The Asymmetric Relation Between Money Supply and Inflation

Alibey Kudar[1] | *Turkish Aerospace Industries, Ankara, Turkey*

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Abstract

In this study using yearly data, it is examined if the effect of money supply (broad money) on inflation is asymmetric or not. 38 countries which have 5% and above inflation rate in average during the period of 1989–2018 are investigated through the panel data analyses. The study differs from other researches, which use monetary shocks in explaining the asymmetric relation, in which that it uses broad money change intervals along with control variables to see the asymmetric impact. Using broad money change intervals, it is concluded that the relation between broad money and inflation is explained better in the asymmetric pooled and fixed effect panel data models, compared to the symmetric models. According to the results, the effects of negative and positive changes in money supply on inflation are not symmetric. Moreover, as broad money increases, inflation goes up further. In the light of this information, it is possible to mention an asymmetric relation between broad money and inflation.

Keywords	***DOI***	***JEL code***
Money supply, broad money, inflation, asymmetry	*https://doi.org/10.54694/stat.2023.24*	*C50, E30, E40*

INTRODUCTION

As known, in monetary economics, according to Fisher's transaction approach which is related to the quantity theory of money, there is a relationship between money supply (or the amount of money in circulation) and price level. The equation is $MV_T = PT$ and in the equation, (M) refers to the money supply, while (V_T) stands for the transactions velocity of circulation of money. The product of (M) and (V_T) should be equal to the product of the total amount of transactions (T) and the price level (P). From the perspective of income, quantity theory of money is later formulated as $MV_Y = PY$ as it is quite difficult to measure the volume and price level of transactions. In the income version of the quantity theory, (V_Y) is the income velocity of money, while (Y) is the real national income (or aggregate output). If it is assumed that (V_T) or (V_Y) and (T) or (Y) are stable, then the money supply and the price level will

[1] Turkish Aerospace Industries, Fethiye Mahallesi Havacılık Bulvarı No. 17, Kahramankazan, Ankara, Turkey. E-mail: akudar@gmail.com, phone: (+90)3128111800.

affect each other. Therefore, we can say that any increase in the amount of money in circulation will lead to an increase in price levels and, as said by Friedman (1963), "inflation is always and everywhere a monetary phenomenon".

Using monetary data might allow us to get information on the outlook for increase in price levels. Thus, monetary policy is important for the stock of money since it affects money supply. Decreasing policy rates make borrowing more attractive. However, monetary policy is not only a factor to affect broad money. Interest rates borrowers face or banks' lending criteria are also important (Berry et al., 2007). Investigating the monetary growth and inflation in Nigeria for the periods of 1982–1996 and 1996–2012, Moses et al. (2015) stated that the relationship between the two variables weakened in the second period and that this could be assigned to the developments in Nigerian financial system along with economy being more sophisticated.

While broad money is assumed a key driver of inflation, it might also determine the relationship between economic growth and inflation. Sare et al. (2019) stated that the ratio of broad money to GDP could be an indicator or a treshold in order for a country to keep its growth. According to the study, below the treshold, the effect of inflation can be even good for economic growth, as supported by Tobin (1965), Gregorio (1996), and Mundell (1965). Amassoma et al. (2018) examined the influence of money supply on inflation, however, they could not reach a relation in both long and short term. They stated the reason for this could be the recession in economy.

When investigating inflation, the expectation of inflation should also be taken into account. The formulation including the expectation of inflation can be shown as follows:

$$p_t = B\, E_t p_{t+1} + k\, X_t + shock_t,$$

where p is the inflation rate at time t, $E_t p_{t+1}$ is the expected rate of inflation at time $t+1$, X_t is the output gap (Coibion et al., 2018). If the government attempts to reduce unemployment by the use of monetary policy, then the rate of inflation will be on increase (El-Agraa, 2011). The expectation of inflation can also increase due to claims on central government. As mentioned by Ogunmuyiwa (2020), in addition to monetary policy, fiscal policy is another instrument to lower inflation. Adjusting the level of expenditures and taxes, especially governments in developing countries try to stabilize economy and curb price level increase. If the expenditures of central government are considerably more than taxes and there is a perception that the government will print money to pay its debts, then the expected rate of inflation will increase.

The effect of monetary growth on price levels might be indirect as well. As the amount of money in circulation increases, foreign exchange rates will increase, causing therefore costs to go up for countries with negative net exports. Odusola and Akinlo (2001) explained that the major causes of inflation were budget deficit (fiscal aspect), increase in money suppy (monetary aspect) and foreign exchange rate (balance of payments aspect). The balance of payment aspect of inflation is related to higher import prices due to foreign exchange rates rising.

In this study, the asymmetric relation between money supply and inflation is examined through broad money change intervals. The study differs from other researches, which use monetary shocks in explaining the asymmetric relation, in that it uses broad money change intervals along with control variables to see the asymmetric impact. The paper is organized as follows: Section 1 investigates the literature and provides theoretical background as well as empirical studies. Section 2 explains the methodolgy of study. As "monetary shocks" (error terms) may not reflect the real asymmetric impact of money supply on inflation, the nonlinear relation is analysed with growth rates in broad money divided into four groups. Besides, in order to get more reliable results, control variables are used in the models. In section 3, the asymmetric effect of broad money is assessed. First of all, unit

root tests are performed and then panel data analyses are used. As per the chosen panel data models, otoregressive regression analyses are performed and the impact of broad money growth rates on inflation is examined. The last section is the conclusion section of the paper which summarizes and discusses the analysis results along with the limitations of study. The results are compared to the empirical studies in the litareture.

1 LITERATURE

In many researches in the literature, it is seen that the impact of money supply on inflation is investigated without taking different economic conditions, which potentially may influence the relation, into consideration. Conducting a research without using control variables will probably lead to inappropriate results. Even if different economic conditions are considered, adding these conditions into a regression analysis directly as independent variables would cause endogeneity concerns. Therefore, the relation between broad money and inflation might be established as follows, using control variables:

$$p_t = a + \sum_{i=1}^{m} A_i P_{t-i} + \sum_{i=0}^{m} B_i M_{t-i} + \sum_{i=0}^{m} C_i CV_{t-i} + \varepsilon_t , \quad (1)$$

where: p is the inflation rate, M is the broad money growth, CV is the control variables.

In line with the literature, the control variables may be chosen as real GDP growth rate, change in official exchange rate, claims on central government and domestic bank credits.

Let's consider real GDP growth rate. As Kennedy (2000) stated, real GDP growth requires increase in money supply to meet extra money demand. However, if increase in money supply is bigger than the real GDP growth rate, the value of money will decrease, therefore leading to inflation.

Similarly, bank credit is an important factor for broad money to grow. As bank credits increase, so will broad money. On the other hand, as Marshal et al. (2015) concluded, bank credit and economic growth had a short term relation as well. For this reason, it is likely that there could be a endogeneity problem. Although money is created on the basis of credit, some researches showed that credit was not the main determinant of money supply or deposits, and that deposits were the main factor of credits, and that deposits could exceed the effect of credits on money supply. Therefore credits can be taken into account as a control variable (Tiryaki and Hasanov, 2022).

The amount of claims on central government might be a signal for a government to print money. Because, as the claims on central government increase, it will be difficult for the government to pay its debts. Therefore, due to potential default risk, expected inflation rate would rise and eventually result in price level escalating. As supported by Klein and Ichimura (2000), claims on central government and financial deficit are closely related to each other and financial deficit will lead enterprises and residents to hold more currency and deposit. As a result of this, increase in reserve money and broad money would arise.

As for exchange rate, it is assumed that monetary authority would like to adjust money supply in order to stabilize exchange rates, which means the monetary authority either decreases or increases interest rates depending on the changes in foreign exchange rates. For an illustration, for BRICS countries, Si et al. (2018) concluded that there were co-movement and causality relation between exchange rates and interest rates. In addition, as said by Bianchi and Deschamps (2018), Singapore's monetary policy is based on the exchange rate. For this reason, it is deemed fit to consider exchange rate as a control variable.

As theoretical background, another approach to the quantity theory of money is the Cambridge cash-balance approach that is $M^d = kPY$. In this formula, (M^d) is the demand for money and (P) is the price level. (Y) reflects the real national income, while (k) is the proportion of nominal income which people want to hold in money. As per the formula, considering money-market equilibrium, demand

for money and supply of money need to be equal. Thus, in equilibrium $M = kPY$ (Cesarano, 2008; Runde, 1994; Buthelezi, 2023). The literature offers also non-monetary theories. These are demand pull inflation (demand is not met by supply), cost push inflation (cost increases faster than productivity), profit push inflation (profit is the main cause of inflation), imported inflation (the effect of external inflation) and politically caused inflation (O'Neill, 2017; Alpago, 2021).

In accordance with the monetarist theories, Şahin (2019) stated that inflation in Turkey rises as money supply increases, and that money supply with budget deficit leads to inflation (Şahin, 2019; Kaya and Öz, 2016). Similarly, the studies by Chaundhary and Parai (1991), Altıntaş et al. (2008), Lozano (2008), Bakare et al. (2014), Koyuncu (2014), and Dekkiche (2022) are the empirical studies implying that money supply and inflation show a significant relation. On the other hand, Şahin and Karanfil (2015) did not reach a causality relation between the variables (Şahin, 2019). Koti and Bixho (2016) found that money supply did not cause inflation in Albania, while Ditimi et al. (2018) indicated that money supply was not an important factor in Nigeria's inflation, using the ARDL-ECM method (Dekkiche, 2022).

In the literature, it is seen that the asymmetric effect of monetary policy on inflation is investigated through positive or negative monetary shocks. Examining the relation between money growth and inflation, the study by Cooray and Kheraief (2018) revealed that the response of inflation to positive and negative monetary shocks was asymmetric. Just as the study by Cooray and Kheraief (2018), the researches by Olayiwola and Ogun (2019), and Khundrakpam (2013) focused on positive and negative monetary shocks, concluding that monetary policy or money supply had asymmetric impact on prices. This can raise the question whether different amounts of change in broad money could also cause asymmetric effect on inflation. Thus, instead of asymmetric impact of positive or negative monetary shocks, the asymmetric relation between money supply and inflation might be examined via the change in broad money. In addition, in the literature, it seems that these monetary shocks are the error terms of autoregressive models. However, since the error terms may arise from variables which are not used in the model, it may not be meaningful to call these residuals as monetary shocks. For an illustration, if real economic growth in a country is considerably high, then it can be necessary to further increase money supply compared to previous year and if the economic growth is not taken into consideration in the model, this will result in error term in the model increasing and indicate a positive monetary shock which is actually not.

2 METHODOLOGY

In this study using the Worldbank indicators and yearly data, the countries which had 5% or greater inflation rate in average during the period of 1989–2018 are examined as De Grauwe and Polan (2005) suggest that the relation between monetary growth and inflation is weak for countries that have low inflation. The period used is from 1989 to 2018 and the countries are shown in the Appendix 1. Although there are other countries which had minimum 5% or greater inflation rate in average during the period of 1989–2018, those countries could not be analyzed due to missing data of some variables used in this study. In addition, when the period is extended, the number of missing data increases. Hence, the period is defined as 1989–2018 to analyze as much data (many country) as possible.

The variables used in the study are illustrated through the Appendix 2. In line with the literature, the control variables are chosen as real GDP growth rate, change in official exchange rate, claims on central government and domestic bank credits. Therefore, RGDP, EXCH, COCG and DBC are included in the models as control variables. M is used for the symmetric relation, while MG1, MG2, MG3 and MG4 are the groups defined as per the changes in broad money and incorporated into the models investigating the asymmetric relation. The broad money is defined in the Worldbank indicator note as "the sum of currency outside banks; demand deposits other than those of the central

government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper".

As stated before, the study differs from other researches, which use monetary shocks in explaining the asymmetric relation, in that it uses the broad money change intervals along with control variables to see the asymmetric impact. In the light of aforementioned literature and as a new alternative approach to the asymmetric relation, based on the distribution of observations, the percentage changes in broad money (the observations) are defined and divided into four groups as follows:

Group 1: the changes in broad money less than 0% (reduction in broad money),

Group 2: the changes in broad money between 0% and 25%,

Group 3: the changes in broad money between 25% and 50%,

Group 4: the changes in broad money greater than 50%.

The groups and their intervals are defined according to the explanations stated below:

- In the literature, to detect assymetric relation, it seems that negative monetary shocks are also included in the studies. For this reason, in order to see the negative impacts of reduction in broad money on inflation, the first group is composed of negative changes in broad money.
- For the positive changes in broad money, the second and third group intervals are defined as 0%–25% and 25%–50%, respectively. The reason for this is that some observations in the real GDP growth variable have quite high values. For instance, the growth rate of Eswatini in 1990 reached 21 percent. Therefore, in order to better understand the assymetric positive impact of broad money on inflation, it is deemed fit to define the intervals greater than 21%. This would also allow us to see the impact of excess broad money growth on inflation (all the broad money growths will be higher than all the real GDP growths in the third and fourth groups). As known, if the money supply rises faster than real output, prices will usually increase. The second reason is that as the intervals get smaller, the number of groups increase, decreasing the number of observations in the groups. This could statistically cause bias and distorted results. Therefore, the fourth group includes all the broad money changes greater than 50% in order to limit the number of groups.

After that, as per the groups, the relation between broad money and inflation is re-established as stated below:

$$p_t = a + \sum_{i=1}^{m} A_i p_{t-i} + \sum_{i=0}^{m} D_1 B_{1i} MG1_{t-i} + \sum_{i=0}^{m} D_2 B_{2i} MG2_{t-i} + \sum_{i=0}^{m} D_3 B_{3i} MG3_{t-i} + \sum_{i=0}^{m} D_4 B_{4i} MG4_{t-i} + \sum_{i=0}^{m} C_i CV_{t-i} + \varepsilon_t, \quad (2)$$

where:

$D_1=1$, $D_2=0$, $D_3=0$ *and* $D_4=0$; if the change in broad money belongs to Group 1,

$D_1=0$, $D_2=1$, $D_3=0$ *and* $D_4=0$; if the change in broad money belongs to Group 2,

$D_1=0$, $D_2=0$, $D_3=1$ *and* $D_4=0$; if the change in broad money belongs to Group 3,

$D_1=0$, $D_2=0$, $D_3=0$ *and* $D_4=1$; if the change in broad money belongs to Group 4,

CV is the control variables.

As we do not have specific data on expected rates of inflation to cover all the countries in this study, the control variables used might also be considered as proxy variables for expectations about inflation. Therefore, expected rates of inflation are indirectly incorporated into the analyses as control variables. For instance, claims on central government and domestic bank credits could be the indirect factors that people consider could decrease or increase inflation. As mentioned in the literature section, as claims on central government or domestic bank credits increase, the expected rate of inflation would increase.

In order to state that there is an asymmetric relation between broad money and inflation, within the scope of this study, it is investigated whether the following two requirements are met:

i) the adjusted R squared of Formula (2) should be greater than that of Formula (1),
ii) instead of $H_0 = [B_i^{Group1} = B_i^{Group2} = B_i^{Group3} = B_i^{Group4}]$ implying a symmetric relation, $H_A = [B_i^{Group1} \neq B_i^{Group2} \neq B_i^{Group3} \neq B_i^{Group4}]$ showing an asymmetric relation should be accepted.

The first condition implies that Formula (2), which is an asymmetric relation, has a better explanation on the relation between broad money and inflation, while the second condition indicates that different changes in broad money have different effects on inflation.

3 EMPIRICAL STUDY

Within the scope of the study, first of all, unit root tests are applied in order to decide whether the variables can be used at I(0) or not. Im-Pesaran-Shin (2003) and Levin-Lin-Chu (2002) unit root test results shown in Table 1 and Table 2 respectively imply that:

- according to both tests, p, M and RGDP can be used at I(0),
- although COCG (Intercept and Trend) is not stationary at I(0) as per Im-Pesaran-Shin Unit Root Analysis, it is deemed stationary at I(0) as both COCG (Intercept) and COCG (Intercept & Intercept and Trend) are stationary at I(0) as per Im-Pesaran-Shin and Levin-Lin-Chu unit root analyses,
- both tests indicate that DBC is not stationary at I(0). Thus, the log difference of DBC, ld_DBC, is used in the analyses investigating the symmetric and asymmetric relations.

In addition, as M is stationary at (0); MG1, MG2, MG3 and MG4 are deemed stationary at I(0) as well.

Table 1 Im-Pesaran-Shin unit root analysis

Variable	I(0) / I(1)	Intercept		Intercept and trend	
		Im-Pesaran-Shin t-bar	Significance level	Im-Pesaran-Shin t-bar	Significance evel
p	I(0)	–2.76771	***	–3.26773	***
	I(1)	–	–	–	–
M	I(0)	–4.1183	***	–4.54576	***
	I(1)	–	–	–	–
RGDP	I(0)	–4.17596	***	–4.54576	***
	I(1)	–	–	–	–
EXCH	I(0)	–4.2592	***	–4.59112	***
	I(1)	–	–	–	–
COCG	I(0)	–1.82384	**	–2.12721	–
	I(1)	–	–	–	–
DBC	I(0)	–0.977661	–	–1.82642	–
	I(1)	–4.5421	***	–4.64426	***

Note: For the model with intercept, the critical values are –1.72, –1.77 and –1.88 for 10%, 5% and 1% respectively. For the model with intercept and trend, the critical values are –2.35, –2.41 and –2.51 for 10%, 5% and 1%. ***, **,* reflect significance level of 1%, 5% and 10% respectively.
Source: Own construction

Table 2 Levin-Lin-Chu unit root analysis

Variable	I(0) / I(1)	Intercept			Intercept and trend		
		Coefficient	t ratio	z-score [p value]	Coefficient	t ratio	z-score [p value]
p	I(0)	–0.57891	–23.279	–16.2876 [0.0000]	–0.66247	–24.423	–15.3744 [0.0000]
	I(1)	–	–	–	–	–	–
M	I(0)	–0.72906	–26.061	–20.1039 [0.0000]	–0.83735	–28.450	–19.7083 [0.0000]
	I(1)	–	–	–	–	–	–
RGDP	I(0)	–0.71486	–25.473	–18.6035 [0.0000]	–0.80596	–28.067	–18.0388 [0.0000]
	I(1)	–	–	–	–	–	–
EXCH	I(0)	–0.98298	–32.793	–27.3207 [0.0000]	–0.99555	–33.140	–23.9638 [0.0000]
	I(1)	–	–	–	–	–	–
COCG	I(0)	–0.14557	–10.775	–3.74581 [0.0001]	–0.22131	–12.671	–2.67754 [0.0037]
	I(1)	–	–	–	–	–	–
DBC	I(0)	–0.063047	–5.871	0.880028 [0.8106]	–0.153	–9.873	0.733616 [0.7684]
	I(1)	–0.8077	–27.621	–20.782 [0.0000]	–0.84611	–29.214	–19.1121 [0.0000]

Source: Own construction

Since 38 countries are examined and panel data is used in the study, it is needed to decide what panel data analysis model to be used. Therefore; F test, Breusch-Pagan Test and Hausman test are applied for comparison. The null and alternative hypotheses for these tests are shown below:

F test	Breusch-Pagan test	Hausman test
H_0 = Pooled Panel Data Analysis H_A = Fixed Effect Panel Data Analysis	H_0 = Pooled Panel Data Analysis H_A = Random Effect Panel Data Analysis	H_0 = Random Effect Panel Data Analysis H_A = Fixed Effect Panel Data Analysis

As per Table 3 which reflects model selection, it is seen that both pooled and fixed effects prevail against random effect panel data and that it will be more appropriate to apply pooled panel data. However, for the avoidance of any doubt, both pooled and fixed effect panel data analyses are applied to see the relations.

The pooled and fixed effect panel data analyses results are shown in Table 4 and Table 5 respectively. As planned, the analyses are performed on both symmetric and asymmetric relation. As per the results, both P values and adjusted R squared values of the asymmetric relations are better than those of symmetric relations.

After concluding that adjusted R squared values of asymmetric relation are greater, as the second condition, the hypotheses which are $H_0 = [B_i^{Group1} = B_i^{Group2} = B_i^{Group3} = B_i^{Group4}]$ and $H_A = [B_i^{Group1} \neq B_i^{Group2} \neq B_i^{Group3} \neq B_i^{Group4}]$ are tested and the results thereof are shared in Table 6.

As per Table 6, for both pooled and fixed effect models, the F statistics have an implication that the betas of different groups are not statistically equal to each others, thus indicating that the relation is asymmetric.

Table 3 Panel Data Analysis model selection

Tests used			Selected model
F test	Breusch-Pagan test	Hausman test	
Symmetric relation			
0.876151 (0.681787)	–	–	Pooled
–	2.08892 (0.148371)	–	Pooled
–	–	33.3836 (0.006572)***	Fixed effect
Asymmetric relation			
1.16221 (0.235279)	–	–	Pooled
–	0.304118 (0.581313)	–	Pooled
–	–	45.4549 (0.007418)***	Fixed effect

Note: ***, **, * reflect significance level of 1%, 5% and 10% respectively.
Source: Own construction

Table 4 Pooled Panel Data Analysis results

Independent variable	Dependent variable: inflation	
	Panel data analysis: pooled	
	Symmetric relation	Asymmetric relation
Constant	0.882625 (0.0859)*	1.72424 (0.0152)**
p_1	0.611151 (1.07e-122)***	0.540793 (1.36e-096)***
M	0.200412 (3.79e-029)***	–
M_1	0.0851506 (3.98e-06)***	–
M_2	–0.0331218 (1.58e-069)***	–
MG1	–	–0.184506 (0.0338)**
MG1_1	–	–0.587201 (4.50e-011)***
MG1_2	–	0.154766 (0.0778)*
MG2	–	0.102975 (0.0105)**
MG2_1	–	0.100769 (0.0122)**

Table 4 (continuation)

Independent variable	Dependent variable: inflation	
	Panel data analysis: pooled	
	Symmetric relation	Asymmetric relation
MG2_2	–	–0.050833 (0.1631)
MG3	–	0.134193 (3.16e-07)***
MG3_1	–	0.123031 (1.70e-06)***
MG3_2	–	–0.0339215 (0.1266)
MG4	–	0.242289 (5.97e-036)***
MG4_1	–	0.141102 (9.71e-012)***
MG4_2	–	–0.0314155 (4.89e-066)***
RGDP	–0.679792 (9.33e-019)***	–0.587916 (2.04e-015)***
RGDP_1	0.165466 (0.0359)**	0.166504 (0.0272)**
RGDP_2	0.118097 (0.1047)	0.138205 (0.0473)**
EXCH	–0.000319 (0.5992)	–0.000436 (0.4496)
EXCH_1	0.000509 (0.4023)	0.0003094 (0.5911)
EXCH_2	2.32036e-05 (0.9693)	9.35856e-06 (0.9869)
COCG	–0.150150 (0.0045)***	–0.167587 (0.0009)***
COCG_1	0.347071 (5.84e-06)***	0.330745 (5.40e-06)***
COCG_2	–0.177569 (0.0007)***	–0.127888 (0.0100)**
Id_DBC	–6.79550 (1.82e-05)***	–6.97568 (4.26e-06)***
Id_DBC_1	3.90248 (0.0121)**	3.04975 (0.0395)**
Id_DBC_2	–2.20387 (0.1256)	–2.15244 (0.1179)
P-value (F)	4.8e-290***	1.4e-306***
Adjusted R squared	0.745976	0.773218
Durbin-Watson	2.078846	2.075212

Source: Own construction

Table 5 Fixed Effect Panel Data Analysis results

	Dependent variable: inflation **Panel data analysis: fixed effect**	
Independent variable	**Symmetric relation**	**Asymmetric relation**
Constant	1.85907 (0.0085)***	3.23739 (0.0003)***
p_1	0.566570 (2.66e-096)***	0.494842 (1.44e-075)***
M	0.191828 (2.72e-025)***	–
M_1	0.087383 (4.36e-06)***	–
M_2	–0.029899 (6.52e-052)***	–
MG1	–	–0.182592 (0.0402)**
MG1_1	–	–0.596345 (4.87e-011)***
MG1_2	–	0.111542 (0.2111)
MG2	–	0.083138 (0.0444)**
MG2_1	–	0.088592 (0.0312)**
MG2_2	–	–0.06602 (0.0769)*
MG3	–	0.109276 (4.90e-05)***
MG3_1	–	0.109711 (2.80e-05)***
MG3_2	–	–0.05218 (0.0227)**
MG4	–	0.236651 (8.00e-033)***
MG4_1	–	0.151358 (9.65e-013)***
MG4_2	–	–0.028307 (4.08e-050)***
RGDP	–0.695415 (1.13e-017)***	–0.590117 (3.27e-014)***
RGDP_1	0.118634 (0.1477)	0.131189 (0.0918)*
RGDP_2	0.079877 (0.2962)	0.113066 (0.1207)
EXCH	–0.00053 (0.3924)	–0.00069 (0.2359)

Table 5 (continuation)

	Dependent variable: inflation Panel data analysis: fixed effect	
Independent variable	**Symmetric relation**	**Asymmetric relation**
EXCH_1	0.000275 (0.6581)	6.9860e-06 (0.9905)
EXCH_2	–0.000175 (0.7767)	–0.00028 (0.6273)
COCG	–0.15153 (0.0061)***	–0.174298 (0.0009)***
COCG_1	0.332102 (1.54e-05)***	0.317535 (1.22e-05)***
COCG_2	–0.155858 (0.0041)***	–0.10632 (0.0382)**
Id_DBC	–7.17756 (8.39e-06)***	–6.85155 (7.65e-06)***
Id_DBC_1	3.43576 (0.0291)**	2.90239 (0.0514)*
Id_DBC_2	–2.56010 (0.0799)*	–2.09729 (0.1311)
P-value (F)	2.4e-260	6.3e-280
Adjusted R squared	0.744817	0.77457
Durbin-Watson	2.050529	2.06198

Source: Own construction

Table 6 Fixed Effect Panel Data Analysis results

	F Statistic	
Null & alternative hypotheses	**Pooled**	**Fixed effect**
$H_0 = [B_i^{Group1} = B_i^{Group2} = B_i^{Group3} = B_i^{Group4}]$	14.4672	15.2546
$H_A = [B_i^{Group1} \neq B_i^{Group2} \neq B_i^{Group3} \neq B_i^{Group4}]$	(3.52964e-022)***	(2.08619e-023)***

Source: Own construction

DISCUSSION AND CONCLUSION

In this study, it is investigated whether there is an asymmetric relation between money supply (broad money) and inflation. Unlike previous studies in the literature, the asymmetric relation is not examined through monetary shocks which are positive or negative error terms of autoregressive models of money supply or interest rates as monetary shocks may not reflect a real shock. Instead, broad money change intervals are used in order to see the nonlinear relation. In the study, real GDP growth rate, change in official exchange rate, claims on central government and domestic bank credits are added into the models as control variables and growth rates in broad money are divided into four groups. The first group reflects negative rates, in other words, reduction in broad money, while the fourth group is the growth rates which are above 50%. Using broad money change intervals, it is concluded that the relation between broad money and inflation is explained better in the asymmetric pooled and fixed effect panel data models, compared

to the symmetric models, as the betas of groups are not statistically equal. According to the results, the effects of negative and positive changes in money supply on inflation are not symmetric. Moreover, as broad money increases, inflation goes up further. In the light of this information, it is possible to state that the effect of money supply on inflation is not symmetric but asymmetric. Since all the broad money growths are higher than all the real GDP growths in the third and fourth groups, another economic interpretation is that as the excess broad money growth rises, its impact on inflation increases. In this regard, considering the control variables are included in the model, the results of this study are also in line with the monetarist theory of inflation and even imply that there is a non-linear relation between the variables. The results obtained are similar to the results of analyses by Cooray and Kheraief (2018), Olayiwola and Ogun (2019), and Khundrakpam (2013), indicating an asymmetric relation. Therefore, as mentioned by Alpago (2021), taking into consideration the statement that inflation is a result of poor monetary and fiscal policy might be more effective in making decisions about how to fight inflation. Furthermore, inflation is discussed differently in developing and developed countries (Shaikh et al., 2022). In developed countries, inflation might be more related to monetary approach but in developing countries, it may not be purely monetary. Since even political and structural factors could play a role in inflation, it would be quite challanging to decompose inflation into its demand-pull, monetary, cost-push and structural components as the process is dynamic and the shocks to prices are mixed (Totonchi, 2011; Esumanba et al., 2019, Shaikh et al., 2022). For this reason, in case that more variables defined by non-monetary theories are included in studies to be carried out, it is likely to obtain interesting analysis results.

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APPENDICES

Appendix 1 The countries investigated

Algeria	Guatemala	Nigeria
Bangladesh	Haiti	Pakistan
Bhutan	Iceland	Papua New Guinea
Bolivia	India	Paraguay
Botswana	Indonesia	Peru
Chile	Israel	Philippines
Costa Rica	Jamaica	Sri Lanka
Dominican Republic	Kenya	Sudan
Ecuador	Madagascar	Trinidad and Tobago
Egypt, Arab Rep.	Mauritius	Tunisia
El Salvador	Mexico	Turkey
Eswatini	Myanmar	Uruguay
Ghana	Nepal	

Appendix 2 The variables used

Variable	Explanation
p	Inflation
M	Change in broad money
MG1	Group 1 – Change in broad money (less than 0%)
MG2	Group 2 – Change in broad money (between 0% and 25%)
MG3	Group 3 – Change in broad money (between 25% and 50%)
MG4	Group 4 – Change in broad money (greater than 50%)
RGDP	Real GDP growth rate
EXCH	Change in official exchange rate
COCG	Claims on central government (% of GDP)
DBC	Domestic bank credits (% of GDP)

Source: The data is derived from Worldbank indicators