THE IMPACT OF INTEREST RATES ON GROSS FIXED CAPITAL FORMATION: THE EFFECTS OF THE COVID-19 PANDEMIC AND REGULATORY RESPONSES

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Abstract

The South African economy has faced significant challenges in gross fixed capital formation due to the 2008–2009 global financial crisis, the pre-COVID-19 technical recession, and the COVID-19 pandemic. Despite the South African Reserve Bank's (SARB) efforts to reduce the repo rate to 3.5 percent between 2020 and 2021, the economy continues to face significant challenges (Statistics South Africa [StatsSA], 2021). Therefore, the purpose of this study is to investigate the impact of interest rates on gross fixed capital formation in South Africa. This study uses the autoregressive distributed lag (ARDL) method to investigate the impact of interest rates on gross fixed capital formation. The main findings of the study reveal a negative relationship between real interest rate and gross fixed capital formation in South Africa. Furthermore, savings reveal a positive relationship with gross capital formation. In conclusion, real interest rates affect changes in gross fixed capital creation, with higher interest rates causing decreased investment activity. This study recommends to policymakers that the SARB must lower interest rates to improve investment activity.

Keywords: Gross Fixed Capital Formation, Interest Rate, Autoregressive Distributed Lag, Fully Modified Ordinary Least Square, Canonical Cointegration Regression, South Africa, South African Reserve Bank, COVID-19

Authors' individual contribution: Conceptualization — M.P.C.; Methodology — M.P.C.; Investigation — M.P.C.; Resources — I.C.; Supervision — I.C.; Funding Acquisition — I.C.

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1. INTRODUCTION

South African gross investment is one of the critical variables that has been affected by the sluggish economic activity, owing to the pre-COVID-19 technical recession and the COVID-19 pandemic. After the 2008-2009 financial crisis, gross fixed capital formation increased marginally from 19.27% of gross domestic product (GDP) in 2010 to 20.37% of GDP in 2013 (South African Reserve Bank (SARB), 2013). That is, the increment was around 1.1%. This increment was not supportive as far as the South African economic growth and development prospects are concerned, as per the National Development Plan (NDP). Furthermore, gross fixed capital formation further decreased from 19.42% of GDP in 2016 to 12.43% of GDP in 2020, owing to the 2017–2018 technical recession and the COVID-19 outbreak (Statistics South Africa [StatsSA], 2020). That is, private sector, general government, and public corporations' investment decreased significantly. In an attempt to remedy the economy, the Monetary Policy Committee (MPC) reduced the repo rate from 5.25% to 3.5% in 2020 quarter 2, which resulted in a decline in the prime lending rate from 9.42% to 7% (SARB, 2021). Despite the MPC's efforts, gross South African investment still contracted to -3.1% in the first quarter of 2021 (StatsSA, 2021). The cause of this contraction is that private businesses invested significantly less in transport equipment and machinery and other equipment, while public corporations and the general government withheld investment projects due to financial strain (SARB, 2021).

However, gross investment bounced back a little in 2021 quarter 2 with a general increase of 0.9% (StatsSA, 2021). Private sector investment explains the whole bounce-back as private businesses increased their investment and/or capital spending (SARB, 2021). The SARB (2021) further indicates that the construction industry is the one responsible for the bounce-back since assets such as transport equipment (contributed 1.1% increase), other assets (contributed 6.4% increase), and machinery and equipment (contributed 1.8% increase) represent the incurred capital/investment spending. The general government and public corporations' investment spending continued withholding investment projects due to continued financial strain (SARB, 2021; StatsSA, 2021).

Based on the above facts regarding South African gross investment, it is evidently clear that South African gross investment depends mostly on the private sector. However, it should be noted that its investment spending increased at a slow rate compared to the pre-COVID-19 period, despite the repo rate being at its lowest since 1998. As such, the South African government aims to create a conductive macroeconomic environment to further encourage private sector investment and revive public sector investment amid the COVID-19 pandemic. To this end, President Cyril Ramaphosa presented the Economic Reconstruction and Recovery Plan (ERRP) to aid the recovery of the economy amid the coronavirus outbreak. In brief, the ERRP supports, among other things, extensive infrastructure investment, employment-focused strategic localisation, reindustrialisation and export promotion, energy security, and cleaning the public sector administrations. To ensure that these priority interventions are implemented quickly, the South African government intends to mobilise resources, make regulatory changes to ensure a supportive policy environment, and ease some of the conditions of doing business, skills development, economic diplomacy, and further integration into the African and global economies.

Given the foregoing facts regarding South African gross investment, the main objective of this study is to investigate the link between investment and interest rates. This study seeks to answer the following question:

RQ: What is the impact of interest rates on investment?

This investigation is primarily motivated by the fact that during a recession, investment typically decreases due to stock market volatility (due to market uncertainty caused by the COVID-19 pandemic) and dramatically changing share prices, both of which have a direct impact on the MPC's interest rate decisions.

The existing literature shows an extensive utilization of the ordinary least squares (OLS) method to examine the impact of interest rates on capital formation or investment (for example, the study of Xaba, 2019). Econometrics literature has harshly critiqued this approach. For instance, the method is particularly sensitive to data outliers (Kwakwa et al., 2018). Additionally, because the approach makes impractical assumptions across broad dataset ranges, it has weak extrapolation qualities. To evaluate the relationship between the gross fixed capital formation (proxy for investment activity) and interest rate in South Africa, the study contributes by utilising the autoregressive distributed lag (ARDL) approach. This approach has the benefit of producing the most accurate and reliable estimates, even with smaller sample sizes as compared to the OLS method.

It is very important to note that although the studies by Kasongo (2019), Mongale and Baloyi (2019), and Meyer and Mothibi (2021) used the method proposed by this study, the authors did not use additional/supplemental methods to test for the robustness of the results. To verify the stability of the results to be estimated by the ARDL approach, the study uses other supplemental cointegration methods such as the fully modified OLS (FMOLS) and canonical cointegration regression (CCR). This is significant because it demonstrates that pluralistic methods/perspectives are frequently practical and acceptable for a given subject and that no single perspective or method can ever fully capture the context because several realities exist (Davis et al., 2011).

The structure of this paper is as follows. Section 2 reviews the relevant literature. Section 3 presents the study's data and methodology. Section 4 presents the results of the study. Section 5 discusses the results and their implications. Section 6 concludes the paper by offering the study's conclusion and policy recommendations.

2. LITERATURE REVIEW

The study reviews the theoretical and empirical literature underpinning the relationship between interest rates and gross fixed capital formation or investment. Theoretical literature is discussed first, followed by empirical literature.

2.1. Theoretical literature

2.1.1. Classical theory of interest rates

According to Metzler (1951), David Ricardo, John Stuart Mill, Alfred Marshall, and Arthur Pigou were the original founders of the classical theory of interest rates. In essence, the theory views interest as a phenomenon, with the rate of interest being solely controlled by real variables such as supply and demand for capital in a setting of perfect competition (Snippe, 1985). Snippe (1985) goes on to say that when monetary variables are neglected, the supply of capital is controlled by the preference for saving money or time, and the demand for capital is determined by the productivity of capital. When firms borrow money to invest, interest is essentially a cost of doing business. As a result, interest rates have an impact on investment (Brady, 2017). High investment is encouraged by low interest rates, whereas high interest rates discourage investment (Hayes, 2010). Therefore, the correlation between interest rates and investment is negative. Furthermore, savings from families satisfy enterprises' desire for investment, which reflects supply in the market for goods, whereas investing represents demand (Tabibu, 2020). As a result, in the goods market, the interest rate is fixed at the point where the demand for investments and the supply of savings intersect (Brady, 2017). Therefore, according to classical theory, investment is a decreasing function of interest rates, while savings are a rising function of interest rates. Therefore, the theory suggests that the researcher should anticipate a negative relationship between the interest rate and investment, as well as a positive relationship between the interest rate and savings (one of the chosen independent variables).

2.1.2. Keynesian theory of interest rate

According to Keynes (1936), the market rate of interest reflects people's unwillingness to give up control over their money. The assumption that the interest rate is the price at which the demand for savings equals the supply of savings is refuted in this theory. Keynes (1936) disproves the notion that interest rates are used to compensate for savings. Keynes (1936) believes that the willingness of an individual to hold their money in the form of cash is how control over future spending is reserved. This component is defined as a liquidity preference. Briefly, liquidity preference is the function of a fixed amount of money at a fixed interest rate. Through liquidity preference, Keynes (1936) emphasises that income fluctuations affect transaction and cautious incentives, whereas interest rate changes influence speculative motives. As a result, the aggregate demand for money to fulfil the speculative motive often responds consistently to incremental changes in interest rates (Próchniak & Wasiak, 2016).

Central banks, according to Keynes (1936), influence investment processes not only by managing the amount of money in circulation but also by influencing people's liquidity decisions, which are influenced by speculative incentives. As a result, in his interest rate theory, Keynes (1936) questioned the contribution of the classics in this field. This criticism is based on an inaccurate understanding of interest rates, which Keynes (1936) believed was due to disregarding the effect of income on interest rate levels. Most economists supported Keynes's interest rate theory, which required rejecting previously accepted orthodoxy while also embracing a new mode of economic reasoning. This critique is a counterargument to Keynes's interest-rate theory, which is founded on the idea of liquidity preference.

Just like the classical economists' theory, the theory suggests that the researcher should anticipate a negative relationship between the interest rate and investment, and the theory also encourages the researcher to account for the effect of real income on interest rates and investment.

2.2. Empirical literature

Xaba (2019) investigated the influence of interest rates on savings and investments in South Africa from 2007 to 2017 using the OLS technique. In the study, variables such as interest rate (repurchase rate), savings, and investment were employed. The study found a statistically significant positive relationship between the interest rate and savings and a statistically significant negative relationship between the interest rate and investment, demonstrating the compatibility of classical and neo-classical interest rate theories. Tabibu (2020) obtained the same results in the case study of South Africa using the same method.

The study by Kasongo (2019) employed ARDL technique to establish a positive and statistically significant relationship between the real interest rate (the rate of investment returns) and investment. The research advocated for foreign direct investment (FDI) as an alternative for local investment and flexibility of investment policy to attract more investors.

Mongale and Baloyi (2019) examined the determinants influencing international investment decisions in South Africa from 2007 to 2017. In the study, household disposable income, labour productivity, investment infrastructure (measured by gross fixed capital formation), interest rate, labour unrest, and FDI were discovered to have a positive and statistically significant relationship.

Using the Johansen cointegration method, Bader and Malawi (2010) assessed the impact of interest rates on investment in Jordan from 1990 to 2005. Variables included gross fixed capital formation, real interest rate, and income (GDP). According to the findings, there is a statistically significant inverse relationship between the real interest rate and gross fixed capital formation (investment).

Meyer and Mothibi (2021) applied the ARDL technique to examine the impact of risk-rating agencies' choices on economic growth and investment in South Africa from 1994Q1 to 2020Q2. The study discovered a statistically negative relationship between the loan interest rate and investment, as well as a statistically significant positive relationship between the risk-rating index, economic growth, and investment.

As previously noted, the OLS approach was used in the research of Xaba (2019) and Tabibu (2020) in South Africa, which has been strongly criticised in the econometric area. It is also worth mentioning that the studies of Kasongo (2019), Mongale and Baloyi (2019), and Meyer and Mothibi (2021) followed the researcher's method, but the authors did not use the supplemental econometric methodologies to examine the robustness of the results. Consequently, the ARDL-predicted findings will be verified for robustness using alternative cointegration methods such as FMOLS and CCR.

Leshoro and Wabiga (2023) investigated the asymmetric effects of interest rates on private investment in South Africa. The study utilised annual time series data from 1971 to 2019. The study used the nonlinear autoregressive distributed lag (NARDL) technique to analyse data. Findings from this study revealed that interest rates and private investment have short-run and long-run asymmetric relationships. This study is among the first to use the asymmetric effects of interest rates on investment.

Shama and Alhakimi (2020) examined the causal relationship between interest rate and investment in Egypt using the ARDL approach. The study used time series annual data for the period 1980 to 2018.

The results indicated the presence of a long-run cointegration relationship between investment and interest rates. In addition, the findings also revealed that interest rate Granger causes investment.

Dotsis (2020) examined investment under uncertainty with a zero lower bound on interest rates. The study used the shadow rate model of Black (1995). The results showed that the presence of a lower bound on interest rates can produce a positive relationship between interest rate volatility and investment.

3. DATA AND METHODOLOGY

3.1. Data

The study follows the empirical model used in the study of Bader and Malawi (2010), which examined how the interest rate influenced investment in Jordan. Equation (1) presents the linear empirical model that was used by the authors.

$$GFCF_t = \gamma_0 + \gamma_1 ITR_t + \gamma_2 GDP_t + \mu_t \quad (1)$$

where $GFCF$ is gross fixed capital formation (proxy variable for investment), and ITR is the interest rate. Coefficients γ_0, γ_1 and γ_2 are the linear parameters that were to be estimated in the study. Furthermore, μ denotes the stochastic error term, and t time. The empirical model described in Eq. (1) is used in this study, but GDP is replaced by gross national income (*GNI*), and savings (*SAV*), government expenditure (*GEX*), business confidence (*BCE*), and technological change (*TEC*) are included as independent variables. According to the theoretical and empirical literature examined in this study, the inclusion of these factors is to avoid specification bias. As a result, Eq. (2) represents the study's linear empirical model in natural logarithm (*L*) format. The researcher chooses the natural logarithm format to ensure stability of the residuals' variance and interpretation simplicity.

$$LGFCF_t = \varphi_0 + \varphi_1 LITR_t + \varphi_2 LGNI_t + \varphi_3 LSAV_t + \varphi_4 LGEX_t + \varphi_5 LBCE_t + \varphi_6 LTEC_t + \mu_t \quad (2)$$

where $GFCF$ is measured as a percentage of GDP, and ITR by real interest rate (percentage). Furthermore, GNI, SAV, and GEX are measured as a percentage of GDP. BCE and TEC are measured by indices provided by the World Bank. Lastly, $\varphi_0, \dots, \varphi_6$ are the linear parameters to be estimated in this study, and μ_t as well as L denote the stochastic error term, time, and natural logarithm operator, respectively. Time series data covering the period 1990Q1 to 2021Q4 for the variables indicated in the empirical model expressed by Eq. (2) is sourced from the World Bank database.

3.2. Methodology

The ARDL technique is used to estimate the empirical model presented by Eq. (3). The method's adoption is informed by the empirical literature. Pesaran et al. (2001) were the first to propose this method. The ARDL method has several advantages, some of which are as follows: 1) the ARDL model produces reliable and consistent estimates for both short- and long-run relationships, even with a small sample size; and 2) variables can be integrated in the order 0, 1, or a mix of 0 and 1 to test for short- and long-run relationships. As a result, variables with an integration order of 2 cannot be used. The mathematical expression for the ARDL model of the study is presented by Eq. (3).

$$\Delta LGFCF_t = w_0 + \sum_{i=1}^{n} w_{1i}\,\Delta LGFCF_{t-i} + \sum_{i=1}^{n} w_{2i}\,\Delta LITR_{t-i} + \sum_{i=1}^{n} w_{3i}\,\Delta LSAV_{t-i} + \sum_{i=1}^{n} w_{4i}\,\Delta LGNI_{t-i} + \sum_{i=1}^{n} w_{5i}\,\Delta LGEX_{t-i} + \sum_{i=1}^{n} w_{6i}\,\Delta LBCE_{t-i} + \sum_{i=1}^{n} w_{7i}\,\Delta LTEC_{t-i} + \pi_8 LGFCF_{t-1} + \pi_9 LITR_{t-1} + \pi_{10} LSAV_{t-1} + \pi_{11} LGNI_{t-1} + \pi_{12} LGEX_{t-1} + \pi_{13} LBCE_{t-1} + \pi_{14} LTEC_{t-1} + \mu_t \quad (3)$$

where, Δ is the difference operator, w_{ni} and π_n are the estimates for short- and long-run coefficients, and $\sum_{i=1,t-1}^{n}$ is the lag order.

As the study makes use of additional cointegration methods such as the FMOLS and CCR to test the robustness of the ARDL method's expected findings, Eq. (4) and Eq. (5) present the FMOLS and CCR estimator, respectively:

$$\vartheta_{FMOLS} = \left(\sum_{t=1}^{T} Z_t Z_t'\right)^{-1}\left(\sum_{t=1}^{T} Z_t\, Y_t^{+} - T\hat{J}^{+}\right) \quad (4)$$

where $Y_t^{+} = Y_t - \hat{\rho}_{OX}\hat{\rho}_{XX}{}^{-1}\Delta X_t$ is the correction term for endogeneity, $\hat{\rho}_{OX}$ and $\hat{\rho}_{XX}$ are the kernel estimates of long-run covariances, $j = \Delta X_{OX} - \rho_{OX}\hat{\rho}_{XX}{}^{-1}\hat{\Delta}_{XX}$ is the correction for serial correlation, and $\hat{\Delta}_{OX}$ as well as $\hat{\Delta}_{XX}$ are the kernel estimates of one-sided long-run covariances.

$$\vartheta_{CCR} = \left(\sum_{t=1}^{T} Z_t^{*} Z_t^{*1}\right)^{-1} \sum_{t=1}^{T} Z_t^{*} Y_t^{*} \quad (5)$$

where, $Y_t^{*} = \left(X_t^{*1}, D_t'\right), X_t^{*} = X_t - \left(\hat{\sum}^{-1}\hat{\tau}_2\right)\hat{v}_t$ and $Y_t^{*} - \hat{\sum}^{-1}\hat{\tau}_2\hat{\beta} + \left(\hat{\pi}_{22}{}^{-1}\hat{\varphi}_{21}\right)^{1} v_t$ denote the transformed, $\hat{\beta}$ is an estimate of the cointegrating equation coefficients, $\hat{\tau}_2$ is the second column of the estimate of τ and $\hat{\sum}$ denotes the estimated contemporaneous covariance matrix of the residuals.

Briefly, the FMOLS estimator uses a semi-parametric approach to construct long-run estimates, and it is also concerned with both data and parameter transformation (Phillips & Hansson, 1990). In contrast, CCR is strictly concerned with data transformation (Park, 1992).

4. ECONOMETRIC ANALYSIS AND INTERPRETATION OF RESULTS

The study makes use of the Dickey-Fuller stationarity/unit root test. Therefore, Tables 1a and 1b present the results of the Dickey-Fuller unit root test for level and 1st difference, respectively.

Table 1a. Level results for Dickey-Fuller GLS stationarity test

Time series	*Intercept*		*Intercept and trend*	
	t-statistic	*prob.*	*t-statistic*	*prob.*
LGFCF	0.403652	0.6887	-3.87464	0.0004***
LITR	-0.884915	0.3824	-0.886565	0.3804
LSAV	-2.001978	0.0521***	-4.785596	0.0000***
LGNI	-0.199748	0.8427	-2.135877	0.0389**
LGEX	1.286695	0.2069	-1.174269	0.2484
LBCE	0.403637	0.6887	-3.874646	0.0004***
LTEC	-1.203331	0.2359	-1.560255	0.1266

*Note: ***/**/* denote statistical significance at 0.01, 0.05, and 0.10, respectively.*
Source: Calculations generated by the Authors through EViews 12.

According to Table 1a, the results show that *LGFCF*, *LSAV*, *LGNI*, and *LBCE* are stationary under the 'intercept and trend' assumption at the 0.01 and 0.05 significance levels, and *LSAV* is stationary under the 'intercept' assumption at the 0.10 level of significance. Therefore, the order of integration for variables *LGFCF*, *LGNI*, and *LBCE* is 0 at the 0.01 and 0.05 levels of significance under the 'intercept and trend' assumption, and the order of integration for *LSAV* is 0 under the 'intercept' assumption at the 0.10 level of significance. The first-difference findings of the Dickey-Fuller generalized least squares (DF-GLS) test for variables that were not stationary at level under different assumptions are shown in Table 1b.

Table 1b. 1st difference results for Dickey-Fuller GLS stationarity test

Time series	*Intercept*		*Intercept and trend*	
	t-statistic	*prob.*	*t-statistic*	*prob.*
LGFCF	-2.46667	0.0198**	N/A	N/A
LITR	-5.806979	0.0000***	-6.355369	0.0000***
LSAV	-	-	-	-
LGNI	-3.172623	0.0029***	-	-
LGEX	-1.903652	0.0652*	-2.190746	0.0352**
LBCE	-2.466525	0.0198**	-	-
LTEC	-4.23978	0.0001***	-4.449466	0.0001***

*Note: ***/**/* denote statistical significance at 0.01, 0.05, and 0.10, respectively.*
Source: Calculations generated by the Authors through EViews 12.

According to Table 1b, the results show that *LGFCF*, *LITR*, *LGNI*, *LGEX*, *LBCE*, and *LTEC* are stationary under all assumptions. As a result, for all assumptions, the order of integration for *LGFCF*, *LITR*, *LGNI*, *LGEX*, *LBCE*, and *LTEC* is 1. Having all the time series (using DF-GLS unit root test) being integrated to the order of 1 enables the researcher to use the ARDL methodology since the methodology requires the variables under study to be integrated to the order of 0, 1, or the combination of the two (Brooks, 2019). Therefore, Table 2 presents the values of different information criteria and the chosen lag order.

Table 2. Information criteria values for lags 0 and 1

Information criterion	*Lags*	
	0	*1*
Final prediction error (FPE)	2.60e-16	1.29e19*
Akaike information criterion (AIC)	-18.85859	-18.58104*
Schwarz information criterion (SC)	-18.58104	-24.56783*
Hannan-Quinn information criterion (HQ)	-18.76812	-25.87824*

*Note: * marks the lag order selected by the respective information criterion.*
Source: Authors' own computations using EViews 12.

The results presented in Table 2 indicate that the optimal lag order is 1. This is because information criteria select lag 1, as shown by the * symbol on the table above. Consequently, the ARDL model to be estimated in this study is ARDL (1, 1, 1, 1, 1, 1, 1) if the selected lag order is allowed to be kept fixed across all the independent variables and the dependent variable. Therefore, Table 3 presents the bounds test results for the model ARDL (1, 1, 1, 1, 1, 1, 1).

Table 3. Results for the bounds test

Model	*Cal. f-statistic*	*Conclusion*
LGFCF = f(*LITR*, *LSAV*, *LGNI*, *LGEX*, *LBCE*, *LTEC*)	3.7474**	Cointegration

*Note: Significance levels at I(0) and I(1): 0.01 (2.88, 3.99), 0.05 (2.27, 3.28), 0.10 (1.99, 2.94). ***/**/* denote statistical significance at 0.01, 0.05, and 0.10, respectively.*
Source: Authors' own computations using EViews 12.

Table 3 shows that the study's principal empirical model is cointegrated at 0.05 and 0.10 significance levels since the computed f-statistic is greater than the critical f-statistic at the upper bound (I[1]) at the 0.05 and 0.10 levels of significance. Therefore, Table 4 provides estimates for the ARDL long-run coefficients, as well as the FMOLS and CCR long-run estimates (for robust checks).

Table 4. ARDL (1, 1, 1, 1, 1, 1, 1), FMOLS and CCR long-run & short-run coefficient estimates

Regressor	*Long-run coefficients*			*ARDL (1, 1, 1, 1, 1, 1, 1) Short-run coefficients*
	ARDL	*FMOLS*	*CCR*	
C	-2.316046 (-34.9748) ***	-2.364057 (-76.7751) ***	-2.367682 (-61.4894) ***	N/A
LITR	-0.714893 (-7.4331) ***	-0.637039 (-3.1334) ***	-0.637039 (-3.1334) ***	-0.511943 (-4.76089) ***
LSAV	0.471882 (3.0442) ***	0.462135 (4.5056) ***	0.422135 (4.5056) ***	0.417255 (2.786139) **
LGNI	0.630795 (3.1651) ***	0.701001 (6.9764) ***	0.701001 (6.9764) ***	0.569871 (5.530580) ***
LGEX	0.514729 (2.4253) **	0.581240 (2.8157) **	0.581240 (2.8157) ***	0.514613 (4.980094) ***
LBCE	0.680292 (5.6507) ***	0.680292 (5.6507) ***	0.680292 (5.6507) ***	0.410028 (3.290517) ***
LTEC	0.510179 (2.3593) **	0.532514 (5.2437) ***	0.532514 (5.2437) ***	0.436732 (2.171370) **
Coefficient of determination, f-statistic & error correction term (ECT)				
R-squared	0.7005512	0.700552	0.700523	
Prob. (F-statistic)	0.0000***	N/A	N/A	
ECT	-0.677504***	N/A	N/A	

*Note: Values inside the parentheses are the computed t-statistics. ***/**/* denote statistical significance at 0.01, 0.05, and 0.10, respectively.*
Source: Calculations generated by the Authors through EViews 12.

Using the ARDL method, the results in Table 4 reveal that a 1% rise in *ITR* results in a 0.7149% decline in gross fixed capital formation in the long run. This statistically significant negative relationship is corroborated by the FMOLS and CCR methodologies, which show that a 1% increase in *ITR* results in a 0.6370% decline in gross fixed capital formation in the long run. In the short run, a 1% increase in *ITR* significantly results in a 0.5119% decline in gross fixed capital formation. In the case study of South Africa, using OLS, Xaba (2019) found a statistically significant relationship between the interest rate and savings and savings, and a statistically significant relationship between the interest rate and investment. Tabibu (2020) examined the influence of the real interest rate on investment in South Africa. According to the study, there is a statistically significant inverse association between the real interest rate, the real exchange rate, unemployment, and investment. Mongale and Baloyi (2019) examined the determinants influencing international investment decisions in South Africa from 2007 to 2017. In this study, the dependent variable and all the independent factors were discovered to have a positive and statistically significant relationship. Meyer and Mothibi (2021) examined the impact of risk-rating agencies' choices on economic growth and investment in South Africa. The study discovered a statistically negative relationship between the loan rate (interest rate) and investment. Based on the results of this current study and the findings of previous studies, it can be concluded that there is a negative relationship between interest rate and investment.

Furthermore, the results indicate that a 1% increase in *SAV* leads to a 0.4719% rise in gross fixed capital formation over time. In the long run, the FMOLS and CCR methodologies support this statistically significant positive relationship, indicating that a 1% increase in *SAV* leads to 0.4621% and 0.4221% increases in gross fixed capital formation, respectively. In the short run, a 1% increase in *SAV* leads to a 0.4173% rise in gross fixed capital formation. These results are in line with the loanable funds theory of interest, which sees savings as the sole source of investment/capital expenditure. Previous researchers such as Adebola and Dahalan (2012), examined the degree of capital mobility and the application of the savings-investment link for Tunisia from 1970 to 2009. The results revealed low capital mobility. In addition, the long-run estimates showed that savings are positively associated with investment. Nasiru and Usman (2013) explored the relationship between savings and investments in Nigeria from 1980 to 2011. The results of the bounds test suggest that there is a long-run relationship between savings and investment.

Table 4 shows that a 1% rise in *GNI* and *GEX* leads to a 0.6308% and 0.5147% increase in gross fixed capital creation in the long run. These positive and statistically significant relationships are further verified by the FMOLS and CCR approach results, which show that a 1% rise in *GNI* and *GEX* leads to 0.7010% and 0.5812% increases in gross fixed capital creation, respectively. In the short run, a 1% rise in *GNI* and *GEX* leads to 0.5699% and 0.5146% increases in gross fixed capital formation, respectively. These long- and short-run results support the Keynesian school of thought, in which income is viewed as a significant determinant of investment and capital spending decisions, and government intervention (via increased/decreased tax rates or government expenditure) is pivotal in improving the state of the economy during recessions or economic downturns (including stimulating investment or capital formation) and balancing out the economy equilibrium when there is an excess boom in the economy. Using vector autoregression and ARDL methods, Akinlo and Oyeleke (2018) examined the effect of government expenditure on private investment in Nigeria from 1980 to 2016. The findings revealed that government expenditure has a positive but insignificant impact on private investment in the long run. Kim and Nguyen (2020) examined the causal impact of public-sector spending on corporate investment. Results showed that positive government expenditure reduces corporate investment by hurting firms' investment opportunity sets.

Table 4 further demonstrates that a 1% rise in *BCE* and a 0.51% increase in *TEC* result in a 0.6803% and 0.5101% increase in gross fixed capital formation, respectively, in the long term. The FMOLS and CCR technique results supplement these findings by indicating that a 1% rise in *BCE* and *TEC* leads to a 0.6803% and 0.5325% increase in gross fixed capital formation, respectively, in the long term. In the short run, a 1% rise in *BCE* and technical change/innovation leads to 0.4100% and 0.4367%

increases in gross fixed capital formation, respectively. Long- and short-run positive relationships between business confidence and gross fixed capital formation validate the classical economists' theory of firms, which states that when firms are optimistic about future returns, they choose to increase capital asset investment to enhance production (Maredza & Nyamazunzu, 2016). Therefore, changes in firm/business confidence, may have a substantial influence on investment/capital spending decisions. In other words, uncertainty about the future might undermine trust, prompting organisations to postpone investment/capital decisions until the situation improves (Maredza & Nyamazunzu, 2016). Lastly, the long- and short-run positive relationship between business confidence/innovation and gross fixed capital formation is consistent with the endogenous growth theory, which states that business confidence/innovation is built on both improved and increased technological states, which organically expand the capital stock and/or investment spending (Musso, 2004). Using the ARDL technique, de Jongh and Mncayi (2018) analysed the relationships between business confidence, investment, and economic growth in the South African economy. Findings suggested that both changes in business sentiment and domestic investment significantly affect changes in current GDP levels. Madzivire (2017) investigated the impact of business confidence on private investments in South Africa. The results of the study indicated that private investments are subject to permanent changes because of changes in business confidence. Khan and Upadhayaya (2020) determined how informative business confidence is for investment growth in the United States (US). The main findings revealed that business confidence has predictive ability for investment growth in the US.

R-squared is 70.05%, which indicates that variances in *ITR*, *SAV*, *GNI*, *GEX*, *BCE*, and technical change or progress account for 70.05% of the variance in gross fixed capital formation. This model is satisfactorily fitted since the overall model is significant at the 1%, 5%, and 10% levels of significance (using the F-statistic), and R-squared is greater than 50%. In evaluating the short-run dynamics, the ECT is statistically significant with a coefficient of -0.6775. This means that over the next period (quarter), the model's disequilibrium is rectified to 67.75%. This is satisfactory because 67.75% is greater than 50%. That is, the estimated ARDL ECM significantly shifts towards an equilibrium steady state.

The study uses the Granger causality test to determine the direction of cointegration so that proper policy recommendations may be carefully recommended. Therefore, Table 5 presents the results for the Granger causality test.

Table 5. Causality test results

Hypothesis under test	*N*	*F-statistic*	*p-value*	*Interpretation of results*
LGFCF is not Granger-caused by *LITR*.	47	15.72	0.0001***	LITR Granger-causes LGFCF.
LITR is not Granger-caused by *LGFCF*.	47	0.87	0.3573	Granger-causality is absent.
LGFCF is not Granger-caused by *LSAV*.	47	17.03	0.0000***	LSAV Granger-causes LGFCF.
LSAV is not Granger-caused by *LGFCF*.	47	1.17	0.2851	Granger-causality is absent.
LGFCF is not Granger-caused by *LGNI*.	47	9.17	0.0020***	LGNI Granger-causes LGFCF.
LGNI is not Granger-caused by *LGFCF*.	47	13.85	0.0008***	LGFCF Granger-causes LGNI.
LGFCF is not Granger-caused by *LGEX*.	47	15.20	0.0002***	LGEX Granger-causes LGFCF.
LGEX is not Granger-caused by *LGFCF*.	47	2.59	0.1151	Granger-causality is absent.
LGFCF is not Granger-caused by *LBCE*.	47	9.38	0.0034***	LBCE Granger-causes LGFCF.
LBCE is not Granger-caused by *LGFCF*.	47	9.51	0.0037***	LGFCF Granger-causes LBCE.
LGFCF is not Granger-caused by *LTEC*.	47	12.26	0.0003***	LTEC Granger-causes LGFCF.
LTEC is not Granger-caused by *LGFCF*.	47	0.14	0.1136	Granger-causality is absent.
LITR is not Granger-caused by *LSAV*.	47	16.52	0.0001***	LITR Granger-causes LSAV.
LSAV is not Granger-caused by *LITR*.	47	0.23	0.2523	Granger-causality is absent.

*Note: ***/**/* denote statistical significance at 0.01, 0.05, and 0.10, respectively.*
Source: Calculations generated by the Authors through EViews 12.

At the 1% level of significance, gross fixed capital formation in South Africa is Granger-caused by *ITR*, *SAV*, *GNI*, *GEX*, *BCE*, and *TEC* or progress. According to Table 5, gross fixed capital formation Granger-causes *GNI* and *BCE* in South Africa at the 1% level of significance. As a result, the long-run relationship is directed from the *ITR*, *SAV*, *GNI*, *GEX*, *BCE*, *TEC* or progress to gross fixed capital formation, and then from gross fixed capital formation to *GNI* and *BCE*.

Lastly, coefficients and residuals for the estimated ARDL model need to be diagnosed if policy implications and recommendations to be provided are to be declared reliable. Therefore, Table 6 presents the results of the stability (for diagnosing the estimated ARDL coefficients) and residual diagnostics tests.

Table 6. Results for stability and residuals diagnostics tests

Test	*Hypothesis under test*	*Prob.*	*Conclusion*
Ramsey specification error (stability)	No specification error.	0.7394	No specification error.
Normality	The residuals are normal.	0.1068	The residuals are normal.
Serial correlation	There is no serial correlation.	0.3519	No serial correlation.
Heteroscedasticity	There residuals are homoscedastic.	0.4810	No heteroscedasticity.

Source: Calculations generated by the Authors through EViews 12.

The probability value for the stability test statistic (0.7394) is greater than the significance levels of 0.01, 0.05, and 0.10, as shown in Table 6. This suggests that the estimated ARDL model is correctly specified. In addition, the tested hypotheses on all residual diagnostic tests are not rejected at the 0.01, 0.05, or 0.10 level of significance. This simply indicates that there is no serial correlation or heteroscedasticity in the residuals and that they are normally distributed.

5. DISCUSSION OF THE RESULTS

Negative and statistically significant relationship between gross fixed capital formation and interest rates in both the long and short run show the consistency of the classical economists' theory of investment, the loanable funds theory, and the Keynesian theory of interest rates. These theories read the interest rates as the cost of capital/investment. As a result, the economic consequence suggested here is that if the monetary authority (SARB) raises interest rates in both the long and short run, South Africa's gross fixed capital creation would fall. This should caution the SARB since shocks in investment activity are affected by the variations in interest rates in South Africa.

Positive and statistically significant relationships between savings and gross fixed capital formation in both the long and short run confirm the loanable funds theory of interest, which sees savings as the sole source of investment/capital expenditures. The implication is that if South Africa wants to expand its gross fixed capital formation, it must raise its short- and long-term savings capacity — more especially if variations in gross fixed capital formation are affected by the shocks in savings.

Positive relationship between gross national income, government expenditure and gross fixed capital formation in both the long and short run inform the Keynesian school of thought, in which income is viewed as a significant determinant of investment and capital spending decisions, and government intervention (via increased/decreased tax rates or government expenditure) is pivotal in improving the state of the economy during recessions or economic downturns (including stimulating investment or capital formation) and balancing out the economy equilibrium when there is an excess boom in the economy. Furthermore, shocks in the South African investment activity are affected by variations in gross national income and government expenditure. The economic implication is that South Africa's gross national income and government expenditure enhance gross fixed capital formation in both the long and short run.

Lastly, positive relationship between business confidence, technological change (innovation) and gross fixed capital formation in both the long- and short run are consistent with classical economics' firm and endogenous growth theories, which hold that when companies are positive about future returns and potential robust technology/innovation, they choose to increase capital assets and investment activity to boost output, more especially if variations in business confidence and technology/innovation affect shocks in gross fixed capital formation. Therefore, increased business confidence and technology/innovation prospects increase investment activity in South Africa.

6. CONCLUSION

Savings are positively and considerably related to gross fixed capital formation, whereas the interest rates is negatively and significantly related to gross fixed capital formation. According to the economic implications, as interest rates rise, overall investment declines, but savings and investment rise. As a result, the South African monetary authority and the central government must comprehend the process of saving and investing, as well as their connection to interest rates. This is because the interest rates Granger-cause savings. This would allow these two essential parties to make better policy decisions that would encourage economic growth or recovery amid the COVID-19 spillover effects and post-COVID-19 pandemic.

Local enterprises in South Africa require investment and/or capital formation for several reasons, including the procurement of new machinery, the construction of new structures, and the raising of cash to expand plant capacity. South Africa's public sector requires investment and capital formation to carry out public works projects such as improving the country's infrastructure, building new or renovating buildings, roads, hospitals, and bridges, among other things. The accumulation of investment and capital boosts the country's economic potential and raises South Africans' living standards. The processes of saving and investment/capital accumulation are critical to the income cycle and influence income levels. As a result, the SARB must guarantee that interest rates on deposits and loans are adjusted to boost investment, resulting in economic development, increased GDP, and a greater quality of life for South Africans. As previously stated, higher savings contribute to higher gross fixed capital formation. As a result, the South African national government should promote a saving culture. Yet, given the country's high unemployment rate and the effects of the COVID-19 pandemic, this will be challenging. That is, the South African national government should design and implement policies to foster savings culture in the face of COVID-19 because the COVID-19 spillover effects will undoubtedly be present for a long time.

Gross fixed capital formation is positively and strongly related to gross national income. The implication for economic policy is that rising national income leads to increasing investment activity. Based on the Keynesian idea that when total investment increases by a certain amount, total income increases by a multiple of that amount (since bi-directional cointegration is established in this study), and this study recommends the adoption and implementation of policies aimed at creating employment, with greater participation from the private sector, and the promotion of an entrepreneurship culture. This would aid in the government's attempts to address employment difficulties by increasing productive capacity, leading to higher production and income to support firms' and consumers' investment projects or ventures.

Government expenditure has a positive and strong relationship with gross fixed capital formation. The economic policy conclusion is that increasing government expenditure leads to more investment activity. This study suggests that the government utilises its spending programmes to acquire goods and services for public investment rather than for immediate usage. Furthermore, the government should be cautious not to use its spending programmes to reduce the economy's savings, as this would raise interest rates and lead to lower investment/capital spending in areas such as house construction and productive capacity, which include the facilities and infrastructure that enable the economy to produce goods and services.

Gross fixed capital formation is positively and strongly related to business confidence. The implication for economic policy is that an increase in business confidence leads to higher investment activity. According to the findings of this study, the government should ensure that the business environment is conducive to doing business. This will foster steady and durable corporate confidence in the banking sector and the overall economy, allowing for a more positive stance on the government's growth prospects, potential investment programmes, and national aspirations.

Gross fixed capital formation is positively and strongly related to technological development. The implication for economic policy is that higher technological advances lead to increased investment activity. This study suggests that technology improvements be encouraged since they have a positive impact on investment decisions. As a result, the investment costs change, and demand shocks have an influence on investment profitability. When technological advances have an impact on future profitability, there will be considerable long-term repercussions, causing investment thresholds to rise and option values to fall. This would boost industry-level investment, increasing company quality and efficiency and, as a result, consumer surplus and welfare.

Owing to the differences in the South African macroeconomic structure and environment, the empirical findings and policy implications suggested by this study may not be relevant to other emerging economies. As a result, generalising the empirical findings and policy implications from this study may be impractical in other emerging economies. Furthermore, the purpose of this study was solely to analyse the impact of the factors presented in the study's empirical model. That is, there may be other factors influencing South Africa's gross fixed capital formation.

The influence of interest rates volatility or shocks on savings and investment in South Africa is a suggestion for further research. This is because of the revelation made in this study, i.e., that the interest rates balance the equilibrium investment funds and savings.

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