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# Effect of GDP, Interest Rate and Inflation on Private Investment in Rwanda

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## Abstract

Rwanda is one of the developing counties whose private investment is still low. Viewed against the background of growing evidence of a link between investment and economic growth, an inconsistent trend in Rwanda's private investment is a matter of concern. The question of what determines private investment behavior in Rwanda becomes an important one. Studies in developing countries emphasized on the importance of macroeconomic policy in explaining variations in investment, and in particular, identify the macroeconomic determinants of private investment to include: interest rates, output growth, public investment, bank credit to the private sector, inflation, real exchange rate, and the level of trade. This study proceeds in the same vein and investigated the effect of GDP, interest rate and inflation rates on private investment in Rwanda (1995-2009) by means of econometric analysis based on the co-integration and Error Correction Model (ECM). The study findings support the existence of a short-run dynamic adjustment and the long-run equilibrium relationship between these macroeconomic variables and private investment level. The results showed that gross domestic product growth affects private investment and both in the long-run and short-run. The impact of real interest rates on private investment is highlighted in this study especially in the short-run model. Finally, a positive impact of inflation rate on private investment is confirmed by the empirical results in this study. Therefore, the empirical evidence provided suggests that there would be an increase in the level of private investment when the private sector is squeezed for credit.

**Keywords:** GDP, Interest rate, Inflation, Private Investment, co-integration, error correction, Rwanda

# I. Introduction

An important ingredient for future growth is increasing private investment in productive capacity backed by higher private savings (Acosta and Loza, 2004). In addition physical and social infrastructures are necessary facilitating factors to compliment private investment and provide human capital. In other words, the major share of additional saving and investments required must come from the private sectors.

Generally, an economy's rate of growth is proportional to its rate of investment. Adam Smith, in 1776, noted that when we compare the state of a nation at two different periods and find that the annual production of its land and labour is evidently greater at the latter than the former, it means that the land are better cultivated and manufactures are more expensive, we may be assured that the capital must have increased during the interval between those two periods. A vast number of measures have been undertaken to introduce a market economy developing countries. This re-orientation of general economic policy is to reduce government's role in direct productive activities and it associates the private sector as close as possible. Restoring private investor's confidence poses a major challenge to African government, as the structural adjustment and policy reforms effect to most African countries have not been matched by a sufficient stimulation of private investment. Private investment response remains weak, when considerable progress has been made in reducing policy distortions in correcting internal and external imbalance and in restarting short-term growth (Oshikoya, 1994).

Governments of developing countries, Rwanda inclusive, are now giving new attention to the potential for private sector involvement in their economies and more in terms of private investment. This is because many developing countries desire to cope with the changing regional and international economic environment.

Rwanda's economy is recovering rapidly from the after effects of 1994-Genocide which destroyed the social fabric human resource base, institutional capacity and economic framework as well as social infrastructure. Despite the difficult situation experienced since 1994, the government has attempted to stabilize from this bleak economic condition and lay basis for long-term sustainable growth and development. When the Rwanda government launched its economic recovery program in 1995, it focused on macro-economic policies intended to overcome certain imbalances and distortions in the economy but much is remaining to be done to create a conductive environment for private investments.

The government has pursued a program of financial and structural reforms that have been supported by the IMF and WB. In addition, the bilateral and multilateral assistance also helped in this progress, this is particularly the UNDP working hand in hand with the ministry of finance and economic planning. As consequence, Rwanda's macro-economic and financial performance has improved with a GDP growth estimated at 6% in 2010; the industry and service sector also had continued to recover and registered about 14.3% and 43.6% growth in 2009 (National Bank of Rwanda, 2010).

Despite the efforts made, the private sector remains weak. In Rwanda, the low level of private investment remains a problem because of different challenges to Rwanda's economic activities such as: limited rural

development and agricultural transformation, poor economic infrastructure, high transport costs, energy shortages, inadequate human and institutional capacity, limited access to finance, low levels of domestic private savings and investment, low purchasing power of the population, etc.

To solve those challenges, the government of Rwanda has put in place some strategies advocated in the Investment Promotion Policy (Ministry of Economic Planning and Finance, 2000; Ministry of Trade and Industry, 2009). These are articulated around three main axes that are (1) to establish a modern, liberal and efficient legal framework for investment; (2) to establish a skill attraction and dissemination; (3) to set up public investment priorities to support private investment. Despite these strategies, the problem of low level of private investment persists. Thus, a detailed study is needed to investigate the effects of GDP, interest and inflation rates on private investment in Rwanda.

Many studies have been trying to analyse public investment in order to know the role of government in economic growth and development. Few of them had looked at the private sector as to analyse its role in economic growth and development in the country; thus this study intends to establish the effect of some macro-factors such as GDP and inflation and interest rates on private investment in Rwanda for the reason of making the community aware of the improvement of their investment and its importance. This study was guided by following questions:

(i) Do GDP, interest and inflation rates influence private investment in Rwanda?
(ii) At which extent that private investment in Rwanda can be affected by different factors, if any?

The main objective of this study was to investigate the effects of GDP, interest and inflation rates on private investment in Rwanda, between the period of the year 1995 and 2009. Specifically, this study intended to:

(i) investigate the main factors influencing private investment in Rwanda
(ii) determine the extent to which those factors affect private investment in Rwanda

The following hypothesis was tested in this study: "Factors, such as interest rate, inflation rate, and GDP do not influence private investment in Rwanda".

## II. Literature Review

The level of national income/output or GDP is then defined simply as: $Y = C+I+G+(X-M)$.
Where Y: national income; C: consumption; I: investment, G: government expenditure, X: Exports, and M: imports.
From the above equation of national income or output, the investment variable is the background of the study. The investment variable, which is an explanatory variable of national output, is divided into public and private investments. This study is concerned with private investment. Therefore, definition of investment and private investment are given in the following section.

### *a. Definition of key concepts*

#### *(i) Investment*

Investment is defined as the current commitment of funds for a period of time to derive a future flow of funds that will compensate the investing unit for the time the funds are committed, for expected rate of inflation and also for the uncertainty involved in the future flow of funds (Serven and Solimano, 1992). It is also defined investment as the portion of final product that adds to the nation's stock of income yielding physical assets or that replaces old, worn out physical assets (Mlambo and Oshikoya, 2001). Investment means the creation or acquisition of new business assets and the expansion, restructuring or rehabilitation of an existing business enterprise (Uwimana, 1990).

Investment plays a very important and positive role for the progress and prosperity of any country. Many countries rely on investment to solve their economic problems such as poverty, unemployment, etc (Haroon and Nasr [undated]). Some of the advantages of private Investment are:

a) It increases the level of employment in the country, the individual income; therefore, it improves standard of living by reducing the poverty in the country.
b) It pushes up the growth rate of GDP and GNP.
c) It also helps to attract foreign investors to invest in the country
d) Positively growing private investment has a positive impact on the economic development.

#### *(ii) Private investment*

It is defined private investment as final goods that business firms keep for themselves and add to the nation's for income-yielding asset. It consists of, firstly, inventory investment which includes all changes in the stock of raw materials, parts, and finished goods held by business; and secondly, of fixed investment which includes all final goods purchased by business that are not intended for resale (Mlambo and Oshikoya, 2001).

### *b. Theoretical framework*

#### **(i)** *Investment theories in Developing Countries*

Earlier studies of private investment in developing countries opted to move away from the traditional theories and placed emphasis on the role of financial sector in development. Studies provided a theoretical and empirical framework for analyses of financial markets and they argued that the level and quality of private investment in developing countries is positively associated with the real interest rate (MacKinnon, 1991). Lacking the privilege of a fully-fledged theoretical model applicable to their context, the empirical literature on the determinants of private investment in developing countries tended to start off with the neoclassical model and attempt to reformulate it by incorporating variables (often on an ad hoc basis) that are supposed to have strong association with investment (Admasu, 2002).

Real exchange rate is often included in the investment model in recognition of the universality of devaluation in adjustment programs. In the long run, real devaluation is expected to lead to an increase in investment in the traded goods sector and a decrease in the non-traded goods sector with ambiguous

overall effect (Agenor and Montel, 1996). In the short run, an expected real devaluation under restricted capital mobility and high import content of capital goods is supposed to lead to an investment boom as the expected depreciation leads to a switch to foreign goods.

The issues of devaluation in developing countries are accompanied by the issues of volatility of relative prices. Inflation and volatility are included in investment model under the assumption that high volatility increases the threshold marginal profitability of capital below which investors will be in a range of inaction, i.e. no significant investment or disinvestment.

Public investment in developing countries assumes a relatively larger role than in industrial counties. It becomes important to take account of its complementarity and substitutability with private investment. In theory, crowding in and crowding out effects of public investment could take place at the same time and the net effect on private investment is indeterminate. The crowding out effect of public investment in developing countries however may not be felt through higher taxes and/or increased interest rates as in industrial countries.

***(ii) Empirical studies in private investment***

The theories of investment date back to Keynes in 1936, who first called attention to the existence of an independent investment function in the economy, and the empirical literature on private investment behaviour is vast. For instance, private investment in the developing countries has faced many economic problems such as low growth rate, inflation and foreign debt, deficit in trade balance and low standard of living. Private and public investment could complement each other rather than compete with each other and private investment had larger impact than public investment on economic growth (Admasu, 2002; Khan and Rinluhart, 1990).

A World Bank Study empirically examined the link between real private investment and other variables such as real public investment, credit to the private sector, real rate of interest and a dummy for 1976 in Ghana. Public investment was found to crowd-in private investment, and real interest rate was found not have a substantial effect on private investment (Islam and Wetzel, 1991).

Oshikoyo (1994) analysed the determinants of domestic private investment in eight African countries during 1970-1988. He estimated impact of domestic inflation rate on private investment behaviour in middle income countries is positive and insignificant. Abbas (2004) studied the determinants of private investment in Iran and found a negative relationship between inflation and private investment and that a 1 percent increase in inflation in the long run would result in 1 percent decline in investment in the short run. Badawi (2004) investigated the impact of macroeconomic policies on private investment in Sudan employing annual data over the period 1969-1998. One of the independent variables, that is real interest rate, impacts negatively on private investment. Interest rate was also found to be less important in determining the level of private investment in Kenya (Frimpong and Marbuah, 2010). Finally, Lesotlho (2006) studied determinants of private investment in Botswana and found a positive and significant impact of GDP growth on private investment. Public investment had a negative relationship with private

investment depending on the situation that there was public non-infrastructural investment in the country. He also found an insignificant impact of inflation rate on private investment in both short and long run.

# III. Methodology

### *3.1 Data*

The study employs secondary sources of data limited to the period 1995-2019 where determinants of private investment are used to estimate the private investment model (Appendix A). The choice of the study period is dependent on data availability on most of the variables used in the study. The model includes four independent variables which are: private investment, Gross domestic product rates (GDP), real interest rate, and inflation rate. These variables are typical of those identified in most studies of private investment in developing economies (Admasu, 2002). The data is drawn from the National Bank of Rwanda (NBR) in its Department of Statistics.

### *3.2 Model specification*

Based on the theoretical review and empirical considerations, the following model was used in this work:

$PRINV_i = f$ (GDP, INT, INF)

Where: $PRINV_i$ stand for private investment; $GDP_i$ stand for Gross domestic product; $INT_i$ is rate of real interest; $INF_i$ is the rate of Inflation.

The explicit estimable econometric model is formulated as follows:

$$\mathbf{lnPRINV_i = \beta_0 + \beta_1 \ln GDP + \beta_2 INT + \beta_3 INF + \mu_i} \quad \textbf{(3.1)}$$

Where all variables were previously defined and $\mu_i$ is the error term. The parameters $\boldsymbol{\beta_0, \beta_1, \beta_2, \beta_3}$ are the parameters to be estimated and 'i' stands for different period of time. PRINV and GDP variables are in natural logarithm (ln) except INT and INF because of negative values which were recorded for some years. Log transformation can reduce the problem of heteroskedasticity because it compresses the scale in which the variables are measured (Gujarati, 1995).

The Error Correction Model (ECM) can be specified as follows:

$$\mathbf{\Delta logPRINV_i = c + a_0 \Delta logGDPi + a_l \Delta INT_i + a_2 \Delta INF_i + \alpha \mu_{it-1} + \varepsilon_i} \quad \textbf{[3.2]}$$

Where, $\boldsymbol{\varepsilon_i}$ is the error term and $\boldsymbol{\alpha}$, the coefficient of the residuals ($\mu_{it-1}$), expected to have a negative sign.

### *3.3 Theoretical and a Priori Assumptions*

Real GDP is used to capture the aggregate demand conditions in the economy and it is expected to exert a positive effect on private investment. Consequently, the coefficient of real GDP was expected to be positive ($\beta 1>0$). The effect of real interest rate on private investment in developing countries is potentially ambiguous. Under the neoclassical investment model, real interest rate is treated as a key component of the user cost of capital and therefore affects private investment negatively. The study assumes that there may be a possible negative relationship between interest rate and private investment.

The study assumed that inflation rate has a negative relationship with private investment. That means higher the rate of inflation in the country then lower would be the interest of investor in investment.

### *3.4 Data analysis*

The data were analysed using econometrics methodology. Econometric analysis was done by STATA 11.0. For the reliability of the analysis, the study employed econometric techniques such as co-integration method and the results conducted to the Error Correction Model (ECM). To capture the possible lagged response of private investment, the short run dynamics, the ECM was explored.

The Augmented Dickey-Fuller Unit Root Test was used for purposes of data analysis throughout the research. According to Gujarati (2008), it is this test which detects the stationary of a variable. Many other tests will also be conducted: the Breusch-Godfrey LM test or the examination of the residuals will be used in relation with the problem of serial correlation; the test of Heterockedasticity was done using the White test for testing the relationship between residuals and explanatory variables.

## IV. Results and Discussion

### *4.1 Tests for Stationarity*

One of the prerequisite for using OLS to estimate the investment function is that all the variables included in the analysis should be stationary (Harris, 2000). A series is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or lag between the two time periods and not the actual time at which the covariance are computed (Gujarati, 2008).

Applied studies usually use the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests to check for stationarity in data series. Both ADF and PP tests can be applied on the variables in levels and first differences to check for stationarity or unit roots. For the purpose of this study, the ADF test is applied to each variable that is used in the analysis. A desirable feature of the ADF test is that it allows for heteroskedasticity as well as serial correlation in the error terms, thus compensating for the mis-specification of the dynamic structure of time series (Harris, 2000).

The results of the Augmented Dickey-Fuller Unit Root Test (ADF test), give us the number of lagged differences *"p"*, taking into account the three models: the trend and intercept model, the intercept model, and the model with no trend and no intercept. Using the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC), according to Gujarati (1995), the number of lagged differences *"p"* is obtained by considering the lowest value of AIC.

The process of obtaining the number of lagged differences *"p"* for private investment and GDP variables in logarithmic form; real interest rate and inflation rate variables, gives the results in Appendix B. From Appendices B.1 to B.4, it is indicated that, only private investment in logarithm form and real interest rate variables are stationary. Private investment is stationary in Trend and intercept model, and Real interest rate is stationary in no trend and no intercept model. As their estimated ADF statistic is larger (in absolute) than their critical value then, the null hypothesis is rejected, suggesting that their series are stationary. Remaining variables are not stationary it is necessary to difference them; for in an econometric model all variables must be stationary. The results of the Augmented Dickey-Fuller Unit Root Test for

two variables in the first and second difference form are in Appendices B.5 and B.6 in Appendix B. From B.6 and B.7, the two variables (GDP growth and inflation rate) now are stationary with GDP in logarithm form. Furthermore, for each one of those variables, stationarity takes place in a model with no trend and no intercept.

As all variables are now stationary, it is possible that they can be co-integrated. In order to determine the long run effects of the explanatory variables on private investment, test for co-integration also requires the use of the Augmented Dickey-Fuller Unit Root Test but at this time on the residuals of the long run equation (3.1). The results are in Appendix B.8. From there, the result shows that the error term is stationary or I(0), implying that the variables have a long-run equilibrium relationship between them. A necessary condition to conclude that a long-term relationship exists is that the series must be co-integrated. Co-integration means an error correction representation which can be represented as in the equation (4.1) after.

### *4.2 Cointegration: The Long Run Model*

Table 1 below is the result of the following long run equation 3.1.

**Table 1: Estimation Results (The long-run)**

Dependent Variable: logPRINV
Sample: 1995 2009
Included observations: 15

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| logGDP | 3.490148 | 0.872496 | 4.000186 | 0.0021 |
| INT | 0.264832 | 0.213997 | 1.237554 | 0.2416 |
| INF | 0.273940 | 0.211279 | 1.296579 | 0.2213 |
| C | -38.99386 | 13.51458 | -2.885319 | 0.0148 |

| | |
|---|---|
| R2 | 0.745398 |
| Adj R2 | 0.675961 |
| S.E. of regression | 0.546498 |
| SSR | 3.285261 |
| LLR | -9.894548 |
| DW stat | 2.153321 |
| Mean dependent var | 10.85040 |
| S.D. dependent var | 0.960042 |
| Akaike info criterion | 1.852606 |
| Schwarz criterion | 2.041420 |
| F-statistic | 10.73490 |
| Prob(F-statistic) | 0.001349 |

From Table 1, only GDP growth is statistically significant meaning that it has long-run effect on private investment in Rwanda as its probability is less than 1% the level of significance. This means that in the long run, the variations in private investment level is underpinned for 74, 5% by GDP growth. On the other hand, other variables (real interest rate, inflation rates), have no-statistically significance on private investment and it means that they do not have any effect on private investment in the long-run in this country.

### *4.3 The ECM estimation*

The regression results from the error correction model specified in equation (3.2) are presented in the Table 2. Results show the negative sign of α which is statistically significant and equivalent to -1.128 meaning that the shocks will disappear at 1.128% each year (α is the rate of disappearance of the shocks each year). Since the coefficient of $\mu_{it-1}$ which is α has a negative sign, the equation has to be accepted due to the fact that this coefficient is restricted to have a negative sign. Therefore the estimation equation of the short-run has economic meaning.

Practically, this shows us that in Rwanda, during this period of 1995-2009; Gross domestic product, real interest rates, inflation rates, had effect on private investment in the short-run. As the results of equation of the Error Correction Model (ECM) applied on equation give the right sign to the coefficient of residuals α, then:

i. A positive sign for ΔlogGDP implies that an increase in gross domestic product has a positive effect on private investment i.e. will increase the level of private investment and vice-versa.
ii. A positive sign for ΔINT implies that an increase of real interest rate has a positive effect on private investment and vice-versa.
iii. A positive sign for ΔINF implies that an increase in inflation rate goes hand in hand with an increase in private investment and vice-versa.
iv. A negative sign for the residuals μ(-1) again suggest that the variables at hand, the logGDP, the real interest rate INT, the inflation rate INF and the logPRINV, are co-integrated. Therefore, there is a short-run relationship between them.

**Table 2: ECM estimation**

Dependent Variable: ΔlogPRINV
Sample(adjusted): 1996 2009
Included observations: 14 after adjusting endpoints

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| ΔlogGDP | 5.866955 | 4.949610 | 1.185337 | 0.2662 |
| ΔINT | 0.171928 | 0.180369 | 0.953203 | 0.3654 |
| ΔINF | 0.182268 | 0.178841 | 1.019163 | 0.3347 |
| μ(-1) | -1.128737 | 0.336801 | -3.351352 | 0.0085 |
| C | -0.197303 | 0.425939 | -0.463219 | 0.6542 |

| | |
|---|---|
| R-squared | 0.693760 |
| Adjusted R-squared | 0.557653 |
| S.E. of regression | 0.569564 |
| Sum squared resid | 2.919630 |
| Log likelihood | -8.891936 |
| Durbin-Watson stat | 2.157164 |
| Mean dependent var | 0.211867 |
| S.D. dependent var | 0.856369 |
| Akaike info criterion | 1.984562 |
| Schwarz criterion | 2.212797 |
| F-statistic | 5.097169 |
| Prob(F-statistic) | 0.020062 |

The results also show that the short-term dynamics can be interpreted as follows:

i. A 1% increase/decrease of GDP leads to an immediate increase/decrease in private investment of 5.87%.
ii. A 1% increase/decrease of the rate of real interest rate results in an immediate increase/decrease in private investment of 0.2%.
iii. A 1% increase/decrease of the inflation rate results in an immediate increase/decrease in private investment of 0.2%.

The error correction model also implies that private investment, GDP, real interest rate and inflation rate have an equilibrium relationship, where changes in the independent variables disturbs the equilibrium, and cause the private investment to change.

### *4.4 Discussion*

This work was interested on analyzing the effects of GDP, interest rate and inflation on private investment basing on different theories and studies done in different countries, especially in developing countries. Finally, the results have given the following equations in the short and long-run:

Equation of the long-run is:
Log PRINV=-38.99386+3.490148 logGDP+0.264832 INT+0.273940 INF

Equation of the short-run is:
$\Delta \log PRINV_i = -0.197303 + 5.866955\ \Delta \log GDP_i + 0.171928\ \Delta INT_i + 0.182268\ \Delta INF_i - 1.128737 \mu_{it-1}$

The long-term estimates somehow, confirm the empirical results found in the investment literature. GDP growth was included in model in order to capture the accelerator effects, with faster growth expected to lead to higher investment rates (Oshikoya, 1994; Mlambo, and Oshikoya, 2001). Therefore, the coefficients of GDP growth are positive and statistically significant both in the long-run and short-run model and are equivalent to 3.49 and 5.87 respectively. This suggests that output recovery will boost the share of private investment both in the long run and in the short-run. Therefore, a one-percent-increase in GDP leads to a 3.49 % increase in the private investment in long-run and to a 5.87% increase in the private investment in the short-run in Rwanda. This indicates that GDP growth has a positive effect on private investment. Thus, given that investment is itself a key factor contributing to real GDP growth (Ghura and Goodwin, 2000), Rwanda can indeed benefit from the virtuous cycle that links increased private investment and real GDP growth.

Real interest rate has a positive sign in most of the trials and is highly significant in short-run (Asante, 2000). In our short-run model, the real interest rate has a positive sign and is significant (0.172). Thus the data supports the McKinnon-Shaw hypothesis, which posits that higher interest rates on deposits attract more real balances, which allows them to finance more investment (Ndikumana, 2000).

Macroeconomic instability affects investment negatively (Serven, 1998), i.e. investment is depressed by overall instability. Inflation, was used here as a measure of instability. However, the results showed that inflation rate has an insignificant impact on private investment level in Botswana, both in the short and long run, as the inflation variable is insignificant in both cases (Lesotlho, 2006). Our results show us that in Rwanda, inflation rates have positive effect on private investment in the short-run. This implies that

more the inflation rate increase by one percent, the investment will increase also by 0.18% in the short-run. Meaning that people in Rwanda consider how inflation stands or look on macroeconomic situation.

## V. Conclusion

The major aim of this study was to analyze the effects of GDP, interest rate and inflation on private investment in Rwanda, over the period of 1995-2009, in the short run and long run. Indeed, knowledge of the factors that affect, largely, private investment in Rwanda, contributes in improving economic policies for the country. The study took a partial analysis and approved the hypothesis that Gross Domestic Product, real interest rate, and inflation rate affect private investment in Rwanda based on the results of this study.

Applying the general to specific approach of the error correction model, our statistical results suggested the existence of stable long run (co-integrating) relationships between explanatory variables and private investment. The variables that affect private investment are consistent with the hypothesized signs and one is found to be statistically significant in the long-run and short-run models (GDP) and other in the short-run model such as real interest rate and inflation rate. In cases where there was ambiguity in the literature, the results have provided the empirical answers in the context of Rwanda.

The results showed that gross domestic product growth affects private investment and both in the long-run and short-run. It is apparent that GDP has been responsible for the numerous change in the private investment observed in the past fifteen years. Increase production might, in some instances, require protectionist measures in order to control imports or encourage local producers. The numerous variations in the real Gross Domestic Product have been a very powerful determinant of private investment. As an illustration, the period before the 1994 genocide, along with the aftermath of the genocide, and the genocide itself have known a tremendous change in the level of production in the country as well as in the level of prices. That certainly explains the importance of the real GDP in the private investment function for Rwanda.

The impact of real interest rate on private investment is highlighted in this study especially in the short-run model. The empirical evidence provided suggests that there would be an increase in the level of private investment when the private sector is squeezed for credit. This finding confirms the importance of the links between the private sector and real interest rate in the economic growth process. The importance of real interest rate which can transfer resources from savers to investors is a need for a well-functioning of private investment in Rwanda.

A positive impact of inflation rate on private investment is confirmed by the empirical results in this study. This suggests that inflation rate cause the increase of the private investment. This result could be the reason why private investment levels started to increase in the 1995-2009 period.

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## APPENDICES

**Appendix A: Data of private investment and its possible determinants during the past fifteen years**

| Year | Private investment | GDP growth | Real interest rate | Inflation rate |
|---|---|---|---|---|
| 1995 | 18,176 | 418,312 | -71.68 | 83.8 |
| 1996 | 21,407 | 477,194 | 3.85 | 7.41 |
| 1997 | 30,850 | 544,701 | -2.04 | 12.01 |
| 1998 | 49,752 | 595,803 | 4.95 | 4.1 |
| 1999 | 5,803 | 632,545 | 19.17 | -10.2 |
| 2000 | 31,620 | 683,800 | 8.01 | 2.1 |
| 2001 | 44,536 | 741,817 | 6.78 | 3.4 |
| 2002 | 47,715 | 823,048 | 7.02 | 2 |
| 2003 | 82,110 | 825,375 | 1.67 | 7.5 |
| 2004 | 89,503 | 868,822 | -2.77 | 12 |
| 2005 | 98,554 | 930,953 | -0.43 | 9.1 |
| 2006 | 107,376 | 991,608 | -0.70 | 8.9 |
| 2007 | 79,431 | 1,079,232 | 0.92 | 6.7 |
| 2008 | 95,156 | 1,200,400 | -3.02 | 9.1 |
| 2009 | 352,920 | 1,356,540 | -7.29 | 15.4 |

Source: National Bank of Rwanda Department of Statistics

**Appendix B.1: Determination of p, number of lagged differences for logPRINV variable in three models (Intercept, trend and intercept, and no trend and no intercept)**

| P | Intercept | | Trend and intercept | | No trend and no intercept | |
|---|---|---|---|---|---|---|
| | Akaike | Schwarz | Akaike | Schwarz | Akaike | Schwarz |
| 3 | 3.110321 | 3.291183 | 1.715880 | 1.932914 | 2.928503 | 3.073193 |
| 2 | 2.852669 | 3.014305 | 2.456835 | 2.658880 | 2.700026 | 2.821253 |
| 1 | 2.719711 | 2.850084 | 2.273333 | 2.447163 | 2.626376 | 2.713291 |
| 0 | 2.596641 | 2.687935 | 2.085404 | 2.222345 | 2.609948 | 2.655595 |

Source: STATA results, (December 2015)

Then: The number of lagged differences in Intercept model is p=0;
The number of lagged differences in Trend and Intercept model is p=3;
The number of lagged differences in No trend and no intercept model is p=0;
As they correspond with the lowest values of the column of AIC.

**Appendix B.2: Determination of p, number of lagged differences for logGDP variable in three models (Intercept, trend and intercept, and no trend and no intercept)**

| P | Intecept | | Trend and intercept | | No trend and no intercept | |
|---|---|---|---|---|---|---|
| | Akaike | Schwarz | Akaike | Schwarz | Akaike | Schwarz |
| 3 | -3.398773 | -3.217912 | -3.447290 | -3.230257 | -3.471592 | -3.326902 |
| 2 | -3.662986 | -3.501351 | -3.744404 | -3.542360 | -3.768097 | -3.646871 |
| 1 | -3.722048 | -3.591675 | -4.015370 | -3.841539 | -3.872974 | -3.786059 |
| 0 | -3.720428 | -3.629134 | -3.988757 | -3.851816 | -3.766041 | -3.720394 |

Source: STATA results, (December 2015)

Then: The number of lagged differences in Intercept model is p=1;
The number of lagged differences in Trend and Intercept model is p=1;
The number of lagged differences in No trend and no intercept model is p=1;
As they correspond with the lowest values of the column of AIC.

**Appendix B.3: Determination of p, number of lagged differences for INT variable in three models (Intercept, trend and intercept, and no trend and no intercept)**

| P | Intecept | | Trend and intercept | | No trend and no intercept | |
|---|---|---|---|---|---|---|
| | Akaike | Schwarz | Akaike | Schwarz | Akaike | Schwarz |
| 3 | 5.386764 | 5.567626 | 5.055822 | 5.272855 | 5.381829 | 5.526518 |
| 2 | 6.901540 | 7.063175 | 5.579732 | 5.781777 | 6.756044 | 6.877271 |
| 1 | 6.699131 | 6.829504 | 6.237472 | 6.411303 | 6.559961 | 6.646876 |
| 0 | 6.789206 | 6.880500 | 6.413336 | 6.550277 | 6.808462 | 6.854109 |

Source: STATA results, (December 2015)

Then: The number of lagged differences in Intercept model is p=3;
The number of lagged differences in Trend and Intercept model is p=3;
The number of lagged differences in No trend and no intercept model is p=3;
As they correspond with the lowest values of the column of AIC.

**Appendix B.4: Determination of p, number of lagged differences for INF variable in three models (Intercept, trend and intercept, and no trend and no intercept).**

| P | Intecept | | Trend and intercept | | No trend and no intercept | |
|---|---|---|---|---|---|---|
| | Akaike | Schwarz | Akaike | Schwarz | Akaike | Schwarz |
| 3 | 5.562272 | 5.743134 | 5.349869 | 5.566903 | 6.196008 | 6.340698 |
| 2 | 6.898362 | 7.059998 | 5.837479 | 6.039523 | 6.992650 | 7.113877 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 6.729425 | 6.859797 | 6.383326 | 6.557157 | 6.739846 | 6.826762 |
| 0 | 6.666379 | 6.757673 | 6.472705 | 6.609646 | 7.102143 | 7.147790 |

Source: STATA results, (December 2015)

Then: The number of lagged differences in Intercept model is p=3;
The number of lagged differences in Trend and Intercept model is p=3;
The number of lagged differences in No trend and no intercept model is p=3;
As they correspond with the lowest values of the column of AIC.

**Appendix B.5: Augmented Dickey-Fuller Unit Root Test for all variables in level**

| | Trend and Intercept Model | | | | Intercept Model | | | No trend and no Intercept Model | |
|---|---|---|---|---|---|---|---|---|---|
| | ADF Test statistic | Critical value | Prob. of trend | Prob. of intercept | ADF Test statistic | Critical value | Prob. of intercept | ADF Test statistic | Critical value |
| logPRINV | -4.026806 | -3.9271 | 0.0072 | 0.0108 | -1.356866 | -3.1003 | 0.1799 | 0.819794 | -1.9677 |
| logGDP | -2.195522 | -3.8288 | 0.0508 | 0.0548 | 0.268296 | -3.1222 | 0.8676 | 2.178048 | -1.9699 |
| INT | -2.416314 | -3.9271 | 0.1267 | 0.1587 | -1.512105 | -3.1801 | 0.3227 | -2.863389 | -1.9755 |
| INF | -2.315238 | -3.9271 | 0.1808 | 0.6489 | -1.704823 | -3.1801 | 0.0333 | 0.534093 | -1.9755 |

Source: STATA results, (December 2015)

**Appendix B.6: Augmented Dickey-Fuller Unit Root Test for logGDP and INF variables in the first difference**

| | Trend and Intercept Model | | | | Intercept Model | | | No trend and no Intercept Model | |
|---|---|---|---|---|---|---|---|---|---|
| | ADF Test statistic | Critical value | Prob. of trend | Prob. of intercept | ADF Test statistic | Critical value | Prob. of intercept | ADF Test statistic | Critical value |
| logGDP | -1.621820 | -3.8730 | 0.3616 | 0.6696 | -2.370923 | -3.1483 | 0.0554 | -0.763808 | -1.9725 |
| INF | -1.446795 | -3.9948 | 0.6530 | 0.7900 | -1.971387 | -3.2195 | 0.3211 | -1.621463 | -1.9791 |

Source: STATA results, (December 2015)

From B.6, it is indicated that those two variables are not stationary. Let us see the results from the Augmented Dickey-Fuller Unit Root Test for them in the second difference form:

**Appendix B.7: Augmented Dickey-Fuller Unit Root Test for logGDP and INF variables in the second difference**

| | Trend and Intercept Model | | | | Intercept Model | | | No trend and no Intercept Model | |
|---|---|---|---|---|---|---|---|---|---|
| | ADF Test statistic | Critical value | Prob. of trend | Prob. of intercept | ADF Test statistic | Critical value | Prob. of intercept | ADF Test statistic | Critical value |
| logGDP | -3.577062 | -3.9271 | 0.1158 | 0.1355 | -2.740760 | -3.1801 | 0.9114 | -2.952233 | -1.9755 |
| INF | -0.886628 | -4.0815 | 0.3872 | 0.4038 | -2.213106 | -3.2695 | 0.7797 | -2.429979 | -1.9835 |

Source: STATA results, (December 2015)

**Appendix B.8: Augmented Dickey-Fuller Unit Root Test on the residuals**

| | Trend and Intercept Model | | | | Intercept Model | | | No trend and no Intercept Model | |
|---|---|---|---|---|---|---|---|---|---|
| | ADF Test statistic | Critical value | Prob. of trend | Prob. of intercept | ADF Test statistic | Critical value | Prob. of intercept | ADF Test statistic | Critical value |
| $\mu_i$ | -6.145157 | -3.9271 | 0.0375 | 0.0222 | -4.376145 | -3.1801 | 0.2514 | -4.164312 | -1.9755 |

Source: STATA results, (December 2015)