

Investigating the Nexus between Public Investment and Morocco's Economic Growth through ARDL Modeling

Exploration du lien entre l'investissement public et la croissance économique du Maroc à travers la modélisation ARDL

Hajar SELLAMI

Doctorant

Faculty of Economics and Management of kenitra
Ibn Tofail University, B.P 401 Kenitra
Economics and Organizational Management
Morocco

hajarsellami150@gmail.com

Pr. Driss DAOUI

Enseignant chercheur

Faculty of Economics and Management of kenitra
Ibn Tofail University, B.P 401 Kenitra
Economics and Organizational Management
Morocco

didich_d@yahoo.fr

Date de soumission : 02/11/2023

Date d'acceptation : 29/12/2023

Pour citer cet article :

SELLAMI H. & DAOUI D., (2023) « Investigating the Nexus between Public Investment and Morocco's Economic Growth through ARDL Modeling », Revue du contrôle, de la comptabilité et de l'audit « Volume 7 : numéro 4 » pp : 250- 267.

Abstract

As a primary pillar of economic growth, public investment, which mainly covers expenditure on education, research and development as well as the infrastructure, has a strong impact on the economic development of countries. In this context, as perspectives of this research, we aim to contribute to the answer to the following questions : should moroccan public policies maintain a high level of public investment to support the economic growth ? What place should they give to private investment in this equation, and what role do inflation and education investment play in the relationship between public investment and growth ?

Thus, based on the endogenous growth theory, we explore the link between public investment and growth in the moroccan context over the period 2004-2020. For this purpose, we use the ARDL (Auto-Regressive Distributed Lag) model to test the cointegration relationship between these two variables. As control variables of the model, we use foreign direct investment, inflation, and education investment. The key points of this study are the analysis of the effect (positive/negative) and (significant/non-significant) of public investment on economic growth.

Keywords: Public Investment, Economic growth, public policies, foreign direct investment.

Résumé

En tant qu'un pilier incontestable de croissance économique, l'investissement public qui englobe principalement les dépenses destinées à l'éducation, à la recherche et développement ainsi qu'aux infrastructures, impacte fortement le développement économique des pays. Dans ce silage, l'objectif principal de ce travail de recherche est de contribuer à la réponse aux questions suivantes : les politiques publiques marocaines devraient-elles maintenir un niveau élevé d'investissement public pour soutenir la croissance économique ? Quelle place devraient-elles accorder à l'investissement privé dans cette équation et quel rôle joue l'inflation et l'investissement en éducation dans la relation « investissement public-croissance » ?

Ainsi, en se basant sur la théorie de la croissance endogène, nous explorons le lien entre l'investissement public et la croissance sur la période 2004-2020 au niveau du contexte marocain. Pour cet objectif, nous utilisons le modèle ARDL (Auto-Regressive Distributed Lag) pour tester la relation de cointégration entre ces deux variables. Comme variables de contrôle du modèle, nous faisons appel à l'investissement direct étranger, à l'inflation et à l'investissement dans l'éducation et l'enseignement. Les points clés de cette étude sont l'analyse d'effet (positif/négatif) et (significatif/non significatif) de l'investissement public sur la croissance économique.

Mots clés : Investissement public, Croissance économique, politiques publiques, IDE.

Introduction:

In order to deal with economic problems such as unemployment, underemployment, poverty, the States undertake to engage the countries in the path of growth. Indeed, this growth represents the essence of public policies around the world. So as to ensure economic growth, a plurality of techniques and mechanisms are available to these public policies. In this regard, public investment is one of the tools that support economic growth and therefore the creation of wealth and employment. Hence, several actions are undertaken by countries to create the conditions that encourage both domestic investment and the attractiveness of foreign investment¹. Through fiscal and monetary policies, investment is a mechanism to stimulate economic activity for public authorities. Thus, the investment effort can be quantified either in value, in volume or in percentage of GDP. In Morocco, according to a *report by the Committee on Finance and Economic Development published on February 15, 2022 (Bank AL-Maghrib and the investment situation)*, the investment effort in value reached on average 32.2% of GDP over the period 2000-2019 against 25.6% as an international average. Thus, the level of investment recorded in Morocco is similar to that recorded in countries with significant economic achievements. However, despite this advance in terms of investment, Morocco has not yet been able to reach the desired economic level².

It should be noted that investment can be made either by the State, by the private sector or by foreign direct investment (FDI). In this article, we focus on the relationship between public investment and economic growth. In this context, we envisage to answer the following question : Should Moroccan public policies maintain a high level of public investment to support economic growth ? To that end, we opted for the ARDL model which is highly valuable when examining economic variables as it offers a comprehensive analysis of their dynamics. Furthermore, it provides insights into the short-term dynamics and long term equilibrium relationships among these variables, allowing for policy analysis and forecasting. The variables used are as follow : economic growth, inflation, public investment made by public institutions and enterprises, public investment made by local authorities, foreign direct investment, investment in higher education and investment in education over the period 2004-2020.

¹ According to a report by the Committee on Finance and Economic Development published on February 15, 2022 (Bank AL-Maghrib and the investment situation)

² Idem

Thus, this research will be divided into two parts : the first will highlight, in its first part, the main mechanisms of the endogenous growth theory by highlighting the importance of research & development, human capital, knowledge sharing as well as the technological and educational factors, and in its second part, the effect of public investment on economic growth from both a theoretical and empirical standpoint. Moreover, the second part will present the methodology and analysis of the results in terms of presentation of the econometric model, the variables employed, the tests used (Augmented Dickey-Fuller, the Bound test, the Breusch-Godfrey serial correlation test, the Breusch-Pagan Godfrey test, Cusum test) as well as the discussion of the results in the light of the theories relating to the subject being researched.

1. Literature review :

1.1. The main mechanisms of endogenous growth theory :

Being a revival that has been the subject of several recent studies in the field, the new theories of growth expand their scope beyond an ordinary denomination of endogenous growth. Through integration of a plurality of variables, at the level of the new models, among others : population growth, research and development, education, the new theory of growth is mainly based on the endogenous aspect of growth (Guellec.D, 1992). However, the notion of growth has long been at the heart of the debates of the various currents of economic thought. For the neoclassical economists, and especially for Solow, economic growth comes mainly from the increase of two main factors : capital and labour. At the level of his model, the increase in population is exogenous. Moreover, and in accordance with the principle of the neoclassical current, the returns to scale of the production function are constant (Ibid). Although Solow's objective, initially, was limited to proving the potential for balanced growth, his model was unable to explain the growth in the long run. This gap comes from the assumption that capital productivity will deteriorate as the stock of capital per capita increases (Ibid). It was only by integrating technical progress that Solow was able to cope with this limitation. Indeed, the choice of this option is motivated by several reasons, the fact that technology is a public good remains the main one. This public character implies that all agents can access it for free. Moreover, it should be noted that the 1980s were marked by a renewal of economic growth's theoretical approaches by giving way to the endogenous growth theory (Roy.W, 2004). Thus, several factors are implicitly involved in this theory. These include : private investment in the sense that the pooling of private investment gives rise to a supplement in the form of a factor common to all firms thus constituting a kind of public good (Romer.P.M, 1986). In addition to private investment, infrastructures and public services are also growth factors (Guellec.D,

1992). In this sense, Barro(1990) is modelling endogenous growth with a focus on the public expenditures' externalities. In his model, the production function encompasses private and public capital in the form of infrastructures (Roy.W, 2004). Endogenous growth due to increased knowledge is distinguished by multisectoral models. In this regard, Romer (1990) highlights the technology that represents a particular good which use is different from usual economic goods. First of all, technology is a sharable good in the sense that two agents can use the same knowledge simultaneously (Guellec.D,1992). Secondly, it should be noted that the right of ownership of a discovery is not absolute (Ibid). In other words, knowledge is a public good whose use is partially limited. On the basis of these characteristics, Romer (1990) proposed his model considering three sectors, the first of which was research. Such as technology, human capital fits into the knowledge section. However, this type of capital is characterized by its rivalry in the sense that as soon as a person acquires a skill, it belongs to him in a strictly personal way. According to Lucas (1988), it is through the use of one's own time and skills that a person educates himself or herself, resulting in human capital coming from himself or herself.

All in all, the strength of the new models comes from, on the one hand, the implication of economic behaviours that the neoclassical model has ignored, and on the other, from the integration of technological and educational factors and their functioning within a framework of general equilibrium. In addition, modelling makes it possible to process rigorously themes relating, for example, to international trade, population growth and economic policies as part of their relationship to growth. However, although the growth theory has been renewed, some theoreticians claim that the clarifications related to growth are not new since Solow has already used technology and education at the level of his model (Malinvaud.E, 1992). In addition, it should be noted that the role of the State mainly affects education, research and infrastructures. Apart from macroeconomic models, endogenous growth, cannot intervene in the policies to be conducted since it is the sectoral analyses that can provide precise indications at this level. In addition to this limit, the multiplicity of sources cited as well as the fragility of empirical models are unable to analyse the problems of economic policy (Guellec.D, 1992).

1.2. The effect of public investment on economic growth :

From a theoretical point of view, liberals and interventionists have emphasized the role of the state within the economic universe. This intervention is taken up through a number of mechanisms, of which public investment expenditure is the main one. Indeed, several economists defending the interventionism have dealt with this subject. Richard Musgrave

demonstrated, in his theory of public finance (1959), the existence of the link between public expenditure and per capita income. Moreover, the Wagner's law has proved the existence of a relationship between two variables: public expenditure and the size of the sector. According to Wagner, public expenditures increase as the size of the sector increases. Moreover, Keynes discussed the link between public expenditure and aggregate demand. This economist confirmed that the increase in this demand encourages companies to increase their production, which has a positive effect on economic growth. On the other side, the liberal current consolidates the idea that the contribution of public investment to production disadvantages private investment by means « crowding out effect ». Thus, liberal economists assume that public investment is not effective in promoting economic growth.

Moreover, the exploration of the link between public investment and economic growth has been the subject of several research projects that have led to different results. In this context, Knight, Loayza and Villanueva (1993) concluded through their study that the impact of public investment on economic growth is positive. Nevertheless, for developing countries, investment in physical capital has been less productive. In Mexico, a study conducted by NAZMI.N and RAMIREZ.M.D (1997) for the period 1950-1990 proved that public investment has a significant and positive effect on Mexican economic growth. By integrating other variables such as public investment in education, health and marginal productivity, the results of the TANZI & ZEE (1997) study in this area confirmed that public expenditures impact positively growth across two channels. The first one is direct having as object the increasing of the capital stock of the economy due to public investment in infrastructure, hence the positive impact on economic growth. The second channel is that the variables cited above promote the accumulation of human capital, there by increasing marginal productivity, and thus increasing economic growth.

In contrast to these researches, Barth & BRADLEY (1987) concluded that the link between real GDP growth rate of real GDP and the level of public expenditure is negative. Working on a sample of 16 OECD countries for the period 1971-1983, the proportion of public investment in GDP had a statistically insignificant impact on growth. For EU countries, public investment does not significantly affect growth, but the volatility of investment has both a negative and statistically significant impact (A.Afonso & D.Furceci, 2008). Using an ARDL model, BENDOMA. M & MESSINE ESSOMBA. C (2017) conducted their study at Cameron for the period 1975-2015. As a result of this study, the authors have shown that public investment impacts negatively economic growth in both the short and long run. In another sense,

Easterly.W and Rebelo.S (1993) have shown that the effect of public investment on economic growth changes by sector. According to these authors, public investment in agriculture has a negative impact while public investment in transport and communications has a positive impact. Moreover, public investment in public enterprises has no significant impact on economic growth. Based on the contributions of the ELALALOUI study. J & HEFNAOUI. A (2018), Moroccan public expenditures has a negative effect on economic growth for the period 1975-2016. Also within the Moroccan context, a research conducted by AZEROUAL. M & OUMANSOUR. N (2019) over a 25 years (1990-2015) used the ARDL model to study the relationship between public investment and economic growth. Following this research, the impact of public investment on economic growth is significant and positive in the short run. However, this effect is not significant in long run.

2. Methodology & Results Analysis :

The "Methodology & Results Analysis" section of this article shows the variables of the analysis and their expected effect, based on the underlying theory, as well as the AutoRegressive Distributed Lag (ARDL) model to be estimated.

We have divided our results analysis into four main parts: Presentation of variables and econometric model (**A**), Stationnarity, cointegration & significance of coefficients (**B**), Long and short term coefficients (**C**), Robustness tests (**D**).

2.1. Presentation of variables and econometric model :

In this research, we will use data provided by the Bank of Maghreb, the Ministry of Finance, and the World Bank database, covering the period from 2004 to 2020. The key variables we will examine include the growth rate of gross domestic product (GDP), public investments made by public institutions and enterprises, public investment made by local authorities, investment in higher education, investment in education, foreign direct investment (FDI), and inflation.

Tableau N°1 VARIABLES

Variabes de la recherche	Code	Effet attend
▪ Economic growth	GDP	
▪ Inflation	IPC	-
▪ Public investment made by public institutions and enterprises	INVT_PUBLIC_EEP	+/-

▪ Public investment made by local authorities	INVT_PUBLIC_COLLO	+/-
▪ Foreign direct investment	IDE	+
▪ Investment in higher education.	ENSUPC	+
▪ Investment in education	EDUC_NATC	+

Source: authors, "based on the theory"

We adopted the ARDL (Bound Testing) model developed by Pesaran and Shin (2001). This cointegration-related testing approach is useful as it can handle both I(0) and I(1) variables. The ARDL model to analyze the short- and long-term relationship between economic growth (GDP) and explanatory variables is as follows:

$$GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + \alpha_2 INVT_PUBLIC_PC_PIB_EEP_{t-1} + \alpha_3 INVT_PUBLIC_PC_PIB_COLLO_{t-1} + \alpha_4 IDE_{t-1} + \alpha_5 ENSUPC_{t-1} + \alpha_6 EDUC_NATC_{t-1} + \alpha_7 \Delta GDP_{t-1} + \alpha_8 \Delta INVT_PUBLIC_PC_PIB_EEP_t + \alpha_9 \Delta INVT_PUBLIC_PC_PIB_COLLO_t + \alpha_{10} \Delta IDE_t + \alpha_{11} \Delta ENSUPC_t + \alpha_{12} \Delta EDUC_NATC_t + \varepsilon_t$$

Where:

- GDP_{t-1} is the GDP growth rate at time $t-1$;
- $\Delta INVT_PUBLIC_PC_PIB_EEP_t$ is the change in public investment made by public institutions and enterprises between t and $t-1$, expressed as a percentage of GDP;
- $\Delta INVT_PUBLIC_PC_PIB_COLLO_t$ is the change in public investment made by local authorities between t and $t-1$, expressed as a percentage of GDP;
- ΔIDE_t is the change in foreign direct investment between t and $t-1$;
- $\Delta ENSUPC_t$ is the change in investment in higher education between t and $t-1$, expressed as a percentage of GDP;
- $\Delta EDUC_NATC_t$ is the change in investment in education between t and $t-1$, expressed as a percentage of GDP;
- α_i are coefficients estimated by the model;
- ε_t is the error term at time t .

2.2. Stationarity, cointegration & significance of coefficients :

In order to test the stationarity of the time series studied, we used the Augmented Dickey-Fuller (ADF) test. ADF has a higher test power compared to other unit root tests such as the simple Dickey-Fuller (DF) test and the Phillips-Perron (PP) test. This means that it is more capable of detecting the presence of a unit root in the data. It is also suitable for small sample sizes, making it useful for studies on time series with a small number of observations. The following table shows the results of this test for the variables in our research.

Tableau N°2 UNIT ROOT TEST RESULTS TABLE (ADF)

<i>Null Hypothesis: the variable has a unit root</i>							
AT LEVEL							
	IPC	INVT_PUBLIC_EEP	INVT_PUBLIC_COL_LO	IDE	GDP	ENSUP_C	EDUC_NATC
t-Static	-0.812	-0.414	1.171	0.341	2.577	2.1190	0.9731
Prob.	0.347	0.517	0.9294	0.769	0.995	0.9878	0.9040
	NO	NO	NO	NO	NO	NO	NO
AT FIRST DIFFERENCE							
	d(IPC)	d(INVT_PUBLIC_EEP)	d(INVT_PUBLIC_COL_LO)	d(IDE)	d(GDP)	d(ENSUP_C)	d(EDUC_NATC)
t-Static	-7.944	-3.1218	-6.6653	-3.311	-	-2.5247	-4.5265
Prob.	0.000	0.0042	0.0000	0.002	0.021	0.0156	0.0002
	***	***	***	***	**	**	***
	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Notes:							
<i>a: (*)Significant at the 10%</i>							
<i>b: Lag Length based on SIC</i>							
<i>c: Probability based on MacKinnon's (1996) one-sided p-values.</i>							

Source: compiled by the authors, "Eviews10"

According to this test, all variables studied are integrated in order (1). These results allow us to use the ARDL (AutoRegressive Distributed Lag) model.

It should be noted that the ARDL model is an econometric model that allows analyzing the long-term relationships between economic variables. It combines elements of linear regression, allowing the analysis of cointegration relationships between variables that may move together in the long run, despite short-term fluctuations. This model is also designed to handle cases where variables may have different differentiation orders. It can be exploited using a combination of independent variables in levels and differences, with lagged delays. This allows for taking into account the response delays of the variables, as well as their short- and long-term behaviors. Additionally, it can be used for long-term forecasting and testing the hypothesis of causality between variables. The summary of our ARDL is illustrated in the following table:

Tableau N°3 ARDL MODEL

R-squared	0.987876	Mean dependent var	10.99998
Adjusted R-squared	0.974019	S.D. dependent var	0.092687
S.E. of regression	0.014940	Akaike info criterion	-5.271254
Sum squared resid	0.001562	Schwarz criterion	-4.836673
Log-likelihood	51.17004	Hannan-Quinn criteria.	-5.249000
F-statistic	71.29440	Durbin-Watson stat	2.631741
Prob(F-statistic)	0.000005		

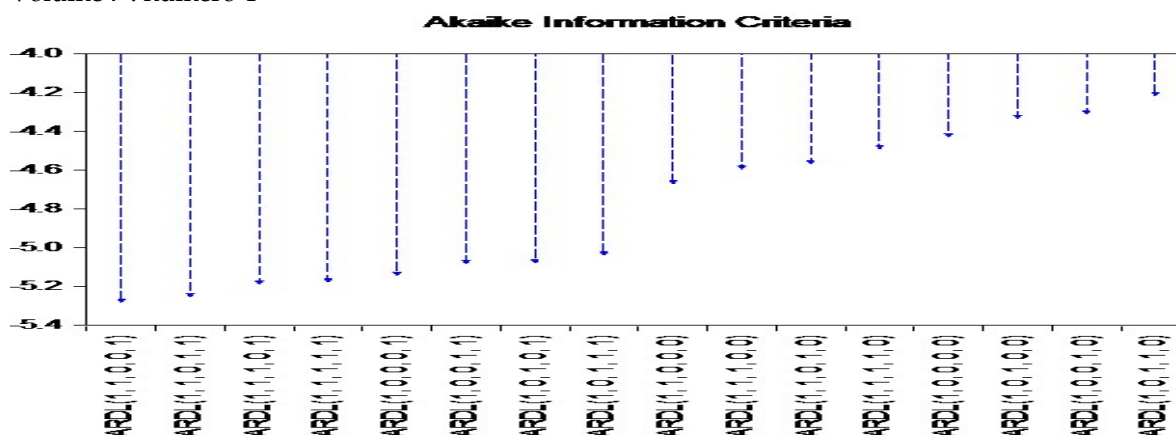
Source: compiled by the authors, "Eviews10"

Overall, the results of the ARDL indicate that the model is well-fitted and that the independent variables strongly influence the dependent variable. The interpretation details are listed as follows:

- **R-squared:** In our case, the R-squared is high at 0.9879, indicating that the model explains a large portion of the variance of the dependent variable.
- **Adjusted R-squared:** In our case, the adjusted R-squared is 0.9740, indicating that the model is well-fitted even when considering the number of variables in the model.
- **S.E. of regression:** In our case, S.E. of regression is 0.0149, which is low, indicating that the model is accurate in predicting the dependent variable.
- **F-statistic:** This is the result of the F-test which measures the overall significance of the model. Here, the F-statistic is 71.29440 with a very low associated probability, indicating that the model is globally significant.
- **Durbin-Watson stat:** In our case, the Durbin-Watson stat is 2.631741, which is close to 2, indicating that there is no significant correlation between the errors.

On the whole, the measures of the model's fit are : Akaike info criterion (*cf Figure 1*), Sum squared resid, Log-likelihood, Schwarz criterion, and Hannan-Quinn criteria. Furthermore, negative values indicate a better fit. Here, the values indicate that the model is well-fitted.

Figure N°1: Akaike information criteria



Source: compiled by the authors, "Eviews10"

2.3. Long and short term coefficients :

2.3.1. Long-term Coefficients :

The ARDL Bound Test checks for the presence of both short- and long-term relationships between variables. In this case, the relationship between the variables is tested at the levels equation.

Tableau N°4 BOUND TEST RESULTS (Levels Equation)

<i>Case 5: Unrestricted Constant and Unrestricted Trend</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
IDE	0.010634	0.018488	0.575193	0.5832
INVT_PUBLIC_PC_PIB_COLLO	2.358611	3.133346	0.752745	0.4761
INVT_PUBLIC_EEP	2.281533	0.464779	4.908856	0.0017
ENSUPC	0.150108	0.249486	0.601667	0.5664
EC = GDP - (0.0106*IDE + 2.3586*INVT_PUBLIC_PC_PIB_COLLO + 2.2815*INVT_PUBLIC_PC_PIB_EEP + 0.1501*ENSUPC)				
F-Bounds Test			Null Hypothesis: No levels of relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	6.428227	10%	3.03	4.06
K	4	5%	3.47	4.57
		2.5%	3.89	5.07
		1%	4.4	5.72

Source: compiled by the authors, "Eviews10"

The ARDL Bound Test allows checking whether there is a short- and long-term relationship between variables. In this case, the relationship between variables is tested at the levels (levels equation).

The results show that the variable INVT_PUBLIC_EEP (*public investment made by public institutions and entreprises*) is significant at the 1% level with a coefficient of 2.2815. This means that for an increase of one unit in INVT_PUBLIC_EEP, the dependent variable increases by 2.2815 units. The other variables are not significant at the 10% level.

The F-Bounds test tests the null hypothesis of no short- and long-term relationship. The F-statistic is 6.428227, which is greater than all critical values at the 10%, 5%, 2.5%, and 1% thresholds. Therefore, we reject the null hypothesis and conclude that there is a short- and long-term relationship between variables.

2.3.2. Short-term coefficients :

In the ECM model, regression coefficients measure the adjustment of the dependent variable to both its past values and short-term deviations between the dependent variable and explanatory variables.

Tableau N°5 ECM REGRESSION RESULTS

<i>Case 5: Unrestricted Constant and Unrestricted Trend</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.24726	1.997962	7.130896	0.0002
@TREND	0.028456	0.004444	6.403032	0.0004
D(IDE)	-0.015143	0.012293	-1.231820	0.2578
D(ENSUPC)	-0.802816	0.173154	-4.636438	0.0024
CointEq(-1)*	-1.431077	0.201366	-7.106863	0.0002

Source: compiled by the authors, "Eviews10"

In this case, the results show that the constant and trend are significant at a significance level of 0.05%. This indicates that the trend of the dependent variable and constant effects have a significant impact on variations in the dependent variable.

The coefficients of D(IDE) are not significant at a significance level of 0.05%, suggesting that *Foreign direct investment* does not have a significant impact on the dependent variable in the short term.

The coefficients of D(ENSUPC) are significant at a significance level of 0.05%, suggesting that *Investment in higher education* has a significant impact on the dependent variable in the short term.

The coefficient of CointEq(-1)* is significant at a significance level of 0.05%, suggesting that error correction is significant. This means that past imbalances are corrected in the short term.

2.4. Robustness tests

The Breusch-Godfrey serial correlation test is used to detect the presence of **autocorrelation in the residuals** of a regression model. The results show two test statistics: the F-statistic and Obs*R-squared.

Tableau N°6 Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.573824	Prob. F(2,5)	0.2950
Obs*R-squared	6.181216	Prob. Chi-Square(2)	0.0455

Source: compiled by the authors, "Eviews10"

- **F-statistic:** This test evaluates whether autocorrelation is present in the model's residuals. If the F-statistic is greater than the critical value, it indicates the presence of autocorrelation in the residuals. In this case, the F-statistic is equal to 1.573824 with a p-value of 0.2950. The p-value is higher than the significance level (0.05), indicating that we cannot reject the null hypothesis, meaning that there is not enough evidence to prove that there is a serial correlation in the residuals.

- **Obs*R-squared:** This statistic measures the degree of autocorrelation in the residuals. The higher the statistic, the more serial correlation there is in the residuals. In this case, the statistic is equal to 6.181216 with a p-value of 0.0455. The p-value is lower than the significance level (0.05), indicating that there is enough evidence to prove that there is a serial correlation in the residuals.

The Breusch-Pagan-Godfrey test is used to test the hypothesis of **heteroscedasticity** in the regression model.

Tableau N°7 Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.652195	Prob. F(8,7)	0.7197
Obs*R-squared	6.832865	Prob. Chi-Square(8)	0.5548
Scaled explained SS	0.951437	Prob. Chi-Square(8)	0.9985

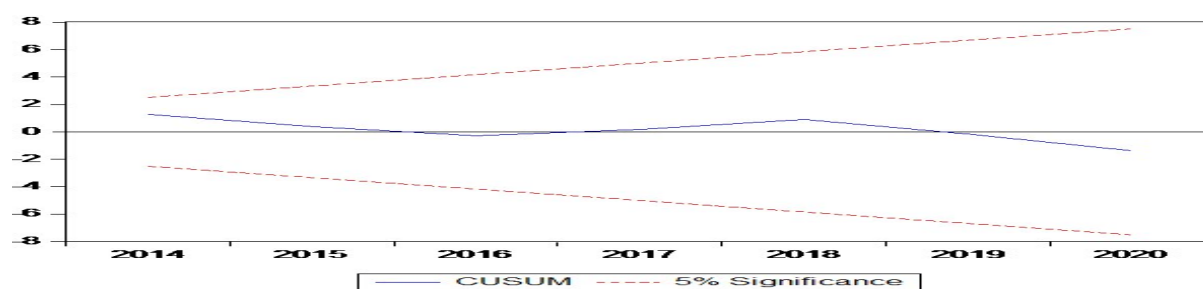
Source: compiled by the authors, "Eviews10"

The results show an F-statistic of 0.652195 with an associated probability of 0.7197, indicating that the null hypothesis of homoscedasticity cannot be rejected. The chi-squared test also gives a high associated probability of 0.5548 for a number of degrees of freedom of 8. Thus, there is not enough evidence to suggest that heteroscedasticity is a problem in the regression model.

The CUSUM (Cumulative Sum) test is used to detect structural changes in the data and is often used in econometrics to test the stability of regression coefficients over a given period. The CUSUM test is a process control test, which examines the cumulative sum of differences

between actual observations and values predicted by a model. When a model is estimated, it is important to check whether the coefficients remain stable over time or whether they change significantly. If the coefficients change, this may indicate the instability of the model and question the validity of the analysis. The CUSUM test can help detect these changes by plotting the cumulative sum of standardized residuals and comparing the results to a threshold value calculated from the null hypothesis of coefficient stability. If the cumulative sum of standardized residuals exceeds the threshold value, this suggests model instability, which can be confirmed by performing statistical tests to determine the significance of the results. Thus, the CUSUM test is a useful tool for checking the stability of regression coefficients and ensuring the validity of results in econometric analysis. In our case, the model is stable according to the CUSUM test.

Figure 2: CUSUM test

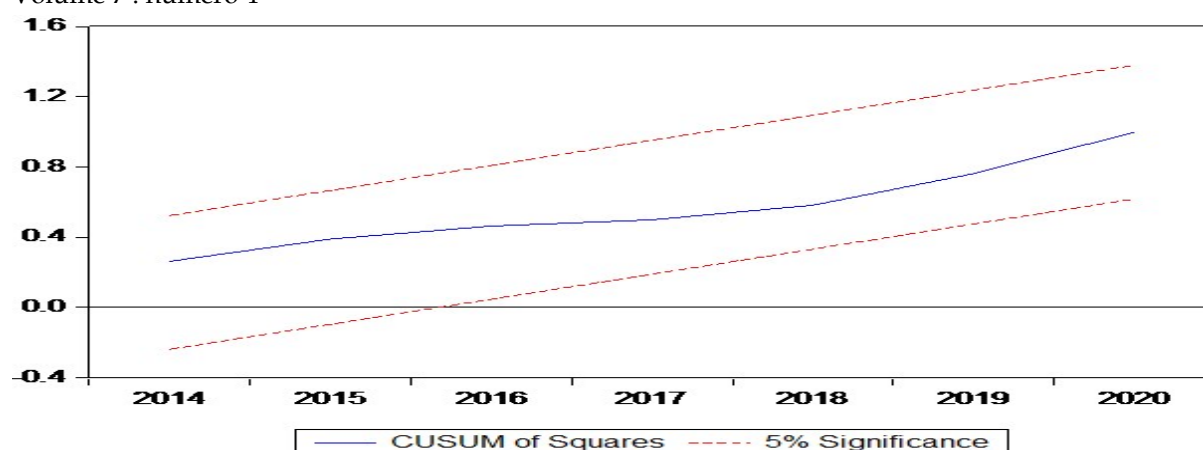


Source : compiled by the authors, "Eviews10"

The CUSUM (cumulative sum) test is used to detect changes in the mean of a time series by plotting the cumulative sum of differences between observations and a reference value, typically the mean of the series before a certain point in time. As the observations deviate further from the reference mean, the cumulative sum increases.

However, the CUSUM test can be sensitive to non-constant variances, which can lead to false positives. To account for this, the CUSUM square test uses the squares of the differences between observations and the reference mean. This test is therefore more robust to non-constant variances, making it a useful tool for detecting changes in the mean of a time series with an unstable variance. In this case, the model is stable according to the CUSUM square test.

Figure 3: CUSUM square



Source: compiled by the authors, "Eviews10"

3. Discussion of Results :

In the short run, the coefficient on the lagged variable *Investment in higher education* is negative and highly significant. This can be interpreted as higher education resources being potentially diverted from non-productive sectors. These results are consistent with the findings of Elalaoui & Hefnaoui (2018), who revealed that public investment spending hurts economic growth in Morocco due to its "unproductive" nature and the use of debt to finance it, leading to additional interest charges that hinder growth. Such a result was observed in OECD countries during the period 1971-1983 by Barth and Bradley (1987), who showed a negative relationship between the real GDP growth rate and the level of public expenditures. For developing countries, Devarajan, Swaroop, and Zou (1996) also showed a negative or non-significant relationship with economic growth. However, this should not make us forget the contribution of investment in education and higher education in the long term for an economy. Lucas Jr, R. E. (1988) showed that public investment in education contributes to long-term economic growth by increasing human capital.

In the long term, the coefficient on the lagged variable *INVT_PUBLIC_EEP (investment made by public institutions and enterprises)* is positive and highly significant. This can be interpreted as the resources invested by public establishments and enterprises likely having positive spillover effects on growth, thus fostering the productive fabric of the nation. These findings are consistent with Tanzi & Zee (1997), who argue that public expenditure has a positive impact on economic growth through both direct and indirect channels. Similarly, Knight, Loayza, and Villanueva (1993), Abiad, Furceri, and Topalova (2016), Gemmell, Kneller, and Sanz (2016), and Nubukpo (2007) have found a positive impact of public investment on economic growth. According to a report published by the World Bank (World Bank, 2019), with an average annual

growth rate of 4.3% between 1985-2015, investment in infrastructure has strongly influenced Moroccan economic growth (GDP per capita).

Conclusion :

From classical to synthesis schools, passing through Keynesians, state intervention can only be essential for investment in infrastructure. This is justified by the fact that public investment reduces the gap between social and private costs, encourages education, and responds to disasters. However, the debate remains on its effectiveness and efficiency. Indeed, by observing the contribution of public investment to the economic growth of Asian countries, the conclusions for our case plead for intersectoral selectivity and a balance between the short and long term. The scope of public investment in the growth of a nation remains dependent on several economic-political choices, hence the need for intersectoral selectivity in decision-making. Between the short and long term, if it is oriented towards key sectors such as infrastructure (short term) and education (long term), public investment can play an important role in stimulating economic growth. This brings us closer to the reflection of Easterly & Rebelo (1993). For these two authors, the impact of public investment on economic growth varies by sector. Public investment in agriculture has a negative impact, while public investment in transport and communications has a positive impact. Public investment in public enterprises has no significant impact on economic growth. Infrastructure and agriculture are two strategic variables for the Moroccan economy. Hence, the prospects for studying the impact of public investment on each of the key sectors of the Moroccan economy by integrating both dimensions (short and long-term).

BIBLIOGRAPHIE

ADB, A. A., Furceri, D., & IMF, P. T. (2016). The macroeconomic effects of public investment: Evidence from advanced economies. *Journal of Macroeconomics*, 50, 224-240.

Azeroual M. et Oumansour N. (2019). Investissements publics et croissance économique au Maroc : une évaluation par l'approche ARDL Bound Testing. *Les cahiers du plan. Numéro spécial. Volume 2*, pp : 66-79.

Barro, R., & Sala-y-Martin, X. (1990). Public Finance in Models of Endogenous Growth. *NBER Working Paper*, 3419.

Barth, J. R., Bradley, M. D., & Panayotacos, P. C. (1987). Understanding international debt crisis. *Case W. Res. J. Int'l L.*, 19, 31.

Bendoma, M., & Messiné Essomba, C. (2017). Investissement public et croissance économique au Cameroun.

Devarajan, S., Swaroop, V., & Zou, H. F. (1996). The composition of public expenditure and economic growth. *Journal of monetary economics*, 37(2), 313-344.

Easterly, W., & Rebelo, S. (1993). Fiscal policy and economic growth. *Journal of monetary economics*, 32(3), 417-458.

Elalaoui, J., & Hefnaoui, A. (2018). L'impact des dépenses publiques sur la croissance économique: approche par le modèle ARDL Cas du Maroc. *Revue du contrôle, de la comptabilité et de l'audit*, 2(3).

Gemmell, N., Kneller, R., & Sanz, I. (2016). Does the composition of government expenditure matter for long-run GDP levels?. *Oxford Bulletin of Economics and Statistics*, 78(4), 522-547.

Guellec, D. (1992). Croissance endogène: les principaux mécanismes. *Économie & prévision*, 106(5), 41-50.

Knight, M., Loayza, N., & Villanueva, D. (1993). Testing the neoclassical theory of economic growth: A panel data approach. *Staff papers*, 40(3), 512-541.

Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of monetary economics*, 22(1), 3-42.

Malinvaud, E. (1992). Implications macroéconomiques des théories microéconomiques modernes. *L'Actualité économique*, 68(1), 11-22.

Nazmi, N., & Ramirez, M. D. (1997). Public and private investment and economic growth in Mexico. *Contemporary Economic Policy*, 15(1), 65-75.

Nubukpo, K. (2007). Dépenses publiques et croissance des pays de l'Union économique et monétaire ouest-africaine (UEMOA). *Afrique contemporaine*, 222(2), 223-250.

Report by the Committee on Finance and Economic Development published on February 15, 2022 (Bank AL-Maghrib and the investment situation)

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of political economy*, 94(5), 1002-1037.

Roy, W. (2004). L'investissement public dans les infrastructures de transport est-il source de croissance endogène?. In *UIC. Management and Policy Studies Seminar (MAPS) on Role of Rail Transport in the National Productivity*, 25-26 mars 2004, Tunis (pp. 14-p). UIC.

Tanzi, V., & Zee, H. H. (1997). Fiscal policy and long-run growth. *Staff Papers*, 44(2), 179-209.