



Research article

Relationship between financial inclusion, monetary policy and financial stability: An analysis in high financial development and low financial development countries

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ABSTRACT

This article studies the linkage between financial inclusion, monetary policy and financial stability in 58 countries including 31 high financial development countries (HFDCs) and 27 low financial development countries (LFDCs) from 2004 to 2020 using the PVAR method. Results of impulse – response function suggest that in LFDCs, while financial inclusion and financial stability are positively correlated, they are negatively correlated with the inflation rate and the money supply growth rate. In HFDCs, financial inclusion is positively correlated with inflation rate and money supply growth rate, while financial stability is negatively correlated with financial inclusion, inflation rate and money supply growth rate. These findings imply that in LFDCs, financial inclusion increases financial stability and reduces inflation. In HFDCs, on the contrary, financial inclusion increases financial instability, leading to long-term inflation. The results of the variance decomposition confirm the above outcomes, specifically, this relationship is clearer in HFDCs. From the above findings, we propose some policy recommendations on financial inclusion and monetary policy for financial stability for each group of countries.

1. Introduction

In recent years, governments and central banks of many countries have become interested in the idea of financial inclusion for its contributions to macro stability and helping countries make monetary policy more effective. According to World Bank, an inclusive financial system offers both individuals and businesses the same chances to conveniently acquire financial products and services at reasonable prices. By a similar definition, financial inclusion is the qualitative and quantitative expansion that makes it easy for investors to access financial products and services [1] and is measured by the number of people owning and using official financial instruments. Financial inclusion has a close relationship with a country's financial stability, helping countries to implement effective monetary policy. Anatolyevna and Ramilevna (2013) [2] claim that financial stability reflects the financial system's health (financial markets, financial intermediaries and financial market infrastructure) that can withstand financial shocks disrupting the distribution of savings for profitable investment opportunities. Accordingly, the definition given above demonstrates that financial stability emphasizes the financial intermediaries' resilience to shocks and ability to continue playing their fundamental role of mediating savings and investment in the economy.

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Research by Mbutor and Uba (2013) [3] on the nexus of monetary policy and financial inclusion show that the effectiveness of monetary policy has a causal relationship with financial inclusion, inferring that increased financial inclusion will improve the efficacy of monetary policy which helps stabilize the macro economy. Financial inclusion allows the expansion of monetary policy and helps policymakers forecast inflation better. Dienillah et al. (2018) [4] provides a positive linkage of financial stability and financial inclusion based on income grouping. Findings suggest that strengthening financial inclusion will contribute to financial stability. However, financial inclusion in a country can cause potential instability in financial markets. Financial inclusion and its tools, according to García and José [5], can generate a fast increase in credit, an unregulated financial system, and significant market risks that can cause inflation to rise and the macroeconomy to become unstable. Lessons learned from the 2008 global financial crisis, high financial inclusion coupled with low interest rates providing a large amount of credit to the economy was pushed into the real estate market as the trigger for the financial system's collapse. Thereby, it can be seen that financial development is crucial when studying the linkage of financial inclusion, monetary policy and financial stability while previous studies has ignored this issue [6–11]. Therefore, this study adds to the gap of previous studies.

Besides, there are many studies on the nexus of financial inclusion and monetary policy [1,12–18] and on the linkage between financial stability and financial inclusion. However, to our best knowledge, the simultaneous correlation between financial inclusion, financial stability, and monetary policy has not been examined empirically. This is one of the reasons that motivated us to do this research.

In addition, research results differ depending on the scope of space, time of research or approach to regional divisions such as Asia and Europe, developed and developing countries, whereas financial development plays an important role as a catalyst or restraint in this relationship. Therefore, this study approaches in a new country grouping based on the Financial Development Index developed by IMF, including the group of high financial development countries (such as the US, Singapore, the UK, ...) and group of low financial development countries (such as Albania, Armenia, Azerbaijan, ...), to analyze the difference of the linkage between financial inclusion, monetary policy and financial stability.

Based on the research gaps, we conduct a study on the relationship between financial inclusion, monetary policy and financial stability in two groups of countries with high and low financial development. The aim is to address the question of how this relationship differs in the two groups, then provide suitable policy implications to stabilize finance in each group. This research has three important contributions as follows. Firstly, it provides an overview of the linkage between financial inclusion, monetary policy and financial stability in two different groups of countries, enabling researchers to gain deeper insights into this topic. Secondly, this study helps identify the important factors that affect financial stability in each group of countries, and provides specific policy recommendations to enhance domestic financial stability, helping to make appropriate decisions that meet the needs of the people. Finally, based on the study results, researchers can make assumptions and predictions about the future of the financial system in the two different groups of countries.

The rest of the study is structured as follows: Section 2 describes literature reviews. Section 3 summarizes the data and the research methodology. Section 4 explains the results and discussion. Finally, the conclusion and some policy recommendations are presented in Section 5.

2. Literature review

2.1. Theories of monetary policy, financial inclusion and financial stability

The theory of the correlation between monetary policy, financial inclusion and financial stability can be approached on the basis of the following four theories:

George's Asymmetric Information Theory [19] stated that in financial services marketing activities, distinguishing between good borrowers and bad borrowers is a challenge because information asymmetry arises when one person in a credit agreement has as much knowledge or information as the other person. Bofondi and Gobbi (2003) [20] argued that information asymmetry causes credit to narrow, affecting operational efficiency and financial stability. Financial inclusion, characterized by the large influx of new and inexperienced clients into the formal financial sector, presents a challenge in the debt market as lenders find it difficult to identify whether a certain customer borrowing is good or not, thereby threatening financial performance and subsequently financial stability. As a result, it is challenging for banks to operate in the context of financial inclusion in the face of asymmetric information.

The finance-growth theory of Bagehot and Street (1915) [21] argued that if a significant portion of the population cannot easily access financial products within their repayment capacity, it will lead to income inequality and long-term imbalance, slowing down economic growth and development. Sparatt and Stephen (2013) [22] argued that monetary policy implementation in a country is aided by financial inclusion and stability, which are necessary for economic growth.

Diamond's theory of financial intermediation describes how banks serve as financial intermediaries between borrowers and savers as it mobilizes and lends funds, bridging the gap between customers in the market [23]. This demonstrates that access to financial market for poor customers is largely determined by the existence of perfect financial markets. Banks aim to lower market transaction costs by raising the level of financial inclusion. This lessens information asymmetry, which in turn lessens market imperfections among participants.

Keeley (1990) [24] proposed the bank value hypothesis, which states that banks with market power can reduce the risk so that it maintains a relative monopoly. Ahamed and Mallick (2019) [25] indicated that the level of financial inclusion is highly influenced by how competitive the banks are in the market. Next, banking competition is the main factor determining bank stability, thereby helping banks to make monetary policies.

Thus, each of the four theories discussed above provides a unique explanation of how financial inclusion affects monetary policy and financial stability. Based on these theories, we study the relationship of financial inclusion, monetary policy and financial stability to explore the difference among countries with high financial development index and low financial development index.

2.2. The role of financial development

Levine (2005) [26] defined financial development as improving the functions provided by the financial system including saving savings, allocating capital to profitable investment opportunities, monitoring and risk management of these investments, diversifying risks, and facilitating the exchange of goods and provision of services. To some extent, financial development can reduce information asymmetry, reduce financial constraints, and promote risk sharing. Financial development also helps the financial system to be able to absorb shocks in the economy, reduce the amplification of the harmful effects of adverse shocks occurring in the economy, and reduce macroeconomic volatility and inequality in society.

Patrick (1966) [27] developed the idea of “supply-first” and “demand-following” related to financial development and these are also important theoretical bases for subsequent studies. The idea of “supply - first” refers to the input role of financial institutions in performing the function of transferring resources between sectors in the economy. Here, due to specialization and improved management ability as well as professional proficiency, intermediary organizations fully, accurately and promptly respond to the capital needs of regions in the economy, as well as transferring capital from traditional non-growth industries such as agriculture, heavy industry, mining, etc. to modern industries with higher growth potential such as information technology and service sectors. The idea of “demand - follow” can be understood that when there is financial development, financial products such as loans, deposits, insurance, and financial services such as brokerage and rating will be more diversified in terms of both value and duration as well as increased reliability, in line with the different requirements of market participants. This promotes entities to participate in the economy more in both the role of providing and using capital. As a result, capital resources in the economy are exploited to the maximum, contributing to the increase of financial inclusion, and countries implementing better monetary policy, thereby helping to stabilize the macroeconomy.

Indeed, after the 2008 global financial crisis, there were researchers like Kouki et al. (2020) [28] and Matsebula and Sheefeni (2022) [15] aimed to describe the negative effect of financial inclusion on financial stability leading to persistently elevated inflation. According to these researchers, the 2008 global financial crisis originated in HFDCs such as the United States and then spread to other regions. However, the extent of the impact as well as the consequences of this crisis are different. We assume that this difference is partly due to the influence of financial development, specifically the difference between HFDCs and LFDCs. In HFDCs such as the United States, Great Britain, France, etc., a large number of financial institutions lead to easy access to finance by financial consumers. Through the mechanism to reduce the difficulties and obstacles that external financial constraints cause for businesses so that they can expand and develop their products and services. After a while, the overdevelopment of the manufacturing and service sectors leads to increased inflation, affecting input costs as well as inflows and outflows of financial markets. This causes instability in the manufacturing and service sectors as well as economic instability. Thus, high financial development is often accompanied by increased inflation, then monetary policy is promoted to stabilize the economy [29]. The evidence is that after the Dot-com crisis in 2000, the Fed’s interest rates were always low to stimulate demand for consumer investment loans. The lack of control over subprime loans, which made it easy for Americans to access money, pushed a large amount of money into real estate, and the excessive growth caused

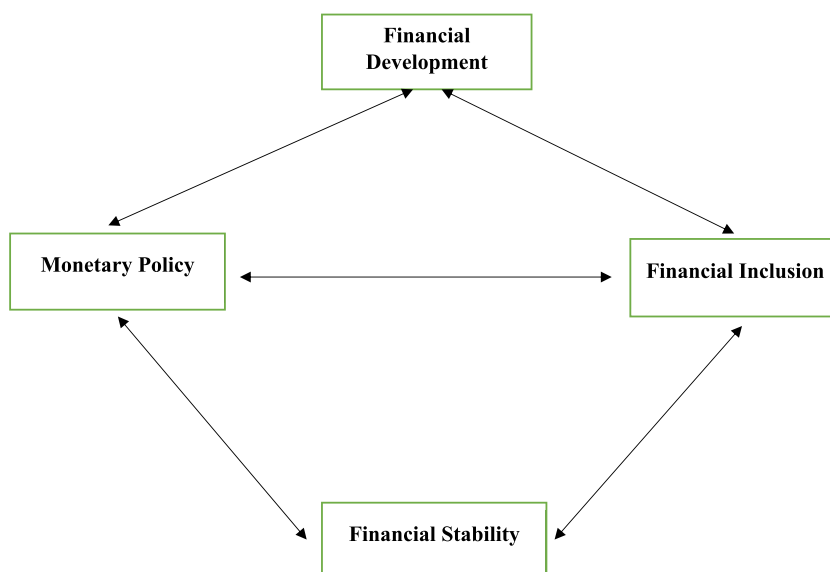


Fig. 1. The linkage between financial inclusion, monetary policy and financial stability under the role of financial development.

inflation to rise. When the Fed adjusted interest rates, loans could not be paid, leading to instability and collapse of the financial system. This shows that in HFDCs, when financial inclusion is at a high level, monetary policy always plays a critical role in the event of financial instability [17]. In contrast, when the level of financial development is low, consumption and investment continue to be the factors contributing to economic growth, and individual businesses need more comprehensive financial access to serve their production and consumption needs. At this time, the role of the financial market and the country's monetary policy is very important for these regional countries as a premise to develop the manufacturing sector, helping to stabilize the financial system. This was empirically studied by Arshad et al. (2023) [30] who concluded that increased financial inclusion help to lower inflation rates in developing nations. Thus, financial development plays an important role as well as an environment to regulate the linkage between financial inclusion, monetary policy and financial stability through the process of capital flow between financial institutions, financial markets and financial consumption (Fig. 1).

2.3. Empirical studies on the linkage of financial inclusion, monetary policy, and financial stability

There is currently a very small number of research focused on financial inclusion. However, the majority of studies support the linkage between monetary policy and financial inclusion [31–33].

Arshad et al. (2021) [30] studied the connection between financial inclusion and monetary policy in developed and developing countries from 2004 to 2018. The findings demonstrated a causal linkage between monetary policy and financial inclusion in developing countries.

Jungo et al. (2022) [1] compared the differences in the relationship between financial inclusion and monetary policy in Sub-Saharan Africa (SSA), Latin America and the Caribbean (LAC) countries using PCA to calculate the financial inclusion index. The PVAR estimation results confirmed that financial inclusion increases the efficacy of monetary policy in the SSA as well as improves the efficacy of the monetary policy of LAC countries. In order to ensure the stability of the monetary system, governments are urged to establish or improve policies that broaden financial services and encourage financial investment in developing countries.

El Bourainy et al. (2021) [12] considered finance as an instrument to reduce inflation and expand financial inclusion in rural areas. Specifically, the paper studied financial inclusion and monetary policy in 37 developing countries in the period 2009–2018, using the inflation rate to represent monetary policy. Applying the Principal Component Analysis (PCA) to calculate the financial inclusion index and using the GMM model, the results showed that increased financial inclusion helps to lower the inflation rate in developing countries.

Ridwan (2022) [13] investigated how financial inclusion affects the efficacy of the interest rate channel in the transmission of monetary policy in 15 West-African countries in the period 2005–2020 using the PCA to calculate the financial inclusion index and inflation rate to represent monetary policy. The GMM regression results showed that the efficacy of the interest rate channel for conveying monetary policy is enhanced by financial inclusion.

Hussain (2023) [10] studied the impact of financial inclusion on monetary policy in Iraq. The results of the study suggested that financial inclusion affects monetary policy and enhances the effectiveness of the domestic economy because financial inclusion increases the degree to which members of society respond to changes in monetary policy tools.

Several empirical research demonstrating the impacts of financial inclusion on financial stability have been carried out. By different approaches, the results of the studies are different.

Morgan and Pontines (2014) [34] approached financial inclusion in the SME sector mainly by decreasing bad debts and the likelihood of insolvency of financial institutions. The study stated that policies aimed at increasing financial inclusion, at least for SMEs, will also help to maintain financial stability. Approaching financial inclusion based on deposits, Amatus and Alireza (2015) [35] argued that deposits negatively affect financial stability. Similarly, Barik and Pradhan (2021) [17] also confirmed the negative impact of financial inclusion on financial stability. The primary causes of these adverse consequences reasons for these negative effects are the quick expansion of credit to the private sector, the decline in banks' credit standards, the difficulty in credit rating, the increase in unrealized assets, and insufficient supervision by the banking industry.

Neaime and Gaysset (2018) [36] examined the linkage of financial stability and financial inclusion in 8 MENA countries. Findings indicated that financial stability of these countries is positively contributed by financial inclusion. Siddik et al. (2018) [7] explored how financial inclusion impact financial stability in 217 countries around the world, approaching from the perspective of businesses since their stability is a prerequisite for macro-financial stability. The GMM regression results indicated that financial stability is significantly improved by financial inclusion. Olusegun et al. (2021) [16] explored the relationship between financial inclusion and financial stability in Nigeria, using the Zscore to represent financial stability. The ARDL results show that financial stability is positively influenced by financial inclusion, implying that higher levels of financial inclusion will lead to greater financial stability. Danisman and Tarazi (2020) [37] approached financial inclusion based on the benefits of society, especially disadvantaged individuals.

Recently, Anthony-Orji et al. (2022) [38] analyzed the impact of financial inclusion on financial development in Nigeria from 1982 to 2019. Using the OLS method, the results suggested that deposits from commercial banks in rural areas have a direct impact on financial development. In addition, findings indicate that investment is a very important variable for financial development and financial stability in Nigeria. Chinoda and Kapingura (2023) [9] conducted a study on the comprehensive relationship between digital financial inclusion, financial competition, and bank stability in the sub-Saharan African region during the period 2014–2020 by using the GMM regression. The research results show that digital financial inclusion has a significantly positive relationship with stability in the sub-Saharan African (SSA) region and there are both short-term and long-term relationships between financial inclusion, financial stability, and economic growth in SSA countries. Therefore, policymakers, regulatory agencies, and financial advisors need to follow a

comprehensive approach when developing and implementing policies and strategies to promote comprehensive finance in order to achieve sustainable economic growth in the region.

The review of previous studies shows that the role of financial development in the correlation between financial inclusion, monetary policy and financial stability has not been considered by any research. Most studies only approach groups of developed and developing countries [30] or only research within a region such as Africa, Europe, and Asian countries [28,37,39]. Therefore, this study approaches a new country grouping based on the Financial Development Index suggested by the IMF, which includes two groups of countries: high financial development countries and low financial development countries (Appendix A). This proved to be most important when, after severe economic crises, IMF experts warned that financial development should only reach an optimal level, which if exceeded would hinder the economic growth of a country [40]. Therefore, the role of financial development in the economies of countries is an issue that needs to be reconsidered for a more appropriate answer. The division into two groups of high financial development and low financial development countries will highlight the linkage between financial inclusion, monetary policy and financial stability, so that authorities can have a more objective view of the financial system, making the right policy decisions in the face of shocks to the economy of the financial system, making sound policy decisions in the face of economic shocks.

In addition, previous studies have only examined the connection between financial stability and financial inclusion or monetary policy and financial inclusion. There are no empirical studies examining the correlation between financial inclusion, monetary policy,

Table 1

Review of selected studies on the relationship between financial inclusion, monetary policy and financial stability.

Authors	Method	Variables	Countries	Main results
Morgan and Pontines (2014)	GMM	Financial inclusion; financial stability; non-FDI capital flow to GDP; bank NPLs	148 economies (2004–2011)	An increased share of lending to small and medium-sized enterprises (SMEs) aids financial stability, mainly by reducing non-performing loans (NPLs) and the probability of default by financial institutions.
Neaime and Gaysset (2018)	GMM and GLS	Financial stability; ATM per 100,000 adults; Banks per 100,000 adults; Gross enrolment ratio (secondary); Inflation.	8 MENA countries (2002–2015)	Financial inclusion contributes positively to financial stability
Siddik et al. (2018)	GMM	Financial Stability (Bank Z-score); Financial Inclusion; Logarithm of GDP per capita; Broad money (% of GDP); Real Interest rate; Domestic credit to private sector (% of GDP).	217 countries around the world	Financial stability is significantly improved by financial inclusion.
Arshad et al. (2021)	SVAR	Inflation rate; Financial inclusion index; Board money; Economic growth; Interest rate; Exchange rate.	10 developed and 30 underdeveloped countries (2004–2018)	Effective monetary policy enhances financial inclusion in a country, and a higher degree of financial inclusion lowers the inflation rate and makes monetary policy effective
Barik and Pradhan (2021)	PCA and GMM	Bank Z- Score (Z_SCORE); Financial inclusion; Inflation (INF) and GDP Growth Rate (GDPGR)	BRICS countries (2005–2015)	Financial inclusion has a negative and significant effect on financial stability.
El Bourainy et al. (2021)	PCA and GMM	Inflation Rate; Financial inclusion index; Interest Rate; Foreign Exchange Rate; Broad Money; Foreign Exchange Reserves	37 developing countries (2009–2018)	An increased level of financial inclusion has an impact on decreasing the inflation rate in developing countries.
Jungo et al. (2022)	PCA and PVAR	Financial inclusion; Monetary expansion; Growth rate of gross domestic product; interest rate; exchange rate	41 Sub-Saharan Africa (SSA) countries and 31 Latin America and the Caribbean (LAC) countries	Financial inclusion increases the efficacy of monetary policy in the SSA as well as improves the efficacy of the monetary policy of LAC countries.
Olusegun et al. (2021)	Panel ARDL	Financial Stability (Z-score); financial inclusion indicators; Bank Size (Total Assets); Growth rate of real GDP	Nigeria in the period 2014–2018	Financial inclusion had positive impact on financial stability
Ridwan (2022)	PCA and GMM	Inflation Rate; interest rate; exchange rate depreciation; growth rate of money supply; commercial bank's branches, number of depositors, and Number of Automated Teller Machine	15 West-African countries in the period 2005–2020	The efficacy of the interest rate channel for conveying monetary policy is enhanced by financial inclusion
Anthony-Orji et al. (2022)	OLS	Financial depth (FID); financial development; foreign direct investments; real interest rate;	Nigeria from 1982 to 2019	Deposits from commercial banks in rural areas have a direct impact on financial development.
Chinoda and Kapingura (2023)	GMM	digital financial inclusion, financial competition, and bank stability	sub-Saharan African region during the period 2014–2020	Digital financial inclusion has a significantly positive relationship with stability in the SSA region
Hussain (2023)	PLS statistical program	Financial inclusion; monetary policy: level of cash offer, liquidity rate; internal lending rate; Monetary Policy Rate	Iraq	Financial inclusion affects monetary policy and enhances the effectiveness of the domestic economy because financial inclusion increases the degree to which members of society respond to changes in monetary policy tools.

and financial stability simultaneously. While as analyzed above, these three aspects are closely related. Furthermore, the previous articles have different periods and research areas, and mainly use the GMM method [1,9,17,28,37] or the OLS method [38]. In this study, we use the PVAR method to explore the transmission mechanisms of financial inclusion and monetary policy to financial stability from a global perspective.

Based on the research gaps, we conducted a study on the relationship between financial inclusion, monetary policy and financial stability in two groups of countries with high and low financial development. The aim is to address the question of how this relationship differs in the two groups in order to provide suitable policy implications to stabilize finance in each group.

3. Data and methodology

Based on the theories mentioned in section 2 and on Arshad et al. (2021) [30], Matsebula and Sheefeni (2022) [15], Barik and Pradhan (2021) [17], we use Z-score to represent financial stability, Money Supply Growth Rate (M2G) and Inflation Rate (INF) to represent monetary policy, and Financial Inclusion Index (FII) to represent financial inclusion, which is calculated using principal component analysis (PCA). In addition, control variables are added to increase the level of explanation for the model. Table 1 presents the measurement methods and data sources of variables.

In this paper, the panel vector autoregression (PVAR) model is applied to examine the dynamic linkage between financial inclusion, monetary policy and financial stability of studied countries. The PVAR model treats all variables as being endogenous in common rather than distinguishing between exogenous and endogenous variables. Additionally, each proxy in PVAR is dependent on its historical data as well as all other variables, demonstrating that all variables are equal and concur. As a result, this model is ideal for our research. The PVAR model is as follows:

$$Y_{i,t} = A_1 Y_{i,t-1} + A_2 Y_{i,t-2} + \dots + A_m Y_{i,t-m} + \beta_x X_{i,t} + u_i + \varepsilon_{i,t}$$

where: $Y_{i,t} = (Zscore_{i,t}, FII_{i,t}, INF_{i,t}, M2G_{i,t})$ is a (1×4) vector of endogenous variables with Zscore: Financial stability, FII: Financial inclusion index, and INF: Rate of inflation and M2G: Money Supply Growth Rate M2.

Table 2
Description of variables used in the model.

Variable	Sign	Measurement	Studies	Data source
Main Variable				
Financial stability	Z-score	Zscore= (ROA + EA)/(σ(ROA)) With: EA is equity/total assets	[1,7,9,10,16,17,28,34,35,37]	World Bank; FAS
Monetary Policy				
+ Inflation Rate	INF	Annual CPI growth rate	[1,3,12,13,32]	World Bank; FAS
+ Money Supply Growth Rate M2	M2G	Annual growth rate of money supply	[1,12,30]	World Bank; FAS
Financial Inclusion				
+ Out standing loans of commercial banks	LCB	Loans from commercial banks/GDP	[1,3,9,10,32]	World Bank; FAS
+ Out standing balance of deposits of commercial banks	DCB	Deposits from commercial banks/GDP		World Bank; FAS
+ Number of commercial banks over 1000 km ²	CBBP	Number of branches of commercial banks over 1000 km ²		FAS
+ Number of branches of commercial banks per 1,000,000 people	CBP	Number of branches of commercial banks per 100,000 adults		World Bank; FAS
+ Number of ATMs over 1000 km ²	ATMKM	Number of ATMs over 1000 km ²		FAS
+ Number of ATM	ATM	Number of ATMs per 100,000 adults		World Bank; FAS
Control Variable				
Economic growth	GDPN	Annual GDP growth rate	[6,9,36]	World Bank; FAS
Population growth rate	POP	Annual population growth rate	[41]	World Bank; FAS
Trade openness	OPEN	Ratio of total import and export of goods and services by GDP	[15,36]	World Bank; FAS
Unemployment rate	UNE	The number of unemployed people divided by a country's labor force	[42]	World Bank; FAS
Domestic credit provided to the private sector	DOP	Domestic credit provided to private sector/GDP	[7]	World Bank; FAS
Economic Integration	FDG	Net FDI/GDP	[4,6]	World Bank; FAS
+ Loan interest rate	IR	Interest rate	[1,3,12,30]	World Bank; FAS
+ Nominal exchange rate	EX	The exchange rate is determined without considering the inflation correlation between the two countries.	[43]	World Bank; FAS

$Y_{i,t-m}$ is a 1×4 lagged endogenous variables vector;
 A_1, A_2, \dots, A_m are the (mxm) estimated coefficients vectors;
 m is the optimal lag; $X_{i,t}$ are the (1xh) the exogenous vectors, including Loan Interest Rate (IR), Exchange Rate (ER), Economic Growth (GDPN), Trade Openness (OPEN), Unemployment Rate (UNE), Domestic credit provided to the private sector (DOP), Economic Integration (FDG).

β_x are the (hxm) estimated coefficients matrices;
 u_i is the fixed effect vector of dependent variable;
 $\varepsilon_{i,t}$ is a vector of white noise errors.

A single variable cannot adequately capture financial inclusion. As a result, numerous different criteria are employed to assess financial inclusion. In 2004, the IMF divided the variables representing financial inclusion into two groups: the financial utilization index and the financial access index.

The financial utilization index, which are demand-side factors, includes:

1. Outstanding loans from commercial banks (LCB)
2. Outstanding balance of deposits at commercial banks (DCB)

The financial access index, which are supply-side factors, includes:

3. Number of commercial bank branches over 1000 km² (CBBP)
4. Number of commercial bank branches per 100,000 adults (CBP);
5. Number of ATMs over 1,000km² (ATMKM);
6. Number of ATMs per 100,000 adults (ATM);

The Financial Inclusion Index (FII) is calculated using the PCA according to the equation below:

$$FII_j = W_{j1}X_1 + W_{j2}X_2 + \dots + W_{j6}X_6$$

which: W is the weight of the six X factors mentioned above.

Table 2 below describes all the variables in the research model. Research data of 58 countries are collected for the period 2004–2020 and divided into two groups of countries based on their level of financial development. Based on the IMF dataset, we figure up the average financial development index for all nations worldwide (world average FD) for the study period. High financial development countries have an average FD greater than the world average FD (including 31 countries), and conversely, low financial development countries have an average FD less than the world average FD (including 27 countries).

4. Research results and discussion

4.1. The Principal Components Analysis results

Table 3 presents the result of the Principal Components Analysis (PCA).

4.2. PVAR results

4.2.1. Descriptive statistics

Table 4 shows that the average variable Zscore and FII of HFDCs are 17.445 and 47.197, respectively, higher than those of LFDCs: 16.790 and 24.794. This indicates that HFDCs have higher financial inclusion and macro stability than LFDCs. In contrast, the rates of inflation growth and money supply growth are higher in LFDCs than those in HFDCs, indicating a higher level of monetary policy volatility in LFDCs. These results once again confirm that the approach of this study is appropriate.

4.2.2. Unit root test

Estimating the PVAR model requires data series to guarantee stationarity. From the existing dataset, the ADF (Augmented Dickey-Fuller) method on panel data is used to test the stationarity of the data. Results in Table 5 show that, in the model of LFDCs, the Zscore, INF, M2G, IR, POP and FDG are stationary at level I(0), while other variables including FII1, FII2, EX, GDPN, OPEN, UNE, and DOP are stationary at first differences I(1). For the model of HFDCs, the Zscore, FII2, INF, M2G, IR, POP, OPEN, UNE and FDG are stationary at

Table 3
 PCA result.

FII	ATM	ATMKM	DCB	LCB	CBP	CBBP
W	-0.197	-0.180	0.632	0.631	-0.262	-0.249

Therefore, the FII is calculated according to the following equation:

$$FII = -0.197*ATM - 0.180*ATMKM + 0.632*DCB + 0.631*LCB - 0.262*CBP - 0.249*CBBP.$$

Table 4
Descriptive statistics of variables in the model.

	Low financial development countries (LFDCs)				High financial development countries (HFDCs)			
	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum
Zscore	16.790	8.347	1.472	43.203	17.445	11.366	3.419	66.270
ATM	32.492	27.597	0.012	261.912	64.236	48.940	1.410	324.172
ATMKM	20.081	18.306	0.000	83.195	1299.572	6581.825	0.307	58782.900
DCB	60.633	37.841	8.697	328.332	82.574	72.142	16.938	541.283
LCB	95.11	60.364	6.153	525.188	68.844	49.717	12.058	390.093
CBP	16.922	14.702	0.000	71.230	20.073	14.137	3.796	92.338
CBBP	9.620	8.957	0.000	41.132	260.442	150.346	1.000	521.000
FII	24.994	16.311	-13.492	133.029	47.197	35.782	-11.802	161.508
INF	6.710	6.475	-1.584	59.220	3.978	3.621	-4.863	29.507
IR	6.405	4.043	0.409	22.300	4.167	4.024	0.010	25.409
M2G	16.287	13.619	-20.010	121.239	11.026	7.949	-20.430	49.106
EX	476.276	1257.175	0.214	6771.097	1111.404	3983.550	0.269	23208.370
GDPGN	3.853	4.651	-15.136	34.500	3.654	5.343	-54.236	26.631
POP	0.840	1.115	-1.854	2.764	1.410	2.004	-1.833	19.360
OPEN	82.249	28.386	16.352	157.974	100.752	81.731	22.106	442.620
UNE	8.151	6.905	0.130	37.320	7.070	5.299	0.100	29.450
DOP	34.469	17.842	6.351	139.597	77.669	45.247	14.777	267.934
FDG	4.842	5.537	-37.173	54.365	5.387	9.762	-40.087	109.025

Table 5
Unit root test results by ADF method.

Variable	LFDCs	HFDCs
Zscore	76.668**	118.662***
FIII	35.745	73.091
INF	94.096***	98.029***
M2G	97.152***	97.683***
IR	91.001***	101.509***
EX	50.135	56.600
GDPN	66.577	62.579
POP	70.222***	120.637***
OPEN	62.420	84.790**
UNE	64.310	89.559**
DOP	48.033	52.576
FDG	75.758**	118.155***

level I(0), and other variables are stationary at first differences I(1).

The variables in the research model in LFDCs and HFDCs are not stationary at the same level. Therefore, we can proceed to estimate the PVAR model.

4.2.3. *Optimal lag selection*

Identifying the optimal lag to employ in the system of equations is required before processing PVAR estimation and the results are presented in Tables 6 and 7. .

4.2.4. *Results of autocorrelation and stability condition test*

Fig. 2 shows that all eigenvalues of the characteristic polynomial in the models are within the unit circle, indicating that the PVAR models at different stages ensure stability and sustainability. Then, we proceeded with impulse – response functions and variance decomposition results.

Table 6
Results of optimal lag testing of model variables for LFDCs.

Lag	LogL	AIC	LR	SC	HQ	FPE
0	-7884.56	78.44963	NA	87.63789	82.16171	2.10E+19
1	-7637.79	77.49809	354.1557	88.93654	82.11925	8.90E+18
2	-7388.71	76.52511	329.8026	90.21374	82.05535	3.88E+18
3	-6531.4	69.92036	1039.889	85.85918	76.35968	6.46E+15
4	-5609.02	62.71314*	1016.327*	80.90214*	70.06154*	6.39e+12*

Note: * denotes the optimal lag order under this criterion. More indicators point to the fourth order, so lag 4 is chosen as the optimal lag length.

Table 7
Result of optimal lag test of model variables for HFDCs.

Lag	LogL	AIC	LR	SC	HQ	FPE
0	-7981.69	70.84297	298.7551	81.27347	75.04285	1.08E+16
1	-7812.79	70.6406	237.5468	83.123	75.66668	9.66E+15
2	-7582.46	69.93867	301.4982	84.47297	75.79096	5.48E+15
3	-7405.15	69.66786*	214.7907*	86.25406	76.34635	5.04E+15*

Note: * denotes the optimal lag order under this criterion. More indicators point to the third order, so lag 3 is chosen as the optimal lag length.

Table 8
The result of the autocorrelation test of the model.

LFDCs			HFDCs		
Lags	LM-Stat	Prob	Lags	LM-Stat	Prob
1	17.370	0.362	1	28.230	0.297
2	11.842	0.755	2	31.103	0.186
3	9.610	0.886	3	26.966	0.358
4	20.373	0.425			

The test for autocorrelation with the null hypothesis H0: There is no autocorrelation in the model. The research model requires a p-value >5%, meaning that H0 cannot be rejected, and it can be concluded that the model does not have autocorrelation. Results in Table 8 indicate that at lag 4, the model does not have autocorrelation. Similarly, for HFDCs, at lag 3, the model does not have autocorrelation.

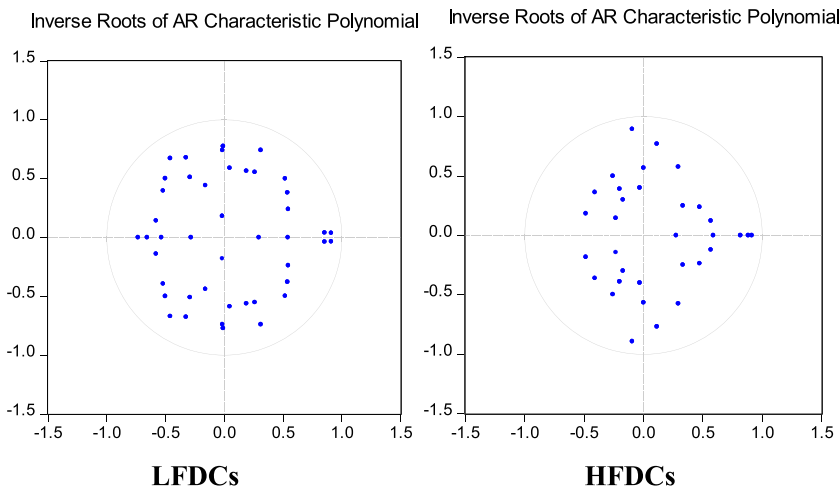


Fig. 2. Inverse roots of AR characteristic polynomial.

4.2.5. Results of impulse – response function (IRF)

To explore the mechanism of interaction between the variables, we conduct the impulse-response function (IRF).

The results in Fig. 3 suggest that in LFDCs:

- When the financial inclusion shock increased by one standard deviation, financial stability increased by 0.32%, the inflation rate and money supply growth increased by 0.12% and 0.30%, respectively. The research results once again confirm the positive correlation between financial stability and financial inclusion. In addition, there exists a negative correlation between financial inclusion and the rate of inflation and the growth rate of the money supply.

The results in Fig. 4 show that in HFDCs:

- When the financial inclusion shock increases by one standard deviation, financial stability decreases by 0.14%, inflation rate and money supply growth increase by 0.37% and 1.28%, respectively, and continuously lasting for more than 10 years. The research results once again confirm the negative correlation between financial stability and financial inclusion. In addition, financial inclusion, inflation rate and the growth rate of the money supply are positively correlated.
- When there is a monetary policy shock, i.e. the inflation rate increases by one standard deviation, financial stability decreases by 0.04% in year 1 and lasts for many years, financial inclusion increases by 0.80% and ends in the year. The results suggest a negative

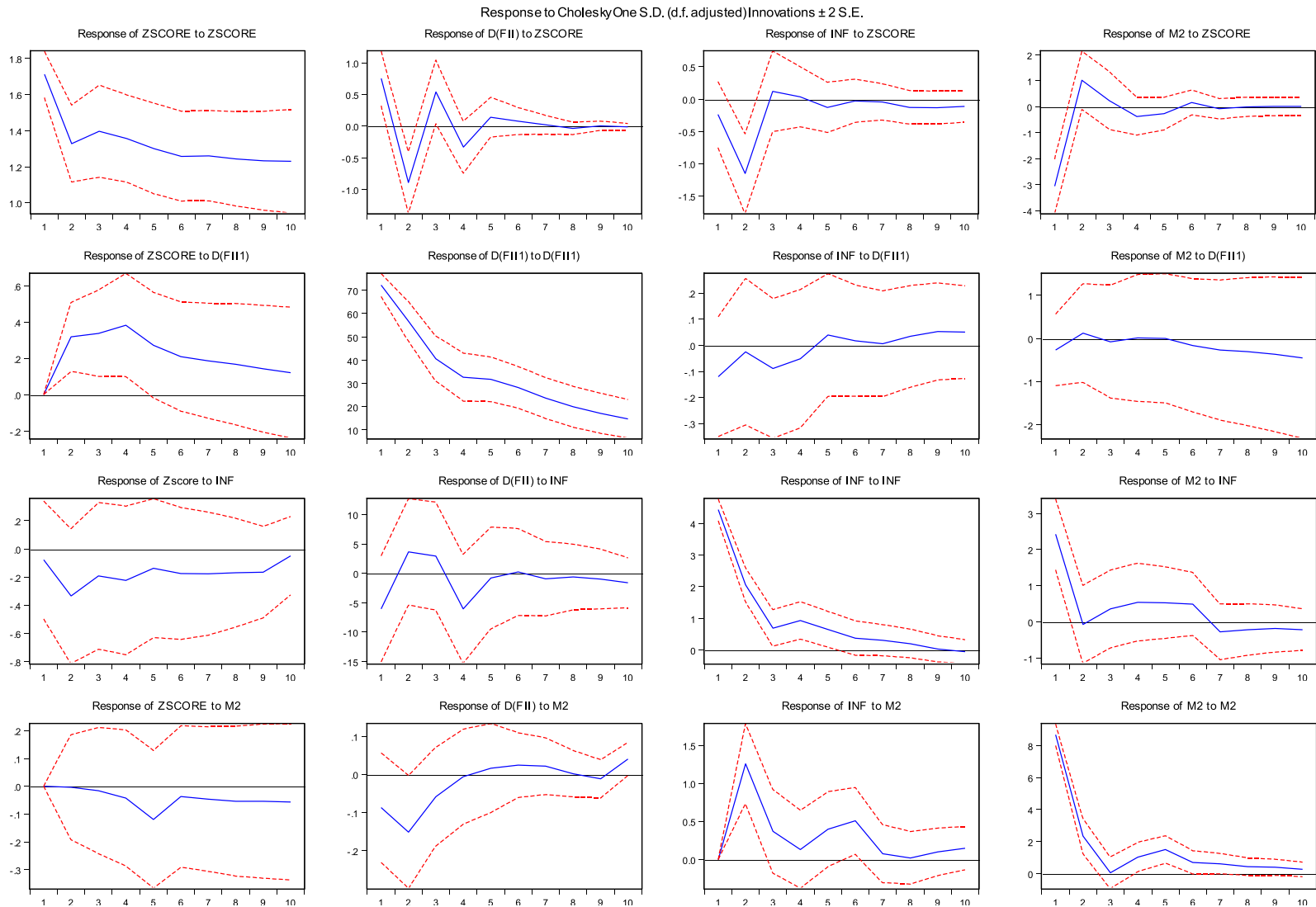


Fig. 3. Impulse-response function results for LFDCs.

- When there is a monetary policy impact shock represented by an inflation rate increase of one standard deviation, financial stability decreases by 0.08% in year 1 and lasts for many years, financial inclusion decreases by 6.00% and lasts up to year 4. These results show that there is a negative correlation between monetary policy and both financial inclusion and financial stability.
- When there is a monetary policy impact shock represented by an increase in the money supply growth rate by one standard deviation, financial stability declines by 0.02% in year 3 and lasts for many years, while financial inclusion declines by 0.09%. These results once again confirm the negative relationship between monetary policy and both financial stability and financial inclusion.
- When the financial stability index shock increases by one standard deviation, financial inclusion increases by 0.75% in the first year and ends in this year, the inflation rate and the money supply growth rate decrease by 0.24 and 3.1%, respectively. This implies that financial stability is negatively correlated with financial inclusion, inflation rate and money supply growth rate.

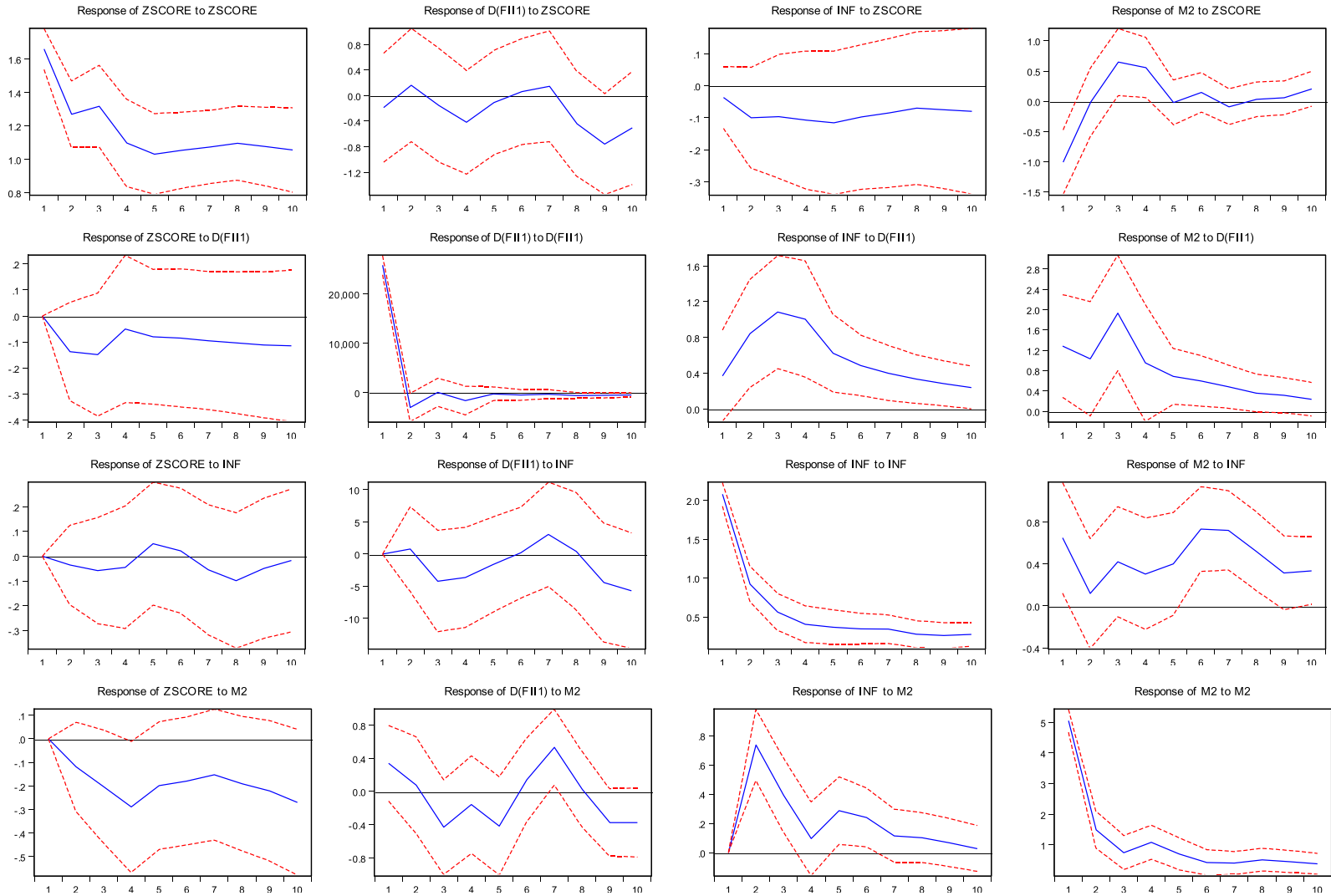


Fig. 4. Impulse-response function results for HFDCs.

- When the financial stability index shock increases by one standard deviation, financial inclusion declines by 0.19% in the first year and at the end of the year, the inflation rate and the money supply growth rate decrease by 0.04% and 1.01%, respectively. This shows that financial stability is negatively correlated with financial inclusion, inflation rate and money supply growth rate.

correlation between the inflation rate and financial stability, a positive correlation between the inflation rate and financial inclusion.

- When there is a monetary policy shock, the growth rate of money supply increases by one standard deviation, financial stability decreases by 0.12% in year 2 and lasts for many years, financial inclusion increases by 0.34%. Findings demonstrate a negative correlation between money supply growth rate and financial stability and a positive correlation between money supply growth rate and financial inclusion.

4.2.6. Discussion

In summary, the above research results suggest that the relationship between financial stability and financial inclusion as well as the relationship between financial inclusion and inflation rate and money supply growth are different in the two groups of countries:

- In LFDCs, when there is an increased shock in the level of financial inclusion, the financial stability of the countries also increases, while the inflation rate and the growth rate of money supply decrease. This implies that low levels of financial inclusion in LFDCs change the behavior of both consumers and businesses and even financial intermediaries in ways that can affect the stability of the financial system as a whole. Specifically, when a large segment of the population lacks access to financial services, they may be more vulnerable to financial shocks and less able to manage financial risks, which can have ripple effects throughout the entire economy. This can increase the likelihood of financial instability, leading to higher rates of delinquency, default, and bankruptcy, which can then spread to other parts of the financial system [44]. In addition, a higher level of financial inclusion will help control inflation at an acceptable level, thereby helping these countries effectively implement their monetary policy, contributing to improving economic growth. This is demonstrated in Beck and Demirgüç-Kunt (2008) [45] which shows that countries with higher financial inclusion tend to have more effective monetary policy frameworks, which can help control inflation and contribute to financial stability, promoting economic growth. The role of financial development in these countries is extremely important, as a premise for strengthening financial inclusion towards financial stability, helping production to be sustainable and expanding, and promoting economic development. Financial inclusion is therefore an expanded priority for these countries. In general, financial inclusion is an important tool for promoting financial stability in LFDCs, as it can help build a strong and flexible financial system that is better able to withstand economic shocks and promote long-term growth and development. These results are consistent with Dienillah et al. (2018) [4], Neaime and Gaysset (2018) [36], Danisman and Tarazi (2020) [37], Olusegun et al. (2021) [16] and Jungo et al. (2022) [1].
- In HFDCs, higher levels of financial inclusion increase financial instability and increase inflation. This implies that, in these countries, when the level of financial inclusion is higher, one financial inclusion shock will easily lead to financial instability

Table 9
Variance decomposition results.

Variance decomposition of Zscore										
LFDCs						HFDCs				
Period	Zscore	FII	INF	M2G	Other variables	Zscore	FII	INF	M2G	Other variables
1	100.000	0.000	0.000	0.000	0.000	100.000	0.000	0.000	0.000	0.000
2	97.391	0.386	0.608	0.242	1.374	95.164	2.835	0.042	0.058	1.901
3	95.544	0.583	0.633	0.465	2.776	90.570	2.979	0.054	0.292	6.105
4	94.732	0.481	0.702	0.685	3.400	86.454	4.395	0.136	0.532	8.483
Variance decomposition of FII										
LFDCs						HFDCs				
Period	Zscore	FII	INF	M2G	Other variables	Zscore	FII	INF	M2G	Other variables
1	0.184	99.816	0.000	0.000	0.000	0.444	99.556	0.000	0.000	0.000
2	2.896	95.250	0.114	0.350	1.390	3.812	88.407	0.022	0.015	7.744
3	3.218	94.015	0.558	0.350	1.859	3.197	83.336	0.144	0.016	13.308
4	3.067	89.359	0.825	0.716	6.033	3.205	81.739	0.321	0.016	14.720
Variance decomposition of INF										
LFDCs						HFDCs				
Period	Zscore	FII	INF	M2G	Other variables	Zscore	FII	INF	M2G	Other variables
1	0.246	0.593	99.161	0.000	0.000	0.002	0.007	99.990	0.000	0.000
2	4.154	2.547	82.683	6.898	3.717	0.054	0.039	84.314	11.592	4.002
3	3.864	5.592	77.493	8.266	4.785	0.305	0.035	79.185	15.151	5.324
4	3.601	7.806	74.283	7.881	6.429	0.516	0.045	78.181	15.115	6.142
Variance decomposition of M2G										
LFDCs						HFDCs				
Period	Zscore	FII	INF	M2G	Other variables	Zscore	FII	INF	M2G	Other variables
1	9.460	1.652	3.103	85.785	0.000	3.735	0.072	0.785	95.408	0.000
2	9.510	2.460	2.846	83.208	1.975	3.228	3.642	0.756	88.530	3.843
3	9.054	5.545	3.391	78.843	3.167	4.910	3.792	1.196	84.093	6.009
4	8.816	6.076	4.315	76.940	3.853	4.847	4.276	1.882	82.423	6.572

accompanied by high and persistent inflation (Fig. 4). The strong development of financial institutions has created conditions to provide more financial services to the economy in these countries, making it easier for people to access and use. The long-term use until there was liquidity instability led to the collapse of the banking systems in those countries, as evidenced by the 2007–2009 financial crisis that originated in the US and spread rapidly to other HFDCs such as the UK, France ... The results of this study are consistent with the views of Hesse and Čihák (2007) [46] that countries with higher financial inclusion tend to have more interconnected financial systems, which may increase the vulnerability of the financial system to risks and shocks. Additionally, the results are also consistent with previous experimental studies [7,15,28]. The role of financial development in HFDCs brings financial instability, which is the cause of inflation and financial crises that lead to crises in the manufacturing sector. Therefore, monetary policy aimed at controlling inflation is the priority of these countries.

As a result, in both LFDCs and HFDCs groups, low inflation helps countries implement better monetary policy, increases financial stability, and promotes economic development. Research results are consistent with Barik and Pradhan (2021) [17] that inflation reduces financial stability and vice versa.

Figs. 3 and 4 also show a two-way relationship between financial inclusion, monetary policy, and financial stability. This implies that under the role of financial development, financial stability in LFDCs is the basis for businesses and individuals to use financial services to promote financial inclusion and well implement monetary policy. For HFDCs, financial stability stems from good financial inclusion control, which helps to prevent rising inflation.

4.2.7. Variance decomposition results

After analyzing the IRF, we continue to perform variance decomposition to see how a shock in the variables Zscore, FII, INF and M2G will be explained by the remaining variables. Table 9 shows the results of the variance decomposition.

The results of the variance decomposition in LFDCs suggest that the change of the Zscore explained by itself about 96.92%, only 0.36% explained by FII, 0.49% explained by INF, 0.35% explained by M2G and 1.89% explained by the remaining variables (average of 4 periods). The change in FII is explained about 94.61% by itself, 2.34% by the Zscore, 0.37% by INF, 0.35% by the M2G, and 2.32% by the remaining variables. The change of INF and M2G is mainly explained by itself, in addition by the Zscore variable of 2.97% and 9.29%, respectively. These results show that the relationship between these variables in LFDCs is rather weak compared to HFDCs.

In HFDCs, the Zscore variable is mainly explained by itself around 93.05%, 2.55% by FII, 0.06% by INF, 0.02% by M2G and 4.11% by other variables. The variable FII is explained by itself about 88.3%, Zscore, INF, and M2G accounts for 2.64%, 0.12%, and 0.01%, respectively. The change in INF and M2G is mainly explained by itself, in addition by the Zscore and FII, respectively, which are higher than in LFDCs. The results show that the relationship between the variables in HFDCs is more pronounced.

Compared to previous models such as the GMM model in Jungo et al. (2022) [1], Barik and Pradhan (2021) [17], Kouki et al. (2020) [28], Danisman and Tarazi (2020) [37], which only assess the impact of independent variables on the dependent one, in this study, through the PVAR method that does not distinguish between exogenous and endogenous variables, but considers all variables as common endogenous variables, we have analyzed how the variables responded to each shock in the remaining variables.

5. Conclusion and policy implications

5.1. Conclusion

This study uses the PVAR model to analyze the nexus of monetary policy, financial inclusion and financial stability in low financial development countries (LFDCs) and high financial development countries (HFDCs). The results of the impulse – response function show that, in LFDCs, financial stability and financial inclusion have a positive correlation. Financial inclusion and financial stability are negatively correlated with the inflation rate and the money supply growth rate. In HFDCs, financial stability is negatively correlated with financial inclusion and inflation rate and money supply growth rate, while financial inclusion is positively correlated with inflation rate and the growth rate of the money supply. These findings imply that, in LFDCs, financial inclusion increases financial stability and reduces inflation. Meanwhile, in HFDCs, on the contrary, increased financial inclusion will increase financial instability leading to long-term inflation. The variance decomposition outcomes provide evidence that the relationship between monetary policy, financial inclusion and financial stability in HFDCs is more pronounced than in LFDCs.

5.2. Policy implications

This study provides financial institutions and governments with insights to help them have a financial inclusion development strategy and pursue an appropriate monetary policy, thereby improving financial stability for the whole system and conducting monetary policy effectively:

For LFDCs: Firstly, to contribute to financial stability in this region, financial inclusion can be expanded by increasing access to financial services for previously underserved population groups, such as low-income households and small businesses. Financial inclusion finance can help minimize financial damage and increase the overall financial recovery ability. Secondly, policymakers need to ensure that efforts to promote financial inclusion and financial stability are supplemented by appropriate macroeconomic policies. Specifically, monetary policy should maintain low inflation to promote financial inclusion and financial stability. Thirdly, Governments should address financial exclusion by identifying the barriers that prevent individuals and small businesses from accessing financial services, and developing policies to address these barriers. This can include measures such as providing financial education,

improving financial infrastructure in underserved areas, and promoting financial inclusion for marginalized groups such as women and low-income individuals.

For HFDCs: Firstly, to stabilize the financial sector in this region, authorities need to effectively control the supply of finance to individuals and businesses to limit excessive use of financial consumption. They should monitor credit standards and improve credit evaluation procedures and loan provisions for their customers. Secondly, maintaining low inflation levels is a prerequisite for promoting financial stability. Thirdly, Governments should invest in public education programs that promote financial literacy, particularly among low-income and vulnerable populations. This can help to increase awareness of the causes and effects of inflation and promote greater understanding of monetary policy, financial stability and financial inclusion. In addition, promoting financial literacy among consumers can help them make informed decisions about financial products and services, reducing the risk of over-indebtedness and financial instability. Governments may consider promoting financial inclusion in a phased manner, starting with basic financial products and services, and gradually expanding to more complex financial products and services as consumers become more financially literate and capable of managing risk.

5.3. Further research suggestion

The development of Industry 4.0 has caused governments of countries to issue many documents directly related to guidelines, policies and plans to proactively approach Industry 4.0, serving the development of e-finance towards Digital Finance. This leads to broader, easier access to finance through financial applications. Therefore, the level of financial inclusion is assessed through criteria such as the number of people using online shopping accounts, the number of people paying money through bank accounts, and the number of people using credit cards. However, this study is not able to fully access this data. Therefore, assessing the level of financial inclusion at a broader level with the above approach, thereby making appropriate policies in the 4.0 era is left for further research.

Author contribution statement

Tran Thi Kim Oanh: Conceived and designed the experiments; Wrote the paper.

Le Thi Thuy Van: Performed the experiments; Contributed reagents, materials, analysis tools or data.

Le Quoc Dinh: Analyzed and interpreted the data; Wrote the paper.

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

APPENDIX

Table A1
Countries covered by the study.

High financial development countries	Low financial development countries
Australia	Albania
Bulgaria	Armenia
Brazil	Azerbaijan
Botswana	Bosnia and Herzegovina
Chile	Belarus
China	Bolivia
Colombia	Costa Rica
Czech Republic	Dominican Republic
Egypt, Arab Rep.	Algeria
Hong Kong SAR, China	Ecuador
Croatia	Georgia
Hungary	Ghana
Indonesia	Guatemala

(continued on next page)

Table A1 (continued)

High financial development countries	Low financial development countries
Israel	Honduras
Jordan	Jamaica
Japan	Kyrgyz Republic
Kuwait	Cambodia
Macao SAR, China	Moldova
Morocco	North Macedonia
Mexico	Mongolia
Mauritius	Nigeria
Malaysia	Nicaragua
Peru	Pakistan
Philippines	Paraguay
Qatar	Romania
Russian Federation	Ukraine
Singapore	Uruguay
Thailand	
Turkey	
Vietnam	
South Africa	

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