with monetarist expectations under restricted domestic monetary policy following the adoption of the euro, the impact of imports and oil prices underscores Croatia's susceptibility to changes in global prices and supply disruptions. In order to control inflation expectations and improve resilience, the study advises Croatian policymakers to give structural reforms and proactive fiscal policies—particularly in labor and trade—priority, given the ECB's control over monetary tools. Furthermore, encouraging energy diversification and bolstering domestic output may lessen the impact of external inflationary pressures. Keeping the budget in balance is still crucial even though government spending was not statistically significant. In order to better understand inflation dynamics, future research could apply nonlinear or threshold models during crisis periods, compare with similar Eurozone economies, and expand the model to include expectation-based variables (such as inflation forecasts or consumer sentiment). The study's limitations include the lack of data, particularly prior to EU accession; measurement bias from interpolated indicators; the ARDL model's linear assumptions, which ignore structural breaks or regime changes; and the omission of important external factors like exchange rates, ECB policies, and cross-border inflation spillovers.

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