Inflation under a Currency Board: The Bulgarian Experience

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Abstract: The objective of this paper is to study inflation in Bulgaria under a currency board. The theoretical fundamentals of inflation are systematized. The empirical investigations on inflation in Bulgaria under a currency board are reviewed. The determinants of inflation in Bulgaria under a currency board are identified. A vector autoregression model is specified to forecast inflation and analyze the efficiency of two macroeconomic instruments (the government’s fiscal reserve and the central bank’s minimum reserve requirements) in managing inflation. The empirical results imply that Bulgaria’s inflation is influenced by its past values and the previous values of oil prices, the Euro area’s inflation and the Bulgarian central bank’s minimum reserve requirements. The only macroeconomic instrument Bulgarian policymakers can use to impact on inflation are the minimum required reserves of commercial banks. Since the minimum reserve requirements lack the dose effect, the reversibility and the flexibility of other monetary tools, their use is recommended in heavy crises only and when no other options are available.

1. INTRODUCTION

During energy and price crises, inflation becomes a painful social problem and a key issue of macroeconomic management. Policymakers in a small open economy under a currency board, such as the Bulgarian one, have limited opportunities for harnessing inflation. They are deprived by the open-market operations, the base interest rate and the exchange rate policy. However, Bulgarian policymakers can raise the fiscal reserve of the government and the minimum reserve requirements of the Bulgarian National Bank (BNB), thus decreasing the money supply and possibly the inflation rate.

In economic theory, three types of inflation are known - demand-pull, cost-push and structural. The first type of inflation results from demand-side factors, which can be real (unsatisfied demand) and monetary (excessive monetary expansion). Real inflationary factors on the demand side appear when GDP is above its potential level (inflationary gap). Monetary sources of inflation exist if the growth rate of the money supply exceeds the growth rate of potential output.

The second type of inflation is caused by adverse shocks in aggregate supply (a decrease in the quantity and quality of production factors, an increase in the costs of inputs and a drop in productivity), which shift the aggregate supply curve to the left and lead to stagflation. Stagflation is a combination of stagnation (a decline in output) and inflation (a rise in price level).

The third type of inflation arises from real convergence (reduction of economic disparities between more developed and less developed countries) and/or changes in the structure of relative

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prices of individual goods and services in the economy, stemming from various factors - political, social, economic, environmental and technological.

Each type of inflation requires specific measures tailored to its cause. Demand-pull inflation implies a restrictive monetary policy. In the conditions of the Bulgarian currency board, this can be achieved by increasing the government deposit in the Issue Department of the BNB or the minimum required reserves of commercial banks. However, monetary restrictions are extremely risky in the present situation, as they could deepen the crisis.

Cost-push inflation can be overcome by long-term policies for increasing the quantity and quality of factors of production such as investing in infrastructure, education, research and innovation. In the event of an energy crisis, this means territorial diversification of energy supplies and investments in new energy sources and technologies for reducing the price of energy and ensuring sufficient energy supply. The current energy and price crisis cannot be resolved at the national (macroeconomic) level, but only at the communitarian (European) level through the joint efforts of the member states and the institutions of the European Union (EU).

Structural inflation can be a natural economic phenomenon or artificially caused by targeted national and supranational policies, such as the EU Green Deal. In the second case, funds should be provided not only to achieve the goal of these policies but also to overcome their negative side effects (loss of jobs, rising prices of vital goods and services, impoverishment, reduced competitiveness, etc.).

The goal of this research is to investigate inflation in Bulgaria under a currency board. The objective of the study is achieved by the fulfillment of the following tasks:

- Systematization of the theoretical foundations of inflation (section 1);
- Review of empirical literature on inflation in Bulgaria under a currency board (section 2);
- Empirical analysis of inflation in Bulgaria under a currency board (section 3);
- Formulation of advisable anti-inflationary policies for Bulgaria under a currency board (conclusion).

The empirical analysis employs a vector autoregression and monthly seasonally adjusted data for the inflation in Bulgaria and the Euro area, the Bulgarian government’s fiscal reserve, the minimum reserve requirements and the representative prices of crude oil and natural gas obtained from the Eurostat, the BNB and the Federal Reserve websites.

### 2. THEORETICAL FOUNDATIONS OF INFLATION

Inflation is a complex process. Factors that lead to inflation are monetary, demand factors, supply factors and structural factors (Totonchi, 2011). Therefore, inflation is a function of the interaction of several factors. It follows that inflation is a complex macroeconomic and institutional phenomenon (Kibritçioglu, 2002).

Inflation and the inflation process are described by the quantitative theory of money. According to Irving Fisher, many authors, such as Locke, Hume, Adam Smith, Ricardo, Mill, Walker, Marshall, Hadley, Fetter, and Kemmerer, assume that prices depend on the amount of money (Fisher, 1920, p. 14). The direct relationship between the quantity of money and prices is argued by David Hume (Hume, 1752). Also, Hume argues that limiting the amount of money leads to lower labor
costs (Hume, 1752, p. 29). The relationship between the amount of money and the price of labor by Hume, respectively, leads to a relationship between the amount of money and unemployment. The relationship between labor costs and unemployment is also examined by A. W. Phillips (Phillips, 1958), who argued that increasing wages would reduce unemployment but increase prices. Thus, the theses of Hume and Phillips correspond to each other, because the increase in the amount of money is associated with both an increase in wages and an increase in prices.

Fisher points out that inflation depends on three main factors. Factors on which inflation depends are the amount of money in circulation, the velocity of money and the amount of goods that can be purchased with the amount of money in circulation (Fisher, 1920, p. 14). Fisher builds on the understanding of Locke, Hume, Adam Smith, Ricardo, Mill, Walker, Marshall, Hadley, Fetter, and Kemmerer that the price level changes in proportion to the amount of money in circulation, adding that this connection is valid when the speed of money in circulation and trade are constant. He derives the following equation $MV = \sum pQ$ (Fisher, 1920, p. 26). Algebraically derived quantitative theory leads to several conclusions. The first conclusion is that at a constant velocity of money ($V$) and a constant quantity of goods ($Q$), a change in the quantity of money ($M$) will lead to a change in prices ($p$). The second conclusion is that with a constant amount of money ($M$) and a constant amount of goods produced ($Q$), but with a change in the velocity of money ($V$) the prices of goods ($p$) will change. The third conclusion is that if the quantity of money ($M$) and the velocity of money ($V$) are constant, but the quantity of goods produced ($Q$) changes. Then the prices will change inversely proportional to the change in the quantity of goods produced (Fisher, 1920). Therefore, both a change in the amount of money in circulation and a change in the velocity of money will lead to a proportional change in prices. While the change in the quantity of goods produced leads to an inversely proportional change in prices.

Fisher, starting the theory of inflation, through the quantitative theory of money allowed to development of two theories of inflation: a monetary theory and a Keynesian theory of inflation. The main difference between Keynesian theory and monetary theory is that monetarists assume that the velocity of money is constant (Friedman, 1959), and Keynesians assume that the velocity of money is variable (Keynes, 2018, p. 272). This difference in the theoretical views of monetarists and Keynesians leads to different interpretations of quantitative theory and, respectively, to different theoretical justifications for the causes that determine inflation.

Milton Friedman (Friedman, 1992) points out that inflation is always caused by a larger increase in the money supply compared to an increase in the quantity of goods produced. It follows that inflation is determined by the money supply, provided that the velocity of money is constant. Therefore, inflation is a monetary phenomenon (Friedman, 1992). M. Friedman and A.J. Schwartz (Friedman & Schwartz, 1963) developed the thesis that in the long run an increase in money supply only leads to an increase in inflation. An increase in the mass of money does not lead to an increase in output. Prolonged inflation, which is a monetary phenomenon in the long run, is accelerated by the government’s policies and government policy decisions. This thesis is developed by Friedman, who points out that the reasons for accelerating inflation are the introduction of a fixed exchange rate, the refusal of governments to increase or impose new taxes and the government’s decision to increase government spending (Friedman, 1974). The fixed exchange rate leads to imports of external inflation. In the case of a currency board, the fixed exchange rate is a mandatory condition, which leads to the import of inflation. The monetary theory of inflation was developed by Phillip Cagan (Cagan, 1987), who stated that hyperinflation is determined not only by rising money supply but also by irrationally adapting inflation expectations. The inflationary expectations of the
economic lambs are adjusting belatedly to the real dynamics of the money supply. He linked the adjustment of inflation expectations to the actual demand and supply of money, arguing that there was a mismatch between inflation expectations and the money supply (Cagan, 1956). Cagan argues that the inflationary expectations of economic agents have a reverse direction of the dynamics of the demand for money (Cagan, 1956). Thomas J. Sargent and Neil Wallace (Sargent & Wallace, 1973) further developed the monetary theory of adaptive expectations of inflation developed by Cagan, based on the condition that adaptive expectations that affect inflation are rational. The catch stems from Cagan's thesis on the inverse relationship between current inflation and future money growth rates. This feedback, according to Sargent & Wallace (Sargent & Wallace, 1973), is a rationality of inflationary adaptive expectations because lagging money production has a limited impact on inflation as opposed to lagging inflation, which has a significant impact on current inflation. In fact, Sargent & Wallace deduce the rationality of adaptive expectations from the logic that an increase in inflation does not lead to an increase in money supply, which means that there will be no significant increase in money supply in the future. Thomas J. Sargent (Sargent, 1977) argues that inflationary adaptive expectations are irrational when the government intervenes and the central bank begins to print money.

Quantitative theory of money is the basis of the theory of demand-pull inflation developed by Keynes. According to John Maynard Keynes (Keynes, 2018, p. 106), real inflation or demand inflation will occur when investment continues to increase when it reaches full employment. Keynes's theory of demand inflation accepted the assumption of the quantitative theory that an increase in the amount of money leads to inflation. However, Keynes considers the relationship between the amount of money and prices at a variable rate of money in circulation. The assumption of the change in the velocity of money in circulation enables Keynes to consider the effect of effective demand on changes in the amount of money and on prices, respectively. Inflation occurs when an increase in wages does not lead to an increase in production. Also, with a change in the velocity of money, if there is an increase in employment and an increase in nominal wages for equipment and declining profitability, prices will rise. Linking the rise in prices with the dynamics of Keynes' nominal wages, he actually puts marginal costs as a factor leading to higher prices. According to Paul Davidson and Sidney Weintraub (Davidson & Weintraub, 1973), when wages change, this will increase the costs of companies and lead to an increase in the price level. The authors argue that the dynamics and size of wages are determined by factors such as competition and monopoly, which are manifested in the market mechanism (Davidson & Weintraub, 1973, pp. 1125-1126). The dynamics and magnitude of inflation depend on the ratio between the increase in wages and the increase in labor productivity (Davidson & Weintraub, 1973, p. 1131). Shultz (1975), Kahn (1984) and Trevithick (1984) accepting the thesis of Davidson and Weintraub take a step forward by pointing out the reason that leads to a constant increase in wages. The reason is the conclusion of employment contracts, which do not allow the reduction of salaries, but only their increase. Robert J. Gordon (Gordon, 1981) cites as an example of structural inflation the entry of three-year contracts that fix wages and the transition from the gold standard to the fiat monetary system. The cost-structural cause of inflation is the frequent change in the costs of companies, which is calculated in the prices of goods (Gordon, 1981, p. 520). Structural inflation occurs when prices do not respond to changes in demand. Gordon points out that a demand reduction will not lead to lower raw material prices and lower wages (Gordon, 1981, pp. 536-527). There is a structural cost gap that leads to inflation.

Structural inflation is caused by the uneven increase in wages relative to labor productivity in different sectors of the economy. Another reason for structural inflation is the different
productivity of labor in each sector of the economy. These are developed by Baumol (1967), Balassa (1964) and Samuelson (1964). Baumol (1967) emphasizes the desire of the less developed sector to equalize wages with the more developed sector, which leads to increased costs. The increase in costs caused by structural disparities between the two sectors will determine inflation. Balassa (1964) divides the economy into two sectors: marketable and non-marketable goods. According to him, the sector of non-tradable goods will have higher prices than the sector of tradable goods, because the prices of tradable goods will be determined by international trade. Balassa (1964) and Samuelson (1964) conclude that rising prices in the tradable sector lead to rising prices in the services sector. This mechanism is realized by increasing labor productivity in the tradable sector.

Scacciavillani (1994) accepts the Cagan equation (Cagan, 1956) as the basis for deriving the factors that cause chronic inflation. Then he synthesized the Cagan equation using the Hamilton and Whiteman method (Hamilton & Whiteman, 1985). Thus, Scacciavillani argues that the dynamics of inflation can be caused by speculative phenomena, which he calls “bubbles”, “sunspots” and “external influences” (Scacciavillani, 1994, p. 1). Speculative phenomena manifest themselves as a difference between the money supply and the price level. Scacciavillani applies the Autoregressive Fractionally Integrated Moving Average, which tests the difference between money supply and price level. Scacciavillani concludes that chronic inflation is a consequence of fiscal imbalance (Scacciavillani, 1994). Scacciavillani manages to measure the expectations that lead to self-fulfilling change that do not correspond to economic logic and theory. Self-sustaining change leads to money bubbles. The fiscal imbalance creates conditions for self-fulfilling change, which leads to the creation of money bubbles.

Authors such as Öniş and Özmcuur (1990) studied inflation in Turkey between 1981 and 1987. They use the Vector Autoregressive model to analyze the interaction between the exchange rate, the money supply and the price level. The main conclusion drawn by Öniş and Özmcuur is that inflation in Turkey between 1981 and 1987 was determined by the combination of exchange rate devaluation and the growth of the monetary base. A different thesis on the causes of inflation in Turkey is presented by Akcay et al. (1996), according to whom the high budget deficit leads to higher inflation. The increase in the budget deficit leads to an increase in inflation through two channels and provided that the central bank does not increase the issue of money. The first channel is increasing the demand for credit, which will push private investment and lead to higher interest rates. The effect will be a reduction in the production of goods and services, which will cause an increase in inflation. The other channel through which the budget deficit can lead to higher inflation is when interest rates rise, which stimulates the financial sector to create new risk-free financial assets that have higher interest rates and have the liquidity of money. Akcay, Alper and Ozmccur apply the Vector Autoregression model and Vector Error Correction, which examine both the long-term and short-term relationship between budget deficit, money in circulation and inflation. The authors conclude that budget deficits lead to an increase in inflation in the long run, through inflation expectations, which are formed by rising prices of one commodity, which leads to a general increase in prices as a consequence of creating an inertial inflation mechanism. A similar thesis is developed by Cheng Hoon Lim and Ms. Laura Papi (Lim & Papi, 1997), who point out that money, the exchange rate, budget deficits, inertia factors, and exchange rate devaluation policies determine inflation. The authors consider the effect of the described variables on inflation in the long and short term. In the long run, the authors measure the impact of money supply, the exchange rate, the budget deficit on inflation, through co-integration. In the short term, Cheng Hoon Lim and Ms. Laura Papi applied least squares regression...
analysis. The empirical conclusion they draw is that the money supply and the exchange rate have the greatest effect on inflation in Turkey. The authors also argue that political intervention by devaluing the exchange rate significantly determines the dynamics of inflation. According to Pierre-Richard Agénor and Alexander Hoffmaister (Agénor & Hoffmaister, 1997), the main causes of inflation are the rising money supply, the devaluation of the currency exchange rate, the growth of nominal wages and the difference between production and inflation. Nominal wage growth is cited as a strong factor influencing inflation dynamics. The method they use to quantify the impact of money supply, nominal wages, exchange rates and output on inflation is a generalized Vector Autoregression model.

The budget deficit is a major factor that provokes rising inflation. According to Luis Catao and Marco Terrones (Catao & Terrones, 2001), reducing the budget deficit by one percentage point leads to a reduction in inflation in the long run by 6 percentage points. The empirical study conducted by Catao and Terrones is characterized by the inclusion of a linearly transformed variable that covers the nonlinear effects between the budget deficit and inflation. In addition to a linearly transformed variable, the study focuses on the long-term effects of the budget deficit on inflation. The linearly transformed variable is the association of the constant component of the budget deficit with the ratio of narrow money to gross domestic product, which ratio expresses the tax base of inflation (Catao & Terrones, 2001, pp. 4-5). The econometric model applied by Catao and Terrones is the Autoregressive Distributed Lag Model, which covers the delay of the dependent and independent variables. Examining the effects of reserve money, broad money, nominal GDP, and budget deficits on inflation in 161 countries, Stanley Fischer, Ratna Sahay, and Carlos A. Végh (Fischer et al., 2002) used regression analysis to draw the following empirical conclusions. Rising money leads to rising inflation. The budget deficit determines the rise in inflation. The increase in money supply has been cited as a reason for high inflation by Muhammad, Zafar and Arfeen (Muhammad et al., 2016), who apply the Autoregressive Distributed Lag Model and Error Correction Model. The main conclusion they draw is that when money increases, the currency depreciates and inflation rises. The authors also point out that when the budget deficit increases, it leads to an increase in inflation. A similar thesis is argued by Gary G. Moser (Moser, 1994), who by regression analysis proves the connection between the increase in the budget deficit, which leads to an increase in the money supply, which leads to an increase in inflation.

Interestingly the empirical study by Michael Sarel (Sarel, 1995), aims to examine the nonlinear relationship between inflation and economic growth. Sarel concludes that inflation, when up to eight percent of its effect on economic growth is from neutral to slightly positive. However, when inflation is above eight percent, the effect on economic growth is strong and negative. In fact, according to Sarel, the eight percent value of inflation is the trajectory of structural refraction of the effect of inflation on economic growth. This structural refraction leads from a neutral-positive effect of inflation on economic growth to a strongly negative effect of inflation on economic growth. Therefore, macroeconomic policies must be implemented, which include policy measures and institutional changes to keep inflation below 8 percent (Sarel, 1995). Sarel applies regression analysis with a dummy variable. The dependent variable is the average GDP growth per capita, and the independent variables are inflation, such as the consumer price index, initial income per capita, population growth rate, government spending as a percentage of GDP and the rate of change in trade conditions. Sarel argues that macroeconomic policy must take as its primary macroeconomic objective the avoidance of high inflation (Sarel, 1995, p. 13).
3. REVIEW OF EMPIRICAL STUDIES ON INFLATION IN BULGARIA UNDER A CURRENCY BOARD

The development of inflation in the conditions of a currency board is characterized by a specific manifestation of inflationary factors and channels on the dynamics of the inflationary process. A major factor in inflation on a currency board basis is the confidence of economic agents in a fixed exchange rate (Hanke & Shuler, 1994). Confidence in the fixed exchange rate is determined by the usefulness of the currency. The usefulness of the currency means that current inflation is low. This creates trust in economic agents for economic predictability and price stability. The future inflation expectations of economic agents are determined by the trust created. Confidence in the fixed exchange rate is created by the usefulness of the reserve currency to which the local currency is fixed. Hanke and Shuler (Hanke & Shuler, 1994) argue that confidence in the local currency is due to low inflation, which is reflected in the reserve currency. Also, interest rate levels are a consequence of interest rates on the reserve currency. However, Hanke and Shuler say that political risk, taxes, and transaction fees can provoke inflation (Hanke & Shuler, 1994). From the developed logic of Hanke and Shuler it can be said that in the conditions of a currency board the introduction of external inflation from the reserve currency is one of the reasons that leads to higher domestic inflation and undermines confidence in the fixed exchange rate. According to Stacie Beck, Jeffrey B. Miller and Mohsen Saad (Beck et al., 2003) in a currency board environment, inflation expectations are determined by the dynamics of the size of monetary aggregates and confidence in government policy and structural gaps between inflation expectations and price behavior. The authors conclude that the factors of inflation in the conditions of the currency board are the state policy, which leads to budget deficits and structural breaks between inflation expectations and the price level. And the mass of money does not have a significant effect on inflation. Stacie Beck, Jeffrey B. Miller and Mohsen Saad, apply Cagan’s hyperinflation model as a theoretical framework, as well as the Vogelsang and Perron model, which covers the structural refraction between inflation expectations and price levels. The econometric technique used by the authors is the method of the smallest squares with a proxy variable.

According to Martin Zaimov and Kalin Hristov (Zaimov & Hristov, 2003), inflation in Bulgaria under the currency board is a consequence of the structure and flexibility of the Bulgarian economy. The authors argue that in the conditions of the currency board inflation in Bulgaria is not caused by monetary factors and inflation expectations do not lead to inflation. Kalin Hristov and Mihail Mihaylov (Hristov & Mihaylov, 2003) argue that the rate of inflation in Bulgaria is determined by the monetary policy of the European Central Bank. In fact, this is an effect of the currency board in which Bulgaria finds itself. The authors further develop their thesis, explaining that inflation in the conditions of a currency board can also be determined by the structure of the economy and its microeconomic characteristics. The microeconomic factors that lead to structural differences are the cost of production and the cost of non-tradable goods. The structure of production costs and the structure of costs of non-tradable goods are factors that determine inflation. Also, the increase in prices on a currency board can be caused by the government’s policy, which by raising taxes can increase the costs of companies, which, in turn, to maintain the rate of profit and increase the prices of their goods. It is clear that in the conditions of a currency board inflation is provoked by real determinants of inflation. Kalin Hristov and Mihail Mihaylov, following the logic of “markup” and using “markup models” as a basis, created a model to argue the rate of change in inflation. The econometric model created by Hristov and Mihaylov is based mainly on the thesis that the profit margin that companies put in leads to an increase in inflation in the conditions of...
a currency board. The set variables in the Hristov and Mihaylov model, which determine inflation in a currency board environment, are energy prices, prices of imported goods and labor costs per unit of output (Hristov & Mihaylov, 2003, p. 11). The econometric technique with which the authors assess the impact of inflationary factors on the dynamics of the inflation process is the equation with error correction (single equation ECM). The econometric results of Hristov and Mihaylov are that non-energy commodity prices, labor costs, the lev-dollar exchange rate, and oil prices lead to higher inflation in a currency board environment (Hristov & Mihaylov, 2003). Apart from import inflation and labor cost inflation, according to Nikolay Nenovski and Kalina Dimitrova (Nenovski & Dimitrova, 2003) inflation in Bulgaria after the introduction of the currency board is determined by the mismatch between money supply and demand, as well as the effectiveness of factors determining production. Inflation under currency board conditions, including inflation in Bulgaria under currency board conditions, is not a consequence of monetary factors. One of the reasons for the inflation in the conditions of the currency board is the firmness of the real wages; another reason is the degree of breakdown of the real economy and the different development of the sectors of the real economy. The main reason for inflation in Bulgaria in terms of the currency board is the discrepancies that are realized between supply and demand in the tradable and non-tradable sectors. Nikolay Nenovský, Victor Yotzov and Kalin Hristov (Nenovský et al., 2000) quantify, using the Vector Autoregression model, the behavior of inflation in the conditions of a currency board and conclude that rising commodity prices and real wages are key factors of inflation in the conditions of a currency board.

Inflation in Bulgaria in the conditions of the currency board is determined by the unbalanced structure of the economy. One of these factors is the prices of non-tradable goods, which tend to approach international prices for services and transport. The dynamics of international prices affect inflation in the conditions of a currency board. Liberalization of prices in the conditions of a currency board leads to an increase in inflation (Choukalev, 2000).

The structure of the Bulgarian currency board is such that the generation of inflation is allowed by reducing the required minimum reserves and reducing the government deposit (Raleva, 2013). When the required minimum reserves decrease, lending goes up, new money is created and the money supply rises. Also, the realization of budget deficits leads to a reduction in government deposits with the central bank, which again leads to an increase in money supply.

4. EMPIRICAL ANALYSIS OF INFLATION IN BULGARIA UNDER A CURRENCY BOARD

4.1. Methodology

The determinants of inflation in Bulgaria and the opportunities for its management are analyzed by a vector autoregression (VAR), which includes the following variables:

- \( \text{INFL}_t \) - rate of change of the Harmonized index of consumer Prices in Bulgaria in month \( t \) compared to the previous month (percent);
- \( \text{INFL}_t \) - rate of change of the Harmonized index of consumer prices in the Euro area in month \( t \) compared to the previous month (in percent);
- \( \text{OIL}_t \) - rate of change of the representative price of crude oil in month \( t \) compared to the previous month (in percent);
- \( \text{GAS}_t \) - rate of change of the representative price of natural gas in month \( t \) compared to the previous month (in percent);
**FISC_RES**, - rate of change of the fiscal reserve of Bulgarian government in month $t$ compared to the previous month (in percent);

**MRR**, - minimum required reserves of commercial banks in Bulgaria (percent from deposits).

The dependent (target) variable is **INFL_BG, INFL_EA, OIL** and **GAS** are factors beyond the control of Bulgarian macroeconomic management. **INFL_EA** can be considered a proxy for two groups of inflation sources - monetary factors on the demand-side and structural factors. **OIL** and **GAS** reflect the supply-side (cost-push) origins of inflation. **FISC_RES** and **MRR** are the macroeconomic tools Bulgarian policymakers can use to affect inflation in Bulgaria.

### 4.2. Data

The VAR uses monthly seasonally adjusted data for the period January 1999 - October 2021. The data sources are Eurostat for the inflation in Bulgaria and the EA, the Federal Reserve Bank of Saint Louis for the prices of crude oil and natural gas and the Bulgarian National Bank for the government’s fiscal reserve and the minimum reserve requirements in Bulgaria.

### 4.3. Results

The group unit tests show that **INFL_BG, INFL_EA, OIL, GAS, FISC_RES** and **MRR** as a group are stationary at level, which implies the construction of an unrestricted VAR model (see Table 1).

#### Table 1. Group unit root test on the level values of INFL_BG, INFL_EA, OIL, GAS, FISC_RES and MRR

<table>
<thead>
<tr>
<th>Method</th>
<th>Statistic</th>
<th>Probability</th>
<th>Cross-sections</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levin, Lin &amp; Chu*</td>
<td>-12.9542</td>
<td>0.0000</td>
<td>6</td>
<td>1636</td>
</tr>
<tr>
<td>Im, Pesaran and Shin W-stat</td>
<td>-27.2926</td>
<td>0.0000</td>
<td>6</td>
<td>1636</td>
</tr>
<tr>
<td>ADF - Fisher Chi-square</td>
<td>448.675</td>
<td>0.0000</td>
<td>6</td>
<td>1636</td>
</tr>
<tr>
<td>PP - Fisher Chi-square</td>
<td>530.632</td>
<td>0.0000</td>
<td>6</td>
<td>1638</td>
</tr>
</tbody>
</table>

* Shows the optimal number of lags according to the respective criterion

The optimal lag length in the VAR is one (See Table 2). The VAR is estimated with one lag (see Table 3). After the step-by-step elimination of insignificant variables **FISC_RES(-1)** and **GAS(-1)**, the results in Table 4 are obtained.

#### Table 2. Test for the optimal number of lags in the VAR

<table>
<thead>
<tr>
<th>Number of lags</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15326.86</td>
<td>26.66462</td>
<td>26.74546</td>
<td>26.69710</td>
</tr>
<tr>
<td>1</td>
<td>464.8549*</td>
<td>23.16891*</td>
<td>23.73473*</td>
<td>23.39622*</td>
</tr>
<tr>
<td>2</td>
<td>494.9788</td>
<td>23.23131</td>
<td>24.28211</td>
<td>23.65346</td>
</tr>
<tr>
<td>3</td>
<td>494.3506</td>
<td>23.22905</td>
<td>24.76483</td>
<td>23.84603</td>
</tr>
<tr>
<td>4</td>
<td>547.0717</td>
<td>23.32850</td>
<td>25.34927</td>
<td>24.14033</td>
</tr>
<tr>
<td>5</td>
<td>600.0691</td>
<td>23.41792</td>
<td>25.92368</td>
<td>24.42458</td>
</tr>
<tr>
<td>6</td>
<td>562.3605</td>
<td>23.4851</td>
<td>26.3925</td>
<td>24.55001</td>
</tr>
<tr>
<td>7</td>
<td>594.1298</td>
<td>23.39719</td>
<td>26.87291</td>
<td>24.79353</td>
</tr>
<tr>
<td>8</td>
<td>647.6885</td>
<td>23.47515</td>
<td>27.43585</td>
<td>25.06632</td>
</tr>
</tbody>
</table>

* Shows the optimal number of lags according to the respective criterion

Source: Authors
The AR roots graph (see Figure 1) shows that the one-lag VAR is stable, all roots are inside the unit circle.

**Table 3.** Results from the econometric estimation of the VAR

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.670994</td>
<td>0.254601</td>
<td>2.635478</td>
<td>0.0089</td>
</tr>
<tr>
<td>INFL BG(-1)</td>
<td>0.285620</td>
<td>0.059543</td>
<td>4.796854</td>
<td>0.0000</td>
</tr>
<tr>
<td>INFL EA(-1)</td>
<td>0.505115</td>
<td>0.184328</td>
<td>2.740301</td>
<td>0.0066</td>
</tr>
<tr>
<td>OIL(-1)</td>
<td>0.014521</td>
<td>0.003264</td>
<td>4.448796</td>
<td>0.0000</td>
</tr>
<tr>
<td>GAS(-1)</td>
<td>0.004060</td>
<td>0.003154</td>
<td>1.287313</td>
<td>0.1991</td>
</tr>
<tr>
<td>FISC RES(-1)</td>
<td>-0.001435</td>
<td>0.002129</td>
<td>-0.674046</td>
<td>0.5009</td>
</tr>
<tr>
<td>MRR(-1)</td>
<td>-0.058086</td>
<td>0.026580</td>
<td>-2.185321</td>
<td>0.0297</td>
</tr>
</tbody>
</table>

**Source:** Authors

**Table 4.** Results from the econometric estimation of the VAR after the step-by-step removal of insignificant variables FISC_RES(-1) and GAS(-1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-Statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.654052</td>
<td>0.254331</td>
<td>2.571650</td>
<td>0.0107</td>
</tr>
<tr>
<td>INFL BG(-1)</td>
<td>0.292382</td>
<td>0.059294</td>
<td>4.931066</td>
<td>0.0000</td>
</tr>
<tr>
<td>INFL EA(-1)</td>
<td>0.517067</td>
<td>0.183598</td>
<td>2.816295</td>
<td>0.0052</td>
</tr>
<tr>
<td>OIL(-1)</td>
<td>0.014987</td>
<td>0.003249</td>
<td>4.613999</td>
<td>0.0000</td>
</tr>
<tr>
<td>MRR(-1)</td>
<td>-0.056321</td>
<td>0.026546</td>
<td>-2.121603</td>
<td>0.0348</td>
</tr>
</tbody>
</table>

**Source:** Authors

The VAR model can be described by the Equation

\[
\text{INFL$_{BG}$} = 0.65 + 0.29\times\text{INFL$_{BG}(-1)$} + 0.52\times\text{INFL$_{EA}(-1)$} + 0.01\times\text{OIL(-1)} - 0.06\times\text{MRR(-1)}
\]  

(1)

The monthly inflation rate in Bulgaria is impacted by its own past values and the previous values of inflation in the Euro area, the minimum reserve requirements of the Bulgarian National Bank, and the crude oil representative price. The signs of all significant regression coefficients
are in agreement with economic theory - positive before \textit{INFL\_BG(-1)}, \textit{INFL\_EA(-1)} and \textit{OIL(-1)}, and negative before \textit{MRR(-1)}. The positive regression coefficients indicate that 1% change in \textit{INFL\_BG(-1)}, \textit{INFL\_EA(-1)} and \textit{OIL(-1)} will lead to a change in \textit{INFL\_BG} in the same direction of respectively 0.29%, 0.52% and 0.14%. The negative regression coefficient shows that 1% change in \textit{MRR(-1)} will cause a change in \textit{INFL\_BG} of 0.06% in the opposite direction.

The value of the coefficient of determination (\(R^2 = 0.26\)) means that 26% of the variation of the inflation in Bulgarian can be explained by changes in the independent variables in Equation 1. The probability of the F-statistic (0.00) shows that the alternative hypothesis of adequacy of the model used is confirmed. It should be made clear that this does not mean that the model is the best possible one but simply that it adequately reflects the relationship between the dependent and independent variables.

The results from the Ramsey test (RESET) - probability of the F-statistic of 0.16, suggest acceptance of the null hypothesis of lack of errors in the specification of Equation (1). The null hypothesis of the absence of a serial correlation of residuals in Equation (1) is confirmed (see Table 5). The results of the heteroscedasticity test on the residuals in Equation (1) (see Table 6) mean that the null hypothesis of non-heteroscedasticity should be accepted.

| Table 5. Results from the serial correlation test on the residuals in Equation (1) | F-statistic | 0.77 | Probability F (1, 267) | 0.38 |
| Observations R-squared | 0.79 | Probability Chi-Square (1) | 0.38 |

\textbf{Source:} Authors

| Table 6. Results from the heteroscedasticity test on the residuals in Equation (1) | F-statistic | 0.00 | Probability F (1, 270) | 0.95 |
| Observations R-squared | 0.00 | Probability Chi-Square (1) | 0.94 |

\textbf{Source:} Authors

The causality tests indicate that both in the short term and the long run, Bulgaria’s inflation is caused by the inflation in the EA, the price of crude oil and the minimum reserve requirements of the Bulgarian National Bank (see Tables 7 and 8).

| Table 7. Results from the short-run causality tests | Independent variables | Probability |
| INFL\_EA | 0.00 |
| OIL | 0.00 |
| GAS | 0.09 |
| FISC\_RES | 0.48 |
| MRR | 0.01 |

\textbf{Source:} Authors

| Table 8. Results from the long-run causality tests | Independent variables | Probability |
| INFL\_EA | 0.00 |
| OIL | 0.00 |
| GAS | 0.20 |
| FISC\_RES | 0.50 |
| MRR | 0.03 |

\textbf{Source:} Authors
The responses of Bulgaria’s inflation to changes in the Euro area’s inflation, the Bulgarian government’s fiscal reserve, the BNB’s minimum reserve requirements and the prices of crude oil and natural gas are displayed in Figure 2.

![Figure 2. Responses of INFL_BG to changes in INFL_EA, OIL, GAS, FISC_RES and MRR](image)

**Source:** Authors

5. CONCLUSION

The empirical results from this research show that the determinants of inflation in Bulgaria under a currency board are the inflation in the Euro area, the crude oil price and the minimum reserve requirements of the Bulgarian National Bank. The only instrument Bulgarian policymakers can use to affect inflation are the minimum required reserves of commercial banks. The lower absolute value of the regression coefficient before MRR than the absolute values of the regression coefficient before INFL_EA and OIL indicates that the opportunities of Bulgarian macroeconomic managers to affect inflation are negligible in comparison with the impact of the
external factors beyond their control. The minimum reserve requirements do not have the desired effect, the flexibility and the reversibility of the other two monetary instruments - the open market operations and the interest rate policy. The use of the minimum reserve requirements can do more harm than good and it is not advisable except in extreme cases of deep recession or overheating of the economy.

The results from the Granger causality tests indicate that inflation in Bulgaria in the period 1999-2021 is caused by structural, supply-side and demand-side factors. Inflation in the Euro area is a proxy for both the monetary policy of the European Central Bank and the economic convergence between Bulgaria and the monetary union. The oil price changes reflect cost-push (supply-side) inflation, while the minimum reserve requirements of the Bulgarian National Bank are a monetary demand-side factor.

References


