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**Impact of Financial Sector Development on Macroeconomic Stability in
Mauritius**

By

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JULY 2024



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Bank of Mauritius

Abstract

This paper empirically examined the impact of the financial system development on macroeconomic stability in Mauritius. The Mauritian financial sector operates in a liberalized system that is heavily dominated by banks. Global Business Companies play a crucial role in intermediating funds through banks from and to foreign countries. Thus, banks are characterized by a relatively high degree of financial dollarization. This study used a non-parametric composite-based approach to build an indicator of macroeconomic stability for Mauritius and Principal Component Analysis to construct a financial system development index. The study used autoregressive distributed lag (ARDL) approach and cointegrating relationship between the variables of interest was confirmed based on the Bounds tests. As a result, an Error Correction Model (ECM) was used and long and short run relationships assessed. The results showed a positive and statistically significant link between financial sector development and macroeconomic stability. The Granger-causality findings showed a bi-directional relationship between financial sector development and macroeconomic stability implying the need to quantitatively establish the determinants of financial development in Mauritius.

JEL Keywords: Financial Dollarization, Autoregressive Distributed Lag, Error Correction Model, Granger-Causality.

¹ Corresponding Author's email: Ashwin.Moheeput@bom.mu. The author would like to thank participants at the validation workshop on the above topic held in November 2021 for valuable insights and comments, COMESA Monetary Institute (CMI) and anonymous reviewers. The usual disclaimer applies.

I. Introduction

Financial sector development and macroeconomic stability are multidimensional concepts that are subject to numerous debates. On the one hand, financial system development embraces the role and importance of financial intermediaries and of financial markets in economic activity, as well as improved access by the population to financial products and services. Evidence suggests that financial institutions (e.g., banks, insurance companies and pension funds) and financial markets (e.g., stock market, bond and derivatives market) play an important role in promoting economic development, as well as fostering inclusion. On the other hand, macroeconomic stability tends to be more subjective and subject to '*social norms*' benchmarks about what is socially and politically accepted as stability.

The many aspects of both concepts create a number of challenges to the modeller. Prominent among these is the need to construct a reliable measure of, both, financial sector development and of macroeconomic stability. Regarding the former, the literature does not throw light on the best way to construct this measure since much depends upon the macro-financial idiosyncrasies of a country's financial sector. For instance, in market-oriented financial systems which comprise more diversified financial players and a broader range of financial products, indicators ranging from bank assets to stock market capitalization weights may be useful in constructing the index. In more bank-dominated systems where banks follow the traditional intermediary roles, indicators such as deepening and financial access may be given relatively more prominence. Regarding the latter, in some countries, fiscal risks may be perceived as an important factor affecting macroeconomic stability. In others, external sector risks may be the most important factor. In countries with well-designed fiscal and external sector buffers, inflation and growth performance may constitute the fulcrum of macroeconomic stability.

A more recent study by the IMF (2019) underscores the relative importance played by the financial sector in the Mauritian economy. The authors built a Financial Conditions Index (FCI), as a leading indicator of economic activity based on a set of domestic and external factors using two approaches, namely Vector Autoregression Analysis (VAR) and Principal Component Analysis (PCA). The FCI provides a good mechanism explaining changes in economic activity in Mauritius and offers a robust out-of-sample prediction of four-quarters ahead real GDP growth rate. This study by the IMF confirms our hypothesis that, due to a depth of the financial system and the good level of financial access, developments taking place in the Mauritian financial system directly affect economic prospects.

However, the quantitative impact of financial sector development on macroeconomic stability in Mauritius is still not clear. This study attempts to address this gap by quantitatively analysing the relationship between financial sector development and macroeconomic stability based on an Autoregressive Distributed Lag Model (ARDL) approach and composite indices of macroeconomic stability and financial sector development.

The rest of the paper is organized as follows. Section 2 presents an overview of macroeconomic and financial sector developments in Mauritius while section 3 provides the literature review. Section 4 provides the methodology while section 5 discusses the empirical findings. Section 6 provides the conclusions of the study.

II. Macroeconomic and Financial Sector Developments in Mauritius

2.1 Macroeconomic Developments

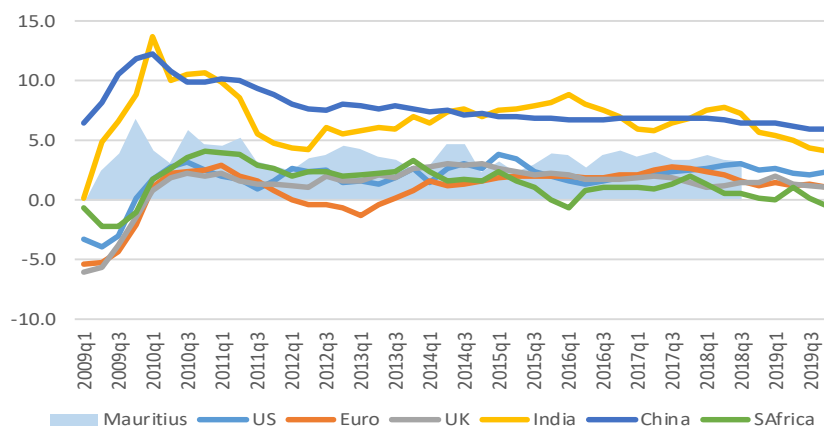
Since independence, Mauritius has successfully undergone important structural transformation of its economy from a low-income monocrop economy to a modern diversified high-income economy that is propelled by the financial services, tourism and manufacturing sectors. As at end-2018, the services sector accounted for nearly 79 percent of GDP, followed by industry (16 percent) and agriculture (4 percent). Since the 2000s, growth averaged 5-6 per cent annually until the 2008 Global Financial Crisis (GFC), after which, annual economic growth averaged 3-4 per cent. Macroeconomic stability has been the key feature of the Mauritian economy, underpinned by political stability and good governance frameworks for institutions.

Headline Inflation has been low in recent years and hovered at an annual average of 0.5 per cent in 2019, on account of favourable food price developments. The Bank of Mauritius (Bank) has been pursuing an accommodative monetary policy in recent years given the low inflation. The Budget deficit has averaged 5.0 per cent of GDP over the past few years and has worsened. The outlook regarding the budget deficit is challenging in view of the country's limited revenue mobilization capabilities and growing need to engage in current spending (principally wage hikes and demographic challenges tied to pensions), as well as capital spending (principally public transport infrastructural projects). The public debt averaged 65.4 percent of GDP in 2019 and has been kept at a sustainable level with the low prevailing interest rates. However, the economy remains vulnerable to negative shocks both externally and domestically. At 9.5 per cent of GDP, the savings level is low when compared to emerging economies and is lower than investment level which stood at 19.8 per cent.

The savings-investment deficiency translated into a current account deficit which averaged 5.7 per cent of GDP in 2019. Due to lack of natural resources, the economy is highly dependent on external trade, namely food items and energy needs, as well as industrial materials for input into construction sector. Its export structure has undergone significant transformation since independence moving from sugar sector to embrace manufacturing, tourism, financial services and transportation. The economy is relatively dependent on Europe making it highly vulnerable to any adverse developments in Europe. The current account deficit is mainly financed by inflows of foreign capital, namely Foreign Direct Investment (FDI) which is essentially geared towards

luxurious real estate projects.² The Global Business Sector (GBC) also plays a fundamental role in funding current account imbalances, and in 2019, the net inflow of GBC averaged 10 per cent of GDP. Europe, South Africa and India are the principal sources of funds into Mauritius and destinations of funds out of Mauritius.

Figure 1: Growth Rate of Mauritius vis-a-vis its Main Trading Partners



2.2 Recent Macro-Financial Trends

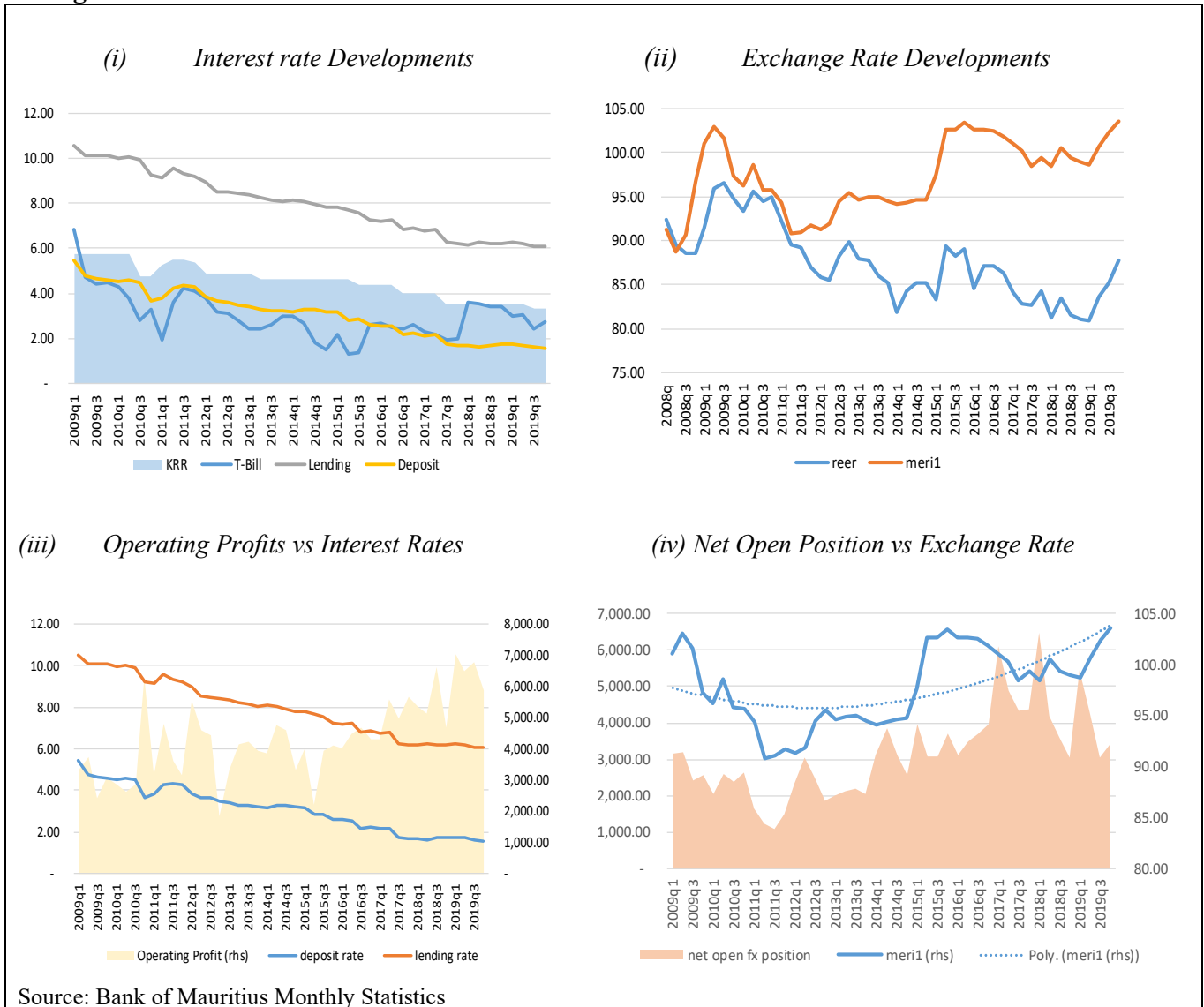
Monetary policy has been largely accommodative in recent years in Mauritius. This is because the low inflation environment has created space for the Bank of Mauritius to lower its policy rate, the Key Repo Rate (KRR) on several occasions during the last decade, mainly to support growth in the midst of numerous external shocks that had plagued the major economies in Europe. Figure 2 depicts the evolution of key selected financial market indicators showing the performance, operations and resilience of banks. Figure 2 (i) shows the downward trend in the KRR, and the ensuing downward trends in the Prime Lending Rate (PLR) and average deposit rate. The yield on Treasury bills, a more market-based interest feature, fluctuated depending on the degree of excess liquidity in the market, but for large periods of time, followed a general downward trend. In Mauritius, exchange controls were abolished in 1994 and the financial system was liberalized shortly afterwards. There are no capital account restrictions that are applicable in Mauritius, an appealing feature for foreign investors and GBC holders³. Figure 2 (ii) depicts the behavior of the local currency, the Mauritian rupee, vis-à-vis major trading partners' currencies weighted

² This has been made possible due to various schemes designed to attract high net-worth individuals in Mauritius in recent years. These include Integrated Resort Scheme, Real Estate Scheme, Invest Hotel Scheme, Property Development Scheme and the Smart City Scheme.

³ The notable restrictions here include: (1) full restrictions on activities that are prohibited by the UN under its embargo, sanctions and prohibition policy; (2) restrictions to hold cash above a value of MUR 500,000; (3) the need for prior approval for foreigners investing in real estate; (4) specific limits imposed on foreign investors investing in shareholdings of local banks and in shares of private companies; Enhanced Due Diligence (EDD) on activities originating from countries black-listed by the Financial Action Task Force (FATF).

appropriately (MERI1), and adjusted for inflation differences (REER). The general tendency over the last decade has been a depreciation of the rupee as evidenced by the upward trend in the MERI1. Figure 2 (iii) shows that banks have largely benefited from the low interest rate environment. Finally, figure 2 (iv) shows that the depreciation of the rupee has also been a factor that has contributed to sound performance of banks. In fact, since the banking system has a positive net open position in foreign currency, it largely benefits from lower exchange value of the rupee when performance is converted to rupee equivalent basis.

Figure 2: Selected Macro-Financial Indicators in Mauritius



Source: Bank of Mauritius Monthly Statistics

2.3 The Financial Sector as a Macro-Critical Sector

Mauritius has a large bank-dominated financial sector. As at December 2018, the ratio of banking system assets to GDP averaged over 300 percent, compared to Non-Bank Deposit Taking institutions (19 percent of GDP), insurance (19 percent of GDP) and pension (20-30 percent of GDP). Banks and Non-Bank Deposit Taking Institutions (NBDTIs) are regulated by the Bank. The regulatory regime has been upgraded to embrace Basel III framework since 2014 and banks are required to maintain additional buffers (e.g. Capital Conservation Buffers, as well as Domestic-Systemically Important Bank (D-SIB) surcharges). Non-bank financial institutions such as insurance and pensions as well as the capital market are regulated and supervised by the Financial Services Commission (FSC). Of the 18 banks, five are domestically owned, including the largest two banks; twelve are subsidiaries of foreign banks; three are branches of foreign banks; and one is a domestic/foreign joint venture. The GBC plays an important role in funding the domestic banking system and owe their presence in the Mauritian jurisdiction to the network of Double Taxation Avoidance Agreements (DTAAs) that the country has signed bilaterally with other countries⁴. Foreign currency deposits of GBC companies account for nearly a third of total banking sector deposits. Many banks in Mauritius are part of financial or mixed conglomerates that include other financial services firms.

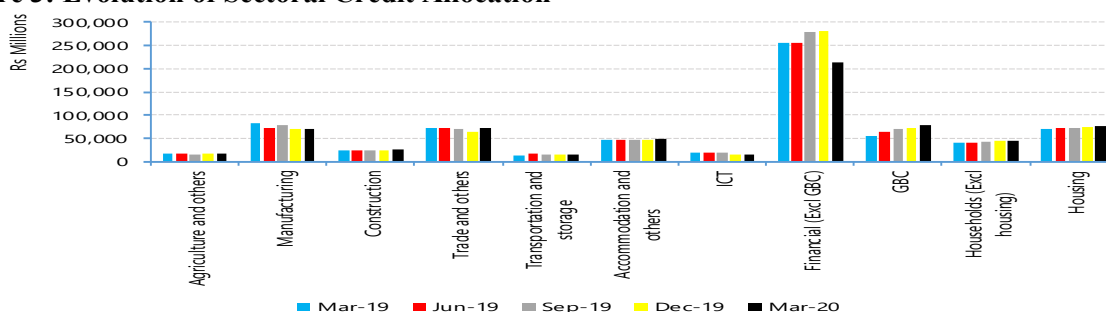
The financial sector indeed plays a macro-critical role in the Mauritian economy. In addition to the weight of banking system assets, the contribution of the financial services averages 12-15 percent of GBC. In the financial sector alone (including the GBC sector), about 15,000 people are employed. Furthermore, the lending portfolio of banks is geared towards sectors which play an important role in the macro-economic landscape. As Table 1 shows, sectors such as the financial services, tourism, real estate / construction as well as manufacturing are important contributors to growth. These sectors are also important recipients of banking credit facilities. For instance, the share of total credit allocated to financial services (including GBCs) averages over 30 percent. Credit allocated to the tourism, real estate / construction and manufacturing sectors was around 5.6, 3.1 and 8.1 percent, respectively, at end-December 2019.

⁴ Out of the 51 DTAAs, 22 were signed with African countries. Collectively, there are about 12,000 GBC structures in Mauritius with total balance sheet assets exceeding 50 times the GDP of Mauritius.

Table 1: Economic Sectors – Weight in GDP⁵ and Weight in Loan Portfolio of Banks

	Employment (bracket: percent of total workforce)	Contribution to GDP (percent)	Weight in Bank Loan Portfolio (percent)
Financial Services (incl. GBCs)	15,000 (2.2 percent)	12-15 ⁶	34
Travel and Tourism	40,000 (6 percent)	8.6	5.6
Real Estate and Construction	-	10	3.1
Manufacturing (incl. smart manufacturing)	125,000 (8 percent)	16	8.1

Figure 3: Evolution of Sectoral Credit Allocation



Financial deepening in Mauritius has improved over time, as evidenced by relatively high levels of deepening indicators namely Loans, Deposits and Broad Money as a percentage of GDP. The banking sector is characterized by a relatively high level of dollarization. Over the period June 2005-2019, loan dollarization was at around 63 percent as a proportion of total loans.⁷ Deposit dollarization averaged 60 per cent over the same period.⁸ A look at the balance sheet structure of banks reveals that Banks’ foreign currency denominated assets and liabilities dominate those denominated in local currency. The relative degree of financial dollarization is relatively high in Mauritius, in part, due to a thriving GBC sector. GBC deposits account for nearly a third of total banking sector deposits and for a smaller share of total assets of the sector. Liabilities denominated in foreign currencies account for nearly 65 percent of total liabilities, while assets denominated in foreign currencies account for nearly 63 percent of total assets (Figure 4).

There are three main prudential requirements in Mauritius with respect to foreign exchange holdings for banks. Firstly, there is a reserve requirement of 6 percent on foreign currency deposits over a fortnight (4.5 percent limit on a daily basis); secondly, banks are not allowed to keep net

⁵ Some figures have been obtained from the Economic Development Board (EDB) – manufacturing and financial services. The rest of the figures was obtained from the World Bank Atlas.

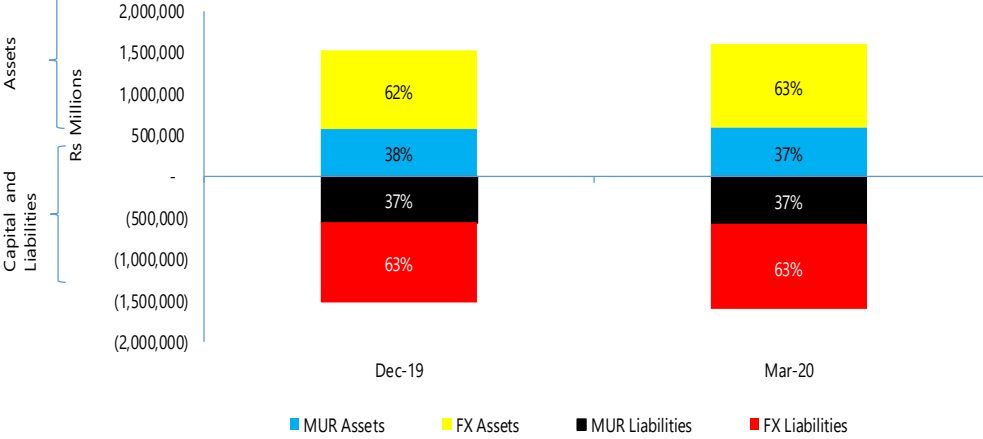
⁶ According to the Economic Development Board (EDB), the GDP contribution of financial services sector is currently made up of 6.9 percent of financial intermediation, which is essentially banking activities and the capital markets, 3.2 percent of insurance activities and 0.7 percent of financial leasing and other credit granting activities.

⁷ Including GBCs.

⁸ Including GBCs.

open foreign exchange positions of more than 15 percent of Tier 1 capital. Thus, whenever mismatches arise in the timing of receipts and payments, banks engage in the interbank market for foreign exchange and / or with the Central Bank in instances of foreign exchange intervention to inject or withdraw foreign currency liquidity in the system; and thirdly, there is a Liquidity Coverage Ratio (LCR) in, both, domestic currency and material foreign currency of at least 100 percent. Thus, banks are required to keep a sufficient level of high quality unencumbered liquid assets in material foreign currencies to withstand a 30-day liquidity shock. Many banks in Mauritius, especially subsidiaries of foreign banks, engage in making liquid placements abroad and these are readily available to top up their liquidity levels in times of need.

Figure 4: Degree of Financial Dollarization of the Mauritian Banking System⁹



III. Literature Review

The relationship between financial sector development and macroeconomic stability has long been established by empirical papers in the literature. This builds on the canonical theoretical models built in the 1970s which provided rationale for the existence of financial intermediaries as vehicles for addressing financial frictions¹⁰ – thus, departing from the Walrasian principle enshrined in the Arrow-Debreu world. Some early papers similarly posited that financial restrictions hampered financial development and economic growth. (McKinnon-Shaw, 1973)

Later contributions pioneered by King and Levine (1993) and Levine (1997) built on the literature of endogenous growth and showed that financial development positively contributes to growth. However, these papers differed in several grounds, namely: country and period of coverage;

⁹ The figure incorporates all on-balance sheet figures only. For net open foreign exchange position limits, off-balance sheet items are considered as well. Banks in Mauritius have positive net foreign exchange positions that are way below the regulatory limit of 15 percent of Tier 1 capital.

¹⁰ For example, some theoretical papers showed the Pareto-Superiority of financial intermediaries over financial markets in addressing informational asymmetries such as Moral Hazard or Adverse Selection, or in providing liquidity insurance to depositors / investors - which financial markets could not do. See the canonical contribution of Diamond and Dybvig (1983) for more details.

methodological choice behind computation of financial development; and empirical estimation methodology.

In King and Levine (1993), several measures of financial development were proposed, namely: liquid liabilities of banks and of non-banks as a share of GDP; the ratio of bank credit to the sum of bank and Central Bank credit; the ratio of private credit to total domestic credit; and lastly, private credit as a share of GDP. The study covered a panel of 80 countries spanning the period 1960-1989. Rajan and Zingales (1996) found evidence of threshold effects between financial development and industry-level growth performance.

Some more recent studies have analysed the relative merits of bank-based financial systems (e.g., China, Germany and Japan) vs market-based financial systems (e.g., UK and USA) in promoting growth. Proponents of the former argue that, in line with earlier literature on '*why are banks special?*', banks can better address market imperfections and take a long-term view of developmental issues. Proponents of the latter argue that financial systems that are centred around banks do exploit maximum economic rent from borrowers. Thus, the borrowers are left with relatively little residual profits to undertake long-term investments. Supporters of market-based systems thus argue that bank-based systems result in lower relative growth. Evidence that emerged afterwards shows that there is ambiguity about which view holds more empirical traction. For instance, Levine (1999) argues that what matters is the legal and institutional system and not whether banks are pareto superior or inferior to markets. Indeed, in modern financial systems, banks and financial markets are complementary in promoting economic growth.

Some papers also posit that the relationship between financial development and growth may go either way. While financial development may promote growth, reverse causality may also be possible, thus creating a simultaneity bias issue. This issue influences the choice of econometric methodology used. In table 2, a summary of the main findings of studies that utilised similar approach to the one used in this study is provided.

Table 2: Summary of Review of Key Empirical Papers in the Literature

Author(s)	Country / Countries of Focus	Methodology	Findings
King and Levine (1993)	80 countries	Contemporaneous regressions and sensitivity analysis	Strong positive link between economic growth and development of financial sector
Beck et al. (2000)	74 developed and developing countries	GMM	Positive impact between financial development and growth
Beck and Levine (2004)	40 countries (1976-1998)	GMM	Stock market and banks positively influence growth
Christopoulos and Tsionas (2004)	10 countries	Multivariate Co-integration	Long-term causality between financial sector development and growth
Islam and Khan (2004)	Bangladesh	Granger Causality	Positive link between growth and development
Caporale et al. (2009)	10 new EU countries	GMM and Granger Causality	Development affects growth but not vice-versa due to lack of financial depth.
Estrada et al. (2010)	125 countries in Asia	Panel data regression	Bank credit and stock market capitalization have a positive and significant effect on growth.
Ujunwa and Salami (2010)	Nigeria	Co-integration and Error Correction	Negative impact between stock market development and growth in Nigeria.
Zermeno et al. (2011)	Selected countries in Latin America and in Southeast Asia (1980-2009)	Non-parametric panel regression	Stock market developments positively affect growth in Asia but not so in Latin America
Seetanah et al. (2010)	10 Least Developed Countries (1995-2009)	GMM	Banks contribute towards growth. Stock markets do not contribute to growth.
Hakeem and Oluitan (2013)	24 Countries in Sub-Saharan Africa	Panel Co-integration Test, Impulse Response and Sensitivity	Uni-directional causality from output to financial sector development.
Adu et al. (2013)	Ghana	Autoregressive Distributed Lag	Negative impact when broad money to GDP is used as proxy for development.

IV. Methodology

4.1 Evolutions of Measures of Financial Sector Development

4.1.1 Financial Deepening Indicators

Financial depth captures the relative importance of the financial sector in the economy. It incorporates the relative size of banks, non-bank deposit-taking institutions, financial markets and non-bank financial entities such as insurance companies and pension funds. Four banking sector measures and one stock market measure popularly used to measure financial depth are highlighted in this section. The ratio of private credit to GDP is the most popular and it stood at 180 percent as at end-2019 in Mauritius. This ratio is lower than the historical average but slightly above its underlying trend reflecting a broad range of financial products, with the development of many substitute products to loans (e.g., equity and fixed income financing and private placements). Financial depth is also measured based on total banking assets to GDP, which encompasses private credit, credit to government and banking sector assets other than credit (Figure 5).

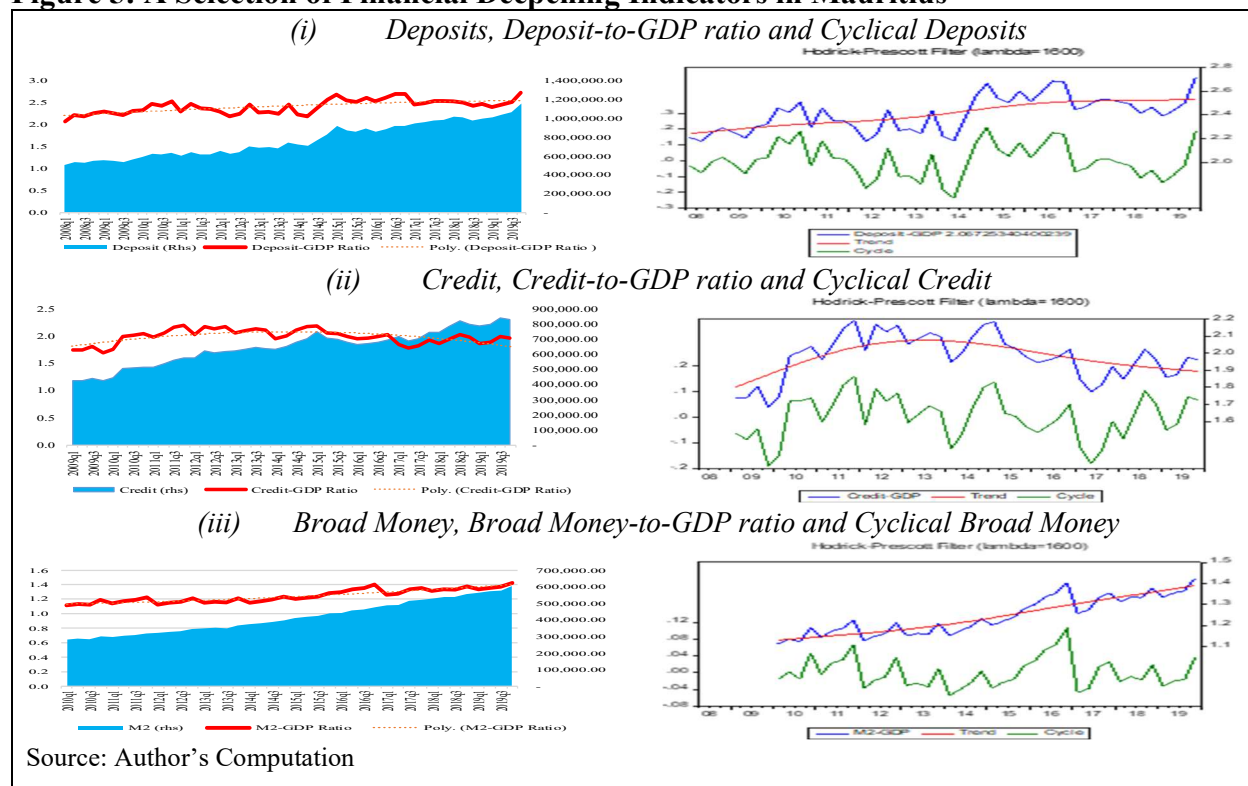
The third useful measure is the deposit-to-GDP ratio. In Mauritius, the deposit-to-GDP ratio averaged 250-300 percent over recent years, and the trend has been upwards. Agreements (DTAAs) with other partner countries, and various Investment Protection and Promotion Agreements (IPPAs) have contribution in attracting of investment flows from Africa and Asia.¹¹ The fourth indicator of financial depth is the Broad Money supply-to-GDP ratio. In developing economies, this measure is a useful determinant of the degree of monetization and inflationary pressures in the economy. In the case of Mauritius, the ratio of broad money¹² to GDP has been rising steadily and has ranged between 120 percent and 140 percent over the past decade (see Figure 5).

Stock market capitalization as a percentage of GDP, is highest in Mauritius at 67 percent (approx. USD 12 billion). This is, in part, due to initiatives taken in recent years by the Stock Exchange of Mauritius (SEM) to launch an international multi-asset class platform with upgraded structures ranging from multi-currency capital raising and listing platforms, as well as dual-currency trading platforms.

¹¹ There are 44 IPPAs (23 signed with African countries).

¹² Broad Money in Mauritius is defined as notes and coins in circulation plus all deposits in the banking system (with the exception of GBC deposits which tend to have a more volatile nature.) This was with the concordance of the IMF.

Figure 5: A Selection of Financial Deepening Indicators in Mauritius



4.1.2 Financial Access Indicators

The financial landscape in many parts of the world has undergone significant changes over the last decade with the introduction of new financial products being offered to a previously unbanked segment of the population facilitated by technological innovation. The setting up of fintech firms and techfins have indeed helped boost this process of financial inclusion in many parts of the world. In some of the lesser developed countries, efforts have been underway to promote financial inclusion through a number of supply-side responses (e.g., mobile banking, internet banking and establishment of more traditional facilities such as growing network of bank branches and Automated Teller Machines (ATMs) in poorer areas) and demand-side initiatives (e.g., financial literacy programs and education).

The level of financial access in Mauritius has improved over time particularly in terms of registered mobile accounts and outstanding deposits with commercial banks as a share of GDP (Table 3).

Table 3: Summary Indicators on Financial Access, 2014-2018

	2014	2015	2016	2017	2018
Number of ATMs per 100,000 adults	45.0	45.6	44.5	43.5	43.2
Number of commercial bank branches per 100,000 adults	22.5	21.7	20.4	18.6	17.1
Number of depositors with commercial banks per 1,000 adults		1956.0	1836.5	1891.4	1876.2
Number of borrowers from commercial banks per 1,000 adults		286.0	284.3	279.0	260.1
Outstanding deposits with commercial banks (% of GDP)	159.2	169.3	164.6	167.1	122.7
Outstanding loans from commercial banks (% of GDP)	75.0	76.5	71.4	68.3	60.2
Outstanding small and medium enterprise (SME) loans from commercial banks (% of GDP)			3.4	3.4	3.1
Number of registered mobile money agent outlets per 1,000 km ²			61.6	65.5	65.0
Number of registered mobile money accounts per 1,000 adults		5.0	128.1	114.1	199.9
Value of mobile money transactions (during the reference year) (% of GDP)			0.0	0.0	0.0

Source: *Financial Access Survey*

4.2 Data Sources and Description

Table 4 provides an overview of data used in this study. The data covers the period 2009Q1 to 2019Q4. The description of the data is provided, as well as the source of the data collection. The details of the derivation of the index of macroeconomic stability and the financial development index are provided in Annex 1.

Table 4: List of Variables, Abbreviation, and Description

List of Variables	Denomination	Description	Source
Macroeconomic Stability	<i>macrostab</i>	Index of Macroeconomic Stability	Non-Parametric Approach
GDP	<i>gdp</i>	GDP growth in Mauritius at constant prices	Statistics Mauritius
Financial Development Index	<i>findev</i>	Index of Financial Development	Principal Component Analysis
Trade	<i>tr</i>	Export plus Import	MSB
GDFCF	<i>gdfcf</i>	Gross Domestic Fixed Capital Formation	Statistics Mauritius
CPI	<i>inf</i>	Consumer Price Index	MSB
Real Effective Exchange Rate	<i>reer</i>	Exchange rate adjusted for inflation differentials between trading partners and weighed according to importance of trade	Consolidated data II
Mauritius Exchange Rate Index	<i>meril</i>	Weighted average of bilateral exchange rates for the Mauritian rupee against the currencies of its important trading partners	Consolidated data II
T-Bill Rate	<i>tbill</i>	3-Month Treasury Bill Rate	MSB
Key Repo Rate	<i>krr</i>	Key policy rate of the Bank of Mauritius	MSB
Net open Foreign Exchange Position	<i>fx</i>	On- and off-balance sheet assets minus liabilities in foreign currency	FSI
Net Interest Income	<i>nii</i>	Income from interest-bearing assets (loans and investments) minus payment on interest-bearing liabilities (deposits and borrowings)	FSI
Deposit rate	<i>drate</i>	Weighted average rupee deposits of banks	MSB
Lending Rate	<i>lrate</i>	Weighted average rupee loans of banks	MSB
GDP of Europe	<i>gdp e</i>	Y-o-y growth rate of GDP of EuroArea countries	MSB
GDP of UK	<i>gdp uk</i>	Y-o-y growth rate of GDP of the UK	MSB
GDP of South Africa	<i>gdps afr</i>	Y-o-y growth rate of GDP of South Africa	MSB
GDP of India	<i>gdp india</i>	Y-o-y growth rate of GDP of India	MSB
Average Foreign GDP	<i>gdp*</i>	Y-o-y average growth rate of GDP of Main Partners	MSB
<u><i>Variables used in Constructing the Financial Sector Development Index</i></u>			
Capital	<i>cap</i>	Total regulatory capital of the banking system (Tier 1 and Tier 2)	Consolidated data I
Total Assets	<i>ast</i>	Total assets of the banking system	Consolidated data I
Total Credit	<i>TC</i>	Total credit by the banking system to the private sector, excluding credit to Government or credit extended by the Central Bank	Consolidated data I
Total Deposits	<i>TD</i>	Total deposits of banking system, including GBC deposits	Consolidated data I
Broad Money (M2)	<i>M2</i>	Notes and coins in circulation plus deposits in banking system (excluding GBC deposits) and debt securities issued by banks	MSB
Operating profit	<i>op</i>	Net interest income plus non-interest income minus operating	FSI
Stock exchange Index	<i>semdex</i>	Quarterly average SEMDEX	SEM
Net Capital Inflows	<i>ncap</i>	Net inflows of capital in the Balance of Payments	MSB

MSB - Monthly Statistics Bulletin of BOM

Consolidated data I - Consolidated Assets and Liabilities from BOM Supervision Department

Consolidated data II - BOM Financial Markets Operations Department

FSI - BOM Financial Soundness Indicators

4.3 Estimation Approach

This study used the autoregressive distributed lag model (ARDL) approach proposed by Pesaran, Shin and Smith (2001). The ARDL approach is more appealing than traditional cointegration approaches such as those of Engle-Granger or of Julius-Johansen since it does not require all variables to be integrated of the same order. Rather, ARDL works effectively, irrespective of whether some variables are I (0) or I (1), or are a mix of I (0) and I (1), provided that they are not integrated of higher orders.

V. Empirical Results

The study used Augmented Dickey-Fuller to test for stationarity and the results are provided in Annex 2. The study also used appropriate methods to determine the optimal lag length and tested for the presence of a long-term relationship between the variables using the Pesaran et al. (2001) bounds test framework. The results showed an F-Statistic of 11.47, which is greater than the upper critical bound value leading to the rejection of the null hypothesis of no cointegration. Thus, there is a long-run association between macroeconomic stability and financial sector development (Table 5).

Table 5: F-Bounds Test: Null Hypothesis: No Levels Relationship

F-Bounds Test		Null Hypothesis: No levels relationship			
Test Statistic	Value	Signif.	I(0)	I(1)	
F-statistic k	4.410433 1	Asymptotic: n = 1000			
		10%	3.02	3.51	
		5%	3.62	4.16	
		2.5%	4.18	4.79	
		1%	4.94	5.58	
Actual Sample Size	40	Finite Sample: n = 40			
		10%	3.21	3.73	
		5%	3.937	4.523	
		1%	5.593	6.333	

In the estimation, the index of macroeconomic stability index is the dependent variable while the index of financial sector development is the independent variable and the results of the long-run regression are reported in table 6.

Table 6: Regression Results (Dependent Variable is the Macroeconomic Stability Index)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
MACROSTAB (-1)	0.673665	0.137982	4.882261	0.0000
MACROSTAB (-2)	-0.125278	0.170814	-0.733417	0.4683
MACROSTAB (-3)	0.311880	0.171517	1.818360	0.0778
MACROSTAB (-4)	-0.312671	0.117224	-2.667285	0.0116
FINDEV	0.024816	0.013541	1.832684	0.0756
C	0.085260	0.037891	2.250112	0.0310
R-squared	0.632874	Mean dependent var		0.246230
Adjusted R-squared	0.578885	S.D. dependent var		0.225799
S.E. of regression	0.146529	Akaike info criterion		-0.865712
Sum squared resid	0.730001	Schwarz criterion		-0.612380
Log likelihood	23.31425	Hannan-Quinn criter.		-0.774115
F-statistic	11.72227	Durbin-Watson stat		1.628205
Prob (F-statistic)	0.000001			

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

In the long run, a 1 percent improvement in financial development will contemporaneously increase macroeconomic stability by 2.48 percent, with the result being significant at the 10 percent level. The results show that the first and third lags of macroeconomic stability explain most of the changes in macroeconomic stability index, with the result being very significant at the 1 percent level for the first lag. The results for the short-run coefficients, denoted by the difference operators, are displayed in table 7. The coefficient attached to the cointegrating value is negative and statistically significant. This implies that any short-term disequilibrium will self-correct and move to long-term trend at a speed of 45 percent.

Table 7: ARDL Error Correction Regression

ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MACROSTAB(-1))	0.126069	0.127154	0.991466	0.3285
D(MACROSTAB(-2))	0.000791	0.120634	0.006555	0.9948
D(MACROSTAB(-3))	0.312671	0.113113	2.764235	0.0091
CointEq(-1)*	-0.452404	0.120869	-3.742941	0.0007

The study also conducted omitted variable tests that indicated that gross fixed capital formation and Euro zone growth are not relevant in explaining macroeconomic stability in Mauritius.

Table 8: Omitted Variables Test

Omitted Variables: GDPCF EUR are jointly insignificant

	Value	df	Probability
F-statistic	1.778549	(2, 32)	0.1852
Likelihood ratio	4.216156	2	0.1215

F-test summary:			
	Sum of Sq.	df	Mean Squares
Test SSR	0.073029	2	0.036514
Restricted SSR	0.730001	34	0.021471
Unrestricted SSR	0.656972	32	0.020530

LR test summary:	
	Value
Restricted LogL	23.31425
Unrestricted LogL	25.42232

Granger-causality tests have also been undertaken. Granger-causality depicts the pairwise causation between lagged values of the given independent variable, the index of financial sector development, and macroeconomic stability, while keeping all other independent variables (if any) unchanged. Table 9 summarizes the results.

Table 8: Granger-Causality (Null hypothesis: No Granger Causality)

	<i>Observations</i>	<i>F-Statistic</i>	<i>P-Value</i>
<i>Financial sector development index does not Granger Cause macroeconomic stability</i>	42	4.72002	0.04934**
<i>Macroeconomic stability does not Granger Cause financial sector development</i>		2.72315	0.0788*

*** denotes significance at the 1 percent level; **denotes statistical significance at the 5 percent level; * denotes significance at the 10 percent level.

The Granger causality tests show causation running from financial sector development to macroeconomic stability as well as from macroeconomic stability to financial sector development.

VI. Conclusion

This study examined the relationship between financial sector development and macroeconomic stability. To address this objective, the study derived a measure of macroeconomic stability by using a non-parametric composite-based approach focusing on GDP growth and inflation and an index capturing financial system development using the PCA approach. The study used ARDL approach to show that there is a positive relationship between financial system development and macroeconomic stability in the long run. The study further conducted granger causality tests and the results showed a bi-directional relationship between financial development and macroeconomic stability implying a need to quantitatively investigate the impact of macroeconomic stability on financial development in Mauritius.

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Annex 1 – Macroeconomic Stability Index and Financial Sector Development Index

Table A1: Deriving an Index of Macroeconomic Stability for Mauritius – A Non-Parametric Composite-Based Approach

1. Deriving a macroeconomic stability indicator is challenging due to the subjective interpretation attached to the notion of ‘stability’. The latter concept would necessarily entail the enactment of thresholds that would separate ‘stability’ from ‘instability’. While the thresholds may be scientifically derived as concepts from historical observations, the values attached to them, if subjective, may lead to biased interpretations. Furthermore, there are social stigmas attached to the notion of macroeconomic instability that are often disseminated by the mass media and that tend to market some indicators as being more ‘socially acceptable’ as representing macroeconomic instability. For instance, high inflation may be signaled as an indicator heralding macroeconomic instability more than external sector vulnerability.

2. The economic features of a country will ultimately influence on the design of an appropriate macroeconomic stability index. Factors affecting those sectors that are macro-critical to growth are usually the kernel of the indicator. For instance, economies that rely on production and exports of non-renewable natural resources (e.g., oil) will witness fluctuations in any measure capturing macroeconomic stability, with big changes in global oil prices. For small open island economies such as Mauritius which are relatively heavily tourism-dependent, shocks in source countries providing tourist flows (e.g., Europe) will usually influence perspectives regarding macroeconomic stability.

2. An appropriate index – usually comprising appropriate coincidental (and potentially leading indicators) - will usually capture the direction of change, but may yield less useful information on magnitude of change. Due to its multi-faceted nature, a measure of macroeconomic stability may entail re-orientation and re-calibration of basic macroeconomic data. Regarding the range of data to be included, it is usually recommended to include those variables that are most likely to epitomize the ‘end result’ of any episode of instability, namely GDP growth and inflation. Usually a well-designed composite index built along principles of including relevant parsimonious materials would capture the direction of change but may be relatively more silent on magnitude. Thus, care should be exercised in interpreting the results.

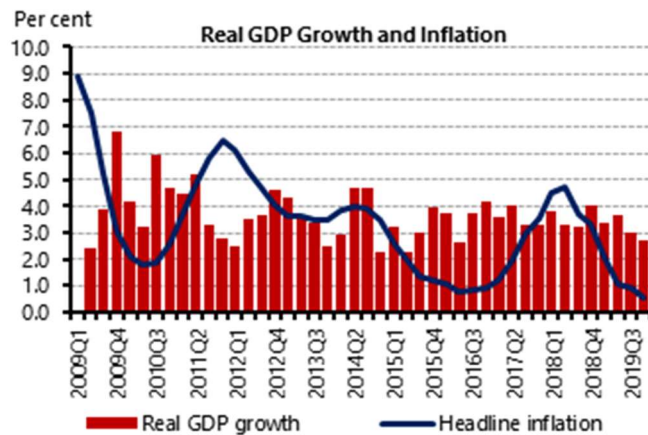
3. Due to potential endogeneity problems, care must be taken to avoid double-counting which may lead to an overestimation of any measure of stability or of instability. As mentioned earlier, because focus will be on the ‘maximum information with minimum variables’ principle, a reliable indicator of macroeconomic stability will focus on those ‘high end’ variables only, towards which all intermediate indicators of stability / instability will ultimately converge. Instabilities in the banking system, external sector and fiscal sector will ultimately feed upon GDP growth and hamper any metric designed to capture the nuts and bolts of GDP



growth changes. Unemployment dynamics are affected by past GDP growth rate, but in turn, affect the future ones. Thus, we shall be focusing on GDP growth as one of the building blocks of our composite index. The other building block will be inflation which captures monetary sector dynamics, evolution of global prices of commodities, as well as domestic currency depreciations.

4. The ‘distance-to-minimum’ concept is used as Non-Parametric approach to represent dispersion of a variable.

The macroeconomic stability metric is captured by looking at the ‘distance-to-minimum’ for GDP growth and for inflation. A higher GDP growth rate at a given point of time than the minimum is synonymous with greater stability. However, higher inflation at a given point of time than the minimum means greater instability. As a result, the measure of aggregation is reached by taking the ‘distance-to-minimum’ approach for GDP growth minus the one for inflation. The Aggregate Index of Macroeconomic Stability (at time t) with period of analysis being 2009Q1-2019Q4 is as follows:

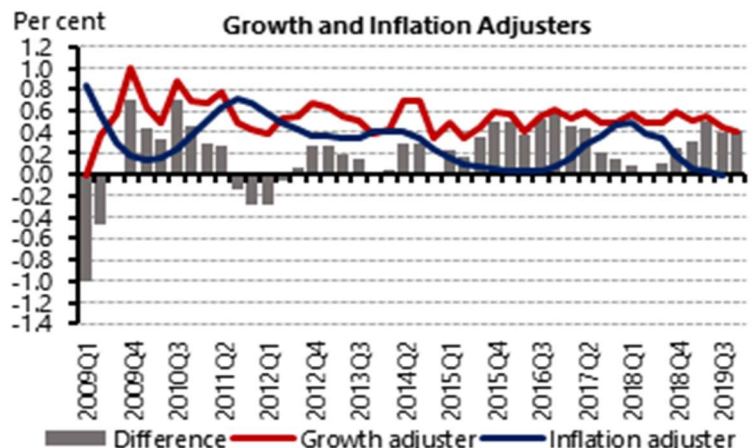


$$\frac{Y_t - Y_{min}}{Y_{max} - Y_{min}} - \frac{infl_t - infl_{min}}{infl_{max} - infl_{min}}$$

Where: Y_t is the GDP growth at time t; Y_{max} is the maximum value over the series over the period under cover; Y_{min} is the minimum value over the series; $infl_t$ is the inflation rate at time t; $infl_{max}$ is the maximum value over the series; and $infl_{min}$ is the minimum value over the series.

5. No relative weight is attached to GDP growth and to inflation in the composite index.

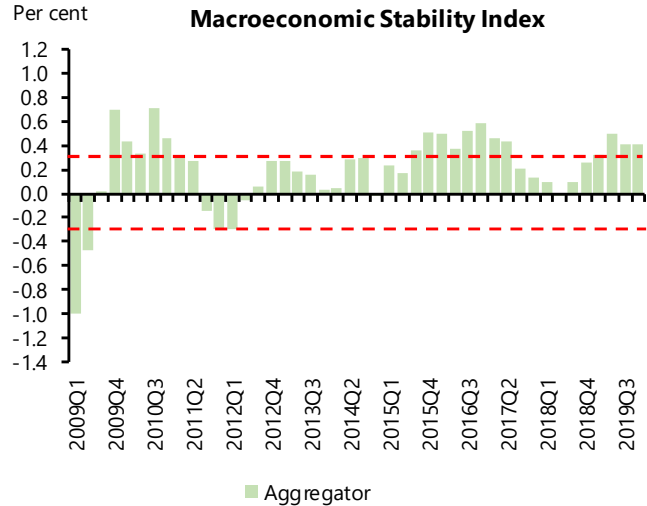
Prior to the COVID-19 pandemic, Mauritius had had a history of stable economic growth. As a result, we do not need to allocate any social-welfare based weights to growth vs inflation. We assume that they are each weighted equally. Furthermore, because of historically low standard deviation for both of the measures over the period under review, we do not need to account for any persistence factor in compiling the metric. The text diagram below shows the appropriate adjusters being performed on GDP growth and inflation to derive the two



components of the composite index, as per the above equation.

6. The aggregate indicator of macroeconomic stability is given by the ‘difference’ bars.

The index is reproduced below as green bars. Over the period under review, the upside (downside) changes each have a mean value of 0.3 (-0.3). These mean values define the bandwidth within which the indicator fluctuates. So long as the indicator lies within the bandwidth, it is regarded as ‘normal’. Within the bandwidth, a rise in the indicator means a ‘more stable’ situation and a fall means ‘less stable’ situation. If the index lies above the upper edge of the bandwidth during a given period, this is synonymous with an ‘exceptionally good’ stance, i.e., there are quite high chances that there are exceptional circumstances that have warranted good macroeconomic conditions (e.g., decline in oil prices, growth in partner countries, etc). These may, however, be viewed as temporary though. Below the lower edge of the bandwidth, the macroeconomic situation can be described as ‘unstable’. These unstable episodes would typically be characterized by episodes of ‘stagflation’, i.e., periods of higher-than-usual inflation and lower-than-usual growth. Years 2009Q1 and Q2 would be classified as ‘unstable’ by our metric due to the fallouts of the food price crisis and the knock-on effects of the Global Financial Crisis (GFC) on the Mauritian economy.



7. Our index offers a measure that is specific, intuitive, simple to measure, relevant and timely and whose performance can easily be assessed against ‘social norms’ ex-post.

Our index is sensitive to its two components when they start to flash red lights¹³. This can be shown in the above text chart. In order to be able to assess how good our index really is, we can compare it with ‘socially acceptable’ notions of instability. Thus, if it is common knowledge that growth is becoming volatile and stalling, our index must show more inclination towards instability. Thus, in the below table, the ratios of $\frac{A}{A+C}$ and of $\frac{D}{D+B}$ must be relatively high. This can be proven with the benefit of hindsight.

	Growth becoming volatile and taking a downward trend	Inflation becoming volatile
Signal shows instability on growth side	CORRECT (A)	INCORRECT (B)
Signal shows instability on inflation side	INCORRECT (C)	CORRECT (D)

¹³ In a previous and separate work undertaken for the CMI (2019), this author used a Probit / Logit Approach to model macroeconomic variables that were most likely to be relevant in explaining financial fragility, where financial fragility

Deriving an Index of Financial Sector Development for Mauritius – The Principal Component Analysis (PCA) Method

Non-Technical Background

- Suppose we want to estimate a variable, say, financial sector development. This variable is unobservable and needs to be estimated. We have a smorgasbord of variables (e.g., credit-to-GDP ratio, stock market capitalization-to-GDP ratio, deposit-to-GDP ratio etc) that may shed light on the level of financial sector development. However, we know that there may be multicollinearity between these variables if we include them as separate repressors in a regression.
- Thus, the question - How can we then best extract a variable (or a few variables only) that best represents financial sector development and that can still retain pretty much of the variation in the observed data? These few variables should retain the algebraic feature that they are orthogonal to each other. By ranking these newly-created independent variables in terms of how much variation in the data they account for, we can choose to focus on one or a couple of them only. These newly created variables are called the Principal Components and the plot that ranks them in descending order is called the Scree Plot.
- PCA is thus a dimensionality-reduction technique that focuses on feature extraction from the underlying data¹⁴. It works when: (a) a researcher is willing to reduce number of variables but cannot identify which ones to eliminate at first sight or with hindsight; (b) the researcher wants to ensure that variables that are retained are independent so that they can be incorporated into a regression without fear of inducing multicollinearity; and (c) the newly created variable may be less interpretable. Thus, interpretability may be sacrificed for the sake of efficiency and effectiveness.

Building the PCA to represent Financial Sector Development in Mauritius

- The following raw data variables are believed to reflect financial sector development:
 - *Credit-to-GDP*
 - *Deposit-to-GDP*
 - *M2-to-GDP*
 - *Assets-to-GDP*

was modelled as a binary outcome in a panel-based dataset. Predictive modelling (i.e., ROC analysis) showed that GDP and inflation were the most important variables there as well.

¹⁴ This feature of dimensionality-reduction is different from a feature elimination process which consists of reducing the feature space by dropping all variables with the exception of those that are most pertinent for the analysis under question. Feature extraction and feature elimination are two ways of reducing dimensionality of the feature space.

- Capital-to-GDP
- Net Capital Inflows-to-GDP
- Operating Profit-to-GDP
- Semdex-to-GDP

▪ The following steps are taken in deriving the principal components:

- Standardize the data so that each series is based on similar footing;
- Derive the underlying covariance matrix for the dataset. The correlations between these raw variables are provided in the third table below. The correlations are pretty high due to the non-stationarity elements of some variables.
- Compute the eigenvalues and eigenvectors to derive the principal components. The eigenvalues capture the variation in the data accounted for by each component. The first table derives the eigenvalues and the second one the factor loadings.

Eigenvalues: (Sum = 8, Average = 1)

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	4.775862	3.672418	0.5970	4.775862	0.5970
2	1.103444	0.352459	0.1379	5.879305	0.7349
3	0.750985	0.055260	0.0939	6.630290	0.8288
4	0.695725	0.222094	0.0870	7.326015	0.9158
5	0.473631	0.322944	0.0592	7.799646	0.9750
6	0.150687	0.116855	0.0188	7.950333	0.9938
7	0.033832	0.017996	0.0042	7.984164	0.9980
8	0.015836	---	0.0020	8.000000	1.0000

Eigenvectors (loadings):

Variable	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7	PC 8
CREDIT	0.441127	0.048864	0.003299	-0.192886	-0.208696	-0.039607	-0.739676	-0.416605
DEPOSIT	0.326116	0.269623	-0.539112	0.433959	0.185807	0.553723	0.024050	-0.016677
CAPITAL	0.425759	-0.023021	0.043663	-0.346845	-0.267386	0.188649	-0.023641	0.767039
GDFCF	0.270878	-0.023632	0.628102	0.678342	-0.261624	0.018511	0.044339	0.025531
M2	0.427841	-0.101567	0.047570	-0.324511	-0.202269	0.123621	0.648948	-0.470890
NCAP	0.000840	0.874200	0.361042	-0.218516	0.231782	0.015817	0.058974	-0.014866
OPPROFIT	0.314522	-0.355298	0.288225	-0.086563	0.821830	0.064038	-0.063111	0.027996
SEMDEX	0.403034	0.151819	-0.311835	0.182963	0.109265	-0.797658	0.145538	0.120083

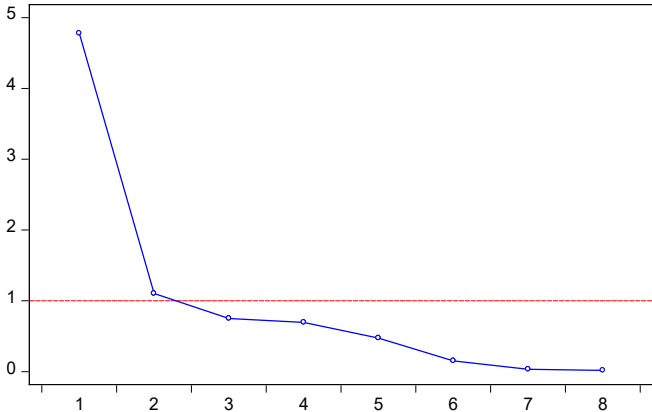
Ordinary correlations:

	CREDIT	DEPOSIT	CAPITAL	GDFCF	M2	NCAP	OPPROFIT	SEMDEX
CREDIT	1.000000							
DEPOSIT	0.619852	1.000000						
CAPITAL	0.963221	0.525856	1.000000					
GDFCF	0.504399	0.343913	0.442234	1.000000				
M2	0.945671	0.512070	0.975298	0.451617	1.000000			
NCAP	0.054741	0.071017	0.014939	0.016872	-0.054530	1.000000		
OPPROFIT	0.575574	0.318938	0.577036	0.409515	0.633192	-0.159921	1.000000	
SEMDEX	0.821484	0.797524	0.726115	0.441196	0.731036	0.046057	0.501942	1.000000

- Principal components are new variables that are constructed as linear combinations of the initial variables. These combinations are constructed in such a way that the new variables (i.e., principal components) are uncorrelated and most of the

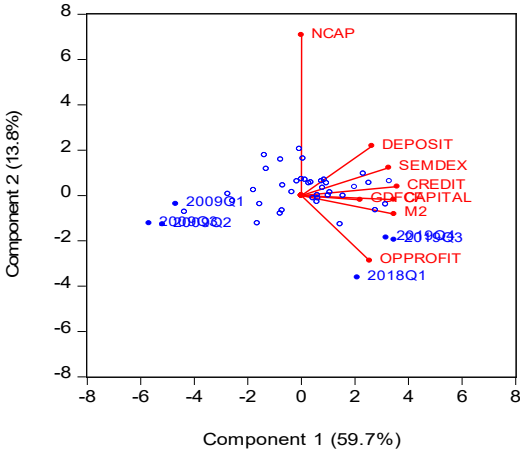
information within the initial variables is compressed into the first components. Thus, in our case, since we have an 8-dimensional data, we have 8 principal components. PCA tries to put maximum possible information in the first component, then maximum remaining information in the second and so on. The end result is shown in the scree plot below. The Scree Plot shows how much variation in the data is accounted for by each principal component. As seen below, the first two principal components account for pretty much of the variation we observe in the raw variables.

Scree Plot (Ordered Eigenvalues)



- This conclusion is also drawn from the orthonormal loadings biplot below. Loadings for the first two principal components show that the first (=highest ranked) principal component accounts for about 60 percent of variation and the second (= second highest ranked) component accounts for about 14 percent of variation.

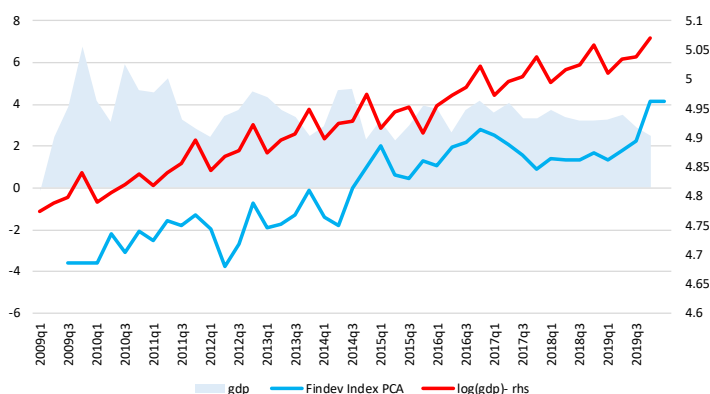
Orthonormal Loadings Biplot



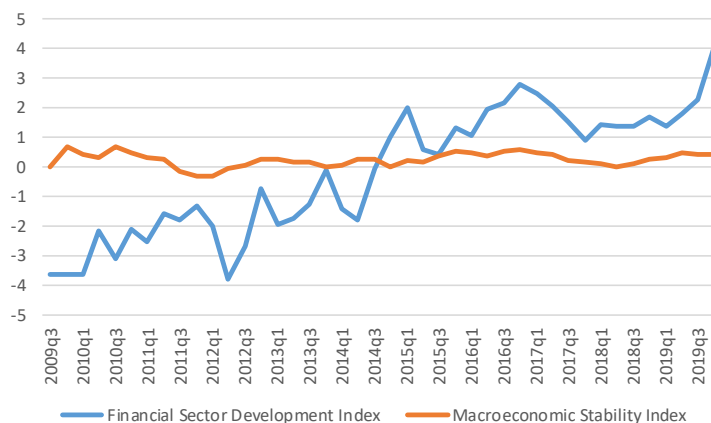
- On this basis, we shall use the first (and highest-ranked) principal component as our index representing financial sector development.

- The two figures below show the time series of this index of financial sector development and its stochastic relationship with: (i) the evolution of GDP, and (ii) the evolution of the macroeconomic stability index, both, for the period under review.
- There appears to be a strong relationship between financial sector development and economic activity (measured by log of GDP) in Mauritius, while the relationship is less strong with macroeconomic stability.

Financial Development Index and GDP growth in Mauritius, 2009Q1-2019Q4¹⁵



Financial Sector Development and Macroeconomic Stability, 2009Q1-2019Q4



¹⁵ The Index of Financial Sector Development which is proposed here differs from the IMF's Financial Conditions Index (2019). The Conditions Index is designed to capture cyclical changes in the economic activity and has a short-term focus. The Development Index is more of structural nature and has a long-term focus.

Annex 2: Unit Root Test Results

Macroeconomic stability index

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.754527	0.0004
Test critical values: 1% level	-3.592462	
5% level	-2.931404	
10% level	-2.603944	

*MacKinnon (1996) one-sided p-values.

Financial sector development index

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.515382	0.5162
Test critical values: 1% level	-3.596616	
5% level	-2.933158	
10% level	-2.604867	

*MacKinnon (1996) one-sided p-values.