Impact of ICT on Macroeconomic Stability and International Competitiveness Case of Rwanda

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Abstract - **The concern of international competitiveness for any country is a must to enjoy a comparative advantage relative to other countries. It used the dynamic vector error correction model (VCEM) to figure out the impact of ICT on financial development, international investment, trade openness, and macroeconomic stability to the economic growth and global competitiveness of Rwanda. The empirical results confirmed that commercial development peroxide by credit given by the financial sector with a robust ICT is highly significant for the short and long-run that tends to say that in Rwanda, growth is a finance-led and knowledge-based economy. At the same time, the higher adjustment coefficient has revealed a quick long term restoration of influence of above-used determinants, all embraced by an adequate ICT infrastructure. To become a middle-income country is a goal set by the Rwandan Government, and to be achieved by 2035 requires raising the level of income of the citizens throughout investment projects and harmonized economic policies. Therefore consistent macroeconomic stability, favorable business environment, trained and skilled human capital under a developed financial system embraced by ICT is paramount agenda for Rwandan decision-makers lead by advanced ICT.**

Keywords: Information and communication technology, Macroeconomic Stability, Access to capital, FDI, International Competitiveness, Rwanda.

I. INTRODUCTION

The Rwandan Government is trying to abandon the manufacturing based-economy and launch the nation into an ICT based-economy [1]. According to the World Economic Forum (2020) [2], numerous positive opportunities in terms of innovation bring by ICT. For a country to compete internationally, it will not be based on a single factor, preferably. It will constitute so many elements mainly selected under the study, including enhanced ICT policy, FDI, Access to capital, inflation rate, and Human capital. Institutions, as

well as other factors that can determine the level of production of a nation to achieve its economic prosperity. The world competitiveness is branded by direct investment stocks abroad (% of GDP), and direct investment flows inward (% of GDP). Then the G.C. report 2018 has testified that there are so many factors that must consider in the course of the country's competitiveness. The ICT development and economic stability in the region is a prominent list of the Rwandan Government, with an ICT-enhanced policy.

II. LITERATURE REVIEW

The major constrain of low-income countries is the lack of adequate ICT infrastructures. At the same time, globally, ICT could propose potential benefits to businesses within the country and lead to effectiveness, efficiency, and competitiveness [3]. ICT can be a leading enabler tool in economic growth, especially for countries that have to recognize its importance. Thus it is surprising that developing countries are trying to work hard to internalize Information and Communication Technology, paired with allocating their minimum resources, to catch up with developed countries' economies [4]. They are vital features that have been considered by so many scholars as to the macroeconomic factor that can stimulate the country's economic growth. These factors are trade openness and financial development [5]. To enjoy a competitive advantage by a nation through ICT need intensive investment, especially in Broadband infrastructure that leads to economic growth in almost countries [6]. [7][8][9][10], trade openness and financial development might influence the country's economic structure based on its economic reality; for some countries, trade openness and commercial development present either a positive or negative impact. In other Economies, economic growth and trade have a bidirectional relationship [11]. However, some exceptions were found contradicting the positive connection of financial development and trade openness to economic growth. Still, most of the researches revealed their positive impact in most economies than the negative impact.

Foreign direct investment (FDI) also has been considered by so many researchers recognized internationally over time as a vital element of economic growth in many economies. It has realized that ICT development, in many ways, can contribute to economic development [12]. Nevertheless, the ICT development will impact on information diffusion efficiency as well as organizational efficiency [13]. Thus will lead to the attraction of (FDI), which is a channel that facilitates the flow of technologies from advanced economies to less developed economies. Increases at the level of investment and efficient production systems as well as improvement of specialization and institution performance in host countries [14][15].

Conversely, (FDI) presents a positive impact on many economies. There is evidence that, due to some economic structure, can have a negative effect [16]. Some researchers' say that the deceptive positive impact of (FDI). Many economists have stated that ICT can influence directly or indirectly the economic growth. Other economists argue that ICT development can promote other prerequisites of development (transportation, education, remote sensing), which are very important in economic growth [17].

High inflation was recognized for a long time ago as an enemy of economic growth as this one affects the entire financial system. In the NBER's study by [18] on a sample of 100 countries, the hypothesis confirmed that an increase of inflation hinders economic growth and other macroeconomic variables. Monetary policy should always strive for consistency in a lower price increase for the sake of having a stable macro environment.

A research conducted by [19] for 32 Asian countries found inflation hurts growth when it surpasses 5.43% but has no effect below this level. Results suggest that inflation hurts economic growth. The findings for the case of Tanzania by Faraji and Kenani (2013) [20] discovered that a 1% increase in inflation could result in economic growth downward of 48.105%. ICT development plays a crucial role in price stability by lowering the cost of transactions, better exchange information, and access to human capital [21].

The price stability should be a target for any macroeconomic policy for every economy; otherwise, economic agents will not trust the business environment and financial system as a good atmosphere for their businesses. ICT development can be used as a tool of competitive advantage for a nation in the value-adding of firms within a country [22]. Strong policy evidence about the contribution of national ICT policy can lead to the economic growth of a nation and its firms as it has been studied in the case of 27 countries about varying growth rates [23].

This term paper is organized as follows: Section 1 provides the theoretical background for the possible interaction between ICT development and economic stability. 2nd section presents a review of the related literature; the research methodology is presented in Section 3; an econometric analysis of the scenario and the empirical results thus obtained are discussed in the 4fth section. Section 5 concludes the paper with practical policy implications.

III. RESEARCH METHODOLOGY

Investigate the relationship between ICT and macroeconomic stability of Rwanda; the research has based on the method used by Taban B. Bagchi (2001-2012) used to assess the influence of ICT infrastructure on the economic growth of G-20 countries.

$$y = f(bd) \qquad (1)$$

Where y stands for GDP per capita, bd represents all main determinants for this study, which are:

(1) Inflation rate (INF)
(2) Access to capital (A.C.) proxied by total credit by the financial sector to private
(3) Human capital (H.C.),
(4) Foreign direct investment (FDI),

And this term paper uses the multiple linear regression form to check the sensitivity of ICT and macroeconomic stability to selected drivers.

$$Y_t = \beta_0 + \beta_1 INF_t + \beta_2 AC_t + \beta_3 HC_t + \beta_3 FDI_t + \mu_t, \qquad (2)$$

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ are factors, and μ_t characterizes an error term which is expected to be a white noise error and t is the period which annually observation.

IV. EMPIRICAL ANALYSIS

4.1 Description of Data

This term paper has utilized time series secondary data from 2005-2018 as per World Development Indicators (World Bank 2018) and IMF 2018. To examine the responsiveness of ICT development to macroeconomic stability to the change of selected variables of interest. Except for total credit and inflation, which are in percentage, other variables computed in thousand billion in current local currency. Data analyzed using the Johansen cointegration method, which involves the Unit root test for stationarity of variables [24]. Vector Autoregressive estimates provide a number of the cointegrating equation based on the Trace and Eigen value test. At the same time, Vector Error Correction Model (VECM) by Engle and Granger (1987)[25] is used to crisscross the speed of adjustment of the model and the short-run relation among variables with Eviews 9 software.

4.2 Unit root test for time series

Figure out the long-run and short-run connection between macroeconomic stability and financial, human capital, access to capital, FDI, and inflation rate. The starting point is whether series are stationary or not by acting the unit root test via the ADF test, and results are demonstrated down.

Table 1: Augmented Dickey-Fuller (ADF) test

Variable	Trend & intercept	Intercept	None			
	t-test statistics	t-test statistics	t-test statistics	Max .Lag by Schwarz info Criterion	Level of integration	Probability
LY_t	-	-6.265341***		9	I(1)	0.0000
LAC_t	-	-5.843311***	-	9	I(1)	0.0000
$LFDI_t$	-	-10.44707***	-	9	I(1)	0.0000
$THC_{t\,(\%)}$	-	-6.914525***		9	I(1)	0.0123
$INF_{t\,IN\,(\%)}$	-	-8.057828***			I(1)	0.0014

*, ** and *** show rejection of the null hypothesis of unit root at 10%, 5%, and 1% significant level, respectively.

Centered on the results in table 1, all series are stationary at the first difference, and the cointegration test is adequate. Having accomplished stationarity, accordingly, as Engle and Granger (1987) [25] indicate, there should be a cointegration test. The animation of cointegration is the indication of long-run affiliation among the variables. Tarce and Eigen value analysis displayed one cointegration equation performed using the Johansen cointegration test as per results.

Table 2: Johansen cointegration test of international competitiveness (Trace)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of C.E. (s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.989761	235.8402	69.81889	0.0000
At most 1 *	0.783761	89.23040	47.85613	0.0000
At most 2 *	0.526564	40.22648	29.79707	0.0022
At most 3 *	0.379341	16.29886	15.49471	0.0378
At most 4	0.031847	1.035688	3.841466	0.3088

Trace test indicates four cointegrating equation. (s) at the 0.05 flat

* signifies rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 3: Johansen cointegration test of the (Max-eigenvalue)

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of C.E. (s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.989761	146.6098	33.87687	0.0000
At most 1 *	0.783761	49.00392	27.58434	0.0000
At most 2 *	0.526564	23.92761	21.13162	0.0197
At most 3 *	0.379341	15.26317	14.26460	0.0347
At most 4	0.031847	1.035688	3.841466	0.3088

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 flat

* signifies rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

4.3 Results of Regression

The dynamic error correction model long-run results in table 4 are interpreted as follow:

1. Consequently, international competitiveness, in the long-run, will increase in by 0.25%,.12%,6.95%,0.01.3% due to the change of one percent of Human capital (H.C.), Foreign direct investment (FDI), access to capital (Local credit provided by financial sector) and Inflation rate respectively.

   Based on long-run results, it is access to capital that has a higher impact, which matches the economic agenda of Rwanda to alter the economy by making the Rwandan financial sector a lucrative business and an engine of macroeconomic stability embraced by advanced ICT infrastructures.

2. The R-squared of 59.7.8% confirms the fitness of the model with all variables, and the speed of adjustment coefficient of -0.61.54 with significance at the 10% level shows that disequilibrium is progressively corrected. To re-establish the long-run equilibrium situation among cointegrating variables at 61.54 % per annum and places of interest, the existence of the long-run relationship between determinants and Rwandan competitiveness aptitude.

3. The diagnostic tests revealed the stability and consistency of parameters for the model, are relying on the scheme of % precarious guaranteed by CUSUM proposed by Brown et al. (1975), absence of serial correlation up to the 16th lag because all probabilities are higher than 10% level of worth under correlogram squared residuals. Breusch-pagan-Godfrey proves that the model of study is homoscedastic as the probability of obs*R-squared (39.12%) is higher than the 10% level of significance. Another point of reliability for the model of foreign direct investment is that residuals are typically distributed as tested by Jarque- Bera with a probability of 31.93% higher than 10%.

Table 4: The dynamic error correction model long-run

Variable	Coefficient	S.E	t-statistic	Conclusion
$LTROP_t$	0.257211	0.13522	1.90210	Significant
$LFDI_t$	0.127272	0.01950	-6.52723	Significant
$TCR_{t\,(\%)}$	6.954571	0.00640	1087.65174	Significant
$INF_{t\,IN\,(\%)}$	0.013531	0.00318	4.25775	Significant

Table 5: VECM Results

Error Correction:	$D(LY_t)$	$D(LTROP_t)$	$D(LFDI_t)$	$D(FinDev_t)$	$D(INF_t)$
CointEq1	-0.615416	0.249851	4.972388	11.02167	3.130542
	(0.28022)	(0.52101)	(2.28415)	(6.27121)	(20.2722)
	[-2.19621]	[0.47955]	[2.17691]	[1.75750]	[0.15443]
C	-0.017464	0.039363	0.222919	0.327885	-0.349934
	(0.02534)	(0.04711)	(0.20653)	(0.56705)	(1.83303)
	[-0.68926]	[0.83556]	[1.07933]	[0.57823]	[-0.19091]

V. CONCLUSION

This course paper has used variables that fall in the view of G.C indicators for performance catalysts, which includes: Inflation rate, Human capital, FDI, and access to capital peroxided by Domestic acclaim provided by the financial sector, and low inflation rate stands for macroeconomic stability for the period of 2005-2019. Its results confirmed the hypothesized study with a more significant contribution of macroeconomic stability, which means that Rwandan policymakers must consolidate ICT infrastructure development, thus facilitating the boost of all used determinants. The increase of the number of ICT infrastructures in different corners of the country, mainly rural areas, and the use of technological banking and mobile banking, are among the best ways to facilitate the financial deepening, and it leads to access to capital. For the more significant impact of commercial development, the government should design different policies that enable all economic agents to earn and need money. This means embracing the citizens' access to capital through advanced ICT infrastructures.

However, other determinants were found with little impact, but they cannot be ignored as sustainable growth cannot due to one item instead of a complexity of factors. And they have dangerous consequences once there are not managed well. For example, macroeconomic instability due to price unsteadiness will hinder the economy's opportunities.

1. Rwandan policymakers must know that Information and Communication Technology infrastructures induce economic growth by directly supporting other foundations and factors of production, thereby improving the nation's economy.
2. The Rwandan policymakers must ensure that policies are in place to sustain the financial deepening through access to capital awareness.
3. Sensitizing and improvements made in Rwanda urgently to decrease the big gap between exports and imports by applying import substitute strategy and put more emphasis on improving domestic investments in most demanded goods where it is feasible. The imports are much more than exports and what is worse is that most required goods are imported, like food, oil products, and gas. This resulted in a deficit trade balance, which has an impact on the value of the national currency against the United States Dollar, which common trade currency and other stable currency in the global market, with trained and skilled personnel in ICT will thus lead to a feasible and strong human capital creation.

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