SAMA Joint Research Program JRP/2021/03

Financial Inclusion, Macro-Prudential Policies and Financial Stability in Oil-Rich Countries: The Case of Saudi Arabia

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April 2022

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ABSTRACT

In compliance with Vision 2030 and the National Transformation Program (NTP), Saudi Arabia launched the Financial Sector Development Program (FSDP) in 2017, which aims to enhance the financial inclusion while promoting financial stability. This research has a twofold objective. The first purpose is to construct a comprehensive index to measure financial inclusion in the Kingdom of Saudi Arabia. Second, apprehending the dynamic interactions and causal feedbacks between financial inclusion, financial stability and macro-prudential policies in Saudi Arabia during the period 1980-2019. Based on unit root tests of the variables which present a mixture order of integration, we use ARDL model to study their dynamics because it can accommodate a very general lag structure and a different level of stationarity. We also use bound test in order to depict long-run cointegration relationships. Our empirical results indicate a long-run relationship between financial stability, financial inclusion and macro-prudential policy. Moreover, we perform Granger causality tests based on Toda and Yamamoto non-sequential methodology. Empirical findings show that both financial inclusion and macro-prudential measures cause financial stability. We hope that the findings of this research will help policy-makers and SAMA in their efforts to achieve a more inclusive and resilient financial sector, allowing the accomplishment of various financial, social and economic goals.

Keywords: *Financial Inclusion, Financial Stability, Macro-Prudential Policies, ARDL.*

JEL Classification: *C32, E59, G20.*

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Table of Contents

List of Tables

List of Figures

1. Introduction

The relationships between financial inclusion and financial stability can be examined at both micro and macro levels. At the microeconomic level, financial inclusion helps households and microenterprises to consolidate their financial position and then can contribute to macroeconomic stability and consequently the stability of the financial system. Another link between inclusion and stability at micro-level occurs through the emergence, capitalization and expansion of new non-financial entities.

At the macroeconomic level, the financial inclusion can lead to more efficiency of financial intermediation, creating a virtuous saving-investment cycle, a source of more financial stability. Inclusion of financial services can also reduce inequality, increase social and political stability, which can in turn lead to greater stability of the financial system.

While at the theoretical framework it is well established that financial inclusion can improve financial stability, empirical studies provide contradicting results. Despite the importance of the research area, the existing literature on the nexus between financial inclusion and financial stability is relatively limited. Some studies find a positive relationship while others suggest a negative one. Among others, Čihák et al. (2016) found a negative correlation between financial inclusion and financial stability. According to the authors, one possible explanation is that financial stability can be impaired by a rapid increase in credit, because not everyone is creditworthy or can handle credit responsibly. The subprime mortgage crisis is an illustrative example of such situation. They also show that financial inclusion can cause synergies and reduce medium instability and expected losses of the financial sector when considering the differences in the following measures of the inclusion-stability nexus: the economic agent, financial services, and stability dimension. For example, higher financial inclusion can help reducing the ratio of nonperforming loans (NPL) to total loans, and the volatility of deposit growth and deposit rate.

Morgan and Pontines (2018) believed that financial inclusion expands the range of borrowers, lowers lending standards and conditions, and consequently raises economic and financial risks. In a country, without appropriate supervision, if lending to microfinance institutions increases, the total effectiveness of the regulation could be impaired and risks in the financial system increases. Mehrotra and Yetman (2015) stated that if greater financial inclusion drives from irresponsible credit growth or unregulated parts of the financial system then systemic risks for financial stability may rise.

On the other hand, financial institutions are interconnected with one another by multiple channels, such as bilateral loans, joint securities portfolios, equity and bonds portfolios, and derivative contracts. In normal circumstances, these connections help sharing risks. Nevertheless, during periods of stress, these links can lead to easily propagated and amplified shocks through chain defaults (domino effect), shortage of interbank refinancing and liquidations of assets.

In order to mitigate these effects and improve the resilience of the financial system, macro-prudential policies have been implemented through different instruments. There are instruments related to individual characteristics such as additional capital requirements for systemic institutions and those targeting structural vulnerabilities in the banking system as a whole such as systemic risk buffer (SRB).

The subprime and debt crises of 2008-2009 have brought the focus on financial stability to the forefront, and the majority of countries have improved and implemented new macro-prudential policies (Basel III recommendations). The purpose of these policies is the minimization of the probability of financial crisis and systematic risks for the whole economy. These policies have great importance in oil-exporter countries because of their heavy reliance on the extractive sector and the volatility and risks that comes with such reliance.

Consequently, the existence of synergies or trade-offs between financial inclusion and financial stability on one side, and the direct effects of macro-prudential policies on financial stability on the other, should be taken into account by policymakers when implementing their strategy. In this vein, we look to contribute to the existing literature by studying the particular case of Saudi Arabia, which has implemented Basel III since 2012 and has introduced reforms to achieve a more inclusive and developed financial sector. Particularly, this research aims to address the following questions:

1- What are the levels of financial inclusion and financial stability in Saudi Arabia during the last three decades?
2- Is there any causal relationship between financial inclusion and financial stability? What is the nature of such relationship?

3- Have macro-prudential measures, introduced by the Saudi Central Bank (SAMA) along with financial inclusion enhancement, supported or impeded financial stability?

In order to answer these questions, the rest of this paper will be divided into the following sections: Section 2 reviews the literature on financial inclusion-financial stability nexus. Section 3 is concerned with the definitions and measurement of the main concepts in this research: financial inclusion, financial stability, and macro-prudential policies. Section 4 summarizes the contextual settings of financial inclusion and macro-prudential policies in the case of Saudi Arabia. Section 5 presents data, their proprieties, econometric methodology and results. Section 6 discusses causality tests and results. Section 7 provides the conclusion of the paper and develops recommendation policies.

2- Selective Literature Review: The Financial Inclusion-Financial Stability Nexus

Many theoretical and empirical studies have explored the relationship between financial inclusion and financial stability. One of the main reasons that motivated such research is the "too much finance" hypothesis, according to which the hump shape of the finance-growth relationship can be explained by the fact that a very large financial system tends to be more vulnerable to financial instability and crises. The "too much finance" hypothesis recognizes the existence of a threshold effect in the finance-growth relationship. Therefore, financial development is beneficial to growth only up to a certain threshold. Moreover, Schularick and Taylor (2012), among others, analyzed the money-credit relationship and financial crises on a long-run dataset (1870-2008), they found that rapid expansions in credit are often precursors to financial crises. Other works such as Sahay et al. (2015) and Cihák and Sahay (2020) claimed that the credit inclusion-financial stability relationship depends crucially on the quality of regulation and supervision of the banking system. They argued that, if the level of regulation and supervision is high, a credit expansion does not endanger financial stability. Using 150 countries panel data, Cihák, Mare, and Melecky (2016) related different financial-stability indicators to different financial services such as account ownership, savings, and credit, and they recognized that the relationship is complex and there exist tradeoffs and synergies between financial inclusion and financial stability. They explained the nature of the relationship in reference to periods of crises and to countries' characteristics, such as financial openness, tax rates, education, and credit information depth.

In a recent paper, Ahamed and Mallick (2019), using data from a global sample of 2,635 banks in 86 countries, showed that the relationship between bank stability and financial inclusion is strong. In particular, banks perform better in terms of reducing risks when financial inclusion is high. When taking individual dimensions and an array of control variables, they also found a positive and significant relationship between financial inclusion and bank stability.

Accordingly, literature on financial inclusion-financial stability recognizes that the relationship has different issues. On one hand, under financial inclusion, banks could attract more risk-free cheaper retail deposits and reduce their managerial costs of production, thus achieving more stability. On the other hand, extending credit to poor households or small firms could have countervailing effects due to informational asymmetries. Then an inclusive financial sector could be associated with loss of banking stability. One of the main purposes of this work is to settle such problematic question in the case of Saudi Arabia and perform adequate econometric tests in order to handle the nature of the financial inclusion-financial stability relationship.

3- Concepts: Definitions and Measurement

3.1 Financial Inclusion

Definition: According to the World Bank (2018) Financial inclusion can be defined as "individuals and businesses that have access to useful and affordable financial products and services that meet their needs – transactions, payments, savings, credit and insurance – delivered in a responsible and sustainable way". It is important to distinguish between financial inclusion and financial development. While the former is part of economic and financial development, the latter is a necessary but insufficient condition for financial inclusion and reveals the improvement in quantity, quality and efficiency of intermediary services.

Measurement: Following recent literature by Sarma and Pais (2011), Hathroubi (2019), World Bank, and United Nations Development Program (UNPD) we construct a comprehensive multi-dimensional index incorporating accessibility, availability and usage of banking services. According to Siddik et al. (2015) financial inclusion should be measured by a comprehensive index of several indicators, such as access, availability as well as usage indicators. In this paper we adopt the definition originated by Sarma (2008, 2012) based on three dimensions as follows[1]:

Table 1

Inclusive Finance Dimensions and Indicators

Dimension	**Indicator**
Accessibility (penetration)	**-** Number of deposit accounts with Commercial banks per 1,000 adults.
Availability (demographic and geographic dimensions)	- Number of commercial banks branches and ATM per 1,000 km^2. -Number of commercial banks branches and ATM per 100,000 adults.
Usage	Volume of credits and deposits as %GDP.

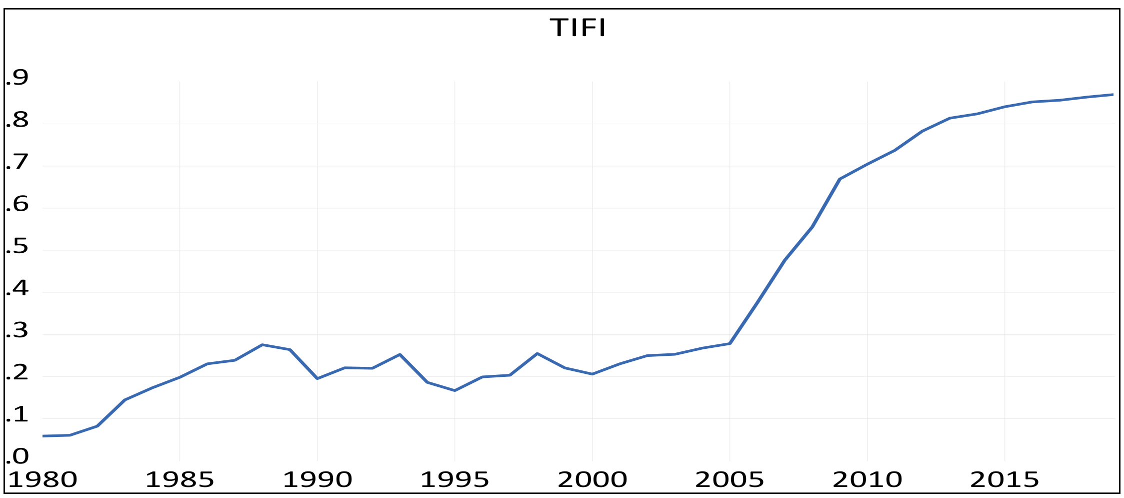
The employed methodology and its implementation for Saudi Arabia follows Hathroubi (2019)[2]. Results indicate that the index remained low until 2004 (IFI<0.3), became medium between the years 2005 and 2008 (0.3<IFI<0.6) and has high values during the last decade. This improvement has been mainly driven by the increase in the number of bank's branches. According to SAMA's bulletin, the number of branches was 1,192 in 1995 and increased to about 2,076 branches in 2019, registering an increase of about 37 new branches on average each year. Indeed, Saudi authorities have introduced a number of reforms of the financial system, including new laws, for small-medium-sized enterprises loan guarantee scheme such as *Kafalah*, and the banking liberalization and streamlining licensing obstacles of foreign

[1] The constructed financial index takes into account geographic specificities of Saudi Arabia and solves the paradoxical results obtained by Sarma (2012) and by Ahmed and Mallick (2019) for Saudi Arabia and Norway.
[2] For more details see Hathroubi (2019).

banks. The adopted reforms aimed to expand and diversify the financial services beyond commercial banks with wider reach and access. Their objective was to give a larger role for the private sector and to develop a more diversified intermediation framework. Among other purposes, this paper aims to investigate the extent to which financial sector improvement has contributed to financial stability.

Figure 1

Financial Inclusion Index for Saudi Arabia 1980-2019



Source: Authors' calculation.

3.2 Financial Stability

Definition: It is recognized in the literature that there is no consensus on the **f**inancial stability definition due to the complexity of the financial systems. In this context, researchers find it easier to speak about instability rather than stability. In a strict sense, when there is no excessive volatility, stress or crises, a financial system can be characterized as stable. The European Central Bank (ECB) defines financial stability as a state where the financial system have the ability to withstand shocks and unravel financial imbalances, thereby mitigate the likelihood of disruptions in the financial intermediation process, which are intense enough to negatively affect the real economy (ECB (2007)).

Measurement:

In the literature, many proxies have been used to measure financial stability. At the individual institutions' level, the $z-score$ is commonly used to measure a bank's solvency risk by comparing buffers (capitalization and returns) with risk (volatility of returns). The $z-score$ is popular because it has a clear (negative) relationship to the probability of a financial institution's insolvency. A lower $z-score$ implies a higher probability of insolvency.

Other proxies include the ratio of non-performing loans (NPL) to gross loans, the ratio of bank credit to bank deposits, the ratio of bank regulatory capital to risk weighted-assets, and the ratio of liquid assets to deposits and short-term funding.

At the macro-level and since the publication of the operational guidelines for regulators by the Basel Committee on Banking Supervision (BCBS) on 2010, the use of cyclical movements in credit-to-GDP ratio gap is suggested as an early warning indicator (EWI) of banking crises. Borio and Lowe (2002, 2004) were the first to document its propriety and their findings have been subsequently confirmed for numbers of countries and long-time span that includes the most recent crisis. Then several studies have adopted it as an indicator of financial stability (see among others, Lang and Welz (2017)).

The credit-to-GDP ratio gap (known as Basel gap or credit gap), is defined as the difference between the deviations of the credit-to-GDP ratio from its estimated trend. It is obtained from a one-sided Hodrick-Prescott (HP) filter and used as a common reference guide for setting the countercyclical capital buffer (CCB), a macro-prudential policy tool introduced by BCBS in 2011 for addressing financial stability risks. The CCB instrument aims to increase the resilience of the banking sector in a financial downturn through the accumulation of capital during the expansionary phase of the credit cycle. In this regard and in order to not interrupt the supply of the credit to the economy, the CCB is built during the upswing of the financial cycle and is released in a downturn to absorb any losses that may arise.

Theoretically, according to Drehmann and Tsatsaronis (2014), the credit-to-GDP ratio gap captures the arguments of Lewes & Kindleberger (1978) and Minsky (1982), who argued that financial crises are engendered by debt accumulation and fueled by excessive credit growth.

Empirically, the Basel gap is consistent with a growing literature documenting that unusual credit surge tends to precede crises (Schularick & Taylor, 2012; Gourinchas & Obstfeld, 2012). In addition, according to Drehmann and Juselius (2014), the credit-to-GDP ratio gap, as an EWI, fulfills the three policy requirements needed in the context of macro-prudential policymaking: timing, stability and interpretability.

In this study, we have opted for the Basel gap to measure financial stability (instability) because of its simplicity and its relatively good statistical performance among single indicators. In fact, the performance of the Basel gap as an EWI of the build-up of cyclical systemic risk related to excessive credit growth has been found to be fairly good in the past (Drehmann et al., 2010; Detken et al., 2014; Drehmann & Tsatsaronis, 2014). Nonetheless, some recent works, such as Castro et al. (2016), have showed that the Basel gap indicator suffers from limitations in the sense that it generates large negative values even for countries (European countries) that have undergone severe credit contraction in the near past. Accordingly, the use and interpretation of the credit-to-GDP ratio gap as a financial stability indicator should be taken with caution in the context of emerging economies, such as Saudi Arabia.

Following the Bank of International Settlement (BIS), we calculate the credit-to-GDP ratio gap (CGDPRG) using one-sided Hodrick-Prescott (HP) filter based on past observations. This method aims to decompose a time series into one-sided trend and a cyclical component. The one-sided approach gives trend-cycle decomposition for a given point of time using only the information available until that point. The trend is given by the solution of the following optimization problem[3]:

$$\min_{\tau_t}\left[\sum_{t=1}^{T}(y_t-\tau_t)^2+\lambda\sum_{t=3}^{T}[(\tau_t-\tau_{t-1})-(\tau_t-\tau_{t-1})]^2\right], \qquad (1)$$

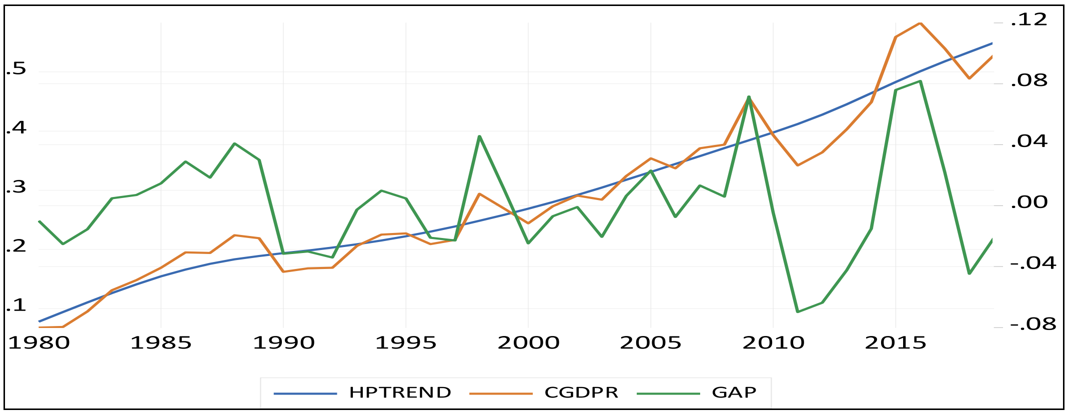
where y_t stands for the value of the credit-to-GDP ratio at time t, while τ_t is the corresponding trend and λ is the trend-smoothing parameter chosen according to the relative cycle length. In the minimizing program, the first element minimizes the distance between the trend and the observed values, while the second sets a limit to the time variance of the trend series. The role of the smoothing parameter λ is to weigh the second expression. Therefore, the choice of an optimal value of λ is crucial. Drehmann et al. (2010) and Drehmann and Yetman (2018) recommended the use of a smoothing parameter $\lambda = 400000$ for quarterly data because they assume that the credit cycle is about four times longer than

[3] For more details about HP filter, see Hodrick and Prescott (1997).

the business cycle. When the value of the smoothing parameter is high it induces that past information receives more weight in determining the current estimate of the trend. Figure 2 shows the HP filter decomposition for the credit-to-GDP ratio on Saudi yearly data for the period 1980-2019.

Figure 2

One-Sided HP Decomposition of Credit to GDP Ratio: 1980-2019



Source: Authors' calculation

3.3 Macro-Prudential Policies

Definition: They are financial policies looking to ensure the global stability of the financial system. Their objective is to stop significant disruptions in credit and other vital financial services in order to maintain a stable economic growth. They allow reducing the financial system's sensitivity to shocks by limiting the buildup of financial vulnerability. According to Borio (2014), it is necessary to prevent and combat financial instability by limiting the risks and costs of financial crises.

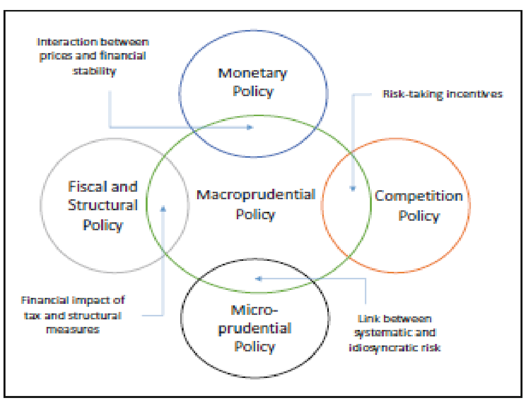
Measurement: Saudi Arabia has implemented a number of macro-prudential instruments before 2008 financial crises and has gone through many steps in the implementation of Basel

III regulations. IMF classifies the macro-prudential tools in two big categories, time varying and structural dimension. Nowadays, SAMA has a strong regulatory framework that enhances the growth of the financial system**,** maintain its soundness, stability and integrity. In the 2020 financial stability report, we find the main macro-prudential measures and policies such as Required Reserves Ratio (RRR), Loan-To-Value Ratio (LTV), Debt-Service-To-Income Ratio (DTR), Countercyclical Capital Buffer (CCBs), and Capital Conservation Buffer (CCB), etc.

In fact, there is no consensus on an optimal framework for macro-prudential policies; different models might be effective depending on the country specifics. According to Zulkhibri and Naiya (2016), financial stability is not affected by macro-prudential policy solely, but by a range of other policies as well. Figure 3 illustrates the interferences between macro-prudential policy and other policies.

Figure 3

Interaction between Macro-Prudential Policy and Other Policies



Source: **Zulkhibri, M. and Naiya, I.**, 2016, figure 1.1.

In this paper, we aim to mainly use loan to deposits ratio (LTDR) as an indicator of macro-prudential instrument. Many reasons could justify this choice. First, some studies such as Le

Lesle (2012) use the LTDR, among other variables, as signaling indicator for liquidity problems at banks. In the same line, Van den End (2013) suggested the use of the LTDR to address both cyclical (short term) and structural (long term) liquidity risks because it complements the liquidity ratios in the Basel III framework, such as the liquidity coverage ratio (LCR) and net stable funding ratio (NSFR). Second, according to Van den End (2013), the LTDR is less prone to interpretation because it integrates the intrinsic characteristics of loans and deposits independent of contractual or assumed maturities. In addition, this ratio is simpler to understand and is available on a long-time span for Saudi Arabia.

4- Contextual Settings: Financial Inclusion and Macro-Prudential Measures in Saudi Arabia

The financial inclusion is important for improving financial system stability, depth, and diversification, as well as supporting economic opportunities for sustainable development. Since all of these economic objectives fall under the role of the Saudi Central Bank (SAMA), increasing the level of financial inclusion has become one of SAMA's strategic goals. In line with Kingdom's Vision 2030 and its operational programs, SAMA aims to enhance financial inclusion by facilitating access to authorized financial services and products for individuals and businesses, as well as incorporating them into the official financial system, which ensures client protection and oversees fairness and transparency among clients.

In addition to the main goals of the financial sector development program (FSDP), increasing the contribution of small and medium enterprises (SMEs) to GDP to 35%, expanding the percentage of funding to 20%, and increasing the number of adults with a bank account to

90% are among the prominent goals that SAMA aims to achieve. Moreover, the issuance of a bank tariff by SAMA that outlined the fees for banking services as well as the upper limit of charges and commissions that banks apply to their services and products is one of the most important initiatives that serve this purpose. It also prohibits requesting financial charges or depositing funds to open bank accounts. Furthermore, SAMA issued the rules governing banking agency activities, which allow banks to use qualified agents to provide financial services on their behalf in unserved and underserved areas. These rules aim to diversify channels of access to financial services for various types of society members.

According to the financial inclusion report (2018) published by King Khalid Foundation (KKF), the following are the most financially excluded segments in Saudi Arabia: women, stateless persons, low-income groups, less literate individuals, and non-profit organizations. Table 2 shows the developments in some of the financial inclusion indicators in Saudi Arabia. The number of bank accounts owned by women has increased by 51% from 2015 to 2019. This can be attributed to the fast development of digital financial services in addition to the kingdom’s initiative towards employing females. Moreover, recent data has shown that the percentage of adults who have bank accounts in Saudi Arabia increased to 82% in 2020 compared to 71% in 2019.

Furthermore, SAMA has recently launched an experimental regulatory “sandbox” to better understand and assess the impact of new technologies in the Kingdom's financial services market. Local and international companies were allowed to test new digital solutions in a real-world setting before launching them in the Kingdom. This regulatory framework helps financial institutions and financial technology firms experience their new solutions with fewer regulations, which will have a beneficial impact on the financial sector by improving and simplifying transaction procedures, lowering costs, and increasing financial inclusion. One of the most significant results of the sandbox was the ability to create a bank account electronically instead of visiting a bank branch, as well as the usage of digital portfolios that allow consumers to conduct financial transactions using their mobile phones.

Table 2

Developments in Some of the Financial Inclusion Measures 2015-2019*

	2015	2019	2015-2019 Growth in %
Deposit Accounts with Commercial Banks	24,053,705 Accounts	33,931,353 Accounts	41
Of Which: Household Sector	95%	97%	44
Of which: Male	74 %	73%	41
Of which: Female	26%	27%	51
Number of Credit cards	2,559,994	3,041,687	19
Number of Debit cards	22,459,275	31,540,067	40
Number of Automated Teller Machines (ATMs)	17223	18882	10
Branches of commercial banks	1989	2076	4

Source: Authors' Calculation based on Financial Access Survey, (IMF).
*The data of deposit accounts by gender are available only from 2015.

SAMA is the authorized regulatory and supervisory authority in all aspects relevant to Saudi Arabia's banking system. SAMA has taken a proactive approach in implementing banking rules published by globally renowned standard-setting bodies such as the Basel Committee on Banking and Supervision (BCBS) and the Financial Stability Board (FSB). SAMA introduced the Basel I Capital Adequacy Accord in 1992, the Basel II regulatory framework in 2008, and then Basel III in 2012 when it joined the Basel Committee. Furthermore, SAMA implemented a systematic approach for assessing and designating Significant Financial Institutions (the Significant Financial Institutions Treatment System or SFITS). The procedure enables SAMA to efficiently monitor and regulate major financial institutions in order to maintain monetary and financial stability and safeguard the financial system from any unwanted consequences. SAMA adopted Basel III changes related to the exposure of unrated corporate SMEs, lowering the Risk-Weighted Assets (RWA) ratio for those businesses to 85 percent from 100 percent, while maintaining the RWA requirement for retail SMEs at 75 percent in order to provide the required assistance to SMEs. More details of regulatory framework are presented in Appendix A.

5- Data and Empirical Methodology

5.1 Data Sources and Statistical Proprieties of the Variables

To investigate the causal relationships between financial inclusion and financial stability under macro-prudential policy, we draw data from a number of sources, including SAMA, World Bank (WB), and International Monetary Fund (IMF) depending on their availability. To measure Financial Inclusion, we use annual time series data for the period 1980-2019 and construct an Inclusive financial index (IFI), taking into account three dimensions: availability, usage, and penetration[4]. Then we construct a Transformed Index of Financial Inclusion (TIFI), which lies between $-\infty$ and $+\infty$ while the IFI lies between 0 and 1. TIFI

[4] For more details on methodology and computation of IFI in the case of Saudi Arabia, see Hathroubi (2019).

preserves the same ordering as IFI because it is a monotonically increasing function of the latter. In addition, it allows carrying out classical econometric regression.

$$TIFI_t = \log(\frac{IFI_t}{1-IFI_t}) \qquad (2)$$

Financial stability is measured by the credit-to-GDP ratio gaps obtained from one-sided HP filter decomposition of the credit-to-GDP ratio series. Macro-prudential policies are measured by the loans to deposits ratio. Economic growth is measured by real per capita GDP growth rate. Financial openness (FO) is measured by foreign direct investment, net inflows as a percentage of GDP, and the size of financial system (FSZ) is measured by $\frac{M_3}{GDP}$.

In order to avoid econometric spurious regression, we first conduct unit roots tests. The obtained results will dictate the nature of the model to estimate and adequate econometric techniques to use.

In Table 3, we present descriptive statistics of the variables with some insights on their correlations. We can observe from Table 4 that correlations between some of the independent variables are relatively high. However, multi-collinearity is not an issue for empirical analysis since we are using ARDL model.

Table 3

Descriptive Statistics of Variables

	FS	TIFI	MP	RPCGDP	FO	HDI	M3GDP
Mean	0.000254	0.397049	0.794888	-0.011602	0.439811	0.736110	49.41449
Maximum	0.081840	0.870200	1.066052	0.113127	2.447781	0.859000	74.73400
Minimum	-0.069885	0.060300	0.588351	-0.256141	-0.542658	0.591000	16.52200
S.D.	0.034299	0.272274	0.143321	0.077502	0.608435	0.084737	11.87717
Observations	39	39	39	39	39	39	39

Source: Authors' Calculation.

Table 4

Correlation Matrix

	FS	TIFI	MP	TIFIMP	RPCGDP	HDI	FO	M3GDP
FS	1.000000	0.026110	0.108737	0.036053	-0.133691	-0.013621	0.067646	0.380512
TIFI	0.026110	1.000000	0.193795	0.992512	0.224314	0.976994	0.647399	0.796039
MP	0.108737	0.193795	1.000000	0.304063	-0.347682	-0.209531	0.188318	-0.142821
TIFIMP	0.036053	0.992512	0.304063	1.000000	0.184907	0.824286	0.659145	0.763661
RPCGDP	-0.133691	0.224314	-0.347682	0.184907	1.000000	0.353491	0.116438	0.360404
HDI	-0.013621	0.976994	-0.209531	0.824286	0.353491	1.000000	0.525840	0.796814
FO	0.067646	0.647399	0.188318	0.659145	0.116438	0.525840	1.000000	0.615260
M3GDP	0.380512	0.796039	-0.142821	0.763661	0.360404	0.796814	0.615260	1.000000

Source: Authors' Calculation.

5.2 Unit Roots Tests

In order to test the presence of unit roots in the variables and avoid spurious regression, many tests have been proposed in the literature *(Augmented Dickey-Fuller [ADF], Phillips-Perron [PP], Andrews and Zivot [AZ], Ng-Perron [NP], Kwiatkowski-Phillips-Schmidt-Shin [KPSS], Ouliaris-Park-Perron, Eliott-Rothenberg-Stock [DF-GLS]).* In this work, we use the unit root tests NP (Ng-Perron, 2001) and DF-GLS (Elliot et al., 1996) because the ADF tests are known to suffer potentially from severe finite sample power and size problem. When the results of the two tests above are inconclusive, we perform Phillips-Perron test (PP), which estimates the non-augmented dickey-Fuller equation and allows controlling for serial correlation.

Results of Table 5 show that series under study have mixed degree of integration. Some are I(0) and others are I(1). This indicates that traditional econometric technics may not be suitable. Therefore, the ARDL model has been proposed to perform cointegration tests between variables with mixed level of stationarity and can accommodate very general lag structure of the variables.

Table 5

Unit Root Tests on Levels and Differences

Variables	Ng-Perron test statistics*				DF-GLS test**	PP***	Results
	MZα	MZt	MSB	MPT			
$TIFI$	0.67	0.35	0.56	25.31	0.17		
$\Delta TIFI$	-15.3	-2.78	0.179	1.58	-3.87	-4.04	I(1)
FS	-43.23	-4.64	0.17	0.58	-5.15	-3.83	I(0)
RPCGDP	-17.32	-2.94	0.169	1.41	-4.49	-4.54	I(0)
HDI	-12.05	-2.30	0.19	2.28	-1.43		
ΔHDI	0.35	0.26	0.74	36.47	-1.04	-3.988	I(1)
FO	-13.45	-2.36	0.175	2.675	-3.03	-2.90	I(0)
MP	-0.86	-0.67	0.73	26.82	-1.10		
ΔMP	-3.33	-1.22	0.36	7.28	-1.39	-4.87	I(1)
$M3gdp$	-0.542	-0.264	0.487	16.69	-0.70		
Δ $M3gdp$	-18.90	-3.063	0.162	1.315	-5.66	-5.62	I(1)
Asymptotic 1%	-13.8	-2.58	0.174	1.78	-2.63	-3.61	
Critical values 5%	-8.1	-1.98	0.233	3.17	-1.95	-2.94	
10%	-5.7	-1.62	0.275	4.45	-1.61	-2.60	

Note: * Perron (2001). ** Elliot et al. (1996). *** Phillips Perron (1988) and are calculated only for differences.
Source: Author's Calculation.

Results of Table 5 show that four variables (TIFI, HDI, MP, M3GDP) are I(1), and three variables (FS, FO, RPCGDP) are I(0). It is then appropriate to use the ARDL model.

5.3 Model Specification and Econometric Techniques

Following the empirical literature, we can formulate the financial inclusion-financial stability nexus under macro-prudential policies as follows:

$$FS_t = \alpha + \beta TIFI_t + \gamma_t MP_t + \delta(TIFI_t \times MP_t) + \vartheta Z_t + \varepsilon_t, \qquad (3)$$

where the dependent variable FS_t represents an indicator of financial stability (credit-to GDP ratio gap in our study), $TIFI_t$ is the constructed financial inclusion index, MP_t represents macro-prudential measures (loan-to-deposits ratio in our study), and the term $(TIFI_t \times MP_t)$ reveals the combined effects of financial inclusion and macro-prudential policy on financial stability. Z_t is a vector of control variables which could influence the financial inclusion-financial stability nexus, such as financial openness (FO), per capita income (real per capita GDP), and Human Development Index (HDI). The latter integrates, among other social characteristics, education. Education in general and financial literacy in particular are essential to understand the growing complexity of financial products, and to improve financial wellbeing and financial inclusion. Analyzing the role of education in the financial inclusion process, Barajas et al. (2020) distinguished between two key concepts– financial literacy and financial capability. According to them, understanding the basic of financial information and concepts makes part of financial literacy, while knowledge, skills, attitudes, and the ability to use financial products to their best advantage make part of financial capability which is a broader concept. Thus, financial capability does not only imply that an individual has the requisite knowledge but is also able to make sound financial decisions. In Saudi Arabia, school enrollments statistics (primary, secondary, tertiary) have been available only since 2013. In order to take into account, the effect of human capital development on financial inclusion and then on financial stability, we use the human development index (HDI) which is available on a long-time span.

Good governance (GG), and quality of institutions (QI) are also cited as one of the main variables that affect the financial inclusion-financial stability relationship. Using individual level data, Allen et al. (2016) stated that stronger legal rights and more politically stable environments are positively correlated to financial inclusion. Navajas and Thegeya (2013) tested the effectiveness of Financial Soundness Indicators (FSIs), which are aggregate measures of the health of a country's financial sector, and are indicators of potential banking crises, to see if they help predict crisis occurrences. Their results indicate significant correlation between some FSIs and crises. Specifically, they show that regulatory capital to risk-weighted assets (CAR) and return on equity (ROE) are significantly and negatively correlated with the occurrence of banking crises. More broadly, using firm-level data, Beck et al. (2005) show that in countries with more developed financial systems and low level of corruption firms face lower levels of financing constraints.

In order to study the interactions and causal relationships between financial inclusion and financial stability and macro-prudential policies, we adopt a strategy in many steps. Firstly, we estimate model (2) using ARDL methodology because our variables present a mixed structure of integration level; some are I(0) and others are I(1). Secondly, we estimate long-run cointegration relationships and short-run dynamics using bounds test to cointegration developed by Pesaran et al. (1996) and Pesaran and Shin (1999). Thirdly, we use Toda and Yamamoto's (1995) non-sequential procedure to test causal relationships. This method surpasses Granger sequential methodology and is based on Wald test, which is independent of the degree of stationarity of the series and their cointegration.

5.4 Theoretical Brief Review of ARDL Model

The popularity of Autoregressive Distributed Lag (ARDL) model stems from the fact that it has a reparameterization in error correction form. Consequently, it is useful to disentangle long-run relationships from short-run dynamics. In this kind of model, the current value of the dependent variable is regressed on its own past realizations (the autoregressive part), as well as current and past values of additional explanatory variables (the distributed lag part). The ARDL-Bounds testing approach proposed by Pesaran et al. (1996, 2001) to investigate the existence of cointegration relationships among variables has many advantages. First, unlike the multivariate procedure of Johansen and Juselius (1990), which is eager in data, bounds test procedure is suitable for small sample size. Second, unlike conventional cointegration procedures, ARDL model can circumvent the problem of the order of integration of the series. Third, ARDL model can provide unbiased estimates in the long-run even when some variables are endogenous.

The general form of ARDL (p,q) model can be written as follows:

$$y_t = \mu + \sum_{i=1}^{p} \alpha_i y_{t-i} + \sum_{j=0}^{q} \beta_j x_{t-j} + \varepsilon_t \qquad (4)$$

Where y_t is the dependent variable and x_t is a vector of explanatory variables, and $\varepsilon_t \sim iid(0, \sigma)$ is the error term. The lag-orders are usually chosen according to an information criterion. The optimal model is the one with the smallest value of the AIC or BIC[5]. In this model, the short-term effect of the variable x on y is revealed by β_0 while the long-run effect is obtained through $\gamma = \frac{\sum \beta_j}{1-\sum \alpha_i}$.

In order to test the existence of cointegration relationship between variables in ARDL model, we first estimate the following specification using OLS.

$$\Delta y_t = \mu + \varphi_1 y_{t-1} + \varphi_2 x_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \sum_{j=0}^{q-1} \beta_j \Delta x_{t-j} + \varepsilon_t \qquad (5)$$

Second, we use F-test to test the existence of a long-run relationship among the variables as follows:

$H_0: \varphi_1 = \varphi_2 = 0 \quad against \;\; H_1: \varphi_1 \neq \varphi_2 \neq 0$

The procedure of the test consists in comparing the calculated F to the critical bounds (lower, upper) value developed by Pesaran et al. (2001)[6]. If the calculated F-statistic is above the upper critical value, the null hypothesis of no long run relationship can be rejected irrespective of the orders of integration for the variables. Conversely, if the calculated F-statistic falls below the lower critical value, the null hypothesis cannot be rejected. Finally, if the F-statistic falls between the lower and upper critical values, the result is inconclusive. Once the cointegration relationship is established, the ARDL long-run model can be estimated as it is in equation (4). The final step is to disentangle short-run and long-run dynamics by estimating an ARDL-EC model.

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[5] The information criteria are only comparable when the sample is held constant.

[6] Recently, Kripfganz and Schneider (2018) obtain asymptotic critical values for the lower and upper bound of all independent variables being purely $I(0)$ or purely $I(1)$ and not mutually cointegrated.

$$\Delta y_t = \mu + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \sum_{j=0}^{q-1} \beta_j \Delta x_{t-j} + \theta (ECM)_{t-1} + \varepsilon_t \qquad (6)$$

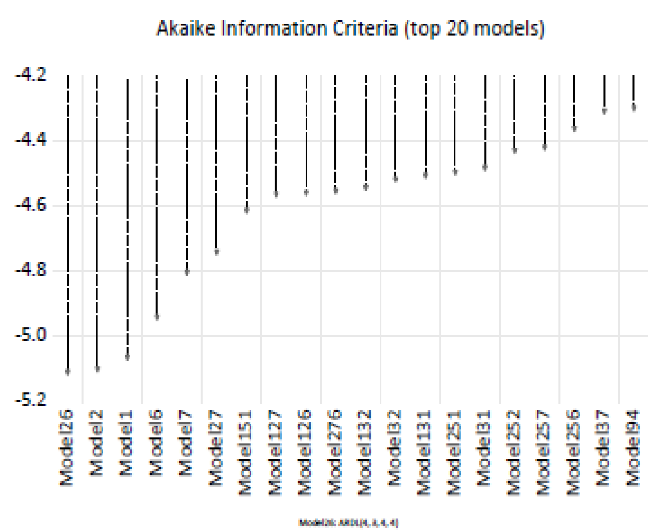
Here α and β are the short-run dynamic coefficients, $(ECM)_{t-1} = (y_{t-1} - \gamma x_{t-1})$ is the error correction term and θ is the speed of adjustment.

5.5 Empirical Results

Unit root tests ensure that all variables are I(0) or I(1) and no variable is I(2). Therefore, we can perform the ARDL-OLS regressions to depict cointegration relationships between financial stability, financial inclusion and macro-prudential policy. We first estimate the lag structure of the ARDL using Akaike Information Criterion (AIC) and Schwarz Information criterion (SIC). Results of Figure 4 show that among 20 estimated ARDL, minimum value of AIC corresponds to the optimal ARDL(4,3,4,4)[7].

Figure 4

ARDL Lag Structure



[7] The same result is given by SIC.

Table 6

Optimal ARDL (4,3,4,4) Estimation

Variable	Coefficient	Standard Error	T-Stat.	Prob.
FS(-1)	-0.157070	0.238460	-0.658688	0.5216
FS(-2)	-0.750578	0.200329	-3.746720***	0.0024
FS(-3)	0.277637	0.227586	1.219923	0.2442
FS(-4)	-0.662839	0.211945	-3.127412***	0.0080
TIFI	1.057728	0.528929	1.999754	0.0669
TIFI(-1)	-1.004564	0.589561	-1.703918	0.1122
TIFI(-2)	0.096525	0.552843	0.174598	0.8641
TIFI(-3)	-2.580088	0.485779	-5.311240***	0.0001
MP	0.450651	0.229153	1.966592	0.0710
MP(-1)	-0.316423	0.318615	-0.993122	0.3388
MP(-2)	0.262821	0.286155	0.918456	0.3751
MP(-3)	-1.220848	0.261864	-4.662138***	0.0004
MP(-4)	0.371527	0.103042	3.605597***	0.0032
TIFIMP	-1.259657	0.725264	-1.736825	0.1060
TIFIMP(-1)	1.339657	0.725264	1.630487	0.1270
TIFIMP(-2)	-0.064672	0.714911	-0.090461	0.9293
TIFIMP(-3)	3.277752	0.682070	4.805592***	0.0003
TIFIMP(-4)	-0.605731	0.228365	-2.652464**	0.0199
C	0.432633	0.168317	2.570344**	0.0233
R-squared	0.899054	Akaike Information Criterion		-5.109783
Adjusted R-squared	0.759283	Schwarz Criterion		-4.239502
F-statistic	6.432336***			
Prob(F-statistic)	0.000721			

Note:**, *** denote significance level at 5% and 1%, respectively.
Source: Authors' Calculation.

Table 7 reports the calculated F-statistic for bounds test when each variable is considered as dependent.

Table 7

ARDL Bounds Test

Dependent variable	F-statistic	Lags	Result
FS	6.0429	2	Cointegration
TIFI	1.6052	2	No cointegration
MP	3.2850	2	Inconclusive
TIFIMP	6.0901	3	Cointegration

Bounds test	Lower	Upper
10%	2.845	3.623
5%	3.478	4.335
1%	4.948	6.028

Source: Authors' calculation.

Bounds test indicates that there exists one cointegration relationship between the three variables only when the regression is normalized on financial stability variable. The calculated F-statistic is higher than the upper value, implying a long-run relationship between financial stability, financial inclusion and macro-prudential policy. When the regression is normalized on financial inclusion index, the null hypothesis of no cointegration is accepted. Bounds test is inconclusive when the regression is normalized on macro-prudential policy indicator.

Once the cointegration relationship is established through bounds test we perform an ARDL long run form and estimate a conditional error correction regression. Results of Table 8 show that estimation of long run coefficients of financial inclusion index and macro-prudential policy are significant but negative. On Average, an increase in IFI and MP by 1% would be accompanied by a decrease in FS by 1.05% and 0.19%, respectively in the long run. In contrast, estimated coefficient of their combined effect through the variable (TIFIMP) is significant and positive. This means if TIFIMP increased by 1%, FS will be increased by 1.17% in the long run. These results indicate that, in Saudi Arabia, financial inclusion could have positive effects on financial stability only if the development of such activity is supported by macro-prudential measures. In other words, financial inclusion could have negative impact on financial stability without having proper supervision. As it was argued by Sahay et al. (2015), when credit is expanded to all, it will increase the risk of financial instability, especially in countries with weak supervision.

Table 8

ARDL Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TIFI	-1.059990	0.338536	-3.131102***	0.0080
MP	-0.197253	0.089399	-2.206429**	0.0460
TIFIMP	1.172058	0.392067	2.989433**	0.0104
C	0.188688	0.075871	2.486948**	0.0273

Note: **, *** denote significance level at 5% and 1%, respectively.
Source: Authors' Calculation.

Results of Table 9 show that the error correction term is negative, as expected, and its coefficient is highly significant. This indicates that the speed of correction between short and long term is relatively important. In addition, a coefficient of -2.293 implies that the model converges in a fluctuating manner to equilibrium and that the deviation from long-term is corrected by 2.293% each year.

Table 9

ARDL-ECM and Short-Run Dynamics

Variable	Coefficient	Standard Error	T-Stat.	Prob.
D(FS(-1))	1.135779	0.147327	7.709236***	0.0000
D(FS(-2))	0.385202	0.125272	3.074926***	0.0089
D(FS(-3))	0.662839	0.138563	4.783671***	0.0004
D(TIFI)	1.057728	0.313080	3.378462***	0.0049
D(TIFI(-1))	2.483563	0.391033	6.351294***	0.0000
D(TIFI(-2))	2.580088	0.401401	6.427713***	0.0000
D(MP)	0.450651	0.151644	2.971766**	0.0108
D(MP(-1))	0.586500	0.157584	3.721831***	0.0026
D(MP(-2))	0.849321	0.169376	5.014428***	0.0002
D(MP(-3))	-0.371527	0.078425	-4.737374***	0.0004
D(TIFIMP)	-1.259657	0.432475	-2.912668**	0.0121
D(TIFIMP(-1))	-2.607349	0.451708	-5.772196***	0.0001
D(TIFIMP(-2))	-2.672021	0.473938	-5.637916***	0.0001
D(TIFIMP(-3))	0.605731	0.116528	5.198176***	0.0003
CointEq(-1)	-2.292850	0.216618	-10.58478***	0.0000
R-squared	0.915328	Akaike Information Criterion		-5.359783
Adjusted R-squared	0.84598	Schwarz Criterion		-4.672719

Note:**, *** denote significance level at 5% and 1%, respectively.
Source: Authors' Calculation.

5.6 Stability and Robustness Check

In order to check the robustness and stability of the estimated ARDL model, we proceed in two ways. First, we perform a set of diagnostic tests relative to the stability of model coefficients, such as CUSUM and CUSUM squares, and relative to the good fitness of the model, such as error autocorrelation or heteroskedasticity and normality tests. Second, we introduce control variables (exogenous variables) which could influence the financial inclusion-financial stability nexus.

5.6.1 Diagnostic Tests

Diagnostic tests of the ARDL model are presented in Table 10. We can observe that the model has the desired econometric properties, in that it has the good specification and residuals are serially uncorrelated, normally distributed and homoscedastic. Therefore, we can interpret the results in a meaningful way.

Table 10

Diagnostic Tests

Test	F-statistic	p-value
Serial correlation[a]	8.2829	0.0159
Normality[b]	0.7306	0.6939
Heteroskedasticity[c]	27.48	0.0704
Model specification[d]	0.1622	0.6842

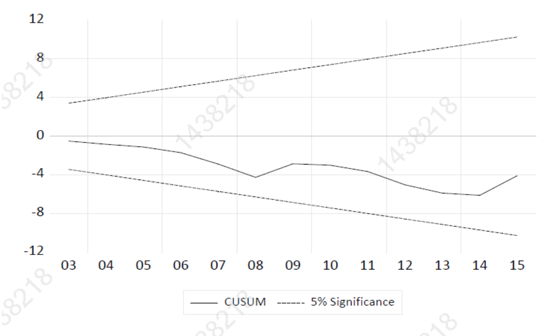
Note: [a] Lagrange multiplier (LM) test of residual serial correlation; [b] Jarque-Bera test ; [c] Harvey test for heteroscedasticity.; [d] Ramsey’s RESET test.
Source: Authors’ Calculation.

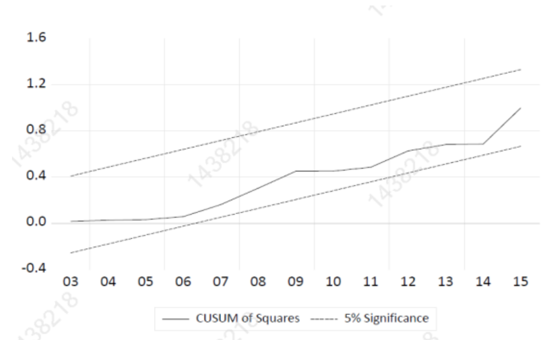
5.6.2 Stability Tests

The cumulative sum (CUSUM) test identifies systematic changes in the regression coefficients, while the cumulative sum of squares (CUSUMSQ) test detects sudden changes from the constancy of the regression coefficients. Results of Figure 5 shows the absence of any instability of the coefficients because the plots of the CUSUM and CUSUMSQ statistics fall inside the critical bands of the 5 percent confidence intervals of parameter stability.

Therefore, a stability exists in the coefficients through the sample period. These results are corroborated by the Ramsey RESET test in Table 10.

Figure 5: ***Stability Tests, CUSUM and CUSUM of Squares***





5.6.3 Control Variables

As it has been developed in subsection 4-3, the financial inclusion-financial stability nexus literature recognizes that many variables could condition such relationship, such as per capita real GDP, education or human development index, financial openness (FO), the size of financial system (FSZ) and good governance (GG). Using World Bank's Global Financial Development database including 164 countries, Morgan and Pontines (2014) show that financial inclusion increases along with per capita GDP but the link between financial inclusion and financial stability is less clear. Bayar (2016) and Frankel and Saravelos (2012) observed that there is a great association between financial openness and financial inclusion via financial development which leads to greater stability of the financial system. In this paper, financial openness is measured by foreign direct investment net inflows (% of GDP). The size of financial system (FSZ) is measured by $\frac{M_3}{GDP}$. We assume that the higher the proportion of financial system's deposit to GDP, the more financially stable the economy is. Results of ARDL model with exogenous variables are presented in Table 11. We depict that only real per capita GDP and the size of financial system have positive and significant effect, at 10% and 1% level respectively, on the financial inclusion-financial stability relationship. Neither financial openness nor human development index has any impact.

Table 11

Financial Inclusion, Financial Stability, and Control Variables

Variable	Coefficient	Standard Error	T-Stat.	Prob.
FS(-1)	0.165568	0.149449	1.107858	0.2843
FS(-2)	-0.463498	0.158960	-2.915813**	0.0101
FS(-3)	0.235637	0.155295	1.517355	0.1487
FS(-4)	-0.507790	0.151499	-3.351759***	0.0041
TIFI	0.510739	0.398775	1.280772	0.2185
TIFI(-1)	-0.412155	0.229133	-1.798757	0.0909
TIFI(-2)	0.207563	0.156399	1.327139	0.2031
TIFI(-3)	-0.317962	0.113316	-2.805988**	0.0127
MP	0.144609	0.128668	1.123891	0.2776
TIFIMP	-0.652321	0.423869	-1.245199	0.2310
TIFIMP(-1)	0.403179	0.258515	1.559593	0.1384
TIFIMP(-2)	-0.064672	0.714911	-0.090461	0.9293
PCGDP2010	1.89E-06	1.04E-06	1.823258	0.0870
HDI	0.008522	0.130941	0.065084	0.9489
FO	0.002737	0.008022	0.341217	0.7374
M3GDP	0.004636	0.000752	6.163630***	0.0000
C	-0.417349	0.172412	-2.420644**	0.0278
R-squared	0.898547	Akaike Information Criterion		-5.292270
Adjusted R-squared	0.803435	Schwarz Criterion		-4.559402
F-statistic	9.447232			
Prob(F-statistic)	0.000027			

Note:**, *** denote significance level at 5% and 1%, respectively.
Source: Authors' Calculation.

Good governance and institutional quality are revealed by Government Effectiveness variable published by World Bank and has been available only since the beginning of 1996. In order to take into account the effect of this variable on financial inclusion-financial stability nexus, we perform two more estimations of our ARDL on the period 1996-2019. One integrates all control variables, including Government Effectiveness, and the other retains Government Effectiveness as the only control variable. In the two cases, we obtain singular matrix and the model is empirically rejected. In order to measure the effect of good governance on financial stability and financial inclusion, the model can be re-estimated by considering either a different proxy or longer period.

Moreover, in order to take into account the introduction of Basel III in 2012 by SAMA, we re-estimate our model by introducing a Dummy variable (BASEL3). Results are presented in Table 12. We recall that Basel recommendations are supposed to enhance regulation in the banking system and aim to prevent banks from hurting the economy by taking more risks than they can handle. Accordingly, Basel recommendations are part of a continuous process to protect financial systems from instability. Estimation of ARDL model shows that the implementation of Basel III recommendations by SAMA has led to an improvement of financial stability in Saudi Arabia but with lagged effect. This result is compatible with the fact that new reforms take time to be fully implemented.

Table 12

Financial Inclusion, Financial Stability, Control Variables, and Dummy Variable (BASEL3)

Variable	Coefficient	Standard Error	T-Stat.	Prob.
FS(-1)	0.182812	0.125615	1.455336	0.1662
FS(-2)	-0.482678	0.143152	-3.371792***	0.0042
FS(-3)	-0.034834	0.184608	-0.188692	0.8529
FS(-4)	-0.196727	0.181283	-1.085194	0.2950
TIFI	0.602020	0.450819	1.335393	0.2017
TIFI(-1)	-1.231526	0.525997	-2.341316**	0.0334
TIFI(-2)	0.074933	0.157716	0.475116	0.6415
TIFI(-3)	-0.141388	0.168247	-0.840360	0.4139
TIFI(-4)	-0.137406	0.143546	-0.957225	0.3536
MP	0.331546	0.201580	1.644734	0.1208
MP(-1)	-0.429791	0.233063	-1.844097	0.0850
TIFIMP	-0.784299	0.609759	-1.286244	0.2179
TIFIMP(-1)	0.403179	0.740531	2.124726	0.0506
BASEL3	-0.046028	0..036953	-1.245596	0.2320
BASEL3(-1)	0.000853	0.025358	0.033639	0.9736
BASEL3(-2)	0.068921	0.026554	2.595562**	0.0203
PCGDP2010	1.29E-06	1.02E-06	1.266031	0.2248
HDI	-0.049969	0.138099	-0.361838	0.7225
FO	-0.002532	0.006780	-0.373484	0.7140
M3GDP	0.003544	0.000919	3.854809***	0.0016
C	-0.090995	0.217057	-0.419224	0.6810
R-squared	0.932778	Akaike Information Criterion		-5.407999
Adjusted R-squared	0.843149	Schwarz Criterion		-4.484279
F-statistic	10.40706			
Prob(F-statistic)	0.000016			

Note: **, *** denote significance level at 5% and 1%, respectively.
Source: Authors' Calculation.

6- Causal Relationships between Financial Stability, Financial Inclusion and Macro-Prudential Policy

In this paper, we use Toda-Yamamoto approach because traditional sequential Granger causality tests face many shortages especially in finite samples. First, Granger causality tests are conducted only on stationary series. However, unit root tests are less efficient on small sample and are not always unbiased. Second, by transforming the series in first difference for the sake of stationarity or cointegration relationship, we obtain good statistical proprieties while losing information on the level of the series which is important to explain the dynamics of the model. These weakness and others lead Toda and Yamamoto (1995) to propose non-sequential procedure to test Granger causality where variables could have different levels of integration. They propose to estimate an augmented VAR $(k + d_{max})$ in level which could integrate probable potential cointegration between the series (where k is optimal lag length of the VAR according to an information criterion and d_{max} is the maximal order of integration for the series in the system). One of the main advantages of Toda and Yamamoto procedure is that we do not have to test cointegration or transform VAR into VECM. Granger causality procedure of Toda and Yamamoto is based on a modified Wald test which follows a $\chi^2(k + d_{max})$ where $(k + d_{max})$ is the degree of freedom which is equal to the number of lags in the augmented VAR. We can summarize Toda and Yamamoto procedure in the following steps:

1. We construct and estimate VAR(k) model on series levels regardless of their integration order, where k is lag length taken from an information criterion (AIC, SIC).

2. We construct and estimate the augmented VAR $(k + d_{max})$, where d_{max} is the maximum order of integration among series, and test if it is correctly specified.
3. We use the modified Wald (MWald) statistic to test for Granger causality in the sense of Toda and Yamamoto.

In what follows we use Toda-Yamamoto methodology in order to test Granger causality relationships between financial stability, financial inclusion and macro-prudential policy. For each pair of variables we estimate the following augmented VAR $(k + d_{max})$ and calculate MWald satatistic.

$$y_t = \mu + \sum_{i=1}^{k} \alpha_{1i} y_{t-i} + \sum_{i=k+1}^{d_{max}} \alpha_{2i} y_{t-i} + \sum_{j=1}^{k} \beta_{1j} x_{t-j} + \sum_{j=k+1}^{d_{max}} \beta_{2j} x_{t-j} + \varepsilon_{1t} \qquad (8)$$

$$x_t = \vartheta + \sum_{j=1}^{k} \gamma_{1j} x_{t-j} + \sum_{i=k+1}^{d_{max}} \gamma_{2j} x_{t-j} + \sum_{i=1}^{k} \delta_{1i} y_{t-i} + \sum_{i=k+1}^{d_{max}} \delta_{2i} y_{t-i} + \varepsilon_{2t} \qquad (9)$$

The test is conducted on the k first coefficients. The null hypothesis is:

In equation (8) $\quad H_0\colon \beta_{1j} = 0$: x_t does not Granger cause y_t

In equation (9) $\quad H_0\colon \delta_{1i} = 0$: y_t does not Granger cause x_t

The empirical results of Granger Causality test based on Toda and Yamamoto (1995) methodology are reported in Table 12. The estimates of MWALD test show that the test result follows the chi-square distribution with 3 degrees of freedom in accordance with the appropriate lag length along with their associated probability.

Table 13

Toda-Yamamoto Causality (MWald) Test Results

Null Hypothesis	χ^2	P-value	Granger causality
FS does not Granger cause TIFI	4.734081	0.1923	
TIFI does not Granger cause FS	**7.028566**	**0.0710**	TIFI → FS
FS does not Granger cause MP	1.873586	0.5991	
MP does not Granger cause FS	**6.434462**	**0.0923**	MP → FS
TIFI does not Granger cause MP	5.719677	0.1261	No causality
MP does not Granger cause TIFI	1.886196	0.5964	
FS does not Granger cause TIFIMP	6.109966	0.1064	
TIFIMP does not Granger cause FS	**6.813225**	**0.0781**	TIFIMP → FS

Source: Author's Calculation.

From results of Table 13, we find out that there is no bidirectional causality between each pair of variables. We observe only unidirectional causality running from financial inclusion to financial stability and from macro prudential policies to financial stability and from the combined effect of financial inclusion and macro prudential policy to financial stability. In addition, there is no causality between financial inclusion and macro prudential policy.

Such empirical results support the fact that higher levels of financial inclusion would lead to greater financial stability. Moreover, when coupled with macro-prudential measures, financial inclusion could lead to more financial stability. The combined effect of the two variables on financial inclusion is positive and the causality test is highly significant.

7- Conclusions and Policy Recommendations

In recent literature, it is well documented that financial inclusion is one of the challenging priorities for developing countries as well as for developed countries. Empirical studies state that financial inclusion leads to consumption smoothing, reduces inequality and spurs economic growth. Because financial inclusion offers credit lines to individuals and small and medium enterprises, it allows the improvements of economic wellbeing of many poor individuals and families. Nevertheless, little is known about its impacts on financial stability. Understanding the interrelationship between financial inclusion and financial stability under macro-prudential policy is an interesting issue especially for oil-rich countries. In this paper, we have attempted to study the case of Saudi Arabia using ARDL methodology and Toda-Yamamoto Granger causality. In this vein, we have constructed a comprehensive financial inclusion index, taking into account three main dimensions: accessibility, availability, and usage of financial services. Computational results show that financial inclusion has evolved considerably in Saudi Arabia especially during the last decade. In addition, we have constructed a financial stability indicator based on the credit-to-GDP ratio gap (CGDPRG) using one-sided Hodrick-Prescott (HP) filter. This variable has been usually used for its performance as an early warning indicator for banking crises.

Econometric results (Bounds tests) indicate that there exists one cointegration relationship between financial stability, financial inclusion, and macro-prudential policy only when the regression is normalized on financial stability variable.

In addition, empirical findings show that both financial inclusion and macro-prudential measures Granger cause financial stability, and their combined effect is also significant. It is then arguable that greater financial inclusion presents opportunities to enhance financial stability. Empirical findings also indicate that financial openness has no clear effect on financial stability, while the size of the financial sector measured by the proportion M3/GDP has a positive impact. Overall, our empirical results confirm the importance of taking into consideration synergies and trade-offs between financial inclusion and financial stability in policy-making.

These empirical findings could have many policy implications:

Given their contribution to financial stability and their impact on financial inclusion, Saudi central bank should continue enhancing macro-prudential policies. Pro-inclusion policies should focus on financial and bank regulation and supervision because empirical literature (Cihák and Sahay, 2020, among others) shows that the relationship between credit inclusion and financial stability depends crucially on the quality of bank regulation and supervision.

Given the recognized positive effect of financial inclusion on financial stability, Saudi authorities should collaborate to eliminate or reduce barriers to financial inclusion especially in the most excluded segments such as the stateless, women and people outside the labor force. Examples of barriers that can be eased are the documentation requirements and fees. Having a detailed strategy addressing the most financially excluded segments with a recorded and measured progress is important to achieve high levels of financial inclusion, which in return can support financial stability. In addition, this will help policymakers and researchers to make better decisions and studies.

The targeted percentage of account ownership among adults has been increased in the Kingdom from 80% to 90%, which shows the strong capability to achieve such set targets. Therefore, efforts in spreading financial awareness should be persistent to reach different segments and ages of the society, as financial awareness plays an important role in enhancing financial inclusion. In Addition, the strong evolution of digital financial services would also enhance financial inclusion; thus, it should be accompanied with strong cyber security. Most importantly, macro-prudential policies should be revised in line with the enhancement of financial inclusion and the accelerating developments of financial services. Furthermore, Policymakers should consider positive and negative aspects of financial inclusion jointly, and control financial inclusion policy to avoid financial instability. This stems from the realization that rapid expansions in credit could have a negative impact on financial stability according to the "too much finance" hypothesis, which states that very large financial systems tend to become more prone to instability and crises.

One of the main limitations of this work is that it does not take into account one of the main specificities of the Saudi financial system: its duality—i.e., the presence of both conventional and Islamic institutions. Islamic finance not only covers the Islamic banking institutions but also non-banking institutions such as *zakat* and *Waqf* institutions, Islamic mutual funds, and Islamic microfinance institutions. During the last decade, Islamic Banking has significantly grew in Saudi Arabia in terms of market share and number of banks. In 2019, it held 66% of assets and deposits and 76% in the total banking sector. A growing literature agreed that there exist differences between Islamic and conventional banks in terms of liquidity, profitability, risk taking and contribution to economic growth and financial stability. In this vein, Zulkhibri (2019) argued that macro-prudential policies need to be Shari'ah compliant in order to moderate systemic risk in the Islamic financial industry and ensure financial stability. Therefore, the particularity of the Saudi financial system where Islamic and traditional banks coexist and the unique risk profile of Islamic products give rise to another question: What is the impact of applying the same requirements and standards by SAMA to both Islamic and conventional products on financial stability?

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Appendix A

Main highlights of the regulatory framework:

Main Macro-prudential measures and policies	
Measure	Regulatory Requirement as of 2019
Capital Adequacy Ratio (CAR)	• Common Equity Tier 1 (CET1) and total regulatory capital must be at least 4.5 and 8 percent of the risk-weighted assets respectively.
Leverage Ratio	• Tier 1 capital /total exposures ratio must be at least 3 percent. • The deposits (liabilities) of a bank must not exceed 15 times the bank's invested capital and reserves.
Net Stable Funding Ratio (NSFR)	• Banks must maintain a minimum of 10 percent ratio (Net stable funding profile of banks in relation to the composition of their assets).
SAMA Liquidity Ratio (SLR)	• Bank's liquidity reserves should be at least 15 percent of their deposit liabilities. SAMA may increase the minimum limit up to 20 percent if necessary.
Loan-to-Deposit Ratio (LDR)	• Banks should maintain a 90 percent loan-to-deposit ratio.
Liquidity Coverage Ratio (LCR)	• Maintain High Quality Liquid Assets (HQLA) equal to at least 100 percent of projected net cash outflows over a 30-day stress period.
Reserve Requirement	• Banks must hold reserves equal to 7 and 4 percent of demand and time and saving deposits respectively.
Loan-to-Value (LTV)	• First Mortgage Loan must be less than or equal to 90 percent of residential real estate value. • Other Mortgage loans must be less than or equal to 70 percent of residential real estate value.
Debt-to-Income Ratio	• The limit differs depending on the level of income and customer's total obligations.
Countercyclical Capital Buffer (CCyB)	• Set at 0 percent of risk-weighted assets.
Capital conservation buffer	• 2.5 percent of risk-weighted assets, to be met with CET1 capital.

Appendix B

1. Eviews Analysis Output

1.1 Descriptive Statistics of the Variables

Date: 07/12/21 Time: 12:26
Sample: 1980 2019

	FS	TIFI	MP	PCGDPG	FO	HDI	M3GDP
Mean	0.000254	0.397049	0.794888	-0.011602	0.439811	0.736110	49.41449
Median	-0.000887	0.252800	0.825845	-0.003672	0.196404	0.744000	49.16900
Maximum	0.081840	0.870200	1.066052	0.113127	2.447781	0.859000	74.73400
Minimum	-0.069885	0.060300	0.588351	-0.256141	-0.542658	0.591000	16.52200
Std. Dev.	0.034299	0.272274	0.143321	0.077502	0.608435	0.084734	11.87717
Skewness	0.415878	0.764863	0.050634	-1.064060	1.403634	-0.086196	-0.210519
Kurtosis	3.234432	1.901347	1.902164	4.942323	4.909752	1.752467	3.975593
Jarque-Bera	1.213511	5.764041	1.975185	13.48996	18.73285	2.577346	1.834714
Probability	0.545117	0.056021	0.372472	0.001177	0.000086	0.275636	0.399574
Sum	0.009901	15.48490	31.00065	-0.452465	17.15262	28.70830	1927.165
Sum Sq. Dev.	0.044703	2.817057	0.780555	0.228250	14.06734	0.272836	5360.554
Observations	39	39	39	39	39	39	39

1.2 Correlation Matrix

Correlation

	FS	TIFI	MP	TIFIMP	PCGDPG	HDI	FO	M3GDP
FS	1.000000	0.026110	0.108737	0.036053	-0.133691	-0.013621	0.067646	0.380512
TIFI	0.026110	1.000000	0.193795	0.992512	0.224314	0.876994	0.647399	0.796039
MP	0.108737	0.193795	1.000000	0.304063	-0.347682	-0.205931	0.188318	-0.142821
TIFIMP	0.036053	0.992512	0.304063	1.000000	0.184907	0.824286	0.659145	0.763661
PCGDPG	-0.133691	0.224314	-0.347682	0.184907	1.000000	0.353491	0.116438	0.360404
HDI	-0.013621	0.876994	-0.205931	0.824286	0.353491	1.000000	0.525840	0.796814
FO	0.067646	0.647399	0.188318	0.659145	0.116438	0.525840	1.000000	0.615260
M3GDP	0.380512	0.796039	-0.142821	0.763661	0.360404	0.796814	0.615260	1.000000

1.3 Optimal ARDL (4,3,4,4)

Dependent Variable: FS
Method: ARDL
Date: 04/16/21 Time: 20:15
Sample (adjusted): 1984 2015
Included observations: 32 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): TIFI MP TIFIMP
Fixed regressors: C
Number of models evalulated: 500
Selected Model: ARDL(4, 3, 4, 4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
FS(-1)	-0.157070	0.238460	-0.658688	0.5216
FS(-2)	-0.750578	0.200329	-3.746720	0.0024
FS(-3)	0.277637	0.227586	1.219923	0.2442
FS(-4)	-0.662839	0.211945	-3.127412	0.0080
TIFI	1.057728	0.528929	1.999754	0.0669
TIFI(-1)	-1.004564	0.589561	-1.703918	0.1122
TIFI(-2)	0.096525	0.552843	0.174598	0.8641
TIFI(-3)	-2.580088	0.485779	-5.311240	0.0001
MP	0.450651	0.229153	1.966592	0.0710
MP(-1)	-0.316423	0.318615	-0.993122	0.3388
MP(-2)	0.262821	0.286155	0.918456	0.3751
MP(-3)	-1.220848	0.261864	-4.662138	0.0004
MP(-4)	0.371527	0.103042	3.605597	0.0032
TIFIMP	-1.259657	0.725264	-1.736825	0.1060
TIFIMP(-1)	1.339659	0.821632	1.630487	0.1270
TIFIMP(-2)	-0.064672	0.714911	-0.090461	0.9293
TIFIMP(-3)	3.277752	0.682070	4.805592	0.0003
TIFIMP(-4)	-0.605731	0.228365	-2.652464	0.0199
C	0.432633	0.168317	2.570344	0.0233

R-squared	0.899054	Mean dependent var	0.000257
Adjusted R-squared	0.759283	S.D. dependent var	0.033203
S.E. of regression	0.016290	Akaike info criterion	-5.109783
Sum squared resid	0.003450	Schwarz criterion	-4.239502
Log likelihood	100.7565	Hannan-Quinn criter.	-4.821309
F-statistic	6.432336	Durbin-Watson stat	2.529685
Prob(F-statistic)	0.000721		

*Note: p-values and any subsequent tests do not account for model selection.

1.4 Long run Coefficients & Bounds Tests

ARDL Long Run Form and Bounds Test
Dependent Variable: D(FS)
Selected Model: ARDL(4, 3, 4, 4)
Case 2: Restricted Constant and No Trend
Date: 04/13/21 Time: 23:12
Sample: 1980 2019
Included observations: 32

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.432633	0.168317	2.570344	0.0233
FS(-1)*	-2.292850	0.291968	-7.853074	0.0000
TIFI(-1)	-2.430398	0.740240	-3.283257	0.0059
MP(-1)	-0.452273	0.197853	-2.285904	0.0397
TIFIMP(-1)	2.687352	0.850785	3.158672	0.0075
D(FS(-1))	1.135779	0.196231	5.787957	0.0001
D(FS(-2))	0.385202	0.155193	2.482075	0.0275
D(FS(-3))	0.662839	0.211945	3.127412	0.0080
D(TIFI)	1.057728	0.528929	1.999754	0.0669
D(TIFI(-1))	2.483563	0.580536	4.278051	0.0009
D(TIFI(-2))	2.580088	0.485779	5.311240	0.0001
D(MP)	0.450651	0.229153	1.966592	0.0710
D(MP(-1))	0.586500	0.214296	2.736869	0.0170
D(MP(-2))	0.849321	0.204732	4.148453	0.0011
D(MP(-3))	-0.371527	0.103042	-3.605597	0.0032
D(TIFIMP)	-1.259657	0.725264	-1.736825	0.1060
D(TIFIMP(-1))	-2.607349	0.645846	-4.037108	0.0014
D(TIFIMP(-2))	-2.672021	0.567400	-4.709236	0.0004
D(TIFIMP(-3))	0.605731	0.228365	2.652464	0.0199

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TIFI	-1.059990	0.338536	-3.131102	0.0080
MP	-0.197253	0.089399	-2.206429	0.0460
TIFIMP	1.172058	0.392067	2.989433	0.0104
C	0.188688	0.075871	2.486948	0.0273

EC = FS - (-1.0600*TIFI -0.1973*MP + 1.1721*TIFIMP + 0.1887)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	17.13515	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	32		Finite Sample: n=35	
		10%	2.618	3.532
		5%	3.164	4.194
		1%	4.428	5.816
			Finite Sample: n=30	

ARDL Long Run Form and Bounds Test
Dependent Variable: D(MP)
Selected Model: ARDL(1, 0, 1)
Case 2: Restricted Constant and No Trend
Date: 04/12/21 Time: 21:30
Sample: 1980 2019
Included observations: 35

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.080462	0.038840	2.071618	0.0470
MP(-1)*	-0.135419	0.046502	-2.912151	0.0067
FS**	0.061452	0.237207	0.259065	0.7974
TIFI(-1)	0.031672	0.034300	0.923373	0.3632
D(TIFI)	0.378403	0.199471	1.897032	0.0675

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FS	0.453789	1.752573	0.258927	0.7975
TIFI	0.233878	0.268163	0.872147	0.3901
C	0.594165	0.116913	5.082094	0.0000

EC = MP - (0.4538*FS + 0.2339*TIFI + 0.5942)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.285016	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Actual Sample Size	35		Finite Sample: n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028

ARDL Long Run Form and Bounds Test
Dependent Variable: D(TIFI)
Selected Model: ARDL(2, 2, 3)
Case 2: Restricted Constant and No Trend
Date: 04/12/21 Time: 21:20
Sample: 1980 2019
Included observations: 33

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.017960	0.036020	-0.498629	0.6228
TIFI(-1)*	-0.024709	0.033834	-0.730304	0.4726
FS(-1)	0.161524	0.327472	0.493247	0.6265
MP(-1)	0.054512	0.048956	1.113482	0.2770
D(TIFI(-1))	0.419385	0.190602	2.200324	0.0381
D(FS)	0.403338	0.218186	1.848597	0.0774
D(FS(-1))	-0.578761	0.255453	-2.265626	0.0332
D(MP)	0.104448	0.144425	0.723194	0.4769
D(MP(-1))	0.171257	0.134032	1.277737	0.2141
D(MP(-2))	0.167418	0.133108	1.257761	0.2211

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FS	6.536984	18.70100	0.349553	0.7299
MP	2.206118	3.292037	0.670138	0.5094
C	-0.726868	1.836430	-0.395805	0.6959

EC = TIFI - (6.5370*FS + 2.2061*MP - 0.7269)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	1.605275	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Actual Sample Size	33		Finite Sample: n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028
			Finite Sample: n=30	
		10%	2.915	3.695
		5%	3.538	4.428
		1%	5.155	6.265

ARDL Long Run Form and Bounds Test
Dependent Variable: D(FS)
Selected Model: ARDL(4, 1, 0)
Case 2: Restricted Constant and No Trend
Date: 04/12/21 Time: 20:52
Sample: 1980 2019
Included observations: 32

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.025547	0.029596	-0.863205	0.3966
FS(-1)*	-1.485976	0.305982	-4.856410	0.0001
TIFI(-1)	-0.039723	0.025966	-1.529808	0.1391
MP**	0.043531	0.041784	1.041819	0.3079
D(FS(-1))	0.949697	0.259962	3.653209	0.0013
D(FS(-2))	0.471956	0.218202	2.162935	0.0407
D(FS(-3))	0.344660	0.198772	1.733947	0.0958
D(TIFI)	0.285890	0.130189	2.195969	0.0380

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TIFI	-0.026732	0.016744	-1.596511	0.1235
MP	0.029295	0.027695	1.057747	0.3007
C	-0.017192	0.019812	-0.867756	0.3941

EC = FS - (-0.0267*TIFI + 0.0293*MP - 0.0172)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	6.042957	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Actual Sample Size	32		Finite Sample: n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028
			Finite Sample: n=30	
		10%	2.915	3.695
		5%	3.538	4.428
		1%	5.155	6.265

1.5 ARDL-ECM and Short run dynamics

ARDL Error Correction Regression
Dependent Variable: D(FS)
Selected Model: ARDL(4, 3, 4, 4)
Case 2: Restricted Constant and No Trend
Date: 04/13/21 Time: 23:14
Sample: 1980 2019
Included observations: 32

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FS(-1))	1.135779	0.147327	7.709236	0.0000
D(FS(-2))	0.385202	0.125272	3.074926	0.0089
D(FS(-3))	0.662839	0.138563	4.783671	0.0004
D(TIFI)	1.057728	0.313080	3.378462	0.0049
D(TIFI(-1))	2.483563	0.391033	6.351294	0.0000
D(TIFI(-2))	2.580088	0.401401	6.427713	0.0000
D(MP)	0.450651	0.151644	2.971766	0.0108
D(MP(-1))	0.586500	0.157584	3.721831	0.0026
D(MP(-2))	0.849321	0.169376	5.014428	0.0002
D(MP(-3))	-0.371527	0.078425	-4.737374	0.0004
D(TIFIMP)	-1.259657	0.432475	-2.912668	0.0121
D(TIFIMP(-1))	-2.607349	0.451708	-5.772196	0.0001
D(TIFIMP(-2))	-2.672021	0.473938	-5.637916	0.0001
D(TIFIMP(-3))	0.605731	0.116528	5.198176	0.0002
CointEq(-1)*	-2.292850	0.216618	-10.58478	0.0000

R-squared	0.915328	Mean dependent var	0.002225
Adjusted R-squared	0.845598	S.D. dependent var	0.036253
S.E. of regression	0.014245	Akaike info criterion	-5.359783
Sum squared resid	0.003450	Schwarz criterion	-4.672719
Log likelihood	100.7565	Hannan-Quinn criter.	-5.132040
Durbin-Watson stat	2.529685		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	17.13515	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

1.6 Financial inclusion, financial stability, and control variables

Dependent Variable: FS
Method: ARDL
Date: 04/18/21 Time: 23:53
Sample (adjusted): 1984 2015
Included observations: 32 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): TIFI MP TIFIMP
Fixed regressors: PCGDP2010 HDI FO M3GDP C
Number of models evalulated: 500
Selected Model: ARDL(4, 3, 0, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
FS(-1)	0.165568	0.149449	1.107858	0.2843
FS(-2)	-0.463498	0.158960	-2.915813	0.0101
FS(-3)	0.235637	0.155295	1.517355	0.1487
FS(-4)	-0.507790	0.151499	-3.351759	0.0041
TIFI	0.510739	0.398775	1.280772	0.2185
TIFI(-1)	-0.412155	0.229133	-1.798757	0.0909
TIFI(-2)	0.207563	0.156399	1.327139	0.2031
TIFI(-3)	-0.317962	0.113316	-2.805988	0.0127
MP	0.144609	0.128668	1.123891	0.2776
TIFIMP	-0.652321	0.523869	-1.245199	0.2310
TIFIMP(-1)	0.403179	0.258515	1.559593	0.1384
PCGDP2010	1.89E-06	1.04E-06	1.823258	0.0870
HDI	0.008522	0.130941	0.065084	0.9489
FO	0.002737	0.008022	0.341217	0.7374
M3GDP	0.004636	0.000752	6.163630	0.0000
C	-0.417349	0.172412	-2.420644	0.0278

R-squared	0.898547	Mean dependent var	0.000257
Adjusted R-squared	0.803435	S.D. dependent var	0.033203
S.E. of regression	0.014721	Akaike info criterion	-5.292270
Sum squared resid	0.003467	Schwarz criterion	-4.559402
Log likelihood	100.6763	Hannan-Quinn criter.	-5.049345
F-statistic	9.447232	Durbin-Watson stat	2.516817
Prob(F-statistic)	0.000027		

*Note: p-values and any subsequent tests do not account for model selection.

1.6 Financial inclusion, financial stability, control variables, and dummy variable (BASEL3)

Dependent Variable: FS
Method: ARDL
Date: 11/01/21 Time: 14:56
Sample (adjusted): 1984 2019
Included observations: 36 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): TIFI MP TIFIMP BASEL3
Fixed regressors: PCGDP2010 HDI FO M3GDP C
Number of models evalulated: 2500
Selected Model: ARDL(4, 4, 1, 1, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
FS(-1)	0.182812	0.125615	1.455336	0.1662
FS(-2)	-0.482678	0.143152	-3.371792	0.0042
FS(-3)	-0.034834	0.184608	-0.188692	0.8529
FS(-4)	-0.196727	0.181283	-1.085194	0.2950
TIFI	0.602020	0.450819	1.335393	0.2017
TIFI(-1)	-1.231526	0.525997	-2.341316	0.0334
TIFI(-2)	0.074933	0.157716	0.475116	0.6415
TIFI(-3)	-0.141388	0.168247	-0.840360	0.4139
TIFI(-4)	-0.137406	0.143546	-0.957225	0.3536
MP	0.331546	0.201580	1.644734	0.1208
MP(-1)	-0.429791	0.233063	-1.844097	0.0850
TIFIMP	-0.784299	0.609759	-1.286244	0.2179
TIFIMP(-1)	1.573425	0.740531	2.124726	0.0506
BASEL3	-0.046028	0.036953	-1.245596	0.2320
BASEL3(-1)	0.000853	0.025358	0.033639	0.9736
BASEL3(-2)	0.068921	0.026554	2.595562	0.0203
PCGDP2010	1.29E-06	1.02E-06	1.266031	0.2248
HDI	-0.049969	0.138099	-0.361838	0.7225
FO	-0.002532	0.006780	-0.373484	0.7140
M3GDP	0.003544	0.000919	3.854809	0.0016
C	-0.090995	0.217057	-0.419224	0.6810

R-squared	0.932778	Mean dependent var	0.001272
Adjusted R-squared	0.843149	S.D. dependent var	0.035355
S.E. of regression	0.014002	Akaike info criterion	-5.407999
Sum squared resid	0.002941	Schwarz criterion	-4.484279
Log likelihood	118.3440	Hannan-Quinn criter.	-5.085596
F-statistic	10.40706	Durbin-Watson stat	2.115437
Prob(F-statistic)	0.000016		

*Note: p-values and any subsequent tests do not account for model selection.