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What Drives Inflation in High-inflation Countries? Evidence from Haiti, Sudan, Türkiye and Zambia

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Abstract

The main purpose of this paper is to investigate the long-term effects of money supply, economic growth, interest rate, exchange rate, domestic credits and the oil price on inflation in Haiti, Sudan, Türkiye and Zambia, which are among the world's highest-inflation countries according to 2021 data. For this purpose, a panel cointegration approach is applied where fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) techniques are employed to explore the long-term effects with the help of annual data for the period 2000–2019. Also, the Dumitrescu and Hurlin panel causality test is used to determine whether there is a causality from these variables to inflation. The empirical findings show that there is a long-term relationship among these variables for the whole panel. The consequences from the FMOLS and DOLS estimates show that (i) money supply has a positive effect on inflation, (ii) economic growth affects inflation positively, (iii) an increase in the exchange rate causes inflation to rise, (iv) the oil price affects inflation positively, (v) interest rate affects inflation negatively, and (vi) domestic credits have a negative effect on inflation. In this context, we find that the exchange rate is the variable that has the greatest effect on inflation. Moreover, the findings of the panel causality test suggest that there is a causal relationship from money supply, economic growth, exchange rate and the oil price to inflation.

Keywords: Inflation, money supply, economic growth, interest rate, exchange rate, domestic credits, oil price

JEL Classification: E31, E40, F31

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1. Introduction

It is very important to provide and maintain economic and social welfare for all countries with different levels of development. Price stability holds a central position in achieving this objective. It creates an environment of confidence in the economy. In such an environment, consumers and investors give more support to the growth process by making rational decisions about consumption, savings and investment (Karki and Risal, 2019). On the other hand, price instability raises the costs of credit by increasing the inflation risk premium in interest rates. Firms and consumers delay their spending decisions due to the increase in credit costs (Nusair, 2019). This widens and deepens the poverty problem in the society by negatively affecting the national income level. It is necessary to determine the factors that feed the inflationary process, as it causes deterioration not only in economic balances but also in social balances because the first step in producing a permanent solution is to determine the source of the problem. Theoretically, money supply, economic growth, interest rate, exchange rate, domestic credits and the oil price are considered among the main sources of this problem.

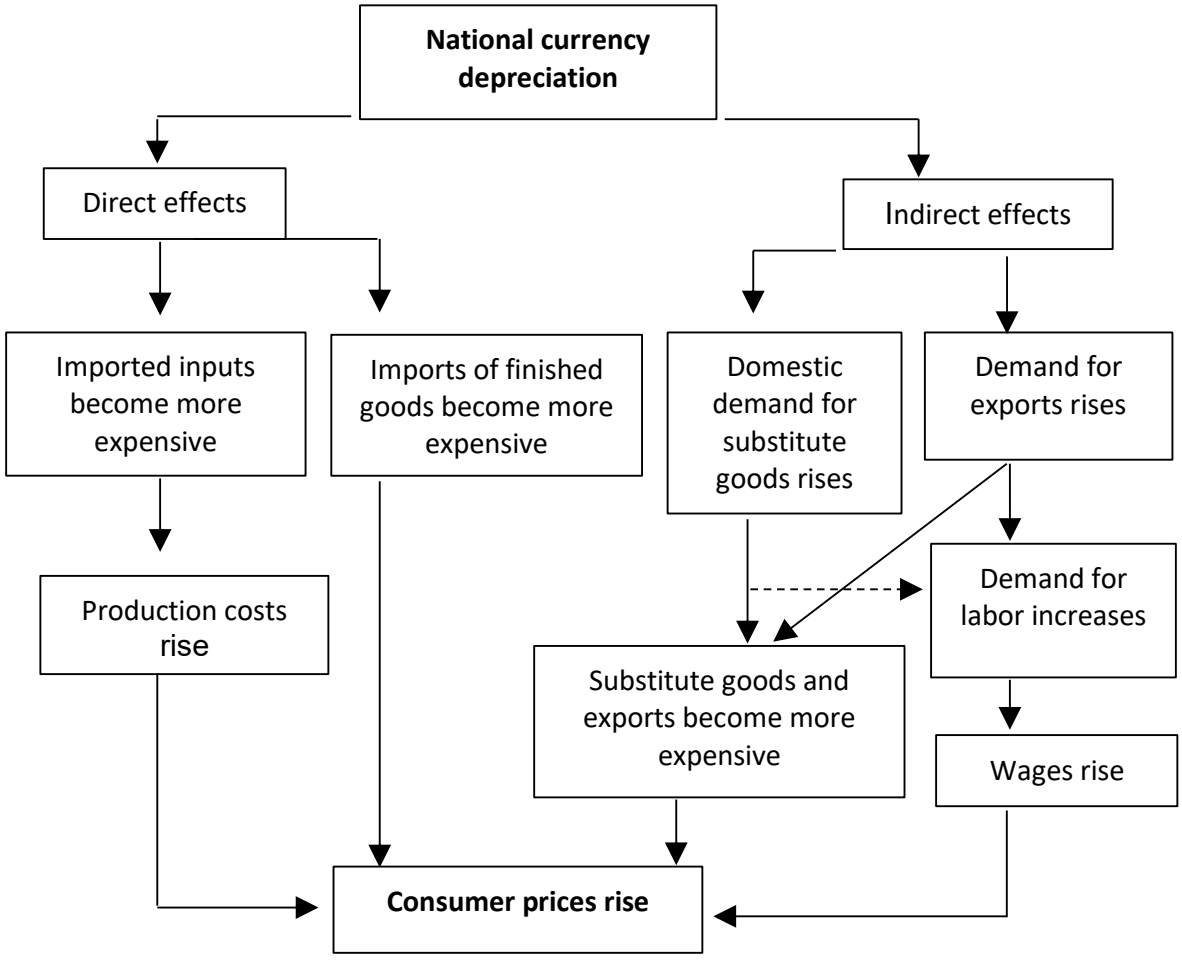
The relationship between money supply and inflation is one of the important debates in the economic literature. The basis of these discussions is based on the quantity theory of classical economists (Gharehgozli and Lee, 2022). According to the quantity theory, there is a one-to-one relationship between the money supply and the price level, as the classics believed that money is demanded only for transaction purposes and that there is full employment in the economy. Therefore, the amount of money in circulation determines the price level (Sultana *et al*., 2019). However, Keynes criticized the quantity theory of money and the relationship between money supply and interpreted inflation differently from the classics. Keynes stated that money is demanded not only for transactions but also for precautionary and speculative purposes (Sriram, 1999). In addition, Keynes claimed that free markets do not have mechanisms that automatically provide full employment (Jahan *et al*., 2014). Within the framework of these assumptions, Keynes stated that an increase in the money supply first lowers the interest rate. Since investment is a negative function of the interest rate, a low interest rate leads to an increase in domestic investment, not the price level. From this point of view, if there is no full employment in the economy, the increase in the money supply is not inflationary (Lin, 1967). The monetarists, who follow the quantity theory of money, hold the view that inflation is always and everywhere a monetary phenomenon (Friedman and Meiselman, 1958). In this context, monetarists argue that inflation will occur if the growth in money supply is more than the growth rate in output (Silaban *et al*., 2021). On the other hand, the structuralists associate the cause of inflation in underdeveloped and developing countries with the structural features of the economy (Duodu *et al*., 2022). According to the structuralists, excess money supply is a consequence of inflation rather than its cause, especially in underdeveloped economies (Atrkar Roshan, 2014), because structural problems such as underproduction in agricultural sector, insufficient exports, budget deficit and unemployment result in monetary expansion to ensure economic recovery (Fischer and Mayer, 1980).

Interest rate is another variable subject to study due to its possible effects on inflation. There are two different perspectives in the literature on the causality chain between the interest rate and the inflation rate (Rasool *et al*., 2018). One of these perspectives was developed by Fisher (1930) and the other by Wicksell (1898). According to Fisher (1930), who claims that there is a positive relationship between the nominal interest rate and the expected inflation rate, the direction of causality is from inflation to interest rate (Anari and Kolari, 2016). Fisher's equation, which shows the relationship between the nominal interest rate and the expected inflation rate, argues that the increased expected inflation rate due to monetary expansion would increase the nominal interest rate. This one-to-one relationship between expected inflation and nominal interest rate is called the "Fisher effect" in the literature (Ayub *et al*., 2014). Contrary to Fisher (1930), Wicksell (1898) accepted that there is a negative relationship between these variables and argued that the direction of causality is from interest rate to inflation rate (Anari and Kolari, 2016). Wicksell (1898) divided the interest rate into two groups, namely the natural rate of interest and the market rate of interest, and defined the natural rate of interest as the rate of interest that tends to neither increase nor decrease commodity prices. Humphrey (1976) interpreted the natural interest rate as the rate that equates saving and investment when the economy is at full employment, and he expressed the market interest rate as the interest rate applied to loans on the money market. The deviation of the market interest rate from the natural interest rate affects the general level of prices (König and Chervyakov, 2017). According to Čaplánová (2003), as a result of monetary expansion, the volume of credit in the banking system increases and banks therefore lower interest rates. Thus, the market rate of interest falls below the natural rate of interest. This situation encourages investors and consumers to borrow more and therefore aggregate demand increases. Since the model is based on the assumption of full employment, an increase in demand raises the general level of prices while supply is constant. It is argued that the market interest rate and the natural interest rate should be equal to ensure price stability (Anderson, 2005).

One of the variables thought to have a significant effect on inflation is the exchange rate. Fluctuations in the exchange rate can change the competitiveness of the economy, the costs of foreign currency debt and the ability to repay. These fluctuations also have an impact on inflation and thus on monetary policy (Pham *et al*., 2020). The reflection of the increase in exchange rate on the prices of imported products and then on the general price level is explained through the pass-through effect (ERPT) (Forbes, 2016). The ERPT is defined by Kim (2021) as the percentage change in import prices resulting from a 1% change in a country's exchange rate. If the rate of change in import prices is equal to 1, there is a complete pass-through effect and if it is less than 1, there is an incomplete pass-through effect. Laflèche (1997) showed with the help of Figure 1 that the depreciation in the exchange rate may be reflected in consumer prices through two different channels, directly and indirectly. Both these channels become more important as the degree of openness of the economy increases (Hüfner and Schröder, 2002). The direct consequences of the depreciation of the national currency are increases in the prices of imported inputs used for

domestic production and imported final goods. Indirect results are the increase in the demand for export products due to the appreciation of foreign currencies and the increase in residents' demand for substitute goods instead of imported goods due to the fact that imported goods become more expensive. As a result, all these changes cause the general level of prices to rise (Laflèche, 1997).

Figure 1: Pass-through from national currency depreciation to consumer prices



Source: Laflèche (1997)

Banks collect deposits with low interest rates and make profit by giving these deposits as credits with high interest rates. Bank credits have the potential to affect the aggregate demand and aggregate supply balance of the economy. If bank credits contribute to the increase in aggregate supply, it creates a disinflationary effect; if it causes an increase in aggregate demand, it creates an inflationary effect.

The oil price is another variable the effect of which on inflation has been much discussed in the literature. It is assumed that changes in the oil price theoretically create a spillover effect on some macroeconomic variables such as inflation, interest rate and economic growth in countries with high foreign dependence on fossil fuels, and the oil shocks in the past confirm this assumption (Wen *et al*., 2021). The oil price affects inflation through two different channels, directly and indirectly. The direct effect works on the demand side of the economy while the indirect effect works on the supply side. Since some of the petroleum products are used as final goods, if these products find a large place in the consumer basket, the increase in the oil price accelerates inflation. On the other hand, since these products are also production inputs, the increase in the oil price causes cost inflation (Zakaria *et al*., 2021). Due to the downward rigidity of prices and wages, a fall in the oil price is unlikely to affect product prices (Lacheheb and Sirag, 2019).

The aim of this study is to examine the long-term effects of money supply, economic growth, interest rate, exchange rate, domestic credits and the oil price on inflation for selected countries (Haiti, Sudan, Türkiye and Zambia) over the period 2000–2019. According to the World Bank, these countries are among the top nine countries with an annual inflation rate above 15% in 2021. However, since Türkiye is quite different from these countries in terms of economic structure and size, they have no common features except inflation. The panel is limited to these four countries as there are not enough data for the other five countries. After determining the long-term relationship among all the variables with the help of Pedroni and Kao's panel cointegration test, long-term coefficients are calculated with FMOLS and DOLS estimators. Finally, Dumitrescu and Hurlin panel causality test is used to investigate the direction of causality. This study contributes to the literature in two aspects. Firstly, although there are studies for a wide variety of country groups in the literature, we analyse four countries that are among those with the highest inflation in the world. Thus, we intend to show the main dynamics leading to high inflation with reference to the countries experiencing this problem. Secondly, the long-term main determinants of inflation are explored using a wider set of variables.

The article is organized as follows. Section 2 presents a brief literature review. Section 3 describes the data. Section 4 explains the model specification and methodology. Section 5 presents and discusses the empirical findings. Finally, Section 6 summarizes the conclusions and policy implications.

2. Literature Review

The determinants of inflation have received a great attention in both academia and practice. Therefore, there is a large body of research analysing the relationship between inflation and other relevant macroeconomic variables. In these studies, different econometric techniques have been applied, from time series to panel data. This paper divides the existing literature into six parts: (a) money supply and inflation, (b) economic growth and inflation, (c) interest rate and inflation, (d) exchange rate and inflation, (e) domestic credits and inflation, and (f) the oil price and inflation.

Since rising inflation is closely related to monetary expansion, the relationship between money supply and inflation has been the focus of empirical research. For instance, Moroney (2002) employed the ordinary least squares to specify and estimate a modern version of the quantity theory of money supply, economic growth and inflation in 81 countries from 1980–1993. The results confirm that high inflation is a monetary phenomenon. Nguyen (2015) investigated the effect of money *M*2 supply on inflation in selected Asian countries from 1985 to 2012 by using the pooled mean group (PMG) estimation-based error correction model and the panel differenced GMM (generalized method of moments) Arellano-Bond estimator. The results of PMG estimation showed that broad money supply (*M*2) has a positive impact on inflation. Sharma and Nurudeen (2019) investigated the relationships among money supply, output and inflation in India by using Johansen cointegration test, Granger causality test and structural vector autoregressive model for the period 1996Q2–2019Q1. Empirical findings showed that money supply (*M*1) has a positive effect on inflation. Islam (2021) analysed the impact of socioeconomic development on inflation in South Asia with DOLS, FMOLS and the Toda-Yamamoto Granger causality test over the period 1990–2018. According to the results obtained, broad money supply has the usual positive impact on domestic inflation. In addition, it was found that money supply causes inflation.

There have been many studies investigating the effect of economic growth on inflation, but there is no consensus among the results of these studies. Mallik and Chowdhury (2001) studied the relationship between inflation and GDP growth for 4 South Asian Countries by applying the Johansen cointegration test and the error correction model (ECM). The results of cointegration tests reflected that economic growth and inflation are cointegrated for all countries. On the other hand, the findings of ECM indicated that inflation and economic growth are positively related and the sensitivity of inflation to changes in growth rates is larger than that of growth to changes in inflation rates. Jayathileke and Rathnayake (2013) examined the link between inflation and economic growth in 3 selected Asian countries for the period 1980–2010. The results of error correction method showed that there is a long-term negative and significant link between these variables in Sri Lanka. No significant relationship was found for the other two countries in the long-term, but a negative and statistically significant relationship was determined for China in the short run. The Granger causality test revealed that there exists a unidirectional causality from economic growth to inflation in China. Kyo (2018) tested the dynamic relationship between the GDP and the consumer price index (CPI) in Japan by applying a Bayesian dynamic linear model for the period 1980–2005. According to the findings, GDP has a negative effect on the CPI. Moghadasi (2018) analysed the impact of economic complexity and GDP on inflation rate and income inequality in Persian Gulf States over the period 2002–2015 by using multivariate regression test. The empirical findings revealed that GDP has a positive and significant effect on inflation rate.

The relationship between interest rate and inflation has been investigated by many researchers using various econometric techniques for different countries. The results obtained vary depending on the selected countries, period and methodology. For instance, Najand and Noronha

(1998) analysed the causal relationships between stock returns, inflation, real activity and interest rates for Japan over the period 1977M1–1994M12, using the state space procedure. The research results demonstrated that the real interest rate has a positive effect on inflation. Asgharpur *et al*. (2007) investigated link between interest rates and inflation changes in a panel of 40 selected Islamic countries over the period 2002–2005. For this purpose, it was used Hsiao causality test. The study showed that there is a unidirectional causal relationship from interest rate to inflation rate. Mahmood *et al*. (2013) studied the linkage among inflation, interest and unemployment rates in Pakistan during the 1992Q2–2011Q3 period by applying Johansen's cointegration test, VECM, impulse response function (IFR) and forecast error variance decomposition (FEVD). The results showed that interest rate has negative effect on inflation rate. Jaradat and Al-Hhosban (2014) examined the linkage between interest rate and inflation in Jordan over the period 1990–2012 by using multiple regression, correlation, cointegration tests and causality tests. According to the results of empirical analysis, it was found that there is a positive bidirectional relationship between these variables. Turna and Özcan (2021) investigated the effect of foreign exchange rate and interest rate on inflation in Turkey over the period 2005Q1–2019Q2. The findings of ARDL model indicated that foreign exchange rate and interest rate have a positive effect on inflation in the short and long-term.

With the globalization process, the relationship between exchange rate and inflation has been one of the most frequently discussed issues, especially in foreign-dependent countries. For instance, Lado (2015) analysed the causality link between exchange rate and inflation rate in South Sudan, using the Granger causality test monthly data from 2011M8 to 2014M11. The paper found that there is a unidirectional causality from exchange rate to consumer price index. Onyekachi and Onyebuchi (2016) studied the relationship between exchange rate depreciation and inflation for Nigeria during the period from 1980 to 2013 through cointegration test, VECM and partial correlation coefficient analysis. The obtained results of partial correlation test indicated that there is a weak and negative correlation between exchange rate and inflation rate in Nigeria. Al-Masbhi and Du (2021) empirically examined the effect of exchange rate on the inflation rate, current account balance, economic growth and interest rate in Yemen over the period 1998–2020. The Granger causality test revealed that there is a causality link from exchange rate to inflation rate. Bilgili *et al*. (2021) investigated the pass-through effect in Turkey for the period 1998Q1–2019Q2 by applying Markov regime-switching models. As a result of the research, it was found that an increase in the exchange rate leads to an increase in the domestic consumer price index. Therefore, according to the empirical findings, the pass-through effect is valid for Türkiye.

There are various studies in the literature that empirically investigate the links between domestic credits and inflation. However, the results of these studies are mixed. For instance, Johnson (2015) used a sample period from 1970 to 2010 in order to examine the economic credits on the inflation and growth for Togo. The error correction model was adopted in empirical analysis. The findings indicated that economic credits do not have a significant effect on inflation

in Togo. Al-Oshaibat and Banikhalid (2019) applied the vector auto regression (VAR) model to determine the effect of bank credits on the inflation rate in Jordan by utilizing a sample period from 1968 to 2017. The empirical findings showed that there is a mutually positive link between bank credits and inflation rate. Bölükbaş (2019) explored the relationship between inflation, current account deficit and the banking sector credits for Türkiye using data for the period 2006M1–2018M11. According to the results of the Granger causality test, there is a bidirectional link between inflation and banking sector credits. Orimogunje (2019) investigated the causality link between bank credits and inflation rate in Nigeria during the period 1996–2014 by applying Granger causality test. The estimation results revealed that domestic credits have no significant relationship on inflation. Ikpesu (2021) tested the impact of banking sector credit on inflation and economic growth in 35 sub-Saharan African economies covering the period 2000–2016. For this purpose, panel VECM technique was used and it was found that banking sector credits affect inflation positively in SSA economies.

In this study, it was also investigated whether the oil price has an effect on inflation, because oil is both a production input and a basic energy source. In general, studies in the literature show that there is a positive link between the oil price and inflation. For instance, Cunado and de Gracia (2005) analysed the relationship between the oil price and macroeconomy for selected six Asian countries over the period 1975Q1–2002Q2 by applying cointegration test and Granger causality test. The obtained results showed that the oil price has a significant effect on price indexes. Asghar and Naveed (2015) investigated long-term pass-through of the global oil price to inflation rate for Pakistan using monthly data for the period 2000M1–2014M12. The results of the ARDL bounds testing approach revealed that the oil price has a positive impact on inflation rate. Moreover, the estimated findings of Granger causality test concluded that the oil price is the Granger cause of inflation. Bawa *et al*. (2020) examined the asymmetric effect of the oil price on inflation in Nigeria over the period 1999Q1–2018Q4 by using a non-linear ARDL approach. The results indicated that an increase in the oil price has a positive effect on headline, core and food inflation. Sarmah and Bal (2021) tested the influence of the crude oil price on inflation rate and economic growth in India during the period of 1997M4–2016M7. For this purpose, structural VAR framework was preferred to detect effect. The empirical findings showed that the crude oil price has a positive impact on the rate of inflation rate. Zakaria *et al*. (2021) aimed to measure the impact of the world oil price on inflation rates for South Asian countries based on data from 1980M1 to 2018M12 with cointegration test, VAR and nonlinear analysis. According to the result of causality test, the oil price Granger causes inflation rate. In addition, impulse-response functions reflected that world oil prices shock influence inflation positively. Finally, nonlinear analysis showed that an increase in the oil price significantly increases inflation.

3. Data

This study focuses on the assessment of the main determinants of inflation in selected high inflation countries: Haiti, Sudan, Türkiye and Zambia. According to the data of the World Bank, these countries are among the top nine countries with an inflation rate higher than 15% in 2021. Four of these countries were selected, which have sufficient data for analysis. In Table 1 the name, definition, measurement and source of our variables are presented. We used a balanced panel annual data from 2000 to 2019 to identify the main causes of high inflation. All the variables transformed into logarithmic form for econometric analysis.

Table 1: Variables, definitions, measurements and sources

Variable	Definitions	Measurements	Sources
INF	Inflation	Consumer price index (2010 = 100)[a]	WDIs
MS	Money supply	Broad money (% of GDP)	WDIs
EG	Economic growth	GDP (constant 2015 in US$)	WDIs
IR	Interest rate	Deposit interest rate (%)[b]	WDIs
ER	Exchange rate	Official exchange rate (LCU per US$, period average)	WDIs
DC	Domestic credits	Domestic credit to private sector by banks (% of GDP)	WDIs
OP	Oil price	Crude oil price ($)	BP

Note: [a]: Since there are no annual index data for Sudan in 2018, the average of the first 10 months was used. [b]: since there are no deposit interest rate (%) data for Haiti in the World Bank database, the lending interest rate (%) was used. WDIs is World Development Indicators; BP is BP Statistical Review of World Energy July 2021.
Source: Authors' own evaluation

4. Model Specification and Methodology

4.1 Model specification

This study investigates the long-term effects of money supply, economic growth, interest rate, exchange rate, domestic credits and the oil price on inflation in selected high inflation countries, namely, Haiti, Sudan, Türkiye and Zambia. The functional form of the model yields:

$$INF = f\left(MS, EG, IR, ER, DC, OP\right) \tag{1}$$

The functional relationship in Eq. (1) can be stated as follows:

$$INF = a_0 + a_1 MS_{it} + a_2 EG_{it} + a_3 IR_{it} + a_4 ER_{it} + a_5 DC_{it} + a_6 OP_{it} + e_{it} \quad (2)$$

where $i = 1, \ldots, N$ for each country in the panel, $t = 1, \ldots, T$ symbolizes the time period, and e_{it} indicates the stochastic error term. The a_0 represents the slope intercept and a_1, a_2, a_3, a_4, a_5 and a_6 are the estimated coefficients for money supply, economic growth, interest rate, exchange rate, domestic credits and the oil price, respectively. The a priori expectation of the model is that the estimated coefficient of the variables money supply, economic growth, exchange rate, domestic credits and the oil price should be positively related to inflation, while the coefficient of interest rate should have a negative sign.

Since it is aimed to determine the long-term effects of selected variables on inflation, econometric methods are basically limited to panel cointegration test, long-term coefficient estimators and causality test. Econometrics methodologies include the following stages:

- The Breusch and Pagan (1980) LM test, the Pesaran (2004) CD_{LM} test and the Pesaran *et al*. (2008) LM_{adj} test were used to determine the cross-sectional dependence (CD).
- The homogeneity of the slope coefficients was investigated with the $\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$ tests of Pesaran and Yamagata (2008).
- The Hadri (2000) test was applied to test the stationarity of the series.
- Pedroni (1999) and Kao (1999) panel cointegration tests were used to determine the long-term relationship.
- FMOLS and DOLS estimators were applied to calculate the long-term coefficients.
- The Dumitrescu and Hurlin (2012) panel causality test was used to determine the existence of causality from selected macroeconomic variables to inflation.

4.2 Cross-sectional dependence test

Cross-sectional dependence means that a shock at any time in cross section i affects cross section j at the same or a later period (Yolal and Anavatan, 2017). In this context, CD can be defined as a macroeconomic shock occurring in one of the countries in a certain period, affecting other countries at different levels in the same period or in another period (Mercan, 2014). CD has a central role in determining the types of correct unit root and cointegration tests. Traditional unit root tests assume cross-sectional independence, but if the data series exhibits CD, the results will be biased. Therefore, before starting econometric analysis using macroeconomic panel data, it is necessary to check for the presence of CD (Tiwari *et al*., 2021). In this study, the LM test developed by Breusch and Pagan (1980), the CD test developed by Pesaran (2004) and the LM_{adj} test developed by Pesaran *et al*. (2008) were used to check the presence of cross section dependence across the selected high inflation countries.

The Breusch and Pagan (1980) LM test statistic is as follows:

$$LM = T\sum_{i=1}^{N-1}\sum_{J=i+1}^{N}\hat{p}_{ij}^2 \tag{3}$$

where p_{ij} shows the estimates of cross-section correlations between residuals and is calculated as follows (Pesaran, 2004):

$$\hat{p}_{ij} = \hat{p}_{ji} = \frac{\sum_{t=1}^{T} e_{it}e_{jt}}{(\sum_{t=1}^{T} e_{it}^2)^{1/2}(\sum_{t=1}^{T} e_{jt}^2)^{1/2}} \tag{4}$$

The null hypothesis of the Breusch and Pagan (1980) LM test, which is appropriate when T is greater than N, is that there is no cross-sectional dependence. If the null hypothesis is rejected, it is decided that there is a cross-sectional dependence between the units.

Pesaran (2004) stated that Breusch and Pagan's LM test may show deviations when N is large and suggested the following simple alternative based on the pair-wise correlation coefficients instead of the squares used in the CD_{LM} test (Pesaran, 2004):

$$CD_{LM} = \sqrt{\frac{2}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\sqrt{T_{ij}}\,\hat{p}_{ij}\right) \tag{5}$$

where N is the cross-section dimension, T is the time dimensions and $\hat{p}_{ij}$ are the pairwise correlation coefficients from the residuals of the ADF regressions (Pesaran, 2004). The null and alternative hypotheses are as follows:

H_0: There is no cross-sectional dependence.

H_1: There is cross-sectional dependence.

The probability values (p-values) are calculated to make a decision about the cross-sectional dependence. If the p-values found are less than the significance values, the null hypothesis is rejected (Aydin, 2019). The Pesaran (2004) CD test is robust when $T < N$ and can be used in both balanced and unbalanced panels.

To correct the bias in large N and finite T panels for linear models, Pesaran *et al*. (2008) developed the following bias-adjusted version of the LM test (Pesaran *et al*., 2008):

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\frac{(T-k)\hat{p}_{ij}^2 - \mu_{Tij}}{\nu_{Tij}} \tag{6}$$

where k is the regressor number, μ_{Tij} is the mean of $(T-k)\hat{p}_{ij}^2$, and v_{Tij} is the variance of $(T-k)\hat{p}_{ij}^2$. Under the null hypothesis with first $T \to \infty$ and then $T \to \infty$, the LM_{adj} test statistic obtained according to this in Equation (6) shows a standard normal distribution asymptotically (Pesaran *et al*., 2008).

The null and alternative hypotheses are as follows:

H_0: There is no cross-sectional dependence.

H_1: There is cross-sectional dependence.

4.3 Slope homogeneity

In addition to the cross-sectional dependence, it is important whether the slope coefficients in the model are homogeneous or heterogeneous in determining econometric techniques such as unit root and cointegration. Swamy (1970), who made the first studies on the homogeneity of the slope coefficients, calculated the test statistic as follows (T.-P. Wu, H.-C. Wu, 2019):

$$\tilde{S} = \sum_{i=1}^{N} (\hat{\beta}_i - \tilde{\beta}_{WFE})' \frac{x_i' M_\tau x_i}{\sigma_i^2} \left(\hat{\beta}_i - \hat{\beta}_{WFE} \right) \tag{7}$$

where $\hat{\beta}_i$ is the pooled OLS estimator, $\tilde{\beta}_{WFE}$ is the weighted fixed effect estimator, M_τ is an identity matrix, and σ_i^2 is the estimator of σ_i^2 (T.-P. Wu, H.-C. Wu, 2019).

Pesaran and Yamagata (2008) developed Swamy's test of slope homogeneity and proposed two statistics for large and small samples. The $\tilde{\Delta}$ test recommended for large samples and the $\tilde{\Delta}_{adj}$ test recommended for small samples is formulated as follows:

$$\tilde{\Delta} = \sqrt{N} \left(\frac{N^{-1} \tilde{S} - k}{\sqrt{2k}} \right) \tag{8}$$

$$\tilde{\Delta}_{adj} = \sqrt{\frac{N(T+1)}{T-k-1}} \left(\frac{N^{-1} \tilde{S} - k}{\sqrt{2k}} \right) \tag{9}$$

where N is the cross-section dimension, T is the time dimension, $\tilde{S}$ is the Swamy test statistic, and k is the number of explanatory variables. In homogeneity tests, the null hypothesis, which states that the slope coefficients are the same, is checked (Udeogu *et al*., 2021).

4.4 Panel unit root test

In order to eliminate the possibility of a spurious regression problem between the variables, it is checked whether the series is stationary with the help of unit root tests. Because of the non-stationary variables, the estimators may show significant deviations (Bhattarai, 2019). There are two-generation tests within the scope of panel unit root tests. While the first-generation panel root tests assume that there is no dependence relationship between the cross-sectional units, the second-generation panel unit root tests allow for the cross-sectional dependence (Tugcu, 2018). In this study, second-generation unit root tests were not used according to the findings of the CD test. Since a balanced panel is used and the time dimension is larger than the cross-section dimension, the stationarity of the series was examined with the Hadri (2000) unit root test, which is among the first-generation unit root tests.

Hadri (2000) proposes a test based on the Kwiatkowski-Phillips-Schmidt-Shin test (KPSS), one of the time series tests (Nell and Zimmermann, 2011). The Hadri (2000) test, which can be applied to a balanced panel, investigates the null hypothesis that the series is stationary (Beirne *et al*., 2007). The test statistic is calculated as follows (Murthy and Okunade, 2018):

$$Z(\lambda) = \frac{\sqrt{N}\left(LM(\lambda) - \overline{\xi}\right)}{\overline{\zeta}} \tag{10}$$

The ordinary least squares residuals are used to calculate the individual KPSS statistics for each cross-section and the mean ($LM(\lambda)$) ($LM(\lambda)$) of these statistics. Then ($LM(\lambda)$) is converted to standardized test stat $Z(\lambda)$. Where λ represents a vector of relative positions of the break points (Murthy and Okunade, 2018). On the other hand, $\overline{\xi}$ and $\overline{\zeta}$ are computed as the averages of the individual means and variances of the $LM(\lambda)$, (Kok and Munir, 2015).

4.5 Panel cointegration test

Cointegration test is used to determine a long-term relationship between variables. In this study, the existence of such a relationship was examined with the Pedroni (1999) and Kao (1999) cointegration tests. Under the assumption that there is no cross-sectional dependence, Pedroni (1999) tests whether there is cointegration or not with the help of seven different statistics. These statistics, which allow for heterogeneity in both short-term dynamics and long-term slope and intercept coefficients, are calculated as follows (Pedroni, 1999):

$$\text{panel v} = T^2 N^{\frac{3}{2}} \left(\sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^2\right)^{-1} \tag{11}$$

$$\text{panel rho} = T\sqrt{N} \left(\sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^2\right)^{-1} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} - \hat{\lambda}_i\right) \tag{12}$$

$$\text{panel PP} = \left(\tilde{\sigma}_{N,T}^2 \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^2\right)^{-\frac{1}{2}} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} - \hat{\lambda}_i\right) \tag{13}$$

$$\text{panel ADF} = \left(\tilde{s}_{N,T}^{*2} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^{*2}\right)^{-\frac{1}{2}} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^{*}\Delta\hat{e}_{i,t}^{*} \tag{14}$$

$$\text{group rho} = T\frac{1}{\sqrt{N}} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{e}_{i,t-1}^2\right)^{-1} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} - \hat{\lambda}_i\right) \tag{15}$$

$$\text{group PP} = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \left(\hat{\sigma}_i^2 \sum_{t=1}^{T} \hat{e}_{i,t-1}^2\right)^{-\frac{1}{2}} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} - \hat{\lambda}_i\right) \tag{16}$$

$$\text{group ADF} = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{s}_i^{*2} \hat{e}_{i,t-1}^{*2}\right)^{-\frac{1}{2}} \sum_{t=1}^{T} \hat{e}_{i,t-1}^{*}\Delta\hat{e}_{i,t}^{*} \tag{17}$$

Of the seven statistics mentioned above, the first four are based on pooling along what qualifies as the within-dimension. The remaining three statistics based on pooling along what qualifies as the between-dimension. Pedroni (1999) calculated within-dimension statistics by summing both the numerator and denominator terms separately over the *N* dimension. On the other hand, he computed between-dimension statistics by dividing the numerator by the denominator before adding them on the *N* dimension. Therefore, panel statistics rely on estimators that effectively pool the autoregressive coefficient across different members for unit root tests on estimated residuals. Group statistics are based on estimators that average the coefficients estimated individually for each member *i* (Pedroni, 1999).

For the panel cointegration test, the null hypothesis that there is no cointegration is the same for every statistic and is as follows (Karaman Örsal, 2009): H_0: $\rho_i = 1$, for all $i = 1, \ldots, N$. Alternative hypotheses for within-dimension and between-dimension statistics vary. The alternative hypothesis for within-dimension statistics is as follows (Karaman Örsal, 2009): H_1: $\rho_i = \rho < 1$, for all $i = 1, \ldots, N$. The alternative hypothesis for between-dimension statistics is as follows (Karaman Örsal, 2009): H_1: $\rho_i < 1$, for all $i = 1, \ldots, N$.

In addition to the Pedroni (1999) test, the Kao (1999) test was also applied to determine the cointegration relationship. In the Kao (1999) panel cointegration test, which is based on the DF and ADF tests, the null hypothesis is "no cointegration" and the alternative hypothesis is "there is cointegration". If the ADF test statistics are significant, the null hypothesis is rejected (Shahbaz *et al*., 2021).

4.6 Panel FMOLS and DOLS

Cointegration tests allow to determine whether there is a relationship in the long-term but cannot estimate the coefficients. Although there are different techniques used to estimate the long-term coefficients of the variables, in this study FMOLS and DOLS estimators were preferred (Shahbaz *et al*., 2021). In the case of endogeneity, serial correlation and residual cointegration, the ordinary least square model may become biased and inconsistent (Pereira *et al*., 2019). For this reason, FMOLS model of Phillips and Hansen (1990) and DOLS model of Stock and Watson (1993) were chosen to overcome possible econometric problems. These models also give successful results for small samples (Tian *et al*., 2021). However, in heterogeneous panels and small samples, DOLS outperforms FMOLS in terms of mean biases (Kao and Chiang, 2001). Compared to FMOLS, DOLS is computationally simpler and reduces bias more. Also, the *t*-statistic produced from DOLS approximates the standard normal density better. Moreover, DOLS is fully parametric and does not need pre-estimation and non-parametric correction (Menegaki, 2019).

4.7 Panel causality test

After determining the cointegration relationship and estimating the long-term coefficients of the variables, the existence of a causal relationship from selected macroeconomic indicators to inflation was investigated using the Dumitrescu and Hurlin (2012) test. This test, which allows for heterogeneity, gives more robust results in small panels in the presence of cross-section dependence. In addition, this test, which can also be applied to unbalanced panels, does not require any conditions regarding time dimension and cross-section dimension (Dumitrescu and Hurlin, 2012).

Dumitrescu and Hurlin (2012) use the following model to test for panel causality:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \tag{18}$$

where α_i is the individual fixed effects, K is the lag orders, $\gamma_i^{(k)}$ is the lag parameters, and $\beta_i^{(k)}$ is the slope parameters.

The null hypothesis and alternative hypothesis of the Dumitrescu and Hurlin (2012) test are as follows:

H_0: There is no causal relationship in the panel.

H_1: There is a causal relationship in at least one cross-section unit.

Zbar statistics ($\bar{Z}$) and Wald statistics ($\bar{W}$) are used to test the hypotheses. While $\bar{W}$ is suitable for $T < N$ case, $\bar{Z}$ is also suitable for $T > N$ case. These statistics are formulated as (Bui *et al*., 2021):

$$\bar{W} = \frac{1}{N} \sum_{i=1}^{N} W_i \tag{19}$$

$$\bar{Z} = \sqrt{\frac{N}{2K}} \left(\bar{W} - K \right) \tag{20}$$

where W_i is the individual Wald statistic, N is the sample size, and K is the lag length.

5. Empirical Findings

In this study, we investigated the effects of money supply, economic growth, interest rate, exchange rate, domestic credits and the oil price on inflation using panel data analysis in four high-inflation countries. The tests and results are discussed below.

5.1 Results of cross-sectional dependence test

The LM test of Breusch and Pagan (1980) and the CD_{LM} test of Pesaran (2004) and the LM_{adj} test of Pesaran *et al*. (2008) was applied to determine the presence of cross-sectional dependence and the results of the these tests are shown in Table 2.

Table 2: Results of cross-sectional dependence test

Test	Statistic	*p*-value
LM	2.082	0.9120
CD_{LM}	0.3317	0.7401
LM_{adj}	–2.723	0.0065

Source: Authors' own calculations

Since the *p*-values of the LM and CD_{LM} statistics are greater than 0.05, the null hypothesis is accepted and the alternative one is rejected. This result means that a shock in one of these countries may not affect the others. On the other hand, the LM_{adj} test confirms the hypothesis that accepts the cross-sectional dependence. However, due to the fact that the time dimension is larger than the cross-section dimension in the panel, the evaluation was made according to the LM test result. The sizes of financial, technical and trade links are the main determinants of economic interaction between countries. As these connections increase, the economic fluctuation in one country affects the others rapidly and significantly. However, the level of economic integration between the countries in this study is weak. For this reason, it was found that there is no cross-sectional dependence empirically. Therefore, under current conditions, the probability of an economic fluctuation in one of these countries to be reflected in other countries is very low.

5.2 Results of homogeneity test

Pesaran and Yamagata (2008)'s techniques were used to determine whether or not slope coefficients are homogenous. Table 3 shows the slope homogeneity test results.

Table 3: Results of homogeneity test

Test	Statistic	*p*-value
$\tilde{\Delta}$	2.209	0.027
$\tilde{\Delta}_{adj}$	2.851	0.004

Source: Authors' own calculations

The null hypothesis that the coefficients in the model are homogeneous was rejected in the light of the *p*-values of both tests. Therefore, the slope coefficients of the cointegration equation are heterogeneous. This result indicates that the slope coefficients may not be the same for each of the countries in the panel. In other words, the effect of macroeconomic variables on inflation may vary by country because the economic structure of each country is different from each other. In this context, for example, while inflation is more affected by the domestic credits in one country, it may be less affected in another country.

5.3 Results of panel unit root test

After the determination the absence of cross-sectional dependence as a result of CD tests, the panel unit root test developed by Hadri (2000) was applied to examine whether the variables are stationary. This test was preferred because the sample is small and the time dimension is larger than the cross-section dimension. Results of Hadri (2000) panel unit root test are presented in Table 4.

Table 4: Results of panel unit root test

Variables	Level		First Difference	
	***Z*-stat**	***p*-value**	***Z*-stat**	***p*-value**
INF	5.6851	0.0000	–1.0771	0.8593
MS	5.1764	0.0000	–1.3301	0.9083
EG	18.7265	0.0000	1.6238	0.0522
IR	6.7398	0.0000	0.2980	0.3828
ER	4.9498	0.0000	–1.1911	0.8832
DC	10.0986	0.0000	0.9150	0.1801
OP	9.9199	0.0000	0.3039	0.3806

Source: Authors' own calculations

The results of the unit root test show that the variables are not stationary at levels. However, after taking the first difference, it is seen that all variables become stationary. Since the panel variables are integrated of the same order, the cointegration test is employed. Therefore, in the next step, the long-term equilibrium relationship between inflation and other macroeconomic variables is investigated.

5.4 Results of panel cointegration test

Since all the series are integrated at the same order, there is a possibility of a long-term relationship between them (Hu *et al*., 2020). Pedroni (1999) and Kao (1999) cointegration tests were applied to determine whether such a relationship exists or not. The results of cointegration tests are displayed in Table 5.

Table 5: Results of panel cointegration test

Pedroni residual cointegration test				
Within-dimension	**Statistic**	**Prob.**	**Weighted statistic**	**Prob.**
Panel v-statistic	−0.241074	0.5953	0.098545	0.4607
Panel rho-statistic	0.093622	0.5373	0.998350	0.8409
Panel PP-statistic	−11.51616	0.0000	−6.871728	0.0000
Panel ADF-statistic	−8.960786	0.0000	−6.176800	0.0000
Between-dimension	**Statistic**	**Prob.**		
Group rho-Statistic	1.798967	0.9640		
Group PP-Statistic	−11.59623	0.0000		
Group ADF-Statistic	−7.248200	0.0000		
Kao residual cointegration test				
	***t*-statistic**	**Prob.**		
ADF	−6.682216	0.0000		

Source: Authors' own calculations

According to the results of the Pedroni cointegration test, most of the seven statistics in the panel are statistically significant. Especially for small samples, panel-ADF and group-ADF statistics give more significant results (Çınar, 2011). Similarly, the result of the Kao test is statistically significant. When both tests are evaluated together, the H_0 hypothesis that there is no cointegration is rejected at the 1% significance level. After the analysis, it was seen that there is a long-term relationship between inflation and other macroeconomic variables in these countries.

5.5 Results of panel FMOLS and DOLS

After determining that the series are cointegrated, the long-term coefficients of the variables are estimated. Although there are different techniques used for this purpose, the FMOLS and DOLS estimators were preferred due to the findings of cross-sectional dependence. The results of regression estimation are shown in Table 6. The analysis findings of FMOLS and DOLS estimators are consistent in terms of the signs and magnitudes of the coefficients and there is no contradiction between them. Kao and Chiang (2001) suggested that DOLS is better than FMOLS in terms of bias in small samples and heterogeneous panels. In this context, the results of DOLS may be focused on.

Table 6: Results of panel FMOLS and DOLS estimations

Variables	FMOLS	DOLS
MS	0.689949 (0.0006)	0.597479 (0.0235)
EG	0.467421 (0.0095)	0.607886 (0.0111)
IR	−0.271044 (0.0004)	−0.311180 (0.0042)
ER	0.787709 (0.0000)	0.773840 (0.0000)
DC	−0.320349 (0.0023)	−0.364447 (0.0075)
OP	0.340878 (0.0000)	0.249784 (0.0001)

Note: Prob. values are in parenthesis.

Source: Authors' own calculations

Both estimators showed that money supply, economic growth, exchange rate and the oil price have a positive and statistically significant effect on inflation. More specifically, a 1% increase in money supply increases inflation by 0.689% (FMOLS) and 0.597% (DOLS). This result confirms the monetarist approach, because monetarists assume that "inflation is always and everywhere a monetary phenomenon" (Hetzel, 2007). In this context, excessive monetary expansion increases the domestic demand and causes the general level of prices to rise. Therefore, the money supply must be controlled in order not to create an inflationary environment (Musgrave and Mus-

grave, 1989). The empirical results regarding the positive effect of money supply on inflation are consistent with the findings of Moroney (2002), Nguyen (2015), Sharma and Nurudeen (2019) and Islam (2021).

In addition to the money supply, economic growth is the second variable that has a positive effect on inflation. Generally, economic growth brings with it an increase in income and employment. In such an environment, consumers look to the future with confidence and spend more. However, if the production rate cannot be increased as much as the demand rate, the price of goods and services will increase (TCMB, 2013). In fact, this situation is theoretically explained with the help of aggregate supply (AS) and aggregate demand (AD) model. If the AD curve moves further to the right than the AS curve, the demand pull inflation occurs (Dwivedi, 2005). According to the findings, it was seen that a 1% increase in economic growth causes an increase of 0.467% (FMOLS) and 0.607% (DOLS) on inflation. This finding is consistent with the previous works of Mallik and Chowdhury (2001) and Moghadasi (2018).

Exchange rate is the third variable that positively affects inflation. According to coefficient estimators, the effect of exchange rate on inflation is greater than other variables because the exchange rate has an important role for economies whose production is highly dependent on imported inputs. Increases in the exchange rate directly affect producer costs. Increases in producer costs cause a decrease in the amount of production on the one hand, and an increase in the prices of goods and services on the other. Thus, exchange rate increases create an inflationary pressure. Therefore, it is not easy to reduce the inflation rate in foreign-dependent economies if the exchange rate increase is not slowed down. According to the results in Table 6, a 1% increase in the exchange rate causes inflation to increase by 0.787% (FMOLS) and 0.773% (DOLS). Similar findings were also found in the study done by Bilgili *et al*. (2021). They stated that an increase in the exchange rate causes an increase in the consumer price index.

The fourth variable that has a positive effect on inflation is the oil price. Oil, which is one of the main energy sources, is not only a transportation fuel, but also a very important industrial input. Therefore, the change in the oil price is important for all countries and affects global inflation because a high oil price increases production, freight and transportation costs, thereby leading to inflation. Table 6 indicates that a 1% increase in the oil price increases inflation by 0.340% (FMOLS) and 0.249% (DOLS). Our findings are in line with several previous studies (Asghar and Naveed, 2015; Bawa *et al*., 2020; Cunado and de Gracia, 2005; Sarmah and Bal, 2021; Zakaria *et al*., 2021).

It was found that interest rate and domestic credits have a negative effect on inflation for the whole panel. The interest rate has a significant effect on both domestic expenditures and foreign portfolio investments. The increase in interest rates leads to a decrease in demand by increasing the costs of credit. This may lead to disinflation. At the same time, the increase in the interest rate may accelerate the foreign capital inflow. The abundance of foreign exchange reduces the costs

of imported inputs through the exchange rate. All this helps to reduce inflation. The estimated results revealed that a 1% increase in interest rate decreases inflation by 0.271% (FMOLS) and 0.311% (DOLS). The result of the effect of interest rate on inflation is also in line with Mahmood *et al*. (2013). However, these results are different from the previous studies, for instance, Najand and Noronha (1998), Jaradat and Al-Hhosban (2014) and Turna and Özcan (2021), who reported that interest rate has positive effect on inflation.

According to the empirical findings, it was seen that there is an inverse relationship between domestic credits and inflation, as well as the interest rate. This means that domestic credits have a greater impact on the supply side of the economy. The coefficient analysis of domestic credits indicates that a 1% increase in domestic credits reduces inflation by 0.320% (FMOLS) and 0.364% (DOLS). This result contradicts the researches of Ikpesu (2021) and Al-Oshaibat and Banikhalid (2019) who found that bank credits affect inflation positively.

5.6 Results of panel causality test

In the last stage of the analysis, pairwise Dumitrescu and Hurlin (2012) test was performed to determine whether the selected macroeconomic variables have a causality effect on inflation, and the results were reported in Table 7.

Table 7: Results of pairwise Dumitrescu and Hurlin causality test

Null hypothesis:	*W*-Stat.	Zbar-Stat.	Prob.
MS does not cause INF	47.6571	31.8885	0.0000
EG does not cause INF	9.37866	4.93887	8.E–07
IR does not cause INF	3.39127	0.72350	0.4694
ER does not cause INF	12.3267	7.01444	2.E–2
DC does not cause INF	3.60034	0.87069	0.3839
OP does not cause INF	5.39101	2.13140	0.0331

Source: Authors' own calculations

The findings in Table 7 can be summarized as follows:

- There is a causal relationship running from money supply to inflation. This result is in accordance with those reported by Sharma and Nurudeen (2019) and Islam (2021).

- There is a causal relationship running from economic growth to inflation. This result is in accordance with those reported by Uddin (2016).
- There is a causal relationship running from exchange rate to inflation. This result is in accordance with those reported by Lado (2015) and Al-Masbhi and Du (2021).
- There is a causal relationship running from the oil price to inflation. This result is in accordance with those reported by Asghar and Naveed (2015) and Zakaria *et al*. (2021).
- There is no causality from interest rate to inflation. This result is different from the research carried out by Asgharpur *et al*. (2007) and Jaradat and Al-Hhosban (2014).
- There is no causality from domestic credits to inflation. This result is in accordance with those reported by Orimogunje (2019), however our finding is not similar with Al-Oshaibat and Banikhalid (2019), Bölükbaş (2019) and Ikpesu (2021).

6. Conclusion

Price stability plays an important role in ensuring macroeconomic balances. In this respect, it is necessary to identify the main factors that threaten price stability, not only for academics but also for policy makers. The aim of this study is to investigate the long-term effects of economic growth, interest rate, exchange rate, domestic credits and the oil price on inflation in four high-inflation countries over the period 2000-2019. For this purpose, we used the panel cointegration tests and the FMOLS and DOLS estimators. In addition, the Dumitrescu and Hurlin (2012) test was applied to determine whether these variables have a causal relationship on inflation.

According to the FMOLS and DOLS estimators, we reached the following findings: Firstly, the coefficient of money supply is positive and statistically significant. This is in accordance with previous studies of Moroney (2002), Nguyen (2015), Sharma and Nurudeen (2019) and Islam (2021). The obtained findings about the effect of money supply on inflation are consistent with the classical approach. Therefore, it is extremely important to avoid excessive money supply, especially in these countries. Secondly, the coefficient of economic growth is positive and statistically significant. This result is supported by the existing literature of Mallik and Chowdhury (2001) for four South Asian countries, Jayathileke and Rathnayake (2013) for China, and Moghadasi (2018) for Persian Gulf states. The positive effect of economic growth on inflation implies that the increase in national income stimulates the demand side rather than the supply side. Hence, these countries should concentrate on the production economy rather than the consumption economy. Thirdly, the coefficient of exchange rate is positive and statistically significant. This finding is in line with Bilgili *et al*. (2021). The exchange rate was calculated as the variable with the greatest impact on inflation. This situation can be interpreted as a result of foreign dependency in both production and consumption because the appreciation of foreign currencies affects the prices of imported consumer goods and imported input prices in a short time. The increase in input prices

causes consumer inflation by increasing production costs. In this framework, the monetary authority should use monetary policy tools rationally and governments should encourage foreign capital inflows. More importantly, measures should be taken to reduce foreign dependency, especially in production. Fourthly, the coefficient of the oil price is positive and statistically significant. This result matches those of previous studies. Since energy is among the essential components of production, the increase in the oil price directly changes the prices of products. This situation immediately affects all sectors of the economy, from agriculture to industry. For this reason, it is inevitable to increase energy efficiency and to invest more in new and renewable energy resources. Fifthly, the coefficient of interest rates is negative and statistically significant. The outcome of our study is similar to the findings of Mahmood *et al*. (2013). This finding does not coincide with the hypothesis that suggests a positive relationship between the inflation rate and the interest rate. Consequently, these countries may need to temporarily increase interest rates to a limited extent without adversely affecting supply. Sixthly, the coefficient of domestic credits is negative and statistically significant. The finding of the negative relationship is inconsistent with the works of Al-Oshaibat and Banikhalid (2019) and Ikpesu (2021). Therefore, domestic credit to the private sector is very important for a low inflation environment.

Finally, the existence of a causal relationship from selected variables to inflation was investigated using the pairwise Dumitrescu and Hurlin (2012) test. The findings show that there is a causal relationship from money supply, economic growth, exchange rate and the oil price to inflation. However, we found no statistically significant causality from the interest rate and domestic credits to inflation.

References

Al-Masbhi, G., Du, Y. (2021). Determinants of exchange rate: Vector error correction method (VECM). Case of Yemen. *Open Journal of Social Sciences*, 9(8), 47–60, https://doi.org/10.4236/jss.2021.98005

Al-Oshaibat, S. D., Banikhalid, H. H. (2019). The impact of bank credit on inflation in Jordan by using vector auto regression model: A case study of Jordan during 1968–2017. *International Business Research*, 12(5), 34–39, https://doi.org/10.5539/ibr.v12n5p34

Anari, A., Kolari, J. (2016). Dynamics of interest and inflation rates. *Journal of Empirical Finance*, 39(A), 129–144, https://doi.org/10.1016/j.jempfin.2016.08.008

Anderson, R. (2005). *Wicksell's natural rate* [online]. St. Louis: Federal Reserve Bank of St Louis. Available at: https://files.stlouisfed.org/files/htdocs/publications/es/05/ES0506.pdf

Asghar, N., Naveed, T. A. (2015). Pass-through of world oil prices to inflation: A time series analysis of Pakistan. *Pakistan Economic and Social Review*, 269–284.

Asgharpur, H., Kohnehshahri, L. A., Karami, A. (2007). The relationships between interest rates and inflation changes: An analysis of long-term interest rate dynamics in developing countries. In: *International Economic Conference on Trade and Industry (IECTI), Bayview Hotel Georgetown, Penang. 3–5 December.*

Atrkar Roshan, S. A. R. (2014). Inflation and Money supply growth in Iran: Empirical evidences from cointegration and causality. *Iranian Economic Review*, 18(1), 131–152.

Aydin, M. (2019). Renewable and non-renewable electricity consumption–economic growth nexus: Evidence from OECD countries. *Renewable energy*, 136, 599–606. https://doi.org/10.1016/j.renene.2019.01.008

Ayub, G., Rehman, N., Iqbal, M., et al. (2014). Relationship between inflation and interest rate: evidence from Pakistan. *Research Journal of Recent Sciences*, 3(4), 51–55.

Bawa, S., Abdullahi, I. S., Tukur, D., et al. (2020). Asymmetric impact of oil price on inflation in Nigeria. *CBN Journal of Applied Statistics*, 11(2), 85–113.

Beirne, J., Hunter, J., Simpson, M. (2007). Is the real exchange rate stationary? The application of similar tests for a unit root in the univariate and panel cases. *Quantitative and Qualitative Analysis in Social Sciences*, 1(2), 55–70.

Bhattarai, K. (2019). Application of panel data models for empirical economic analysis. In: Tsionas, M. *Panel Data Econometrics*, 665–708. ISBN 978-0-12-815859-3.

Bilgili, F., Ünlü, F., Gençoğlu, P., et al. (2021). Modeling the exchange rate pass-through in Turkey with uncertainty and geopolitical risk: A Markov regime-switching approach. *Applied Economic Analysis*, 30(88), 52–70. https://doi.org/10.1108/AEA-08-2020-0105

Bölükbaş, M. (2019). Türkiye'de enflasyon cari açık ve bankacılık sektörü kredileri: 2006–2018 dönemi İçin bir inceleme. *Sosyal Bilimler Araştırma Dergisi*, 8(2), 77–92.

Breusch, T. S., Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies*, 47(1), 239–253, https://doi.org/10.2307/2297111

Bui, Q., Wang, Z., Zhang, B., et al. (2021). Revisiting the biomass energy-economic growth linkage of BRICS countries: A panel quantile regression with fixed effects approach. *Journal of Cleaner Production*, 316, 128382, https://doi.org/10.1016/j.jclepro.2021.128382

Cunado, J., de Gracia, F. P. (2005). Oil prices, economic activity and inflation: Evidence for some Asian countries. *The Quarterly Review of Economics and Finance*, 45(1), 65–83, https://doi.org/10.1016/j.qref.2004.02.003

Çınar, S. (2011). Gelir ve CO2 emisyonu ilişkisi: panel birim kök ve eşbütünleşme testi. *Uludağ Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 30(2), 71–83.

Čaplánová, A. (2003). Profily svetových ekonómov: Knut Wicksell. *BIATEC*, 11(4).

Dumitrescu, E.-I., Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic modelling*, 29(4), 1450–1460, https://doi.org/10.1016/j.econmod.2012.02.014

Duodu, E., Baidoo, S. T., Yusif, H., et al. (2022). Money supply, budget deficit and inflation dynamics in Ghana: An empirical investigation. *Cogent Business & Management*, 9(1), 2043810, https://doi.org/10.1080/23311975.2022.2043810

Dwivedi, D. N. (2005). *Macroeconomics: Theory and Policy*. New York: McGraw-Hill Education.

Fischer, B., Mayer, T. (1980). *On the structuralist view of inflation in some Latin American countries: A reassessment*. Kiel Working Paper No. 103.

Fisher, I. (1930). *Theory of interest: as determined by impatience to spend income and opportunity to invest it*. Clifton: Augustus Kelly Publishers.

Forbes, K. (2016). Much ado about something important: How do exchange rate movements affect inflation? *The Manchester School*, 84(S1), 15–41, https://doi.org/10.1111/manc.12159

Friedman, M., Meiselman, D. (1958). *The relative stability of monetary velocity and the investment multiplier in the United States*, *1897–1958*. Chicago: Department of Economics, University of Chicago.

Gharehgozli, O., Lee, S. (2022). Money Supply and Inflation after COVID-19. Economies, 10(5), 101, https://doi.org/10.3390/economies10050101

Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. *The Econometrics Journal*, 3(2), 148–161, https://doi.org/10.1111/1368-423X.00043

Hetzel, R. L. (2007). The contributions of Milton Friedman to economics. *Economic Quarterly*, 93(1), 1–30.

Hu, Y., Hou, Y. G., Oxley, L. (2020). What role do futures markets play in Bitcoin pricing? Causality, cointegration and price discovery from a time-varying perspective? *International Review of Financial Analysis*, 72, 101569, https://doi.org/10.1016/j.irfa.2020.101569

Humphrey, T. M. (1976). Interest rates, expectations, and the Wicksellian policy rule. *Atlantic Economic Journal*, 4(1), 9–20, https://doi.org/10.1007/BF02304276

Hüfner, F. P., Schröder, M. (2002). *Exchange rate pass-through to consumer prices: A European perspective*. ZEW Working Paper No. 02-20.

Ikpesu, F. (2021). Banking sector credit, inflation and growth in sub-Saharan African countries. *Journal of Transnational Management*, 26(3), 164–178, https://doi.org/10.1080/15475778.2021.1947170

Islam, M. S. (2021). Impact of socioeconomic development on inflation in South Asia: Evidence from panel cointegration analysis. *Applied Economic Analysis*, 30(88), 38–51, https://doi.org/10.1108/AEA-07-2020-0088

Jahan, S., Mahmud, A. S., Papageorgiou, C. (2014). What is Keynesian Economics? *International Monetary Fund*, 51(3), 53–54.

Jaradat, M. A., Al-Hhosban, S. (2014). Relationship and causality between interest rate and inflation rate case of Jordan. *Interdisciplinary Journal of Contemporary Research in Business*, 6(4), 54–65.

Jayathileke, P. M. B., Rathnayake, R. M. K. T. (2013). Testing the link between inflation and economic growth: Evidence from Asia. *Modern Economy*, 4(2), 87–92, https://doi.org/10.4236/me.2013.42011

Johnson, K.-A. (2015). Analysis of the impact of the economic credits on the inflation and economic growth in Togo. *African Journal of Marketing Management*, 7(6), 69–79, https://doi.org/10.5897/AJMM2014.0414

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, 90(1), 1–44, https://doi.org/10.1016/S0304-4076(98)00023-2

Kao, C., Chiang, M.-H. (2001). On the estimation and inference of a cointegrated regression in panel data. In: Baltagi, B. H. et al. *Nonstationary panels*, *panel cointegration*, *and dynamic panels*. Bingley: Emerald Group Publishing Limited, 179–222, https://doi.org/10.1016/S0731-9053(00)15007-8

Karaman Örsal, D. D. (2009). *Essays on panel cointegration testing*. Berlin. Dissertation. Humboldt-Universität, Wirtschaftswissenschaftlichen Fakultät. Supervisors: Bernd Droge, Nikolaus Hautsch. Available at: https://edoc.hu-berlin.de/bitstream/handle/18452/16546/karaman-oersal.pdf?sequence=1

Karki, D., Risal, H. G. (2019). Asymmetric Impact of Oil Price on Inflation: Evidence from Nepal. *NRB Economic Review*, 31(1), 21–46, https://doi.org/10.3126/nrber.v31i1.35306

Kim, K. (2021). Production sharing and exchange rate pass-through. *International Review of Economics & Finance*, 76, 817–835, https://doi.org/10.1016/j.iref.2021.07.017

Kok, S. C., Munir, Q. (2015). Malaysian finance sector weak-form efficiency: Heterogeneity, structural breaks, and cross-sectional dependence. *Journal of Economics*, *Finance and Administrative Science*, 20(39), 105–117, https://doi.org/10.1016/j.jefas.2015.10.002

König, P. J., Chervyakov, D. (2017). *The natural rate of interest I: Theory*. DIW Roundup: Politik im Fokus No. 108.

Kyo, K. (2018). The dynamic relationship between economic growth and inflation in Japan. *Open Journal of Social Sciences*, 6(3), 20–32, https://doi.org/10.4236/jss.2018.63003

Lacheheb, M., Sirag, A. (2019). Oil price and inflation in Algeria: A nonlinear ARDL approach. *The Quarterly Review of Economics and Finance*, 73, 217–222, https://doi.org/10.1016/j.qref.2018.12.003

Lado, E. P. Z. (2015). Test of relationship between exchange rate and inflation in South Sudan: Granger-Causality approach. *Economics*, 4(2), 34–40, https://doi.org/ 10.11648/j.eco.20150402.13

Laflèche, T. (1997). The impact of exchange rate movements on consumer prices. *Bank of Canada Review*, Winter 1996–1997, 21–32.

Lin, M.-T. (1967). *Keynes's Theory and Inflation*. Manhattan. Master's report. Kansas State University, Department of Economics. Available at: https://core.ac.uk/download/pdf/33362789.pdf

Mahmood, Y., Bokhari, R., Aslam, M. (2013). Trade-off between inflation, interest and unemployment rate of Pakistan: A cointegration analysis. *Pakistan Journal of Commerce and Social Sciences*, 7(3), 482–492.

Mallik, G., Chowdhury, A. (2001). Inflation and economic growth: Evidence from four south Asian countries. *Asia-Pacific Development Journal*, 8(1), 123–135.

Menegaki, A. N. (2019). The ARDL method in the energy-growth nexus field; best implementation strategies. *Economies*, 7(4), 105, https://doi.org/10.3390/economies7040105

Mercan, M. (2014). Feldstein-Horioka hipotezinin AB-15 ve Türkiye ekonomisi için sınanması: Yatay kesit bağımlılığı altında yapısal kırılmalı dinamik panel veri analizi. *Ege Academic Review*, 14(2), 231–245.

Moghadasi, L. S. (2018). The study of economic complexity and GDP effect on inflation rate and income inequality in Persian Gulf States 2002–2015. *Mapta Journal of Mechanical and Industrial Engineering (MJMIE)*, 2(3), 31–39.

Moroney, J. R. (2002). Money growth, output growth, and inflation: Estimation of a modern quantity theory. *Southern Economic Journal*, 69(2), 398–413, https://doi.org/10.2307/1061679

Murthy, V., Okunade, A. (2018). Is the health care price inflation in US urban areas stationary? Evidence from panel unit root tests. *Journal of Economics*, *Finance and Administrative Science*, 23(44), 77–94.

Musgrave, R. A., Musgrave, P. B. (1989). *Public Finance in Theory and Practice*. 5th ed. New York: McGraw-Hill Book Co. ISBN 0-07-044127-8.

Najand, M., Noronha, G. (1998). Causal relations among stock returns, inflation, real activity, and interest rates: Evidence from Japan. *Global Finance Journal*, 9(1), 71–80, https://doi.org/10.1016/S1044-0283(98)90015-1

Nell, C., Zimmermann, S. (2011). *Summary based on chapter 12 of Baltagi: Panel unit root tests*. PhD-Course: Panel Data. Vienna: Department of Economics, University of Vienna.

Nguyen, B. (2015). Effects of fiscal deficit and money M2 supply on inflation: Evidence from selected economies of Asia. *Journal of Economics*, *Finance and Administrative Science*, 20(38), 49–53, https://doi.org/10.1016/j.jefas.2015.01.002

Nusair, S. A. (2019). Oil price and inflation dynamics in the Gulf Cooperation Council countries. *Energy*, 181(C), 997–1011, https://doi.org/10.1016/j.energy.2019.05.208

Onyekachi, O., Onyebuchi, E. (2016). An econometric analysis of the relationship between exchange rate depreciation and inflation in Nigeria. *International Journal of Economics*, *Commerce and Management*, 4(9), 52–75.

Orimogunje, O. E. (2019). The impact of banking credit on economic growth and inflation: The case of Nigeria. *IOSR Journal of Business and Management (IOSR-JBM)*, 21(2), 32–44, https://doi.org/10.9790/487X-2102013244

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics*, 61(S1), 653–670, https://doi.org/10.1111/1468-0084.0610s1653

Pereira, D. S., Marques, A. C., Fuinhas, J. A. (2019). Are renewables affecting income distribution and increasing the risk of household poverty? *Energy*, 170(C), 791–803, https://doi.org/10.1016/j.energy.2018.12.199

Pesaran, M. H. (2004). *General diagnostic tests for cross section dependence in panels.* IZA Discussion Paper No. 1240.

Pesaran, M. H., Ullah, A., Yamagata, T. (2008). A bias-adjusted LM test of error cross-section independence. *The Econometrics Journal*, 11(1), 105–127.

Pesaran, M. H., Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*, 142(1), 50–93, https://doi.org/10.1016/j.jeconom.2007.05.010

Pham, T. A. T., Nguyen, T. T., Nasir, M. A., et al. (2020). Exchange rate pass-through: A comparative analysis of inflation targeting non-targeting ASEAN-5 countries. *The Quarterly Review of Economics and Finance*, 87, 158–167, https://doi.org/10.1016/j.qref.2020.07.010

Phillips, P. C., Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I(1) processes. *The Review of Economic Studies*, 57(1), 99–125.

Rasool, H., Adil, M. H., Tarique, M. (2018). Empirical evidence of dynamic interactions among price level, interest rate, money supply and real income: The case of the Indian economy. *Global Business Review*, https://doi.org/10.1177/0972150920980

Sarmah, A., Bal, D. P. (2021). Does crude oil price affect the inflation rate and economic growth in India? A new insight based on structural VAR framework. *The Indian Economic Journal*, 69(1), https://doi.org/10.1177/001946622199883

Shahbaz, M., Topcu, B. A., Sarıgül, S. S., et al. (2021). The effect of financial development on renewable energy demand: The case of developing countries. *Renewable Energy*, 178(C), 1370–1380, https://doi.org/10.1016/j.renene.2021.06.121

Sharma, A., Nurudeen, I. (2019). Monetary policy disturbance in India: The relationships among money, output and prices. *The Indian Economic Journal*, 67(3–4), 246–257, https://doi.org/10.1177/0019466220947699

Silaban, P. S., Harefa, D. N., Napitupulu, J. I. M., et al. (2021). The Impact of BI Interest Rate and Amount of Money Supply on Inflation in Indonesia During 2017–2019. *Media Ekonomi dan Manajemen*, 36(1), http://doi.org/10.24856/mem.v36i1.1636

Sriram, S. (1999). *Survey of literature on demand for money: the cointegration and demand for money in PICs theoretical and empirical work with special reference to error-correction models*. IMF Working Paper No. 1999/064.

Stock, J. H., Watson, M. W. (1993). A simple estimator of cointegrating vectors in higher order integrated systems. *Econometrica*, 61(4), 783–820, https://doi.org/10.2307/2951763

Sultana, N., Koli, R., Firoj, M. (2019). Causal relationship of money supply and inflation: A study of Bangladesh. *Asian Economic and Financial Review*, 9(1), 42–51, https://doi.org/10.18488/journal.aefr.2019.91.42.51

Swamy, P. A. (1970). Efficient inference in a random coefficient regression model. *Econometrica: Journal of the Econometric Society*, 38(2), 311–323, https://doi.org/10.2307/1913012

TCMB (2013). *Enflasyon ve Fiyat İstikrarı*. Ankara: Türkiye Cumhuriyet Merkez Bankası. ISBN 978-605-4911-02-8.

Tian, X.-L., Bélaïd, F., Ahmad, N. (2021). Exploring the nexus between tourism development and environmental quality: Role of Renewable energy consumption and Income. *Structural Change and Economic Dynamics*, 56, 53–63, https://doi.org/10.1016/j.strueco.2020.10.003

Tiwari, A. K., Eapen, L. M., Nair, S. R. (2021). Electricity consumption and economic growth at the state and sectoral level in India: Evidence using heterogeneous panel data methods. *Energy Economics*, 94(C), 105064, https://doi.org/10.1016/j.eneco.2020.105064

Tugcu, C. T. (2018). Panel data analysis in the energy-growth nexus (EGN). In: Menegaki, A. N. *The economics and econometrics of the energy-growth nexus*, 255–271. Cambridge: Academic Press, https://doi.org/10.1016/B978-0-12-812746-9.00008-0

Turna, Y., Özcan, A. (2021). The relationship between foreign exchange rate, interest rate and inflation in Turkey: ARDL approach. *Journal of Ekonomi*, 3(1), 19–23.

Udeogu, E., Roy-Mukherjee, S., Amakom, U. (2021). Does increasing product complexity and diversity cause economic growth in the long-run? A GMM panel VAR evidence. *SAGE Open*, 11(3), https://doi.org/10.1177/21582440211032918

Wen, F., Zhang, K., Gong, X. (2021). The effects of oil price shocks on inflation in the G7 countries. *The North American Journal of Economics and Finance*, 57, 101391, https://doi.org/10.1016/j.najef.2021.101391

Wicksell, K. (1898). *Geldzins und Güterpreise. Eine Studie über die den Tauschwert des Geldes bestimmenden Ursachen*. Jena: G. Fischer.

Wu, T.-P., Wu, H.-C. (2019). The link between tourism activities and economic growth: Evidence from China's provinces. *Tourism and Hospitality Research*, 19(1), 3–14, https://doi.org/10.1177/1467358416683769

Yolal, M., Anavatan, A. (2017). Ülkelerarası büyüme farklılıklarının açıklanmasında kurumların önemi: Panel veri analizi. *Finans Politik ve Ekonomik Yorumlar*, (632), 39–53.

Zakaria, M., Khiam, S., Mahmood, H. (2021). Influence of oil prices on inflation in South Asia: Some new evidence. *Resources Policy*, 71, 102014, https://doi.org/10.1016/j.resourpol.2021.102014