

Financial Inclusion Effect on the Banking Sector Liquidity and Solvency Using Panel Regression Analysis

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Abstract:

Financial inclusion is recognized as a critical driver for enhancing household well-being and economic development. It is also necessary to consider the impact it may have on the stability of banks and financial system. This study seeks to examine the relationship between the financial inclusion and the banking sector liquidity and solvency. The researchers relied on a sample of 10 countries: Egypt, Bolivia, Cameroon, Cambodia, Algeria, Germany, Denmark, Spain, France, and Italy. These countries were classified into Developed Countries (high-income) and Developing Countries (low-income). Researchers used the panel data from these countries in panel regression analysis. The research findings highlighted three key outcomes. Firstly, an increase in the number of ATMs positively affects banks liquidity by enhancing customer accessibility. Secondly, the presence of bank branches, credit cards, and debit cards has a negative impact on banks liquidity. Finally, the solvency of banks is damaged when there is a growth in the number of bank branches.

Keywords: financial inclusion, liquidity, solvency, banking sector

ملخص:

يُعتبر الشمول المالي أحد المحركات الأساسية لتعزيز رفاهية الأسرة والتنمية الاقتصادية. ومن الضروري أيضاً النظر في تأثيره على استقرار البنوك والنظام المالي. تهدف هذه الدراسة إلى فحص العلاقة بين الشمول المالي وسيولة القطاع المصرفي وملاءة القطاع المصرفي. وقد اعتمد الباحثان على عينة من ١٠ دول: مصر، وبوليفيا، والكاميرون، وكمبوديا، والجزائر، وألمانيا، والدنمارك، وإسبانيا، وفرنسا، وإيطاليا. وقد تم تصنيف هذه الدول إلى دول متقدمة (عالية الدخل) ودول نامية (منخفضة الدخل). وقد استخدم الباحثان السلاسل الزمنية المقطعية من الدول محل الدراسة في تحليل الانحدار المقطعي. وقد سلطت نتائج البحث الضوء على ثلاث نتائج رئيسية: أولاً: تؤثر زيادة عدد أجهزة الصراف الآلي بشكل إيجابي على سيولة البنوك من خلال تعزيز إمكانية وصول العملاء للخدمة. ثانياً: تؤثر زيادة عدد الفروع البنكية وبطاقات الائتمان وبطاقات الخصم بشكل سلبي على سيولة البنوك. وأخيراً: تتأثر الملاءة المالية للبنوك سلباً عندما يكون هناك زيادة في عدد فروع البنوك.

1. Introduction

Financial inclusion plays an important role in improving household well-being and economic development. This role is achieved by increasing disadvantaged groups' access to fundamental financial services through the excess use of bank accounts, savings, and lending. The proposed study seeks to evaluate the effect of financial inclusion on banks liquidity and solvency, and thus their stability.

According to the literature, banking security is achieved by providing financial services to families and SME Enterprises. This is because it enables banks to spread their credit portfolio, reduce risk exposure, and reduce non-performing loans, especially when the debtors are SMEs. Another advantageous feature is the availability of abundant risk-free and low-cost store deposits. This could be used as a buffer to reduce dependence on volatile and often expensive money market financing. The financial inclusion industry tends to be more efficient regarding costs and earnings.

Many studies demonstrated that financial inclusion has positive impacts on bank stability specifically, as well as financial stability in general. Hannig and Jansen (2010), for instance, contend that financial institutions must deal with dangers from low-income markets, even though micro loan borrowers usually have high return rates. Since the emergence of digital technology, many financial institutions have become more aware of the advantages of operating in a microfinance area and have been actively looking for new possibilities and markets. Financial inclusion, according to Ahamed and Mallick (2019), has a variety of effects, including allowing families to diversify their sources of income and save money, providing businesses an access to a variety of sources of finance, and improving the economic mechanism of transferring domestic savings into investments.

This study aims to investigate the effect of financial inclusion on liquidity and solvency in the banking sector. The researchers utilized a sample of 10 countries, including Egypt, Bolivia, Cameroon, Cambodia, Algeria, Germany, Denmark, Spain, France, and Italy. These countries were categorized as Developed Countries (high-income) and Developing Countries (low-income) to make a balanced sample. The researchers analyzed panel data from these countries in a panel regression analysis. The results of the study revealed three main findings. Firstly, an increase in the

number of ATMs positively affects the liquidity of banks by improving customer accessibility. Secondly, the presence of bank branches, credit cards, and debit cards negatively affects banks liquidity. Lastly, the solvency of banks is compromised when there is a growth in the number of bank branches.

Literature Review:

Researchers' visions of the financial activity regarding financial inclusion varied. The financial inclusion issue was studied from different perspectives.

Khatib et al. (2022) and Shihadeh (2021) were interested in studying some indicators of financial inclusion such as the number of ATMs, the number of branches, points of sale, the number of clients' deposits cards and credits of small and medium-sized companies, using the rate of return on assets. The results concluded that some indicators such as the number of ATMs and the number of branches help to improve the profitability of banks, but it was found that the point of sale has no effect on profitability.

Al-Chahadah et al. (2020) agreed with the aforementioned researchers. They studied the relationship between financial inclusion and banks performance by measuring banks profitability using different measures, such as financial payments, transfers, and financial access. The results indicated that there is a positive effect of financial inclusion on banks performance and profitability.

Shihadeh & Liu (2019), agreed with the previous researchers in their objective and variables. However, they added the risk variable as a dependent variable with banks performance. The results concluded that financial inclusion has a greater impact on decreasing banks risks than on performance.

Yadav (2022) used different variables such as the ratio of size of bank, Bank Loss Provision to Total Loans, Equity to Total Assets, and Total Earning Assets to Total Assets (Management Quality). The results of the study indicated that private banks are more efficient than public banks from the technical aspect. This is due to the ineffective use of inputs that may obstruct public banks to improve its efficiency through transfer to services based on technology such as banking services via the internet.

In the same framework, Shihadehet al. (2018), Vitenu-Sackey (2019), and Al-Chahadah (2020) conducted studies to examine the impact of financial inclusion on banks performance with different application environments. The studies of Shihadehet al. (2018) and Al-Chahadah al. (2020) were applied on the Jordanian banking environment using annual data of 13 commercial banks from 2009 to 2014. While Vitenu-Sackey's study (2019) was applied on West-African countries, the same variables were used.

The results of Shihadehet al. (2018) indicated that the number of ATMs has a great impact on the total income and return on assets as bank performance variables. Vitenu-Sackey's study (2019) concluded that the financial inclusion has a positive impact on banks performance, and it increases banks performance in countries with low GDP per capital. This effect refers to the importance of increasing of banks existence and offering services to these countries. Meanwhile, the results of Al-Chahadah al.(2020) showed that there is a significant effect with varying degrees for the impacts of the financial inclusion indicators in this study., These effects are represented in payments, digital financial services, companies funding, micro, small and medium-sized enterprises, transfers, bank penetration, financial consumer protection, and financial abilities, on the return of the Jordanian Banks listed in Oman Financial Market.

Moaz (2022) measured the impact of financial inclusion on the banking financial performance, using the secondary data and reports issued by the Central Bank of Egypt. Such reports collected the financial safety indicators for the Egyptian Banking Sector within the period from 2011 to 2020. Data analysis was made using profitability ratios (ROA, ROE, net interest margin), liquidity ratios (liquidity average ratio in local currency, average liquidity rates in foreign currency, ratio of deposits to assets, ratio of loans to deposits), and financial inclusion indicators (Banks total number, points of sale number, number of debit cards, number of ATMs, Banks density) pursuant to CBE reports.

The study results revealed that there is a great positive impact of financial inclusion indicators (number of branches, debit cards number, credit cards number, ATMs number, and banking density) on the dependent variable (profitability). However, there is a great negative impact of financial inclusion indicators (in terms of number of debit cards, number of credit cards, number of ATMs, and number of points of sale) on liquidity as a dependent variable. This partially confirms the current research hypothesis

that there is a great impact of financial inclusion on banking performance in terms of profitability and liquidity indicators.

On the other hand, a number of previous studies concentrated on linking between the financial inclusion indicators and banks financial stability. Dienillah et al. (2018) dealt with the impact of financial inclusion indicators on the financial stability in 19 countries based on the income category within the period (2004 – 2014). Results revealed that financial inclusion has a great positive impact on financial stability in countries of high income only. This impact does not appear in countries of low income; therefore, these countries should increase financial development to enhance financial stability.

Jungo et al. (2022) aimed to analyze the relationship between the financial inclusion and the financial stability of banks using the indicators: number of bank branches, number of ATMs, bank deposits in commercial banks, and bank credit granted from the financial system. Results indicated that financial inclusion contributes to increasing financial stability in countries of Latin America and Caribbean, and that there is no statistical importance of the impact of financial inclusion on financial stability in African Countries.

Kuznyetsova (2022) agreed with the previous studies that aimed to study the impact of financial inclusion on the financial stability of banks. The results of the study revealed the existence of great impact of financial inclusion on financial stability.

According to Merhotra and Yetman (2015), increased financial inclusion creates uncertainty for the stability of the financial system when there is a rapid and careless growth of credit. The unrestricted development of a country's financial system may further erode the security of regulated financial systems.

In line with Diamond's theory of financial intermediation (1984), banks play a role as intermediaries between creditors and investors, offering access to funds and financial diversity. The research suggests that the level of security is influenced by the extent of inclusion. Additionally, Diamond highlights that banks can effectively monitor debtors, thereby fulfilling the function of delegated monitoring. Reducing monitoring expenses has a significant impact on gaining a competitive advantage.

Louzis et al. (2012) discovered that the effectiveness of bank administration raises non-performing loans considerably. Khan (2011) suggests that financial inclusion can have a detrimental impact on financial

stability in terms of credit and loan growth. This occurs when lenders attempt to expand their pool of borrowers, leading to a decline in loan quality standards.

According to Sahay et al. (2015), when credit is extended to all, the danger of financial distress increases due to an absence of appropriate oversight. Additionally, as credit becomes more accessible, financial protections deteriorate, especially in countries with weak banking supervision. Conversely, countries with strong supervision may benefit from increased availability of loans.

From the same point of view, Musau et al. (2018) analyzed the effect of financial inclusion on credit risk and the mediation effect of bank competitiveness of commercial banks in Kenya using the three dimensions of bank availability, bank accessibility and bank usage, and bank competitiveness, while credit risk was represented by the non-performing loans ratio. The results concluded that financial inclusion has a significant effect on stability of commercial banks in Kenya.

Gosh (2015) confirmed that there is a significant correlation between the accessibility of loans and the occurrence of non-performing loans in the financial sector. Similarly, Espinoza and Prasad (2010) found that promoting larger loan sizes could have a delayed effect on the number of non-performing loans. They also noted that effectively managing the consequences of credit risk in a timely and restricted manner poses challenges for bank managers.

Farid (2020) examined the impact of financial inclusion on banks credit risk in the Middle East and North Africa (MENA) region. The study aimed to test the relationship between the most used financial inclusion indicators and the ratio of the provision for loan losses to net loan as a proxy for credit risk.

According to the findings, countries such as Algeria, Egypt, Iraq, Jordan, Kuwait, Libya, Morocco, Syria, Tunisia, UAE, and Yemen are the most affected by credit risk due to financial inclusion. Additionally, these countries must ensure they have sufficient reserves to cover potential loan losses for a minimum of three years.

Regarding the impact of financial inclusion on financial efficiency and sustainability, Le et al.(2019) aimed at the determination of the financial inclusion impact in Asian Countries on financial efficiency and sustainability in a sample of 31 Asian Countries within the period (2004 – 2016). He used the indicators of the number of ATMs for 100.000 adults,

commercial banks branches per 100.000 adults, unpaid deposits at commercial banks (% of total GDP) – Accessibility, unpaid loans with commercial banks (% of total GDP) – Accessibility, bank net interest margin, bank return on assets (% after tax), bank return on equity (% , after tax), bank credit for banking deposits (%), and deposits liquid assets and short term financing (%). The results indicate that the increase of financial inclusion adversely affects the financial efficiency; however, it affects financial sustainability positively. This means that we should pay due attention to the side effects of financial inefficiency related to the increase of financial inclusion.

Another study, conducted by Rasheed et al. (2016), aimed to investigate the relationship between the financial inclusion and financial development promotion through studying miscellaneous indicators such as commercial banks branches, ATMs, trade and financial openness, public debt, GDP per capital. The findings revealed that an increase in the number of bank branches and ATMs has a significant positive impact on the development of the banking sector. On the other hand, the results showed out that the different financial development indicators in most of the developing countries respond differently for financial inclusion.

Sarma and Pais (2011) described the relationship between financial inclusion and banking sector development through examining variables that indicate the soundness of the banking system such as non-performing assets (NPA) as a percentage of total assets, capital asset ratio (CAR) for the banking system, and the real interest rate to the capital cost in the banking system. The results indicated the existence of factors that have an important impact in interpreting the financial inclusion level such as the income measured by the individual share of GDP, adult literacy and civilization, material, electronic communication, and availability of information, telephone network and internet usage. All these factors play positive role to promote financial inclusion among the banking sector variables.

Regarding the impact of financial inclusion on profitability and liquidity, Almaleeh (2020) aimed at assessing whether the profitability and levels of liquidity of Egyptian banks are affected by implementation of financial inclusion plan, through conducting the correlation analysis. The results of this study showed that most of financial inclusion indicators are positively related to Egyptian banks profitability standards. This indicates that financial inclusion has a positive relationship with the profitability of the Egyptian bank.

He found that most of financial inclusion indicators such as number of branches, number of ATMs and number of points of sale are negatively related to liquidity standards at Egyptian banks. This refers to the existence of negative correlation between financial inclusion and liquidity levels in Egyptian banks.

At the level of economic growth, Sulong & Bakar (2018) described the effect of financial inclusion on growth, based on the accessibility of financial services that included: expansion of bank branches, minimizing a barrier in access to finance, and contribution of banking sector, through studying the existing obstacles and non-exploited opportunities in the developing environment. This study confirmed that the negative or weak contribution of financial inclusion on growth is due to the weakness and low availability of the financial system.

Regarding banking liquidity, Rahi et al. (2020) aimed at testing the relationship between banking liquidity and financial efficiency at the bank and identifying the most important procedures required to face the increase or decrease of banking liquidity. With the lack of sufficient liquidity to cover the depositors' requirements or to implement the fiduciary of the bank, investment and service plans shall expose it to financial risks. It is known in the banking sector that banking liquidity and financial efficiency, if administered correctly, shall achieve their basic goals of liquidity, profitability, and safety. They would also help in solving the problem of inconsistency between these goals to fulfill the desires of clients, owners, and supervisory entities. Rahi's study used the trading ratio and quick liquidity ratio (Current Ratio and Quick Ratio). The results of liquidity indicator analysis showed out that there is an inverse relationship between the increase of current liabilities and trading ratio. The higher the current liabilities for current assets, the lower the trading rate, and vice versa. Therefore, this indicator is considered a tool for measuring liquidity and assessing the bank ability to fulfill its liabilities immediately. The applied test results revealed the inexistence of a significant correlation between banking liquidity and financial efficiency.

The study conducted by Chen et al. (2018) contradicted with the findings of the previous study. It examined different measures of liquidity risks, including the liquidity ratio and the reasons behind these risks. The study used unbalanced data from 12 advanced economy commercial banks between 1994 and 2006, using return on average assets (ROAA), return on average equity (ROAE), and net interest margins (NIM) as dependent

variables. The study also considered internal and external factors as independent variables in determining bank performance. The results showed that liquidity risk is an internal determinant of banking performance, specifically related to the reasons for liquidity risks and components of liquid assets and depending on external financing. Furthermore, it was also found out that liquidity risks may result in the decrease of bank profitability (ROAA and ROAE). The NIM revealed that banks that have high levels of illiquid assets in loans might receive higher interest income.

Jansen & Hanning (2010) discussed the challenges faced by banks in determining whether financial inclusion is a risky or beneficial endeavor. According to Richard (2008), asymmetry of information between borrowers and lenders leads to adverse selection and moral hazards, which can cause credit contraction, affecting performance and stability. Moral hazards happen when one of the parts of the financial contract gives deceptive information about their assets, liabilities, or financial situation. However, banks can reduce information asymmetry by obtaining confidential information about creditors while providing access to financial services.

Munteanu (2012) and Jasienè et al. (2012) supported the objective of the previous study, which discussed the identification of factors that affect banks liquidity using a multiple regression model. Munteanu (2012) specifically conducted the study in Romania, while Jasienè et al. (2012) examined commercial banks in different application environments. The analysis of results indicated that banks are somehow successful in managing their liquidity after conducting the liquidity gap analysis in one of the banks.

Pham & Doan (2020) aimed at analyzing the relationship between liquidity risks and financial performance of banks using secondary data of published annual reports for five (5) samples of financial deposits banks in Nigeria for ten years (2009 – 2018).

The studies of Amara & Najjar (2021) and Ferrouhi (2014) both supported the objective of the previous research, which aimed to determine the impact of liquidity risks on bank performance. Amara & Najjar (2021) specifically conducted the study in the MENA region, comparing traditional and Islamic banks, while Ferrouhi (2014) examined the impact of liquidity risks in different application environments. The findings of both studies concluded that the increase of capital interest rate does not affect liquidity risks, although this may vary depending on the specific application environment.

Ferrouhi (2014) deduced that the performance of the Moroccan Bank is determined through a number of determinants such as liquidity ratio, size of banks, external financing for total liabilities, private bank capital share of the bank total assets, direct foreign investments, and unemployment rate.

One major research gap identified in the existing literature is the absence of comprehensive studies that examine the effect of financial inclusion on both liquidity and solvency in the banking sector. This research gap suggests a need for further research in unresolved aspects such as diverse application environments. Since many studies focus on specific countries or regions, there is a gap in cross-country comparisons. There is also a gap in studies that analyze the impact of financial inclusion in various economic contexts, developing and developed countries, to make a balanced sample.

Furthermore, there is a potential research gap in assessing the long-term implications of financial inclusion strategies on banks, particularly in terms of how these strategies may affect the overall stability of financial systems over time. The current research aims to fill this gap by examining the effect of financial inclusion on liquidity and solvency in the banking sector over a ten-year period, from 2010 to 2020.

Moreover, with the increasing adoption of digital banking and technology-driven financial services, there is a research gap in understanding how these developments interact with the efforts of financial inclusion, and how they shape various banking metrics. Therefore, the researchers studied the effect of Automated Teller Machine (ATM) and Web Based Transaction (WBT) on banks liquidity and solvency.

The current research aims to fill the gap in the existing literature by investigating the impact of financial inclusion on liquidity and solvency simultaneously in the banking sector. Using the ratio of liquid assets to deposits and short-term funding as a measure of liquidity, and the Z-score as a measure of bank solvency, this study aims to provide a more comprehensive understanding of how financial inclusion could influence the financial stability of a bank over a ten-year period from 2010 to 2020.

This study aims to address this gap by examining the relationship between financial inclusion, liquidity, and solvency in the banking sector using the control variables: Inflation Rate and Gross Domestic Product (GDP) Growth. Using specific measures of liquidity and solvency; and analyzing data from a significant period, the study seeks to provide a more

comprehensive understanding of how financial inclusion affects the financial stability of a bank.

In this research, the researchers tried to answer this research question: **Does financial inclusion affect liquidity and solvency of the banking sector?**

Therefore, these are the two main hypotheses to be tested:

H1: Financial inclusion has a significant negative effect on the banking sector liquidity.

H2: Financial inclusion has a significant negative effect on the banking sector solvency.

3. Description of Data and Sample

The researchers relied on a sample of 10 countries: Egypt, Bolivia, Cameroon, Cambodia, Algeria, Egypt, Germany, Denmark, Spain, France, and Italy. The data was collected from the World Bank database, and the International Monetary Fund database.

The sample consisted of two groups:

Table. 1 Countries of the Sample

Developed Countries (high-income)	Developing Countries (low-income)
Germany	Egypt
Denmark	Bolivia
Spain	Cameron
France	Cambodia
Italy	Algeria

Source: Prepared by the researchers

The rationale behind this classification is the existence of infrastructure of financial inclusion services and culture of banks clients that differ across countries. To make the sample balanced, the researchers chose to have 5 high-income countries and 5 low-income countries. The selection of countries was based on the availability of data for the five financial inclusion indicators (the number of automated teller machines per 100,000 adults, the number of branches per 100,000 adults, the number of credit cards, the number of debit cards, and Web Based Transactions). The duration of the study extended for 11 years from 2010 to 2020 only. The researchers preferred to drop the two years 2021 and 2022 to avoid the effects of the Russian-Ukrainian war and the effects of the US federal bank

policies which affected the whole banking sector all over the world as reflection for increasing the interest rates on the US dollar.

3.1 Dependent Variables:

The dependent variables are:

1. Banks liquidity, which is measured by liquid assets to deposits and short-term funding.
2. Banks solvency, which is measured by Z-score in each country within the sample.

3.2 Independent Variables:

Based on the review of previous studies, it was found out that the most important variables that were used repeatedly are:

3.2.1 ATMs: The number of automated teller machines per 100,000 adults

3.2.2 Branches: The number of branches per 100,000 adults

3.2.3 The number of credit cards

3.2.4 The number of debit cards

3.2.5 WBT (Web Based Transactions): A transactional interaction between a client and the bank or company, usually using a web browser.

3.3 Control Variables:

Control variables improve a study's internal validity by reducing the effects of extraneous variables.

Based on the review of previous studies, Jungo et al. (2022); Arshad et al. (2021); Barik and Pradhan (2021); and El Bourainy et al. (2021) found out that the most important control variables that were used repeatedly are:

3.3.1 Inflation rate: Inflation rate is measured on an annual basis as it is a fundamental macroeconomic indicator that reflects the general increase in prices of goods and services over time. Economic conditions, including inflation, can affect various aspects of a country's financial system, including interest rates, savings, investments, and consumer behavior. By including the inflation rate as a control variable, the researchers can control the potential influence of overall economic conditions on the relationship between financial inclusion and the dependent variables.

3.3.2 GDP Growth: Real GDP growth is measured through the annual change in its percentage. It is a key indicator of a country's economic health, and it reflects the overall expansion or contraction of a country's economy

over time. Economic growth can influence various aspects of a country's financial system.

To illustrate the impact of financial inclusion on banks liquidity and solvency, the researchers developed the following model, shown in figure 1.

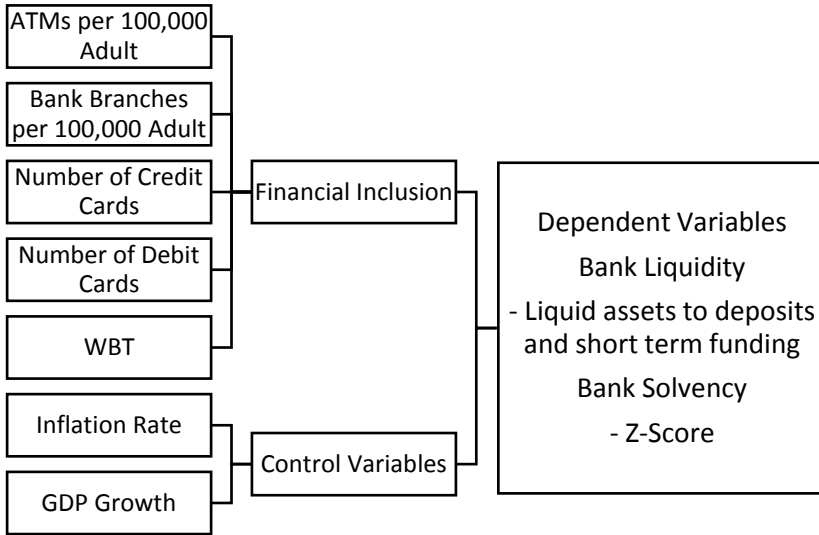


Figure 1: Research model
Source: Prepared by the researchers

4. Results:

4.1 Descriptive Analysis

Table 2. Descriptive Analysis

	LIQUID ASSETS TO DEPOSITS AND SHORT TERM FUNDING	BANK Z SCORE	BANK BRANCHES PER 100000 ADULTS	ATMS_PER_100_000_ADULTS	NUMBER OF CREDIT CARD	NUMBER OF DEBIT CARD	WBT
Mean	42.61608	17.60518	25.01047	54.98143	16825255	23328640	6.13E+10
Median	39.03327	17.46106	17.25837	42.43639	2717260.	5349000.	57009189
Maximum	134.4698	29.11961	95.93169	149.4435	71389734	1.18E+08	7.67E+11
Minimum	14.77554	8.104293	1.685001	1.798498	0.000000	7086.000	1832.000
Std. Dev.	18.67690	5.481443	22.53281	45.11043	22963471	34191397	1.86E+11
Observations	110	110	110	110	110	110	110

Out of the descriptive analysis, the following could be concluded:

- 1- Standard deviation is high in all variables because of the nature of the sample as it consists of different countries five of them are high income and the others are low-income. This can also be noticed looking at the large gaps between the maximum and minimum values for each variable.
- 2- Mean is higher than median in all variables, and this means that the value of the sample tends to be right skewed.
- 3- High rank z score implies a lower probability of insolvency in the sample.

4.2 Correlation

Out of table 3, the following could be concluded:

1- Liquidity

There is a 99% significant low negative correlation between bank branches and liquid assets to deposits and short-term funding. This may indicate that having more bank branches means high capital expenditure, which may lower the bank liquidity.

There is a 99% significant low positive correlation between WBT and liquid assets to deposits and short-term funding. This may indicate that more Web Based Transactions increase the bank liquidity as the bank benefits from their fees. In addition, there is a 95% significant low positive correlation between the number of credit cards and liquid assets to deposits and short-term funding. This may indicate that issuing more credit cards may enhance the bank liquidity.

2- Solvency

There is a 99% significant low negative correlation between bank branches bank z score, which means that the large number of bank branches incurs a huge capital expenditure, which may lead to insolvency and distress.

Table 3. Correlation

		LIQUID ASSETS TO DEPOSITS AND SHORT TERM FUNDING	BANK Z SCORE	ATMS PER 100000 ADULTS	BANK BRANCHES PER 100000 ADULTS	NUMBER OF CREDIT CARD	NUMBER OF DEBIT CARD	WBT	Inflation Rate	Real GDP growth (Annual percent change)
LIQUID ASSETS TO DEPOSITS AND SHORT TERM FUNDING	Pearson Correlation	1	.218*	.178	-.266**	.196*	.147	.350**	-.318**	.022
	Sig. (2-tailed)		.022	.063	.005	.040	.125	.000	.001	.821
	N	110	110	110	110	110	110	110	110	110
BANK Z SCORE	Pearson Correlation	.218*	1	-.177-	-.269**	.005	-.175-	.051	.036	.190*
	Sig. (2-tailed)	.022		.064	.004	.962	.068	.596	.709	.047
	N	110	110	110	110	110	110	110	110	110
ATMS PER 100000 ADULTS	Pearson Correlation	.178	-.177-	1	.773**	.805**	.642**	.354**	-.692**	-.466-
	Sig. (2-tailed)	.063	.064		.000	.000	.000	.000	.000	.000
	N	110	110	110	110	110	110	110	110	110
BANK BRANCHES PER 100000 ADULTS	Pearson Correlation	-.266**	-.269**	.773**	1	.538**	.243*	.178	-.420**	-.440-
	Sig. (2-tailed)	.005	.004	.000		.000	.010	.063	.000	.000
	N	110	110	110	110	110	110	110	110	110
NUMBER OF CREDIT CARD	Pearson Correlation	.196*	.005	.805**	.538**	1	.383**	.692**	-.570**	-.372-
	Sig. (2-tailed)	.040	.962	.000	.000		.000	.000	.000	.000
	N	110	110	110	110	110	110	110	110	110
NUMBER OF DEBIT CARD	Pearson Correlation	.147	-.175-	.642**	.243*	.383**	1	-.214-	-.513**	-.292-
	Sig. (2-tailed)	.125	.068	.000	.010	.000		.025	.000	.002
	N	110	110	110	110	110	110	110	110	110
WBT	Pearson Correlation	.350**	.051	.354**	.178	.692**	-.214-	1	-.264**	-.179-
	Sig. (2-tailed)	.000	.596	.000	.063	.000	.025		.005	.061
	N	110	110	110	110	110	110	110	110	110

Inflation Rate	Pearson Correlation	-.318**	.036	-.692**	-.420**	-.570**	-.513*	-.264*	1	.317**
	Sig. (2-tailed)	.001	.709	.000	.000	.000	.000	.005		.001
	N	110	110	110	110	110	110	110	110	110
Real GDP growth (Annual percent change)	Pearson Correlation	.022	.190*	-.466**	-.440**	-.372**	-.292*	-.179	.317**	1
	Sig. (2-tailed)	.821	.047	.000	.000	.000	.002	.061	.001	
	N	110	110	110	110	110	110	110	110	110

*. Correlation is significant at the 0.05 level (2-tailed).

** . Correlation is significant at the 0.01 level (2-tailed).

Overall, we can find out that there is multicollinearity between the independent variables and the control variables. This result could be accepted for the following two reasons:

- 1- There is a strong theoretical reason to believe that the variables are inherently correlated due to the nature of the financial inclusion as we found correlation between the four dimensions (independent variables) of financial inclusion.
- 2- If the control variables are correlated with the main predictors, as long as the independent variables of interest are still providing valuable insights, the presence of multicollinearity could be accepted.

4.3 Panel Regression

For conducting panel regression, further analysis should be made to be certain that the research sample is suitable for panel regression.

4.3.1 Redundant Fixed Effects Tests

We conducted this type of test to be sure that the best-fit model is not the pooled least square regression, but the panel regression. We conducted this test for our variables with and without the control variables; to be sure that panel regression is the best-fit model.

4.3.1.1 Liquidity Model

Table 4.
Redundant Fixed Effects Tests (Liquidity Model without Control Variables)

Effects Test	Statistic	d.f.	Prob.
Cross-section F	2.798360	(9,95)	0.0059
Cross-section Chi-square	25.867304	9	0.0021

Cross-section fixed effects test equation:

Dependent Variable: Liquid assets to deposits
and short-term funding

Table 4 shows that Both F and Chi-square are less than 5%, and this means that the sample is suitable for panel regression.

Table 5.

Redundant Fixed Effects Tests (Liquidity Model with Control Variables)

Redundant Fixed Effects Tests

Equation: Untitled

Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	3.272849	(9,93)	0.0017
Cross-section Chi-square	30.266428	9	0.0004

Cross-section fixed effects test equation:

Dependent Variable: liquid assets to deposits and short-term funding

Table 5 confirms the same results after embedding control variables, and this confirms that the sample is suitable for panel regression.

4.3.1.2 Solvency Model

Table 6.

Redundant Fixed Effects Tests (Solvency Model without Control Variables)

Redundant Fixed Effects Tests

Equation: Untitled

Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	53.598871	(9,95)	0.0000
Cross-section Chi-square	198.510485	9	0.0000

Cross-section fixed effects test equation:

Dependent Variable: BANK Z SCORE

Table 6 shows that Both F and Chi-square are less than 5%, and this means that the sample is suitable for panel regression.

Table 7.

Redundant Fixed Effects Tests (Solvency Model with Control Variables)

Redundant Fixed Effects Tests

Equation: Untitled

Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	59.412639	(9,93)	0.0000
Cross-section Chi-square	210.043324	9	0.0000

Cross-section fixed effects test equation:

Dependent Variable: BANK_Z_SCORE

Table 7 confirms the same results after embedding control variables, and this confirms that the sample is suitable for panel regression.

4.3.2 Hausman Tests

We conducted Husman test to determine the best fit model for panel regression (fixed effect or random effect) for both models with and without control variables.

4.3.2.1 Liquidity Model

Table 8.
Hausman Tests (Liquidity Model without Control Variables)
Correlated Random Effects - Hausman Test

Equation: Untitled

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	10.049483	5	0.0738

Table 8 shows that P-value is greater than 5%, and this means that the sample is suitable for panel regression with random effect, and this means that we can generalize the results.

Table 9.
Hausman Tests (Liquidity Model with Control Variables)
Correlated Random Effects - Hausman Test

Equation: Untitled

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	9.308035	7	0.2313

Table 9 confirms the same results after embedding control variables. It also confirms that the sample is suitable for panel regression with random effect, and this confirms that we can generalize the results.

4.3.2.2 Solvency Model

Table 10.

Hausman Tests (Solvency Model without Control Variables)

Correlated Random Effects - Hausman Test

Equation: Untitled

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	3.817145	5	0.5760

Table 10 shows that P-value is greater than 5%, and this means that the sample is suitable for panel regression with random effect. It also means that we can generalize the results.

Table 11.

Hausman Tests (Solvency Model with Control Variables)

Correlated Random Effects - Hausman Test

Equation: Untitled

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	4.495717	7	0.7212

Table 11 confirms the same results after embedding control variables. It confirms that the sample is suitable for panel regression with random effect, and this confirms that we can generalize the results.

4.3.3 Panel Regression Random Effect Analysis

We conducted this analysis to test the research hypotheses and determine the effect of financial inclusion on both liquidity and solvency of the banking sector.

4.3.3.1 Liquidity Model

Table 12.
Panel Regression Random Effect Analysis (Liquidity Model without Control Variables)

Dependent Variable: LIQUID_ASSETS_TO_DEPOSITS_AND_SHORT_TER

M_FUNDING_____

Method: Panel EGLS (Cross-section random effects)

Date: 07/14/23 Time: 12:59

Sample: 2010 2020

Periods included: 11

Cross-sections included: 10

Total panel (balanced) observations: 110

Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39.25451	2.581208	15.20781	0.0000
ATMS_PER_100_000_ADULTS	0.791786	0.114340	6.924805	0.0000
BANK_BRANCHES_PER_100_000_ADULTS	-1.079071	0.145869	-7.397525	0.0000
NUMBER_OF_CREDIT_CARD	-5.21E-07	1.64E-07	-3.177366	0.0020
NUMBER_OF_DEBIT_CARD	-2.52E-07	1.07E-07	-2.348087	0.0208
WBT	2.38E-11	1.90E-11	1.251038	0.2137
Effects Specification				
			S.D.	Rho
Cross-section random			3.892055	0.1109
Idiosyncratic random			11.02011	0.8891
Weighted Statistics				
R-squared	0.463137	Mean dependent var		27.66998
Adjusted R-squared	0.437326	S.D. dependent var		15.04362
S.E. of regression	11.28446	Sum squared resid		13243.27
F-statistic	17.94358	Durbin-Watson stat		0.945055
Prob(F-statistic)	0.000000			

Table 12 shows that the model has an explanatory power with 46%. The model also showed that the number of ATMs has a significant positive effect on banks liquidity, while the number of bank branches, number of credit cards and number of debit cards have a negative significant effect on banks liquidity, whereas WBT has no effect on banks liquidity.

Table 13.

Panel Regression Random Effect Analysis (Liquidity Model without Control Variables)

Dependent Variable: LIQUID_ASSETS_TO_DEPOSITS_AND_SHORT_TER

M_FUNDING_____

Method: Panel EGLS (Cross-section random effects)

Date: 08/03/23 Time: 22:20

Sample: 2010 2020

Periods included: 11

Cross-sections included: 10

Total panel (balanced) observations: 110

Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	46.69177	5.429962	8.598913	0.0000
ATMS_PER_100_000_ADULTS	0.693028	0.121216	5.717314	0.0000
BANK_BRANCHES_PER_100_000_ADULTS	-0.957019	0.162086	-5.904387	0.0000
NUMBER_OF_CREDIT_CARD	-6.12E-07	2.00E-07	-3.057638	0.0028
NUMBER_OF_DEBIT_CARD	-2.31E-07	1.28E-07	-1.812689	0.0728
WBT	2.87E-11	2.31E-11	1.239113	0.2181
REAL_GDP_GROWTH__ANNUAL_PERCENT_CHANGE_	-0.037887	0.391048	-0.096887	0.9230
INFLATION_RATE	-0.079880	0.037980	-2.103190	0.0379

Effects Specification

	S.D.	Rho
Cross-section random	6.384735	0.2603
Idiosyncratic random	10.76377	0.7397

Weighted Statistics

R-squared	0.385779	Mean dependent var	19.31051
Adjusted R-squared	0.343627	S.D. dependent var	13.43532
S.E. of regression	10.88487	Sum squared resid	12085.00
F-statistic	9.152018	Durbin-Watson stat	1.020266
Prob(F-statistic)	0.000000		

Table 13 confirms the same results after embedding control variables. It confirms that the number of ATMs has a significant positive effect on banks liquidity. On the other hand, the number of bank branches, the number of credit cards, and the number of debit cards have a significant negative effect on banks liquidity, whereas WBT has no effect on banks liquidity. However, it can be noticed that the explanatory power for the model decreased to be 38%, and this could be attributed to over fitting that occurs when a model is too complex for the available data and starts fitting noise rather than the underlying relationships.

4.3.3.2 Solvency Model

Table 14.
Panel Regression Random Effect Analysis (Solvency Model without Control Variables)

Dependent Variable: BANK_Z_SCORE
Method: Panel EGLS (Cross-section random effects)
Date: 07/14/23 Time: 14:55
Sample: 2010 2020
Periods included: 11
Cross-sections included: 10
Total panel (balanced) observations: 110
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20.39975	2.450201	8.325745	0.0000
ATMS_PER_100_000_ADULTS	-0.050371	0.026902	-1.872364	0.0640
BANK_BRANCHES_PER_100_000_ADULTS	-0.077103	0.036271	-2.125755	0.0359
NUMBER_OF_CREDIT_CARD	7.55E-08	7.50E-08	1.007786	0.3159
NUMBER_OF_DEBIT_CARD	1.88E-08	4.63E-08	0.406649	0.6851
WBT	3.15E-12	7.33E-12	0.430158	0.6680
Effects Specification				
			S.D.	Rho
Cross-section random			5.693713	0.8823
Idiosyncratic random			2.080075	0.1177
Weighted Statistics				
R-squared	0.246474	Mean dependent var		1.927564
Adjusted R-squared	0.210247	S.D. dependent var		2.327284
S.E. of regression	2.068212	Sum squared resid		444.8601
F-statistic	6.803552	Durbin-Watson stat		0.782601
Prob(F-statistic)	0.000016			

Table 14 shows that the model has an explanatory power of 24%. The model also showed that only the numbers of ATMs and bank branches have significant effects on banks liquidity, and this effect is negative, which indicates that financial inclusion may affect bank solvency by expanding bank branches and ATMs, both of which represent a large capital expenditure.

Table 15.
Panel Regression Random Effect Analysis (Solvency Model without Control Variables)

Dependent Variable: BANK_Z_SCORE
Method: Panel EGLS (Cross-section random effects)
Date: 08/03/23 Time: 22:34
Sample: 2010 2020
Periods included: 11
Cross-sections included: 10
Total panel (balanced) observations: 110
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	18.35783	3.286211	5.586320	0.0000
ATMS_PER_100_000_ADULTS	-0.065326	0.027815	-2.348630	0.0208
BANK_BRANCHES_PER_100_000_ADULTS	-0.066017	0.036170	-1.825204	0.0709
NUMBER_OF_CREDIT_CARD	5.87E-08	8.23E-08	0.712274	0.4779
NUMBER_OF_DEBIT_CARD	5.54E-08	5.10E-08	1.086262	0.2799
WBT	6.99E-12	7.39E-12	0.945567	0.3466
REAL_GDP_GROWTH__ANNUAL_PERCENT_CHANGE_	0.174424	0.077036	2.264182	0.0257
INFLATION_RATE	0.026468	0.010524	2.515081	0.0135
Effects Specification				
			S.D.	Rho
Cross-section random			7.750590	0.9383
Idiosyncratic random			1.988017	0.0617
Weighted Statistics				
R-squared	0.314877	Mean dependent var	1.357484	
Adjusted R-squared	0.267859	S.D. dependent var	2.294695	
S.E. of regression	1.963461	Sum squared resid	393.2283	
F-statistic	6.696916	Durbin-Watson stat	0.876649	
Prob(F-statistic)	0.000002			

Table 15 confirms the same results after embedding control variables. It shows that the numbers of ATMs and bank branches have significant negative effects on banks liquidity. The explanatory power for the model has also increased to 31%.

Conclusion:

At the end of the research, the results demonstrate four main findings. The first is that banks liquidity is enhanced by increasing the number of ATMs as it expands the bank availability to its customer.

The second finding is that the number of bank branches, number of credit cards, and number of debit cards have a negative impact on the banks liquidity. Credit cards may have a heavy pressure on the liquidity of the bank, which could be attributed to the fact that financial inclusion concentrates on increasing disadvantaged groups' access to fundamental financial services. Such groups that include families, women, and SME Enterprises. Debit cards for these disadvantaged groups are only considered a tool for getting their salaries and pensions, not a personal savings account. It is quite normal that increasing the number of bank branches decreases the bank liquidity as it represents huge capital expenditures.

The third finding is that bank solvency is also damaged by increasing the number of bank branches and ATMs for the same reason.

The fourth finding is that the number of ATMs enhances the liquidity of the bank. This may be attributed to increasing Customers' Access to Funds, which may lead to reducing the frequency of branch visits and manual withdrawals. This helps maintain liquidity by reducing the need for banks to hold excessive reserves to meet customer demands for cash; however, it negatively affects the solvency of the bank as setting up and maintaining ATMs requires a significant capital investment. The initial costs of purchasing and installing ATMs, along with ongoing maintenance and technological upgrades, can strain the capital resources of a bank. ATMs also come with operational costs, including maintenance, security, monitoring, and compliance with regulations. These costs can add to the bank overhead and affect its profitability (Abo Alkomsan, A. A., & Gameel, M. S., 2023).

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