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AUTHORS	Alex Bara Calvin Mudzingiri

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Alex Bara (Zimbabwe), Calvin Mudzingiri (South Africa)

Financial innovation and economic growth: evidence from Zimbabwe

Abstract

The role of financial innovation on economic growth in developing countries has not been actively pursued. Stemming from the finance-growth nexus, literature suggests that financial innovation has a relationship to growth, which could be either positive or negative. Implicitly, financial innovation has a good and a dark side that affects growth. This study establishes the causal relationship between financial innovation and economic growth in Zimbabwe empirically. Using the Autoregressive Distributed Lag (ARDL) bounds tests and Granger causality tests on financial time series data of Zimbabwe for the period 1980-2013, the study finds that financial innovation has a relationship to economic growth that varies depending on the variable used to measure financial innovation. A long-run, growth-driven financial innovationis confirmed, with causality running from economic growth to financial innovation. Bi-directional causality also exists after conditionally netting-off financial development. Policies that enhance economic growth inter-twined with financial innovation are essential, if developing countries, such as Zimbabwe, aim to maximize economic development.

Keywords: innovation, financial innovation, economic growth, Zimbabwe.
JEL Classification: O3, O4, O5.

Introduction

The impact of financial innovation on economic growth in developing countries has not been pursued extensively, despite it being an integral part of financial development. Research studies on financial innovation in developing countries have, so far focused mainly on welfare issues, particularly on its impact on financial inclusion (Chibba, 2009). Financial innovation has transformed and restructured banking services globally, and its impact on economies is becoming increasingly noteworthy.

The available literature confirms that financial innovation drives economic growth (Lumpkin, 2010; Sekhar, 2013). From a historical perspective, Laeven, Levine and Michalopoulos (2015) point out that financial innovation has been a driving force behind financial deepening and economic development over the past centuries. In turn, Štreimikienė (2014) contends more specifically that "leapfrog" (financial) innovation is a driving force for broad economic growth. Despite mixed evidence on causality, there is also broad consensus that well-functioning banking systems promote economic growth (Demetriades & Andrianova, 2005).

High growth rates in African countries, in recent years, have been sustained by natural resources and agriculture on the back drop of improved macroeconomic management (Mlachila, Park & Yabara, 2013). There has been no mention of growth being driven by or linked to finance. Financial innovation has become an integral part of financial sector development and is an important determinant in generating new economic activity. For example, the high penetration rate of mobile financial services, which is a critical component of financial innovation compared to traditional banking in Zimbabwe, enabled by the integration of financial service with mobile communication technology, has greatly increased financial inclusion (Prior & Santomá, 2010). The 2014 FinScope Consumer Survey report for Zimbabwe indicates that the number of adults formally receiving financial service increased from 38% in 2011 to 69% in 2014, mainly due to mobile money. Furthermore, the number of adults financially excluded decreased from 40% in 2011 to 23% in 2014. Such an increase in access to financial services boosts economic activity, including in marginalized areas, giving the country an impetus for economic growth. In Zimbabwe, technology and financial innovation have smoothened the flow of remittances, which is a major source of income, liquidity, funding and investment for the country(Bracking & Sachikonye, 2010).

So far, the literature suggests that financial innovation drives economic growth; however, the causality and extent to which high growth rates registered by developing countries are driven by financial innovation, had not been specified as yet (Levine, 1997). Remarkably, there has not been much research on the relationship between financial innovation and economic growth in Africa and none for Zimbabwe.

This study bridges a knowledge gap regarding the relationship between financial innovation and economic growth in Zimbabwe. The objectives of this study are to: i) assess the nature of the relationship between financial innovation and economic growth; ii) empirically investigate

Alex Bara, Senior Economist; Agriculture Bank of Zimbabwe, Zimbabwe.
Calvin Mudzingiri, University of the Free State, South Africa.

causality between financial innovation and economic growth in Zimbabwe. The study uses the Autoregressive Distributed Lag (ARDL) bounds test and Granger causality test on financial time series data of Zimbabwe for the period 1980-2013. Two proxies of financial innovation are used in the study, namely, ratio of broad money to narrow money (M2/M1) and growth in banking sector credit to private sector (GBCP) as a proportion of the gross domestic product (GDP).

1. Theoretical and empirical literature review

Financial innovation is anything new that shrinks costs, decreases risks, or affords an improved product/service/instrument that better fulfils financial system players' demands (Frame and White, 2009). Lerner and Tufano (2011) and the World Economic Forum (2012) define financial innovation as the act of crafting and, then, popularizing new financial instruments, technologies, institutions, markets, processes and business models including the new application of existing ideas in a different market context. Financial innovation is the result of the desire of market participants to establish new, efficient ways of increasing profits when providing goods and services (Bilyk, 2006). Financial innovation involves break through over a period in the financial instruments and payment methods that reduce cost and increase benefits on economic agents. Frame and White (2000) associate the appearance of financial innovation with the changing requirements of customers, conditions of suppliers, environmental conditions, policy conditions and technology. Innovation has been a core topic for scholars because of its important contribution to economic growth and to the stability of financial systems (Arnaboldi & Rossignoli, 2015; Lerner & Tufano, 2011).

The debate on financial innovation and financial growth has raged on for over a century (Laeven, Levine, & Michalopoulos, 2015). Joseph Alois Scumpeter, in 1912, in "The theory of Economic Development" noted that economic development is spurred by innovation within financial intermediaries (Mishra, 2008). However, a number of studies tended to ignore the role of financial innovation in economic growth and suggest that financial system is an endogenous variable (Michalopoulos, Laeven & Levine, 2009). Block (2002) suggests that financial innovation is a function of capital, knowledge and labor that operate in a universal environmental institution within an economy.

Michalopoulos et al. (2009) developed a model which sought to explain the finance-growth relationship more effectively through financial innovation other than existing financial development and growth models. They argue that the model's deduction is that "economies without financial innovation will stagnate, irrespective of the initial level of financial development". It follows that economic growth will be inhibited should financiers stop innovating. Financial innovation can play an allocative role within the global economy through new financial instruments, institution, services, technologies and mobilizing financial resources by directing funds to highly productive investment ventures (Mishra, 2008). Innovation is clearly an important phenomenon of any sector of a modern economy. Successful financial innovation reduces costs and risks or provides improved services to users (Frame & White, 2004, 2014).

The role of banks and other financiers in channeling innovations into growth is through screening and sponsoring potentially viable innovative projects, while leaving out likely risky and unviable projects (Idun & Aboagye, 2014, citing Levine, 1997). Alternatively, banks can be innovators by introducing new banking products that help in serving customers better and mitigate the effects of changes in macroeconomic variables such as inflation and interest rates (Idun & Aboagye, 2014). Financial innovation influences the structure of financial markets, the financial behavior of economic agents and the types of financial products traded (Ho, 2006).

Some researchers argue that financial innovation drives economic growth, while others point to its dark side. Arnaboldi and Rossignoli (2015), for example, point out that innovation is a double-edged sword. The right kind of innovation and favorable conditions that may spur banks to invest in new technologies would help the financial system to fulfil its functions and, as a consequence, deliver growth. Too much or inefficient innovation can, however, have serious consequences for the overall economy (Beck, Chen, Lin & Song, 2014).

A well-developed financial system can promote economic growth by enabling economic agents to diversify their portfolios and meet their liquidity requirements. Financial innovations lead to a higher level of savings and capital accumulation, hence, a higher level of economic growth (Levine, 1997; Mishra, 2008). In a new model of economic growth, Michalopoulos et al (2009) argue that growth is not only a consequence of profit-maximizing entrepreneurs willing to introduce new technologies, but also of financial entrepreneurs who find novel ways to finance the technologist. Beddoes (2010) argues that the last few centuries demonstrate that financial innovation is crucial, indeed indispensable, for sustained economic growth and prosperity.

There is empirical evidence of a relationship between financial innovation and economic growth. In their study, Valverde, Paso and Fernández (2007) found a positive relationship between product and service innovations and regional gross domestic product, investment and gross savings in Spain. Laeven et al. (2015) came up with a model that shows a link between financial innovation and economic growth through the interaction between financial institution and technological entrepreneurs. This provides a spread of innovation from commodities to financials.

At the other end of the spectrum, however, Beck et al. (2012) noted that external funding of financial innovation might increase volatility in economic growth. They used bank, industry and country-level data for the period 1996 to 2006 on 32 high income countries to conclude economic growth volatility due to external funding of innovation. Along the same lines, Henry and Stiglitz (2010) note that recent innovation has been about accounting, regulatory and tax arbitrage rather than promoting the efficient allocation of capital and management of risk. Beddoes (2010) cautions that the last few years showed that financial innovations can be used as tools of economic destruction, while Allen (2011) and Llewellyn (2009) go on to argue that the Global Financial Crisis of 2007 was caused by financial innovation.

There are a few empirical studies that investigated the relationship between financial innovation and economic growth for African developing countries. Idun and Aboagye (2014) evaluated the relationship between bank competition, financial innovations and economic growth in Ghana. The study finds a negative relationship between financial innovation and economic growth in the long run, and a positive relationship in the short run. The results also show bi-directional Granger causality between financial innovation and economic growth. Mwinzi (2014), in a study on Kenya, established that financial innovation has a significant, positive impact on economic growth. The study concludes that mobile transactions have a major impact on economic growth. Attempts have been made to relate financial innovation to money demand (Kasekende & Opondo, 2003; Mannah-Blankson & Belnye, 2004) and to savings (Ansong, Marfo-Yiadom & Asmah, 2011). In the studies, financial innovation has a positive relationship tomoney demand or saving.

Most studies on Zimbabwe are confined to the financial-growth debate (Ndlovu, 2013; Tyavambiza & Nyangara, 2015; Zivengwa, Mashika, Bokosi & Makova, 2011). Jecheche (2011) considered stock market and economic growth, while Sibindi and Bimha (2014) investigated banking sector development and economic growth. There are no studies available that attempted to assess the relationship between financial innovation and economic growth. Sibindi and Bimha (2014) used broad money (M2) to GDP as a proxy for banking development sector and established a long-run relationship between economic growth and banking sector development. Tyavambiza and Nyangara (2015) used liquid liabilities (M3) as a share of the GDP, and found a significant negative effect of money supply on economic growth. Granger causality was found to be unidirectional running from money supply to economic growth.

2. Data and methodology

2.1. Data sources and variables. The study uses time series financial data of Zimbabwe for the period 1980-2013 sourced from the World Bank (Group, 2012), the Reserve Bank of Zimbabwe and the Zimbabwe Statistical Agency (ZIMSTAT). The study did not make use of data for the years 2007 and 2008 due to missing values. Data were analyzed using the E-Views 7 econometric package.

There is no agreed measure of financial innovation; hence, researchers tend to proxy it with different variables. Laeven et al. (2015) explain that financial innovation is not limited to new financial instruments, products or institutions, but also includes more mundane financial improvements, such as the new financial reporting procedures, improvements in data processing and credit scoring, as such, the choice of variables that capture financial innovation needs to be all-inclusive beyond those that depict product innovation only. This study uses two variables as proxies for financial innovation, namely: ratio of broad money to narrow money, M2/M1 (Ansong, Marfo-Yiadom, & Ekow-Asmah, 2011; Arrau, De Gregorio, Reinhart & Wickham, 1995; Mannah-Blankson & Belnye, 2004) and growth in financial development – growth in banking sector credit to private sector (GBCP) as a proportion of GDP (following Idun & Aboagye, 2014; Michalopoulos et al., 2009).

2.2. Methodology – the extended Aghion, Howitt, and Mayer-Foulkes (AHM) model. The study follows a financial innovation model developed by Laeven et al. (2015) which extended Aghion, Howitt and Mayer-Foulkes' (AHM) regression framework. Laeven et al. (2015) tested the role of financial innovation on endogenous growth in a model with a key feature which states that "economies without financial innovation will stagnate, irrespective of the initial level of financial development". To test their model, Laeven et al. (2015) extended the AHM regression framework to include not only measures of financial development, but also financial innovation.

In contrast to the AHM model, the Laeven et al. (2015) model stresses the importance of financial innovation. In their model, they stipulated that the level of financial development in any period is an outcome of previous financial innovations. Laeven et al. (2015) model (which was derived from amended the AHM regression framework) is:

$$g - g_1 = b_0 + b_1 F + b_2(y - y_1) + b_3 F(y - y_1) + +b_4 X + b_5 f + b_6 F(y - y_1) + u, \quad (1)$$

where f denotes financial innovation measured as the average growth rate of financial development over the sample period 1960-95, g stands for economic growth, F for financial development, y for income and x for control variables. They estimated a panel cross-country GMM regression. This study estimates a reduced form of equation (1) above by dropping cross-country analysis and reducing it to a single country. In addition, the study is not evaluating convergence in growth; therefore, growth comparative/convergence variables are also dropped and the interpretation of coefficients becomes that of responsiveness rather than speed of convergence. The study, however, introduces an additional variable for financial innovation for comparative purposes. The dynamic regression model to be estimated in this study becomes:

$$\overbrace{RYPC}^{Y}{}_t = [\overbrace{GEX_t, CPI_t, TO_t}^{X} + \overbrace{RGDPPC_{t-1}}^{y_{t-1}} + \overbrace{cpvt_t}^{F} + (\overbrace{gbcp_t, ms_t}^{fi})], \quad (2)$$

where Y is real per capita GDP; X are control variables; y_{t-1} is the lagged variable of real per capita GDP; F is the financial development variable; and fi are financial innovation variables. The linear form of equation (2) becomes:

$$LRYPC_t = \beta_0 + \beta_1 LGBCP_t + \beta_2 LM2/M1_t + \beta_3 LGEX_t + +\beta_4 LCPI_t + \beta_5 LTO_t + \beta_6 LRYPC_{t-1} + \beta_7 LCPVT_t + \varepsilon_t, \quad (3)$$

where prefix L is natural logarithm; $RYPC$ is real income (gross domestic product) per capita; $GBCP$ is growth in bank sector credit to private sector as a ratio of GDP; ($M2/M_1$) is ratio of broad to narrow money (money demand); GEX is government expenditure; CPI is consumer price index; TO is trade openness; $RYPC_{t-1}$ is the lagged real per capita income, and $CPVT$ is domestic credit to the private sector.

2.3. Estimation model. The study uses Autoregressive Distributed Lag (ARDL) bounds tests to establish the relationship between financial innovation and economic growth. The ARDL model is comparatively more robust in small or finite samples consisting of 30 to 80 observations (Ghatak & Siddiki, 2001). Second, the approach can be used where variables have different orders of integration; in other words, it can be used with a mixture of I(0) and I(1) or mutually integrated data (Ghatak & Siddiki, 2001). Third, modelling the ARDL with the appropriate lags will correct for both serial correlation and endogeneity problems (Pesaran, Shin & Smith, 2001). Fourth, ARDL co-integration estimates SR and LR relationship simultaneously and provide unbiased and reliable estimates; in other words, "ECM joins together SR adjustments with LR equilibrium without losing LR information" (Pesaran, Shin & Smith, 1999).

The study estimates the ARDL model by ordinary least squares (OLS), in order to test for the existence of a long-run relationship among the relevant variables first. The study conducts a Wald test (F-test version for bound-testing methodology) for the joint significance of the lagged levels of the variables[1] (Owusu & Odhiambo, 2014). The second step of the analysis is to estimate the coefficients of the long-run relationship and determine their values, followed by the estimation of the associated error correction model (the short-run elasticity of the variables) in order to calculate the adjustment coefficients of the error correction term (Pahlavani, Wilson & Worthington, 2005).

2.4. The basic ARDL model. A generic ARDL model for variables Z, Y and Z can be expressed as:

$$\Delta y_t = \beta_0 + \beta_1 \Delta y_{t-1} + y_1 \Delta x_{t-1} + \delta_1 \Delta z_{t-1} + +\theta_0 y_{t-1} + \theta_1 x_{t-1} + \theta_2 z_{t-1} + \varepsilon_t, \quad (4)$$

where θ_0, θ_1 and θ_2 are long-run coefficients; their sum is equivalent to the error correction term coefficient. The generalized ARDL model for testing the relationship between financial innovation and economic growth in this study is:

[1] Two sets of asymptotic critical values are provided by Pesaran et al. (2001). The first set assumes that all variables are I (0), while the second category assumes that all variables are I (1). The bound testing procedure notes that, (if and only if) the computed F-statistic exceeds the upper critical bounds value, then, the null hypothesis of no long-run relationship can be rejected and conclude that there exists steady state equilibrium between the variables (Al-Malkawi, Marashdeh & Abdullah (2012). Conversely, if the test statistic falls below the lower critical values, then, the null hypothesis cannot be rejected. However, if the F-statistic falls between the upper and the lower critical values, then, the result is inconclusive (Owusu and Odhiambo, 2013).

$$\Delta LRYPC_t = C_0 + \beta_1 \Delta LRYPC_{t-1} + \gamma_1 \Delta LGBCP_{t-1} + P_1 \Delta \frac{LM2}{M1_{t-1}} + \delta_1 \Delta LGEX_{t-1} + q_1 \Delta LCPI_{t-1} +$$

$$+ w_1 \Delta LTO_{t-1} + \delta_1 \Delta LCPVT_{t-1} + \theta_0 LRYPC_{t-1} + \theta_1 LGBCP_{t-1} + \theta_2 \frac{LM2}{M1_{t-1}} + \theta_3 LGEX_{t-1} + \theta_4 LCPI_{t-1} + \quad (5)$$

$$+ \theta_5 LTO_{t-1} + \theta_6 LCPVT_{t-1} + \varepsilon_t,$$

where Δ indicates differencing of a variables, while ε_t is white noise or the error term, $t - 1$ is the lagged period and all other variables are as defined above. Specific models estimated are from the general model. The long run co-integration is assessed by testing significance of the θ coefficients. In the formula, θ represents the long-run multipliers corresponding to long-run relationships. The hypothesis for no co-integration when real GDP per capita is a dependent variable against alternative hypothesis is given as:

$$H_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = \theta_6 = 0;$$
$$H_1 \neq \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq \theta_6 \neq 0. \quad (6)$$

3. Empirical results and analysis

3.1. Unit root tests. Table 1 below shows the levels of integration of variables under consideration.

The variables in this estimated model have varying levels of stationarity ranging between I(0) to I(1) (Table 1). Variables LRYPC, LM2/M1, LGEX, LCPI and LTO are difference stationary, meaning they are non-stationary in levels, but become stationary after differencing them once. The other variables, LGBCP and LCPVT, are stationary in levels.

3.2. ARDL bounds tests for cointegration. Four models were run using the ARDL bounds tests. The results indicate that Model 2 has long- run cointegration of the terms at 5% using both the Pesaran et al. (2001) and the Narayan (2005) critical values (Table 5). Models 1 and 3 are co-integrated at 10%, but the results are inconclusive at 5%. Model 4 shows no cointegration at all levels and is dropped in subsequent analyses. Table 5 below shows tests for cointegration of variables under consideration.

Table 1. Unit root test

	Level				1st Difference				I
	Constant		Constant and trend		Constant		Constant and trend		
	ADF	PP	ADF	PP	ADF	PP	ADF	PP	
LRYPC	-0.727	-0.954	-1.639	-1.844	-4.350***	-4.355***	-4.243***	-4.250***	I(1)
LGBSC	-6.793***	-12.756***	-4.750***	-16.854***					I(0)
LM2/M1	-0.508	-0.630	-1.889	-2.058	-5.818***	-5.861***	-5.710***	-5.779***	I(1)
LCPVT	-3.509**	-3.393**	-3.458*	-3.347*					I(0)
LGEX	-1.393	-1.309	-2.448	-2.359	-6.331***	-6.791***	-6.374***	-11.55***	I(1)
LCPI	2.661	2.172	1.229	2.115	-4.163***	-4.075***	-3.764**	-3.850**	I(1)
LTO	-1.102	-1.102	-3.057	-3.076	-5.233***	-6.028***	-5.636***	-5.863***	I(1)

Source: ***,**,* rejection of the null hypothesis that the series has unit root at 1%, 5%, 10% Level of significance, ADF: Augmented Dickey-Fuller; PP: Phillips- Perron, I: Integration, (Order of).

Table 2. Wald test results (F-values) for cointegration

Model	Lags	F-value	Co-integration (using Pesaran CV)
$\Delta LRYPC_t = \left[F_{RY} \left(LRYPC_t \middle| \frac{LM2}{M1_t},\ LGEX_t, LCPI_t, LTO_t \right) \right]$ *Ratio of M2 to M1 as financial innovation*	(1,1,1,0,0)	3.125	Inconclusive at 5% Present at 10%
$\Delta LRYPC_t = \left[F_{RY} \left(LRYPC_t \middle| LGBCP_t, LGEX_t, LCPI_t\ LTO_t \right) \right]$ *Growth in credit as financial innovation*	(1,1,1,0,0)	5.702	Present at 5%
$\Delta LRY_t = \left[F_{RY} \left(LRY_t \middle| \frac{LM2}{M1_t}, LGEX_t, LTO_t, LCPVT_t \right) \right]$ *Controlled for financial development*	(1,1,1,0, 1)	3.708	Inconclusive at 5% Present at 10%
$\Delta LRY_t = \left[F_{RY} \left(LRY_t \middle| LGBCP_t, LGEX_t, LTO_t, LCPVT_t \right) \right]$ *Controlled for financial development*	(1,1,1,0, 1)	0.994	Nil

		k	1%		5%		1%	
			I(0)	I(1)	I(0)	I(1)	I(0)	I(1
*ΔLRY_t is short for *$\Delta LRYPC_t$	Pesaran (2001) critical values	4	3.74	5.06	2.86	4.01	2.45	3.52
	Narayan (2005) critical values	4	4.77	6.67	3.35	4.77	2.75	3.99
	Unrestricted intercept and no trend							

3.3. Long-run coefficients. Estimated long-run coefficients for the three models are presented in Table 3 below, with results for each financial innovation variable's impact on growth explained. Table 3 shows results for a long-run ARDL bounds test regression analysis.

Table 3. Estimated long-run coefficients

	Model 1 (LM2/M1 as FI variable) ARDL (1,1,1,0,0)	Model 2 (LGBCP as FI variable) ARDL (1,1,1,0,0)	Model 3 (*controlled for FD*) ARDL (1,1,1,0, 1)
Regressors	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
C	0.89 (0.1877)	1.71 (0.0056)	0.79 (0.1850)
LM2/M1	0.40 (0.0321)		0.39 (0.0069)
LGBCP		0.05 (0.3564)	
LGEX	0.23 (0.0073)	0.33 (0.0005)	0.25 (0.0009)
LTO	0.12 (0.3210)	-0.05 (0.5980)	0.11 (0.3564)
LCPI	0.01 (0.6288)	-0.02 (0.2995)	
LCPVT			0.04 (0.3676)

3.4. Ratio of broad to narrow money and economic growth. Long-run estimates for Models 1 and 3 show that ratio of M2 to M1 (LM2/M1) is significant in explaining long-run real per capita income. This is consistent with findings by, i.e, Ogunmuyiwa & Ekone (2010) who reason that money supply ought to have a positive influence on growth. This, however, contrasts with findings by Tyavambiza and Nyagara (2015) who established that money supply (they used ratio of M3 to GDP), broad money, impacted negatively on economic growth. Theory implies that countries could stimulate economic growth through a sustainable increase in money supply which is in line with production to enhance aggregate demand. An increase in money supply (through innovation) reduces cost of financing, operating cost for banks and increases credit available for lending. This had a positive effect on economic growth in Zimbabwe, mostly in the long run. This suggests that an increase in financial innovation in Zimbabwe may have significantly driven economic growth in the long run.

3.5. Growth in banking sector credit to private sector and economic growth. Growth in banking sector credit to private sector (LGBCP), as a measure of financial innovation, has a positive impact on economic growth, although not significant. In addition, Domestic Credit to Private Sector (LCPVT), a variable introduced to control for financial development, has a positive, but insignificant effect on economic growth in the long run. The positive impact of domestic credit to the private sector confirms findings by Ndlovu (2013) and Tyavambiza & Nyangara (2015). Michalopoulos, Laeven and Levine (2009) also found that financial innovation, as measured by the growth rate of private credit to GDP, is positively related to economic growth. Idun and Aboagye (2014), however, concluded that this measure of financial innovation is negatively related to economic growth in the long run, using data for Ghana.

Both domestic credit to the private sector (LCPVT) andgrowth in banking credit to the private sector (LGBCP) variables are not significant in explaining economic growth over the sample period. A possible explanation could be that the results may have been highly influenced by the period under study. During the period under study, Zimbabwe executed its public expenditure through seigniorage. The country provided credit to productive sectors through Reserve Bank of Zimbabwe (RBZ) managed quasi-fiscal facilities[2]. Most of these facilities may not have triggered economic growth due tothe hyperinflation condition (Hanke & Kwok, 2009). Stimulate growth through the monetary side could have been weighed down by other macro-economic challenges afflicting the country. Added to that, an increase in bank credit without consideration of its distribution in the economy[3] may give a false impression. Figures may indicate high access to credit that is not linked to growing the economy. Further, it is also possible that the effects of the better economic period from 1980 to 2000, and 2010 to 2013, neutralized the negative effects of 2000-2008. As such, the effect remains positive, but insignificant.

3.6. Short-run dynamics. The Error Correction Term (ECT) shows the speed of adjustment to restore equilibrium in the long run. In other words, the ECM coefficient shows how quickly variables converge to equilibrium. Ideally, a model with a stable, long-run relationship should have a statistically significant coefficient with a negative sign (Pahlavani et al., 2005). Table 4 below shows the short-run dynamics ARDL bounds test regression analysis.

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[2] Such as the Distressed Companies Fund, Troubled Banks Facility, Agriculture Sector Productive Enhancement Facility (ASPEF), among others.

[3] For example, borrowers are selected in a partisan way and may divert funds to other uses than the intended. For example, in Zimbabwe, during the post land reform period, credit to agriculture was biased towards beneficiaries and most of the funds were abused and not used for the intended purpose.

Table 4. Short-run dynamics estimates

	Model 1 (LM2/M1 as FI variable) ARDL (1,1,1,0,0)	Model 2 (LGBCP as FI variable) ARDL (1,1,1,0,0)	Model 3 (*LM2/M1 controlled for FD*) ARDL (1,1,1,0, 1)
Regressors	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
C	-0.004 (0.7342)	-0.001 (0.9250)	-0.006 (0.6101)
D(LRYPC(-1))	0.49 (0.0065)	0.44 (0.0241)	0.503 (0.0085)
D(LM2/M1(-1))	-0.09 (0.6690)		-0.095 (0.6750)
D(LGBCP(-1))		0.003 (0.8866)	
D(LGEX(-1))	-0.01 (0.8525)	-0.02 (0.7267)	0.070 (0.1758)
D(LTO)	-0.09 (0.3132)	-0.08 (0.4196)	0.042 (0.6490)
D(LCPI)	-0.03 (0.1292)	-0.05 (0.0668)	
D(LCPVT)			-0.034 (0.1800)
ECT(-1)	-0.253(0.0247)	-0.15 (0.1485)	-0.264 (0.0358)
Diagnostic tests			
Wald test (F-statistics for FI variable)	0.187997	0.020819	0.180411
R-squared	0.496676	0.419229	0.432728
F-statistic	3.4538 (0.015626)	2.526 (0.053275)	2.924 (0.028655)
Residuals			
Breusch-Godfrey Serial Correlation LM Test (Obs*R-squared)	1.0811 (0.5824)	1.3196 (0.5169)	1.2174 (0.5441)
Heteroskedasticity test: Breusch-Pagan-Godfrey	2.7511 (0.8394)	5.0819 (0.5334)	7.547962 (0.2731)
Jargue-Bera normality	0.7587 (0.6843)	0.8209 (0.6633)	0.3298 (0.8477)
Stability			
cusum test	See graphs	See graphs	See graphs
Ramsey RESET test	2.9737 (0.1001)	2.6338 (0.1203)	7.665716 (0.0112)

Short-run dynamic estimation results show that the Error Correction Terms for Models 1 and 3 have the expected significant negative sign, indicative of existence of a long-term, co-integration relationship among the variables. The ECTs for Models 1 and 3 are-0.253 and -0.264, respectively, meaning that deviations from the long-run equilibrium following a short-run shock are corrected in approximately four years.

The lagged values of real GDP per capita are positive and significant in explaining current values, suggesting that growth in the previous period affect growth in the oncoming period. Other variables have a weak effect on real GDP per capita in the short run.

For the ratio of broad to narrow money (LM2/M1), the coefficients are negative and insignificant, contrary to long-run estimates. The negative sign for ratio of broad to narrow money, as a proxy for financial innovation, suggests that an increase in the ratio did not translate into economic growth in the short run. In fact, as the ratio increases, growth decreases. This suggests that the increase in money demand did not translate into economic growth in the short run. The relationship of financial innovation and economic growth in the short run is negative, whereas, in the long run, the impact is visibly positive and effective. The results differ strikingly from findings by Idun and Aboagye (2014) that financial innovation is positively related to economic growth in the short run in Ghana. A possible explanation could be that, in the short run, growth in liquidity failed to stimulate economic growth. Rather for Zimbabwe, it could be possible that during the decade-long economic decline period, growth in money supply was not in line with production.

3.7. A dynamic ARDL model. Table 5 below shows analyses of the three dynamic ARDL models under the spotlight.

Table 5. Dynamic ARDL model (dependent variable = lnLRYPC)

	Model 1 (LM2/M1 as FI variable) ARDL (1,1,1,0,0)	Model 2 (LGBCP as FI variable) ARDL (1,1,1,0,0)	Model 3 (*controlled for FD*) ARDL (1,1,1,0, 1)
Regressors	Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
C	-0.12 (0.6746)	-0.16 (0.5845)	-0.53 (0.0866)
LRYPC(-1)	0.87 (0.0000)	0.91 (0.0000)	0.85 (0.0000)
LM2/M1(-1)	0.03 (0.7254)		0.26 (0.0010)
LGBCP(-1)		-0.02 (0.2440)	
LGEX(-1)	0.07 (0.1895)	0.08 (0.1272)	0.03 (0.4181)
LTO	0.07 (0.1567)	0.06 (0.1424)	0.19 (0.0020)

Table 5 (cont.). Dynamic ARDL model (dependent variable = lnLRYPC)

	Model 1 (LM2/M1 as FI variable) ARDL (1,1,1,0,0)	Model 2 (LGBCP as FI variable) ARDL (1,1,1,0,0)	Model 3 (*controlled for FD*) ARDL (1,1,1,0, 1)
LCPI	-0.03 (0.0064)	-0.04(0.0001)	
LCPVT			-0.06 (0.0083)
Diagnostic tests			
R-squared	0.940614	0.943651	0.933897
F-statistic	76.03 (0.0000)	80.38 (0.0000)	70.64 (0.0000)
Residuals			
Breusch-Godfrey Serial Correlation LM Test (Obs*R-squared)	0.2035 (0.9032)	3.0456 (0.2181)	0.4103 (0.8145)
Heteroskedasticity test: Breusch-Pagan-Godfrey	5.691 (0.3374)	3.8921 (0.5650)	4.4410 (0.4878)
Jargue-Bera normality	0.323 (0.8509)	0.5144 (0.7732)	2.0954 (0.3507)
Stability			
CUSUM test	See graphs	See graphs	See graphs
Ramsey RESET test	2.576 (0.1221)	2.2934 (0.1435)	4.6625 (0.0410)

In Model 1, financial innovation (ratio of broad to narrow money) is not significant in explaining economic growth, although the sign is positive as expected. Implicitly, an increase in financial innovation results in higher economic growth. Other variables such as government expenditure and trade openness − though with a positive sign − were found to be insignificant. Inflation has a negative and significant effect on economic growth. This could be due to the fact that, as inflation increases, it reduces the purchasing power of money, thereby reducing growth, especially if it becomes hyperinflationary.

In Model 2, growth in banking sector credit to the private sector has an unexpected negative and insignificant effect on growth. The negative sign is somehow surprising, since an increase in funding to the private sector should, actually, be driving economic growth. One possible explanation could be that the increase in credit, particularly during the economic decline period in Zimbabwe (2000-2009), which was financed by seigniorage, generated negative growth weighed across the whole period due to hyperinflation condition. The financial innovation variables were found to be insignificant in the model. Financial innovation is still at low levels in Zimbabwe. Most bank innovation is consumed by people who are banked and they are in the minority. As such, its impact on general economic growth may be insignificant.

In Model 3, a variable for financial development was introduced in order to isolate the impact of financial development on economic growth. It turns out that, when combined, financial innovation and financial development become significant in explaining growth. However, domestic credit to private sector financial development has a negative sign, implying that an increase in domestic credit reduces real GDP per capita growth.

3.8. Granger causality analysis. Granger causality tests were carried out only for ratio of broad money to narrow money (LM2/M1) (money demand) and economic growth. The choice is made based on the results from the ARDL bounds tests where this proxy for financial innovation was found to be significant. The variable LM2/M1 positively influences economic growth in both the short and long run. Table 6 below shows Granger causality analysis for financial innovation and economic growth using model 1.

Table 6. Causality results: model 1(LM2/M1 as FI variable)

Long-run causality tests		Conclusion	Diagnostic check
Causality direction (independent to dependent)	Coefficient of independent (p-value)		Test statistic (p.value)
LM2/M1 to LRYPC	0.070804 (0.2033)	No evidence of long-run causality running from financial Innovation to economic growth	Serial correlation: 4.541 (0.1032); ARCH: 0.3219 (0.8513) *Normality: 2.6672 (0.2635)*
LRYPC to LM2/M1	-0.114795 (0.0360)	There is evidence of long-run causality running from economic growth to financial innovation	Serial correlation: 0.0000 (1.000) ARCH: 0.06369 (0.9687) *Normality: 14.183 (0.0082)*
Short-Run Causality Tests		Conclusion	Diagnostic check
LM2/M1 to LRYPC	1.4096 (0.2351)	No short-run causality running from financial innovation to economic growth	Serial correlation: 4.541 (0.1032); ARCH: 0.3219 (0.8513) *Normality: 2.6672 (0.2635)*
LRYPC to LM2/M1	1.8400 (0.1750)	No short-run causality running from economic growth to financial innovation	Serial Correlation: 0.0000 (1.0000) ARCH: 0.06369 (0.9687) *Normality: 14.183 (0.0082)*

The Ganger causality tests show a unidirectional causality running from economic growth (LRYPC) to financial innovation (LM2/M1). The result implies that financial innovation is demand following; in other words, as economic growth increases, it "causes" or stimulates demand for financial innovation. Since there are no previous research studies available on financial innovation and economic growth in Zimbabwe, the study compares findings with financial development and economic growth studies for Zimbabwe. The results are consistent with findings of demand following finance in Zimbabwe by Ndlovu (2013) and Sibindi and Bimha (2014) who established a "demand following" finance-growth hypothesis in Zimbabwe. Table 7 below shows Granger causality analysis for financial innovation and economic growth using model 3.

Table 7. Causality, model 3(LM2/M1 as (FI) variable, controlled for financial development)

Long-run causality tests		Conclusion	Diagnostic check
Causality direction (independent to dependent)	Coefficient of independent (p-value)		Test statistic (p.value)
LM2/M1 to LRYPC	-0.253803 (0.0016)	There is evidence of long-run causality running from financial innovation to economic growth	Serial correlation: 2.242 (0.3259) ARCH: 0.9721 (0.6150) *Normality 7.3875* (*0.0249*)
LRYPC to LM2/M1	0.056437 (0.4629)	No evidence of long-run causality running from economic growth to financial innovation	Serial correlation: 11.250 (0.0036) ARCH: 4.604396 (0.1000) *Normality: 0.1318* (*0.9362*)
Short-run causality tests		Conclusion	Diagnostic check
LM2/M1 to LRYPC	0.46649 (0.4946)	No short-run causality running from financial innovation to economic growth	Serial correlation: 2.2423 (0.3259) ARCH: 0.9721 (0.6150) *Normality 7.3875* (*0.0249*)
LRYPC to LM2/M1	1.41391 (0.2344)	No short-run causality running from economic growth to financial innovation	Serial correlation: 11.250 (0.0036) ARCH: 0.06369 (0.9687) *Normality: 0.1318* (*0.9362)*

Under model 3, when financial development is controlled, causality has a reverse effect, running from financial innovation (LM2/M1) to economic growth (LRYPC). From the results, it is concluded that netting off financial development, financial innovation causes economic growth. In other words, there is a supply-leading relationship between financial innovation and economic growth in Zimbabwe when financial development is controlled for. As money supply increases, it reduces the opportunity cost of holding money; that is, interest rate, and this increases investment which drives up production. The results are consistent with findings by Tyavambiza and Nyangara (2015) concerning the finance-leads-growth proposition in Zimbabwe.

The two models (model 1 and model 3) produce evidence of contrasting direction of causality between financial innovation and economic growth. It is difficult to assess which model is more robust and credible considering that the stability test indicates that neither of the two models reveal a serial correlation nor heteroskedasticity. The contrasting direction of causality can be regarded as indicative of bidirectional Granger causality between financial innovation and economic growth[4].

Conclusions and recommendation

This study considers financial innovation and economic growth in Zimbabwe in terms of two objectives, as specified in the introduction.

Using the ARDL bounds test and Granger causality tests, the study establishes that there is a relationship between financial innovation and economic growth in Zimbabwe. The ARDL bounds test findings vary with the measure of financial innovation used and also on the time period (short or long run). Both growth in banking sector credit to private sector (LBCP) and ratio of broad to narrow money (LM2/M1) had a positive effect on economic growth in the long run; the effect for LM2/M1 is significant,while growth in bank creditis not. In the short run, the ratio of broad to narrow money (LM2/LM1) has a negative effect on growth, while growth in banking credit to private sector has a positive effect, although neither is significant. The dynamic full model estimated also shows mixed results, depending on the variable used.

The Granger causality tests suggest a bi-directional effect on financial innovation and economic growth in Zimbabwe. Firstly, a unidirectional causality running from economic growth to financial innovationis established. Controlling for financial development on the financial innovation variables has a reverse causality, running from financial innovation (LM2/M1) to economic growth (LRYPC). The result implies that financial innovation is 'demand following'; in other words, as economic growth increases, it "causes" or drives demand for more financial innovation.

[4] However, caution must be taken in regarding this as bidirectional causality, since different models were used. The other crude basis we can assess the two models by is to use the long-run coefficients and the ECT terms. The ECT terms for both models are low, implying low speed of adjustment to long run. The long-run coefficients are not significantly different, but the levels of significance differ. The coefficient for the financial innovation variable (LM2M1) is mode significant in model 3 (at 0.7%), compared to model 1 (at 3.2%).

Analyzing the outcomes of the estimations enable assessment of whether financial innovation could be a source of growth in Zimbabwe. Since the results show that financial innovation has a positive relationship to economic growth regardless of the variable used, it implies that innovation can be a source of growth in Zimbabwe. The low levels of the Error Correction Term adjustment, of about 25.3% and 26%, however, implies that any deviation from the long-run equilibrium takes on average 4 years to correct itself following a shock in the short-run. As such, financial innovation is not a sustainable source of economic growth in Zimbabwe in the short run.

On the other hand, promoting financial innovation has along-term effect on improvement in economic growth. Initiatives for promoting financial innovation could include investment in technology and infrastructure, which support financial innovation; enhance diffusion and adoption of innovation through consumer education programs; and promote increased use of innovations in the banking sector. No matter what comes first, either economic growth or financial innovation, influencing one will help in achieving the other. Further studies can look at disaggregated financial innovation; that is, product innovation and other types of financial innovation and their individual effect on economic development. Studies could also investigate why isolating the impact of financial development reverses the direction of causality between financial innovation and economic growth. Further studies could also consider other variables as proxies for financial innovation. A research on specific product innovation and its impact on growth as well as development can also be a good departing point for further research.

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