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The Relevance of Education and Innovation Policies: Evidence from Morrocco

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Abstract:- The Moroccan development model considers education and innovation as important pillars to promote productivity, competitiveness and sustained growth. The country has implemented several strategies to improve access to education, modernize school facilities and train teachers, as well as increase the number of researchers and R&D expenditures. Improving the protection of intellectual property rights is also a positive initiative. However, there are still challenges to overcome to achieve universal education, reduce illiteracy, and train inventors. The results of modeling innovation and education policies encourage the Moroccan government to implement policies that promote access to quality education for all citizens, including disadvantaged groups and the country's remote regions, and offer training and professional retraining programs to develop a competent and innovative human capital.

Keywords:- *Innovation policy, Education policy, Error Correction Modeling.*

I. INTRODUCTION

Education and innovation are two key pillars for the socio-economic development of countries. These two ecosystems ensure sustainable growth, increased competitiveness, improved quality of life, and effective poverty reduction. In this context, Morocco has been committed for several years to ambitious reforms aimed at modernizing its educational system and promoting innovation.

Innovation policy based on education is a crucial topic for Morocco's economic development, and the country has invested heavily in education in recent decades to develop human capital capable of stimulating innovation and creativity. However, despite these efforts, Morocco continues to face persistent challenges in terms of innovation and economic growth.

The question would be how the innovation policy based on education can contribute to economic growth in Morocco.

To provide some answers to this issue, it is necessary to analyze the links between innovation, education and economic growth in Morocco, as well as the initiatives implemented to encourage innovation and education.

Overall, this issue raises important issues for the economic development of Morocco, and it is crucial to closely examine the efforts made to promote innovation and education in the country.

In this work, we will briefly present the theoretical foundations of education and innovation, as well as their importance for economic development. Then, we will discuss the current state of education and innovation in Morocco, presenting the main indicators and progress made in recent years. We will develop an econometric model to properly quantify the short- and long-term effects of education and other variables on economic growth, using the error correction model. We will conclude with a general conclusion that will synthesize the different perspectives and challenges to be met to ensure sustainable and inclusive growth in Morocco.

II. THE "EDUCATION-INNOVATION-GROWTH" RELATIONSHIP: THEORETICAL AND EMPIRICAL STUDIES

Studying the relationship between education, innovation and economic growth has been an important research topic in economics for several decades. Many empirical studies have been conducted to explore this complex relationship and determine the underlying mechanisms. In order to synthesize these studies and highlight the key findings, we present in the two tables below a collection of theoretical and empirical studies on this topic. This presentation will help to better understand the links between education, innovation and economic growth, as well as the policy implications that follow.

This section will focus on presenting the results of these models, while seeking to draw useful conclusions for education and innovation policy.

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Table 1: Summary of theoretical models

Authors/Year	Article Title
Joseph Schumpeter/1934	"The Theory of Economic Development"
Innovation can drive long-term economic growth by creating new industries, jobs, and business opportunities. Entrepreneurs play a key role in innovation by developing new technologies, products and services. Public policies must support entrepreneurship.	
Robert Solow/1956	"A Contribution to the Theory of Economic Growth"
Capital and labor influence short-term economic growth, but cannot explain long-term growth. Technological innovation is the primary driver of long-term economic growth. Public policies can play an important role in promoting innovation and economic growth.	
Robert Lucas/1988	"On the Mechanics of Economic Development"
Investment in human capital can stimulate long-term economic growth by producing human capital that in turn drives innovation and economic growth.	
Paul Romer/1990	"EndogenousTechnological Change"
Investments in research and development can stimulate long-term economic growth by increasing productivity, improving competitiveness and generating new business opportunities. Education is crucial for the creation and dissemination of knowledge, which are key factors in innovation and economic growth.	
Michael Porter/1990	"The Competitive Advantage of Nations"
The comparative advantages of an economy can influence long-term economic growth. Competitive advantages are determined by factors such as the quality of institutions, the quality of human capital, and the efficiency of markets. Public policies can play an important role in promoting the competitive advantage of an economy.	
Philippe Aghion/1992	"A Model of Growth through Creative Destruction"
Knowledge externalities stimulate innovation and economic growth and investment in human capital is crucial for the production of knowledge. Public policies can play an important role in promoting economic growth by encouraging research and development and investing in education.	
Daron Acemoglu/1998	"Why Do New Technologies Complement Skills?"
New technologies tend to complement the skills of well-educated workers, which promotes economic growth by increasing productivity and creating new, more skilled jobs.	

Source: authors

Table 2: Summary of empirical studies

Authors/Year	Article Title
Schultz/1961	"Investment in Human Capital"
Investments in education can increase workers' skills and productivity, leading to faster economic growth. Human capital is an important determinant of economicgrowth.	
Nelson et Phelps/1966	"Investment in Humans, Technological Diffusion, and Economic Growth"
Human capital is an important determinant of technological innovation and economic growth. Investments in educationcanstimulate innovation and economicgrowth.	
Romer/1990	"EndogenousTechnological Change"
Economic growth can be stimulated by investment in research and development, as well as by the diffusion of cutting-edge technologies. Public policies can play an important role in promoting innovation and the dissemination of knowledge.	
Mankiw, Romer et Weil/1992	"A Contribution to the Empirics of Economic Growth"
Human capital is a significant determinant of economic growth. Investment in human capital can explain up to 80% of income differences between countries.	
Aghion et Howitt/1998	" EndogenousGrowth Theory"
Investments in human capital and research and development can stimulate economic growth. Public policies that promote innovation can lead to faster and more sustainable economic growth.	
Griliches/1998	"R&D and Productivity: The Econometric Evidence"
Investments in R&D are positively related to firm productivity. Worker education and access to advanced technologies are also important determinants of productivity.	
Hall et Jones/1999	"Why do some countries produce so much more output per worker than others?"
Differences in the level of human capital and advanced technologies explain the differences in productivity between countries.	
Weil/2013	"EconomicGrowth"
Human capital, R&D investments, and innovation-friendly political institutions are important determinants of economic growth. Policies that encourage investment in education and research and development can stimulate economic growth.	
Acemoglu et al./2018	"Innovation, reallocation and growth"

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Innovation is a key driver of economic growth in the United States, but its contribution varies considerably across sectors. Public policies that promote the creation and diffusion of new technologies can stimulate economic growth.

Source: authors

III. MOROCCO AT THE CROSSROADS: PERSPECTIVES ON INNOVATION AND EDUCATION

Morocco is a developing country that has made progress in the field of education in recent decades. Innovation has also become an important issue for the country, which seeks to position itself as a leading player in the regional economy. In this context, it is interesting to analyze the state of education and innovation in Morocco, in order to better understand the challenges facing the country and the initiatives being implemented to address them. This analysis will also highlight the opportunities and future prospects for Morocco in these key areas.

Table 3: Summary of strategies and programs related to the innovation system

Strategy / program / plan	**Year**
National Innovation Strategy (SNI)	2009
The SNI aims to stimulate innovation in key areas such as agriculture, energy, health, information and communication technologies, manufacturing industry, aerospace, and automotive. The ultimate goal is to transform Morocco into a competitive and innovative economy capable of competing in the global market.	
National energystrategy	2009-2030
The national energy strategy aims to ensure the country's energy security, reduce greenhouse gas emissions, and contribute to the fight against climate change while stimulating economic development.	
MoroccanNumeric plan	2013-2020
It aims to develop the digital economy and information and communication technologies (ICT) in Morocco.	
Maroc-Innovation	2014-2020
Developed to promote innovation and stimulate the country's economic competitiveness. This strategy revolves around four main axes: strengthening the innovation environment, supporting innovative entrepreneurship, developing innovation skills, and promoting sectoral innovation.	
National strategy for intellectual property	2014
It aims to strengthen the protection of intellectual property rights in Morocco and to encourage innovation.	
IndustrialAcceleration Plan	2014-2020
It aims to modernize the Moroccan industry by promoting innovation and investment in key sectors.	
National strategy for research, development, and innovation	2015
It aims to strengthen Morocco's innovation capacity and to stimulate research and development.	
Halieutis Plan	2020
Its objective is to modernize the fishing sector in Morocco by encouraging innovation and improving productivity.	
Green Morocco Plan	2020
The goal is to modernize the Moroccan agricultural sector by encouraging innovation and improving competitiveness.	
Digital Transformation Acceleration Plan	2020-2025
The goal is to accelerate the digital transformation of Moroccan companies by promoting innovation and developing digital skills.	
IndustrialRevitalization Plan	2021-2023
It was launched in response to the economic crisis caused by the COVID-19 pandemic and aims to revive the Moroccan industry by encouraging innovation and developing key sectors.	

Source: authors

Morocco has set innovation goals as part of its development strategy "Digital Morocco 2020" and its national innovation strategy "Morocco Innovation 2020." The main objectives include:

Increasing R&D investments to reach 1% of GDP by 2020. According to the latest available data from the OECD, R&D investments in Morocco represented 0.77% of GDP in 2018.

- To increase the number of patents filed by Moroccan companies.
- Increasing the number of innovative companies in Morocco. According to a study by the High Commission for Planning (HCP), the number of innovative companies in Morocco increased from 5,000 in 2014 to 8,000 in 2019.
- Improve Morocco's Global Innovation Index. According to the WIPO report on the Global Innovation Index 2020, Morocco ranks 75th out of 131 countries, with an improvement of 4 places compared to the previous year.

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However, it is important to note that the degree of achievement of these objectives varies depending on the indicators and periods:

- According to World Bank data, R&D (Research and Development) expenditures as a percentage of GDP in Morocco have increased in recent years, from 0.65% in 2010 to 0.78% in 2019. However, this level does not reach 1% and remains low compared to some developed countries that spend more than 2% of their GDP on R&D.
- According to UNESCO data, the number of researchers in R&D (Research and Development) in Morocco has increased in recent years. In 2019, there were approximately 15,800 researchers in R&D, which represents a 7.2% increase compared to the previous year. However, Morocco still needs to make efforts to increase the number of researchers and improve the quality of their training[1].
- Patents: The number of patents filed with the Moroccan Industrial Property Office has increased significantly, rising from 75 in 2012 to 460 in 2018. In 2020, the number of national patents filed by residents in Morocco was 87, compared to 63 in 2019. The number of patents filed by Moroccan residents is still very low.
- Share of innovative companies: According to the Innovation Survey in Morocco conducted by the Moroccan Industrial Property Office, the share of innovative companies increased from 19.3% in 2013 to 25.3% in 2017.

That said, Morocco has made significant progress in innovation in recent years, but there are still challenges to overcome to fully achieve its objectives. According to the Bloomberg 2021 Innovation Index, Morocco is ranked 71st out of 132 countries, which is an improvement from its 75th ranking in 2020. Similarly, Morocco has improved its score in the World Intellectual Property Organization's Global Innovation Index (GII), moving up from 75th place in 2019 to 72nd place in 2020. However, there are still challenges to be addressed in innovation in Morocco. The country must continue to improve its regulatory environment and innovation support system, as well as invest in research and development and education.

[1]The country also faces a brain drain, with many Moroccan researchers choosing to pursue their careers abroad due to the lack of adequate opportunities and funding in their home country.

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Table 4: Summary of strategies and programs related to the education system

Strategy / program / plan	**Year**
National program of scientific and technical research	2005
This program aims to strengthen scientific and technical research in Morocco by funding research projects and encouraging partnerships between businesses and universities. It has funded many projects in areas such as biotechnology, solar energy, health, and agriculture.	
National Program for Scientific and Technical Research	2005
This program aims to strengthen scientific and technical research in Morocco by funding research projects and encouraging partnerships between businesses and universities. It has funded numerous projects in fields such as biotechnology, solar energy, health, and agriculture.	
Emergency plan for Education	2009
This plan aims to improve the quality of education by strengthening teacher training, upgrading school infrastructure, reducing the dropout rate, and improving the governance of the education system.	
Morocco-USA cooperation program in higher Education	2013
Aims to strengthen partnerships between Moroccan and American higher education institutions, through student and faculty exchanges, the establishment of joint research programs, and continuing education.	
Emergency plan for vocational training	2014
Aims to modernize and restructure the vocational training system to better meet the needs of the job market. It notably includes the creation of 200 new vocational training centers and the renovation of 100 existing centers.	
National strategy for higher education	2015
Aims to adapt higher education to the needs of the job market and improve the quality of education by increasing investments in research and enhancing governance and management of higher education institutions.	
Emergency Program for Early Childhood Education	2015
This program aims to promote early childhood education and improve the quality of teaching in preschools. It notably includes the construction and rehabilitation of 2,000 preschools throughout the country.	
Digital plan for Education	2016
This plan provides for the introduction of information and communication technologies in primary and secondary schools. Its main goal is to provide a laptop computer to each student and equip schools with computer hardware and internet connectivity.	
Plan Maroc Numeric	2020
The goal is to develop the use of ICT (Information and Communication Technology) in education and training by implementing digital infrastructure and pedagogical tools for teachers and students.	
Sectoral strategy for education and training	2020
Aims to improve access and quality of education and training, with a focus on technical and vocational education, distance learning, and lifelong learning.	

Source: authors

All of these strategies aim to improve education indicators in Morocco, such as literacy rates, enrollment rates, dropout rates, and the quality of teaching. The country's top priorities include:

- To achieve a universal enrollment rate by 2030, which means ensuring access to education for all Moroccan children of school age.
- To reduce the illiteracy rate to 20% by the year 2021.
- Raise the preschool enrollment rate from 30% to 100% by 2030.
- Increase the success rate in the baccalaureate to 80% by 2021, compared to 71.9% in 2019.
- Improving the quality of education by increasing the number of trained teachers and modernizing school equipment.
- Promote access to higher education by increasing the number of available seats in universities and developing professional and technical programs.

In response to these objectives, efforts related to education in Morocco deliver the following results:

- Illiteracy rate: according to data from the High Commission for Planning, illiteracy rate in Morocco decreased from 28.8% in 2004 to 23.6% in 2014, representing a significant decrease, but still far from the 20% target set for 2021;
- Enrollment rate: According to data from the Ministry of National Education, the enrollment rate in primary education increased from 84.4% in 2004-2005 to 97.8% in 2019-2020. For secondary education, the rate increased from 46.5% in 2004-2005 to 80.2% in 2019-2020. These figures indicate significant improvement, but there are still challenges to be met in achieving the goal of universal enrollment[2].

[2]According to UNICEF data, the net enrollment rate in Morocco was 91% for children aged 6 to 11 in 2019, which represents an improvement compared to previous years. However, there are still significant challenges to be overcome to achieve the goal of universal education, particularly with regard to the quality of education and

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- Preschool Enrollment rate: According to data from the Ministry of National Education, the preschool enrollment rate increased from 7.6% in 2008-2009 to 36.7% in 2019-2020. However, this still falls far short of the goal of 100% by 2030[3].
- Baccalaureate success rate: According to data from the Ministry of National Education, the baccalaureate success rate increased significantly from 47.8% in 2004 to 62.5% in 2019, but still falls short of the 80% target set for 2021.
- Teacher training: according to data from the Ministry of National Education, the number of trained teachers increased from 23,103 in 2005-2006 to 54,766 in 2019-2020. The Ministry has also launched several continuing education programs for teachers. However, the quality of education remains a challenge to overcome.
- Access to higher education: according to data from the Ministry of Higher Education, the number of available seats in public universities increased from 245,126 in 2010-2011 to 365,451 in 2019-2020. The Ministry has also launched several programs to develop professional and technical fields. However, the professional integration of graduates remains a challenge to be addressed.
- The number of graduates varies depending on the levels of education and the years. To give a general idea, here are some figures:

✓ In 2019, the number of high school graduates in Morocco was over 416,000.

✓ In 2018-2019, the number of students enrolled in higher education was around 750,000, of which 55% were in literary and legal fields, 25% in scientific and technical fields, and 20% in economic and management fields.

- In 2019, the number of graduates from higher education was around 184,000, of which 72% were university graduates and 28% were graduates from higher education institutions.
- For the number of PhD students: According to data from the National Agency for Research and Development (ANRD), the number of PhD students enrolled in Moroccan higher education institutions has seen significant growth in recent years. In 2019-2020, the total number of PhD students was 15,270, up from 10,600 in 2015-2016. However, Morocco still falls short of the goals it set for itself, notably the goal of doubling the number of PhD students between 2015 and 2020.
- Regarding the number of doctors: According to data from the High Commission for Planning (HCP), the number of doctors in Morocco was 6,919 in 2019, compared to 6,125 in 2018. This represents a 13% increase in one year.

In short, all these political commitments and indicators show that Morocco must continue to invest in education to improve its economic and social performance and to achieve its goals in education and innovation.

IV. THE "EDUCATION-INNOVATION-ECONOMIC GROWTH" RELATIONSHIP: ERROR CORRECTION MODELING

Our research was inspired by the neoclassical economic growth modeling, developed, notably by economists Mankiw et al. (1992). These authors based their work on the fundamental model of Solow (1956), in which they introduced the variable of human capital stock. Two types of capital are considered in this model: physical capital and human capital. The Cobb-Douglas production function is expressed as follows:

$$Y_t = K_t^{\alpha} H_t^{\alpha} (A_t L_t)^{1-\alpha-\beta}$$

and $0 > \alpha > 1$ and $0 > \beta > 1$

K_t physical capital stock, H_t human capital stock, L_t labor, A_t technical progress.

To confirm or reject our basic research hypotheses which are:

H_1: The accumulation of human capital has a positive impact on growth in Morocco.

H_2:Innovation and/or adaptation to new technology resulting from education generate positive short-term and long-term effects on growth in Morocco.

H_3:The governance, in terms of quality of institutions, has an effect on the innovation system and economic growth in Morocco.

access to education for children from disadvantaged backgrounds or living in rural areas.

[3]It is important to note that Morocco has made significant progress in terms of pre-school education in recent years. According to the 2018 National Survey on Early Childhood, the pre-school enrollment rate increased from 12.4% in 2014 to 29.6% in 2018. This shows that Morocco is on the right track to achieve its goal of raising the pre-school enrollment rate from 30% to 100% by 2030, but there is still much to be done to improve the quality of pre-school education and ensure access for all children

For our study, four models are presented as follows:

Model 1: Measures human capital by the number of years of secondary education. (01)

$$logPIB_t = \alpha_0 + \alpha_1 logFBCF_t + \alpha_2 logsec_t + \alpha_3 logIDE_t + \varepsilon_t$$

Model 2 : Measures human capital by the number of years of higher education. (02)

$$logPIB_t = \alpha_0 + \alpha_1 logFBCF_t + \alpha_2 logsup_t + \alpha_3 logIDE_t + \varepsilon_t$$

Model 3 : Measures human capital by education expenses. (03)

$$logPIB_t = \alpha_0 + \alpha_1 logFBCF_t + \alpha_2 logdep_t + \alpha_3 logIDE_t + \varepsilon_t$$

Model 4: Measures the effect of innovation governance through intellectual property. (04)

$$logPIB_t = \alpha_0 + \alpha_1 logFBCF_t + \alpha_2 logPI_t + \alpha_3 logIDE_t + \varepsilon_t$$

- Where:α_i $(i \in \{0,1,2,3,4\})$ are parameters to be estimated, log is the natural logarithm, and ε is a random variable (error term).
- The variables: $logPIB_t$: the logarithm of Gross Domestic Product per capita; $logsec_t$: the number of years of secondary education; $logsup_t$: the number of years of higher education; $logdep_t$: education expenditures; $logPI_t$: intellectual property.
- Other variables, such as:$logFBCF_t$:gross fixed capital formation;$logIDE_t$: foreign direct investment.

To gather the essential data for our empirical research on Morocco spanning the period from 1970 to 2017, we relied on numerous databases:

- Barro and Lee (2010): the average number of years of education for the population aged 25 years and above for both secondary and higher levels in Morocco.
- World Bank: gross domestic product, gross fixed capital formation, and foreign direct investment.
- UNESCO: Education expenditure.

These variables are presented in the table below:

Table 5: Description of the variables

Variables	Model	Description
Dependent variable	1st model	Real grossdomesticproduct
	2nd model	
	3rd model	
	4th model	
Variables of interest	1st model	Number of years of study at the secondary level
	2nd model	Number of years of study at the higher level
	3rd model	Education expenditure
	4th model	Commissions for using intellectual property as a proxy for the quality of institutions (governance) in terms of innovation(Acemouglu, 2008).
Control variables	1st model	Stock of physical capital; Foreign direct investment and Cereal yields.
	2nd model	
	3rd model	
	4th model	

Source: authors

In our specified models above, the variables are measured as follows:

- Regarding real gross domestic product per capita (or GDP per employee): we divided the gross domestic product by the number of active workers, because inactive individuals may work temporarily in the informal sector or engage in home-based production activities that are not captured in the gross domestic product (GDP) of an economy (Jones, 2000).
- The gross fixed capital formation represents the fixed capital.
- The stock of 'human capital' is estimated in our analysis in three ways:The number of years of secondary and higher education: it is the last diploma obtained, which allows at least to dispel the previous criticism. However, the average number of years of education, which is considered as a stock of human capital, also has limitations. The use of the average number of years of education as a representative variable leads to an underestimation of human capital. Human capital includes a large number of complex human characteristics. In fact, the level of human capital is difficult to measure quantitatively. Thus, the average number of years of education is a proxy for the stock of human capital realized in school, and this is the comment that we favor when talking about human capital. However, the average number of years of education does not take into account the quality of education. Yet, the quality of education is more significant than quantity in influencing economic growth, as asserted by economists Barro & Lee (1998), Barro (2000), Hanushek&Kimko (2000), Altinok (2007), etc. To take into account the measurement of the quality of education in empirical research, these theorists have frequently used the results of different international tests assessing students' academic skills (PISA, MLA, IEATIMSS, PIRLS, CONFEMEN-PASEC, UNESCO-SACMEQ, etc.), which, according to them, measure the real impact of education on economic growth.

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Another measure gets an important role in quantifying the effect of education quality on economic growth: the student-to-teacher ratio. However, data on comprehension tests do not exist in chronological series for Morocco. Economist Dessus (2000) explains that the student-to-teacher ratio is not often used as an estimate of the quality of human capital. Additionally, some of the shortcomings of indicators of human capital quantity also apply to quality indicators.

- Public education spending (as a percentage of GDP): Public education spending refers to government expenditures directed towards education. It includes public expenditures on schools (both public and private) and educational institutions, as well as subsidies provided to private schools. These expenditures reflect the government's effort in terms of financing dedicated to education.
- The commissions for the use of intellectual property (Acemouglu, 2008): royalties and licensing fees are payments and receipts between residents and non-residents for the authorized use of intangible, non-produced and non-financial assets, and property rights (such as patents, copyrights, trademarks, industrial processes, and franchises) and for the use, through license agreements, of original prototypes produced (such as films and manuscripts)[4].
- Foreign direct investments: a direct investment from a country abroad is the outflow of capital to another country to create a business or to take a stake in one. The objective is to have real decision-making power in the management of firms. Diversification of the investment portfolio is important for productivity, considering the balance of payments that measures the inflows and outflows of capital between countries. A positive balance indicates that the national economy receives more investments than it sends out.

After presenting the variables, we will begin our modeling by conducting stationary tests.

- The tests for stationarity:

Before beginning the econometric specification, it is important to recall that an analysis of the stationarity of the proposed data series is a prerequisite for any econometric analysis, particularly when dealing with macroeconomic data. Currently, this study is highly recommended due to the issues of spurious regression that may arise if variables are not stationary.

As part of this work, we perform unit root tests, the most recommended and simplest of which is the augmented Dickey-Fuller (ADF) test and the Phillips-Perron test to detect the presence or absence of a unit root in the series of real GDP per capita, human capital accumulation, FBCF, IDE, and IP.

[4]World Bank website:https://data.worldbank.org/indicator/BX.GSR.ROYL.CD?view=chart

Table 6: Augmented Dickey-Fuller (ADF) Unit Root Test Results

Augmented Unit Root (ADF) Test Results				
Variables	**T-statistics**	**Critical Value (5%)**	**Probability**	**Integration order**
GDP/capita	11.40013	-2.929734	0.0000	I(1)
The KH (dry)	-5.375960	-1.949097	0.0000	I(0)
The KP	-5.885476	-1.948886	0.0000	I(1)
IDEs	-10.53904	-1.948495	0.0250	I(1)
The KH (super)	-4.633673	-3.515523	0.0030	I(0)
The KH (expenses)	-6.665328	-1.948495	0.0000	I(1)
IP	-4.470762	-2.936942	0.0009	I(0)

Source: E-Views output

The results of unit root tests indicate that the variables: average years of secondary and higher education, physical capital, and intellectual property are stationary at level I(0), so there is no risk of cointegration. On the other hand, real per capita gross domestic product, gross fixed capital formation, and public education expenditures are stationary at first difference (integrated of order 1: I(1)). This implies that conventional estimation methods such as ordinary least squares lead to spurious regressions (the famous Granger "spurious regression" of 1974).

Cointegration allows us to assess long-term relationships between non-stationary variables, namely GDP, FBCF, IDE, and DEP (the other variables, being stationary at the level, will not be affected by this test: SEC, SUP, and PI). Hence, the need to test cointegration only between models 1 and 3.

➢ *Johansen's cointegration tests:*

- The cointegration of the 1st model:

Table 7: Results of Johansen's cointegration test of non-stationary variables

Results of Johansen's cointegration test of non-stationary variables				
Trace test	**Own value**	**Trace statistics**	**Critical value 5%**	**Probability**
None*	0.609978	43.20949	12.32090	0.0000
At most 1	0.039673	1.781163	4.129906	0.2141
The test of the Own value Maximum	**Own value**	**Trace statistics**	**Critical value 5%**	**Probability**
None*	0.609978	41.42833	11.22480	0.0000
Atmost 1	0.039673	1.781163	4.129906	0.2141

Source: EViews output

The results of this test show that there is cointegration, as the null hypothesis of no cointegration has been rejected (43.20949>12.32090). Therefore, it can be said that this test confirms the existence of a long-term relationship between the variables (GDP, FBCF, IDE).

- The cointegration of the third model:

Table 8: Results of Johansen's cointegration test of non-stationary variables

Results of Johansen's cointegration test of non-stationary variables				
Trace test	**Own value**	**Trace statistics**	**Critical value 5%**	**Probability**
None*	0.587800	48.92870	24.27596	0.0000
At most 1*	0.174218	9.933813	12.32090	0.2116
At most 2*	0.033761	1.511137	4.129906	0.2568
The test of the Own value Maximum	**Own value**	**Trace statistics**	**Critical value 5%**	**Probability**
None*	0.587800	38.99489	17.79730	0.0000
1*	0.174218	8.422675	11.22480	0.1492
Atmost 2*	0.033761	1.511137	4.129906	0.2568

Source: EViews output

The results of this test show that there is cointegration, as the null hypothesis of no cointegration has been rejected (48.92870 > 24.27596). Therefore, it can be said that this test confirms the existence of a long-term relationship between the variables (GDP, FBCF, FDI, EXP).

➢ *Estimation of error correction models:*

To determine the equilibrium relationship between GDP per capita and other variables, it is necessary to estimate error correction models.

By eliminating the IDEs that are not statistically significant[5], and re-estimating the model for the period 1970-2015, the final equation is written as:

[5] The equation is estimated using the one-year lagged variations of long-term fundamentals. Non-significant lagged levels are then gradually eliminated until the remaining variations are significant.

- 1st model:

$$\Delta lnPIB = 0.690177\,\Delta\, lnPIB_{t-2} + 0.56703\Delta\, lnPIB_{t-3} - 0.461841\Delta FBCF_{t-4}$$
(5.7464) **(4.4873)** **(-2.7165)**
$$+0.133424\Delta lnsec_{t-2} + 0.127976\Delta\, ln\, lnsec_{t-4} - 0.163957TCE_{t-1}$$
(-2.5686) **(2.5776)** **(-2.1263)**

$R^2 = 0.407592$	$R\ ajusté = 0.322962$	$D-W = 2.208876$

According to the ordinary least squares test, we can see that the value of the coefficient associated with the error correction term is 16%, which implies that this model adjusts by 16% in the following year.

- 2nd model:

$$\Delta lnPIB = -0.49727\ \ lnPIB_{t-1} - 0.007536\ lnsup_{t-2} - 0.064555TCE_{t-1}$$
(-3.7207) **(-3.1865)** **(-1.0953)**
$$+0.000790@trend$$
(3.1682)

$R^2 = 0.305779$	$R^2 ajusté = 0.253712$	$D-W = 1.862912$

The value of the coefficient associated with the error correction term is 6%, which implies that this model will adjust by 6% in the following year.

- 3rd model:

$$\Delta lnPIB = -0.593248\,\Delta lnPIB_{t-1} - 0.007536\,\Delta lnPIB_{t-3} - 0.002966TCE_{t-1}$$
(-4.4541) **(2.0024)** **(2.5640)**
$$+0.000790@trend$$
(5.3325)

$R^2 = 0.414352$	$R^2 ajusté = 0.351039$	$F-statistique = 0.351039$	$Probabilité$ 0.000436	$D-W = 1.885377$

The value of the coefficient associated with the error correction term is 0.2%, which implies that this model will adjust by 0.2% in the following year.

- 4th model:

$$\Delta lnPIB = -0.557197\,\Delta lnPIB_{t-1} + 0.260967\Delta lnPIB_{t-3} - 0.002717\Delta FBCF_{t-4}$$
(-4.2953) **(1.8810)** **(-1.8320)**
$$-0.014698\,\Delta IDE_{t-1} - 0.011221\Delta IDE_{t-2} + 1.002956PI - 0.072010TCE_{t-1}$$
(-2.1870) **(-1.8845)** **(3.1259)** **(-2.2855)**
$$+0.0009trend$$
(3.4653)

$R^2 = 0.507263$	$R^2 ajusté = 0.399477$	$D-W = 1.956735$

The value of the coefficient associated with the error correction term is 7%, which implies that this model adjusts by 7% in the following year.

After the first estimation step, in order to properly quantify the short- and long-term effects of endogenous variables in a single equation, a second step is devoted to estimating error correction models in the sense of Hendry.

➢ *Estimation of error correction models in the sense of Hendry*

- 1st model:

$$PIB = -0.655690\ lnPIB_{t-1} + 0.619485\ lnPIB_{t-2} - 0.343499 lnPIB_{t-4}$$
(-5.4934) **(4.3301)** **(-2.6492)**
$$-0.228685 FBCF_{t-4} + 0.17800 lnsec_{t-2} + 0.016561 @trend + 3.303863 C$$
(-1.9590)(-3.5406)(4.3045)(2.9779)

$R^2 = 0.593546$	$R^2 ajusté = 0.523868$	$F - statistique$ 8.518420	$Probabilité$ 0.000010	$D - W = 2.248226$

Table 9: The effects of variables (FBCF, IDE, SEC) on GDP (1st model)

The variables	The short termeffect	The long termeffect[6]	The overalleffect[7]
FBCF	-0.22	0.60	--
IDE	--	--	--
SEC	--	0,47	0.17

Source: EViews output

6 The long-term effect of a non-stationary variable in levels is obtained here by dividing the coefficient associated with this variable (in lagged values) by the opposite of the sum of coefficients associated with lagged values of the dependent variable expressed in levels.

7 For stationary variables in levels.

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As shown in the table above, FBCF negatively affects per capita GDP in the short term (-0.22) but positively in the long term (0.60). The number of years of secondary education has a positive long-term effect (0.47) and an overall positive effect (0.17) on economic growth. Our estimated model indicates that a 1% increase in the number of years of secondary education would lead to a long-term increase in real GDP per capita of 0.47 percentage points, and an overall increase of 0.17 percentage points.

However, since the primary difference between IDEs is not statistically significant, it was subsequently eliminated from the final equation.

- 2nd model:
  The final model re-estimated after eliminating statistically non-significant variables can be expressed as follows:

$$lnPIB = -0.672913\ lnPIB_{t-1} + 0.645257\ lnPIB_{t-2} - 0.415782 lnPIB_{t-4}$$
(-5.2954**)** **(**4.3007**)** **(**-3.1837**)**
$$0.038560 lnsup_{t-2} + 0.013613@trend + 3.826968C$$
(-2.5899**)(**3.9272**)(**3.5795**)**

$R^2 = 0.593546$	$R^2 ajusté = 0.467540$	$F - statistique$ 8.200215	$Probabilité$ 0.000030	$D - W = 2.152496$

Table 10: The effects of variables (FBCF, IDE, SUP) on GDP (2nd model)

The variables	The short termeffect	The long termeffect	The overalleffect
FBCF	--	--	--
IDE	--	--	--
SUP	--	0.09	0.04

Source: EViews output

In this model, gross fixed capital formation has no effect on economic growth in either the short or long term, nor do foreign direct investments. As for the variable of years of higher education, if the population with a higher education degree increases by 1%, the GDP increases overall by 0.09 percentage points in the short term and 0.04 percentage points in the long term.

- 3rd model:
  The final model re-estimated after eliminating statistically non-significant variables can be written as follows:

$$lnPIB = -0.708725\ lnPIB_{t-1} + 0.594655\ lnPIB_{t-2} - 0.326585 lnPIB_{t-4}$$
(-5.0590) (3.4268) (-2.3248)
$$+0.335488 \Delta FBCF + 0.393785\ FBCF_{t-1} + 0.284170 \Delta DEP - 0.343800 DEP_{t-2}$$
(1.9922)(2.6917)(-1.9681)(-2.2217)
$$+0.269150 DEP_{t-3} + 0.010060@trend + 3.931060C$$
(1.9709)(3.3307)(3.5238)

$R^2 = 0.581764$	$R^2 ajusté = 0.464135$	$F - statistique$ 4.945754	$Probabilité$ 0.000340	$D - W = 2.085803$

Table 11:The effects of variables (FBCF, IDE, DEP) on GDP (3rd model)

The variables	The short termeffect	The long termeffect	The overalleffect
FBCF	0.33	-0.9	--
IDE	--	--	--
DEP	0.01	0.08	--

Source: EViews output

In this model, the gross fixed capital formation (GFCF) has a statistically significant positive effect in both the short and long term, with an increase of 0.33 percentage points in the short term and a decrease of 0.9 percentage points in the long term. According to our estimates, a 1% increase in public education spending would lead to a decrease in the growth rate of 0.01 percentage points in the short term and 0.08 percentage points in the long term. Foreign direct investment, on the other hand, has no effect on GDP.

- 4th model:
  The final specification re-estimated after eliminating statistically non-significant variables can be written as follows:

$$lnPIB = -0.567455 lnPIB_{t-1} + 0.319971 lnPIB_{t-3} - 0.002773 FBCF_{t-4}$$
(-4.1362) **(2.2345)** **(-1.7962)**
$$+0.8031745 PI_{t-2} + 0.000719 @trend$$
(2.5101) **(2.7911)**

$R^2 = 0.394924$	$R^2 ajusté = 0.325772$	$D - W = 1.687151$

Table 12: The effects of variables (FBCF, IDE, PI) on GDP (4th model)

The variables	The short termeffect	The long termeffect	The overalleffect
FBCF	--	0.002	--
IDE	--	--	--
PI	--	0.80	--

Source: E Views output

In this model, FBCF has a statistically significant positive long-term effect (0.02) while foreign direct investment has no effect on GDP. We estimate that a 1% increase in intellectual property commission would result in a long-term increase in GDP by 0.80 percentage points.

V. DISCUSSION OF RESULTS

The results of the presented econometric model are based on the analysis of the relationships between explanatory variables and real per capita GDP. Some variables have a significant positive impact on economic growth, while others do not have a significant effect.

- Gross fixed capital formation (GFCF) has a significant positive long-term effect, suggesting that long-term investments can boost economic growth. However, in the short term, GFCF has a negative effect on real per capita GDP, which may indicate that short-term investments can have short-term costs that temporarily affect economic growth. It is important to note that investments cannot be considered in isolation, as they may be influenced by other economic and political factors such as regulation and fiscal policy.
- Foreign direct investments (FDI) do not seem to have a significant effect on GDP, at least not directly. This could be due to the fact that FDI may not be directly linked to the production of goods and services in the local economy, but rather to research and development or the production of goods that are then exported. Additionally, the effects of FDI on GDP may be attenuated by other economic factors, such as local competition and regulation.
- The years of secondary education have a significant positive long-term effect on real GDP per capita, suggesting that education can play an important role in stimulating economic growth. An increase of 1% in the number of years of secondary education would result in a 0.47 percentage point increase in real GDP per capita in the long term. Although the short-term effect is relatively weak, with only a 0.17 percentage point increase. It is important to note that investment in secondary education can have positive long-term economic returns for the Moroccan economy: in addition to preparing students for higher education, secondary education can also provide technical and professional skills necessary to work in several sectors that do not require a higher level of education.
- The variable "years of higher education" is considered to have a positive effect on economic growth. According to the model, a 1% increase in the population with a higher education degree leads to a short-term increase of 0.09 percentage points in GDP and a long-term increase of 0.04 percentage points. This suggests that education is an important factor for economic growth in this model, which is consistent with many other economic studies.
- These estimates suggest that an increase in public education spending may have negative short-term economic effects, but positive long-term effects. A 1% increase in public education spending is estimated to decrease the GDP growth rate by 0.01 percentage points in the short term. This could be due to immediate costs associated with the increase in public spending, such as teacher costs and school construction and maintenance costs. However, in the long term, a 1% increase in public education spending could increase the GDP growth rate by 0.08 percentage points. This could be explained by the fact that investment in education can improve the quality of the workforce and increase the overall productivity of the economy.
- The Intellectual Property Commission (IPC) is estimated to have a positive effect on economic growth, with a 1% increase resulting in a long-term increase of 0.80 percentage points in GDP. This suggests that the protection of intellectual property rights is considered important for stimulating economic growth in this model.

The key results of the mentioned economic models can be summarized as follows:

- Increasing the number of years of secondary education can have significant positive economic effects both in the short and long term. The results indicate that a 1% increase in the number of years of secondary education can increase real GDP per capita by 0.47 percentage points in the long term and 0.17 percentage points overall.
- The second model suggests that the variable "years of higher education" has a positive effect on economic growth, resulting in a short-term increase of 0.09 percentage point of GDP and a long-term increase of 0.04 percentage point.

- The increase in public spending on education may have negative short-term economic effects but positive long-term effects on the GDP growth rate.
- The third model suggests that a 1% increase in intellectual property commission (IPC) would lead to a long-term increase of 0.80 percentage points in GDP. This suggests that the protection of intellectual property rights is considered important for stimulating economic growth in this model.

The results of these economic models can provide a basis for recommendations to the Moroccan government to guide its economic policies and stimulate economic growth. Some possible recommendations based on the results of the models are as follows:

- Investing in Education: Model results suggest that increasing the number ofindividuals with a high school or higher education degree is positively correlated with economic growth, particularly in the long term. Therefore, the Moroccan government may consider investing in education, even though there may be initial costs associated with this strategy, to enhance the skills and productivity of the workforce.
- Improving the protection of intellectual property rights: The results of the model indicate that an increase in the intellectual property commission is associated with long-term economic growth. Therefore, the Moroccan government is encouraged to improve the protection of intellectual property rights to encourage innovation and investment in intellectual property.

Furthermore, it should be noted that the results and recommendations of this study may align with specific characteristics of the Moroccan economy and other relevant factors in formulating effective policies aimed at stimulating economic growth. Among these factors:

- Key sectors of the economy: Morocco has a diversified economy with key sectors such as agriculture, industry, tourism, and services. Economic policies must take into account the specificities of each sector in order to effectively and coherently stimulate economic growth.
- Technological Development Level: The level of technological development in Morocco can vary depending on the sectors. The government may consider investing in research and development (R&D) to stimulate innovation and the adoption of new technologies.
- Level of workforce qualification: The level of workforce qualification can vary depending on the sectors and regions of Morocco. The government could implement training programs to improve the skills and productivity of the workforce.
- Infrastructure: Road, port, air, telecommunications, and other infrastructures are essential for stimulating economic growth. The government has an interest in investing in these areas to improve the efficiency of channels of transmission and commercial exchanges, and to promote investment.
- Geopolitical context: Morocco is located in a specific geopolitical region that can have impacts on the economy. The government may consider developing economic policies that take into account the geopolitical advantages and risks and collaborating with regional and international partners to strengthen stability and economic efficiency.

It is important to emphasize that these recommendations are neither exhaustive nor comprehensive, and that other factors may also be relevant for stimulating economic growth. The Moroccan government must take into account all the economic, social, and political characteristics of the country to formulate effective economic policies.

VI. CONCLUSION

In Morocco, indicators for innovation and education have seen advancements in recent years, but still have room for improvement. Regarding innovation, Morocco established a national strategy for research and innovation in 2014. This strategy aims to strengthen the country's research and innovation capacity and promote collaboration among different actors in the Moroccan innovation system. However, according to the Global Innovation Index 2020, Morocco ranks 97th out of 131 countries studied, indicating some lag in terms of innovation. As for education, Morocco has also made progress in recent years. The literacy rate has significantly increased, and the country implemented an education reform in 2015 aimed at improving the quality of teaching and reducing inequalities in access to education. However, challenges remain, particularly in terms of teaching quality and matching the training provided with the needs of the labor market and productivity in innovative human capital.

In conclusion, economic model results for Morocco suggest that increasing the number of people with a high school diploma or higher education and improving the protection of intellectual property rights are key factors in stimulating long-term economic growth.

Based on these results, it is recommended that the Moroccan government increase its investments in education, especially in higher education, in order to improve the skills and productivity of a competent and innovative workforce. Additionally, it is recommended to improve the protection of intellectual property rights to encourage innovation.

Indeed, it is also important to take into account the specific characteristics of the Moroccan economy, such as key sectors of the economy, level of technological development, skill level of the workforce, infrastructure, territorial specificities, and geopolitical context, in formulating effective economic policies.

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