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# Technology frontier, entrepreneurship and economic growth in MENA countries: Evidence from panel data analysis

*Mohammed BOUZNIT* [1]

[1] *Laboratoire Economie et Développement, Université de Bejaia, (Algeria),* mohammed.bouznit@univ-bejaia.dz

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**ABSTRACT**

*This article aims to empirically analyze the effects of the distance to the technology frontier, entrepreneurship and economic growth in MENA countries, over the period 2006-2020, using panel data analysis. The obtained results using the Generalized Least Squares method (FGLS), in the presence of the heteroscedasticity, autocorrelation and cross-sectional dependence in panel data, show that the economic growth is negatively linked to the technology frontier, nevertheless, entrepreneurship index does not appear significant over time, which may indicate that the entrepreneurship has not yet reached the critical threshold after which it begins to affect economic growth positively. Moreover, reducing the distance to the technology frontier and promoting the innovation activities, as well as the absorption of new technologies, and increasing the entrepreneurial activities will be the best way for MENA countries to catch up developed countries.*

## 1. Introduction

It's well established that identifying the sources of economic growth is crucial to establish the suitable economic policy to sustain the long-run economic growth rate (Bouznit et al., 2015) [1]. Since the end of 1980s, the new, or endogenous, theories of growth have revived the sources of economic growth (Romer, 1986; Lucas, 1988) [2, 3]. According to these theories, the human capital, mainly accumulated from education, is the engine of economic growth through its direct and indirect impact on labor productivity. Indeed, the investment in education increases the stock of human capital, which in turn leads to improve significantly the labor productivity, and thus accelerates the economic growth rate. According to Romer (1986) [3], economic growth is influenced by innovation, which is related to the stock of human capital. Moreover, several empirical studies show that the technology frontier seriously hinders the economic growth of poor and developing countries (Lau et al, 2023) [4]. Indeed, the country's long-run economic growth rate is attributed not only to the accumulation of human and physical capital, and technological progress, but also to the extent of the distance of the technology frontier (the USA is considered the world technology frontier) (Acemoglu et al., 2006; Vandenbussche et al., 2006; Madsen, 2014) [5, 6, 7].This means that the country's economic growth will be enhanced by reducing the distance to the technology frontier. Moreover, over the past 140 years, the increase in productivity was attributed to the changes in educational attainment, and also to the interaction between the educational attainment and the distance to the technology frontier (Madsen, 2014) [7].

On the other hand, the literature palaces greater emphasis on the macroeconomic effects of entrepreneurship (Tahir & Burki, 2023; Gu & Wang, 2022; Galindo & Méndez, 2014) [8, 9, 10]. Moreover, according to Aparicio et al. (2016) [11], the opportunity entrepreneurship is one of the mechanisms that can boost economic growth. More recently, as stated in Tahir and Burki (2023) [8], entrepreneurship is a significant factor of the economic growth in BRCIS countries.

[*] Corresponding Author :*Mohammed BOUZNIT*

Similar results were found in Surya et al. (2021) [12], and Gaba and Gaba (2022) [13]. Thereby, the increase of entrepreneurial activities is a suitable policy to address economic and societal problems (Gu & Wang, 2022) [9]. Nevertheless, due to limited data on entrepreneurship, there are few empirical studies highlighting the nature of the relationship between entrepreneurship and economic growth in MENA countries. In this context, Aydigan and Sevencan (2018) [14] suggest that the economic needs in MENA countries are the main contributor to fostering entrepreneurship, whilst the extent of its impact on economic growth will depend on the level of education.

Therefore, the aim of this paper is to empirically analyze the effects of technology frontier, entrepreneurship, and economic growth in MENA countries, over the period 2006-2020, using panel data analysis. This study is of interest, because it allows for a deeper investigation of the sources of economic growth in MENA countries and an estimate of their effects on GDP per capita. Further, it provides policy implications helping policymakers in establishing suitable strategies to sustain economic growth.

With this aim, the remainder of this article is structured as follows: Section 2 presents the adopted methodology. The used data, obtained results are presented and discussed in Section 3. Finally, the main conclusions are given in Section 4.

## 2. Methodology

The panel data analysis will be used to estimate the effects of technology frontier, and entrepreneurship on economic growth in MENA countries over the period 2006-2020. Based on the available data, the selected countries are Algeria, Egypt, Iran, Saudi Arabia, Tunisia, Morocco, and Syria. In the line with the literature, economic growth, measured as GDP per capita at constant prices; will be considered as a function of a set of explanatory variables namely; gross fixed capita formation per capita at constant prices as proxy of physical capital per capita, human capital, frontier technology measured by the difference in the level of human capital in each country compared to that of the USA (the USA is considered the world technology frontier), Imports and exports of goods and services per capita at constant prices, entrepreneurship defined as a ratio of formal entry density calculated as the number of new registered companies with limited liability. The data are annual figures covering the period 2006-2020, and collected from three international databases; World Development Indictors (WDI), Penn World Table (PWT 10.0), and World Bank Entrepreneurship Database project. The studied countries and the period were chosen based on the data availability. Table1 provides more information about the study variables, their abbreviations in the functional from of the model, and their sources.

Table 1. Studied variables and data sources

| **Variables** | **Symbol** | **Measure** | **Data source** |
|---|---|---|---|
| Gross domestic Product per capita | GDPC | Gross domestic product at constant prices (constant 2015 $US) divided by midyear population. | WDI |
| Physical capital per capita. | GFCFC | Gross fixed capital formation divided by midyear population ( constant 2015 $US) | WDI |
| Human capital | H | Years of schooling and returns to education | Pen World Table 10.0 |
| Technology frontier | TF | TF is difference between the level of human capital in USA and that of each studied country | - |
| Entrepreneurship | ENT | ENT is defined as a ratio of formal entry density calculated as the number of new registered companies with limited liability. | World Bank Entrepreneurship Database project |
| Imports | IMPC | Imports goods and services per capita (constant 2015 $US)) | WDI |
| Exports | EXPC | Exports goods and services per capita (constant 2015 $US) | WDI |

Source: Elaborated by the author

Expect the technology frontier variable (TF), the rest of the used data are expressed in logarithms. Therefore, the functional forms of the econometric model will be considered as follows:

$$LnGDPC_{i,t} = \beta_0 + \beta_1 LnGFCFC_{i,t} + \beta_2 LnH_{i,t} + \beta_3 TF_{i,t} + \beta_4 LnENT_{i,t} + \beta_5 LnIMPC_{i,t} + \beta_6 LnEXPC_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where Ln implies that the studied variable is expressed in the logarithm, and $\beta_0$, $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$, $\beta_5$ and $\beta_6$ are the parameters to be estimated. $\varepsilon$ is the error term with:

$$\varepsilon_{i,t} = \mu_i + \lambda_t + v_{i,t} \quad (2)$$

where $\mu_i$ captures the unobservable individual (cross section) heterogeneity , $\lambda_t$ is the unobservable time heterogeneity, whilst the term $v_{i,t}$ is the random error term. Therefore, two types of the model will be identified; fixed effect model or random effect model. Indeed, in the fixed effect model, the within components $\mu_i$ and $\lambda_t$ are supposed fixed parameters to be estimated and $v_{i,t}$ is random term. Nevertheless, in the random effect model the components $\mu_i$ , $\lambda_t$ and $v_{i,t}$ are supposed random terms identically and independently distributed with zero mean and constant variance.

The equation (1) will be estimated considering two functional forms; the fixed effects model, and the random effects model. To identify which model is better, the Hausman test (1978) [15] will be performed; however this selected model will be subjected to the validity tests by testing for the serial correlation, the heteroscdascity, and the cross-sectional dependence. To address these issues, the Feasible Generalized Least Squares method will be used to estimate the (1), which permits to get unbiased and efficient estimated coefficients.

## 3. Data, results and discussion

The descriptive statistics of the used data are presented in Table 2. The equation (1) was estimated by considering the fixed effects model (Colum A), and the random effects model (Colum B). The obtained results are reported in Table 3.

Table 2. Statistics of the used data

| Variables | | Mean | Std. dev. | Min | Max | Obs. |
|---|---|---|---|---|---|---|
| $LnGDPC$ | overall | 8.50 | .63 | 7.81 | 9.92 | N = 90, i=6, T=15 |
| $LnGFCFC$ | overall | 7.13 | .73 | 5.91 | 8.69 | N = 90, i=6, T=15 |
| $TF$ | overall | 1.43 | .27 | 1.03 | 1.96 | N = 90, i=6, T=15 |
| $LnH$ | overall | .81 | .13 | .519 | .99 | N = 90, i=6, T=15 |
| $LnIMPC$ | overall | 7.41 | .64 | 6.58 | 8.96 | N = 90, i=6, T=15 |
| $LnEXPC$ | overall | 28.59 | 1.39 | 26.87 | 31.52 | N = 90, i=6, T=15 |
| $LnENT$ | overall | -.99 | 1.21 | -3.80 | .80 | N = 90, i=6, T=15 |

Source: Elaborated by the author

*Table 3. Estimates the (1)*

| $LnGDPC$ | A | B | C |
|---|---|---|---|
| $LnGFCFC$ | 0.06*** | 0.21*** | 0.21*** |
| | (0.02) | (0.02) | (0.02) |
| $LnH$ | 2.02*** | -1.65*** | -2.12*** |
| | (0.27) | (0.59) | (0.49) |
| $FT$ | 0.89*** | 1.01*** | -1.3*** |
| | (0.14) | (0.30) | (0.25) |
| $LnENT$ | 0.02** | 0.001 | 0.002 |
| | (0.009) | (0.01) | (0.01) |
| $LnIMPC$ | -0.05** | 0.28*** | 0.18*** |
| | (0.02) | (0.03) | (0.02) |
| $LnEXPC$ | 0.12*** | 0.20*** | 0.23*** |
| | (0.01) | (0.01) | (0.01) |

| | | | |
|---|---|---|---|
| $Constant$ | 1.96*** | 1.65 | 2.35** |
| | (0.53) | (1.04) | (0.93) |
| No. of Obs. | 90 | 90 | 90 |
| No. of groups | 6 | 6 | 6 |
| Period | 2006-2020 | 2006-2020 | 2006-2020 |
| R-squared: | | | |
| -Within | 0.86 | 0.54 | |
| -Between | 0.91 | 0.99 | |
| -Overall | 0.87 | 0.98 | |
| Model | Fixed effect | Random effect | FGLS, p(c), c(ar1) |
| Hausman test: Khi-2(6)(p-value) | 580.34 (0.00) | | |

Notes: ***, and ** show significance at the 1%, and 5% significance level, respectively. (.) The standard deviation
Source: Elaborated by the author

Indeed, the Hausman test (1978) [15] was used to identify which the model is bester. The null hypothesis H0, which indicates the fixed effects model is better than the random effects, has been tested. As the probability value associated to Khi-2 test is less than 1%, we reject the null hypothesis, thereby the fixed effects model is chosen to explain the relationships between economic growth and the explanatory variables; gross fixed capital formation per capita at constant prices, human capital, technology frontier, imports and exports of goods and services per capita. This model shows that the estimated coefficient with respect to the variable of imports of goods and services appears with a negative sign, whilst the rest of the estimated coefficients are positive and statistically significant either at 1%, or 5% significance level. In view to test if this model is robust, the validity tests (i.e. autocorrelation test, heteroscedasticiy test, and cross-sectional dependence test) were used. According to the modified World test (Greene, 2000) [16], we reject the null hypothesis of homoscedastcity, implying that the errors terms of the estimated fixed effects are heteroscedastic. Likewise, the null hypothesis of absence of autocorrelation has been tested using the Wooldridge test (Wooldridge, 2002) [17]. As the p-value is less than 5%, we reject this null hypothesis, and thereby the errors terms are correlated. Further, the used Breusch-Pagan LM test led to accept the alternative hypothesis of the cross-sectional dependence. Consequently, the estimated fixed effects model isn't robust. Therefore, the Generalized Least Squares Method (FGLS) in the presence of the heteroscedasticiy, autocorrelation and cross-sectional dependence in panel data was used to estimate the (1). The obtained results are presented in Colum C in Table 3. The estimated coefficient with respect to the gross fixed capital formation per capita, as proxy investment physical capital, appears with positive sign and significant at 1% significance level. This means that the investment in physical capital positively affects economic growth, and an increase of one standard deviation in gross fixed capital formation per capita leads to augment GDP per capita by 0.21%. This result is in line with the theories of economic growth (Solow, 1956) [18], and also it is consistent with those obtained in the previous empirical studies (Mankiw et al., 1992; Abu-Qarn & Abu-Bader, 2007; Pablo-Romero et al., 2016) [19, 20, 21]. Nevertheless, the estimated coefficient of human capital using FGLS method is negative and significant at 1%, its elasticity is equal to (-2.12). This result is in the contrary with the endogenous theories of growth which suggest that human capital plays a great role on the long-run economic growth (Lucas, 1986; Romer, 1988) [2, 3]. The same unexpected are found in Benhabib and Spiegel, 1994 [22], and Pritchett (1996, 2001) [23, 24]. In fact, the empirical studies highlighting the role which can play human capital, or education, on economic growth found mixed results (positive effect, negative effect, no effect). For instance, Benhabib and Spiegel (1994) [22] studied the effect of human capital on economic growth by comparing two models. In the first one, the human capital is supposed to be a cumulative production factor, like physical capital, which directly affects the economic growth. However, in the second model, the human capital is supposed to have an indirect effect on economic growth through the improvement of the labor productivity (i.e. human capital is supposed as an explicative factor of the total factor productivity (TFP). Their findings show a negative effect of human capital in the first model, whilst it impacts on TFP was positive and very significant. According to Pritchett (1996, 2001) [23, 24], two arguments can be given to explain this puzzle result. First, in the absence of suitable institutional framework, the acquired new skills lead to increase the wages of employees rather than the total factor productivity. The second explanation is related to the quality of education, because an additional year of schooling is not necessary will produce sufficient cognitive skills able, in turn, to faster economic growth rate.

Regarding the frontier technology, the estimated coefficient value is equal to (-1.3), implying a negative impact on GDP per capita. This means that the frontier technology hinders economic growth in MENA countries. Consequently, reducing the distance to the technology frontier by increasing the level and quality of human capital will be necessary for MENA countries to catch up with developed countries. This result is consistent with those found in Lau et al. (2023) [4] for the case of African countries. Likewise, Madsen (2014) [7] argued that the productivity growth, during the past 140 years, was positively affected by the increase in the level of education and the interaction between education and the distance to the technology frontier.

The results further reveal that the imports and exports of goods and services contribute to GDP per capita. Moreover, the estimated coefficient associated to entrepreneurship index isn't significant, implying no effect on economic growth. This can be explained by the fact that the entrepreneurship index has not yet reached the critical threshold after which it begins to affect economic growth positively in MENA countries. In this sense, Aydogan and Sevencan (2018) [14] found a negative effect of self-employment, as proxy of entrepreneurial activities, on economic growth in MENA countries. Furthermore, Wennekers et al. (2005) [25] supported a U-shaped relationship between nascent entrepreneurship and economic growth. Thereby, a significant positive effect of entrepreneurship will be obtained only in countries with higher economic development. Nevertheless, numerous of previous studies argued that entrepreneurship plays a great role on economic growth (Wang et al., 2005. Tahir and Burki, 2023) [26, 8].

## 4. Conclusion

This study highlighted the relationship between the distance to the technology frontier, entrepreneurship and economic growth in six MENA countries (Algeria, Egypt, Iran, Saudi Arabia, Tunisia, Morocco, and Syria). To do so, the panel data analysis was used to estimate an econometric model posing GDP per capita as a function of a set of explanatory variables namely; gross fixed capital per capita (investment in physical capital), human capital, distance to the technology frontier, entrepreneurship index, imports and exports of goods and services. The estimated results, using Generalized Least Squares Method (FGLS) in the presence of considering the heteroscedasticity, autocorrelation and cross-sectional dependence in panel data, reveal that the investment in physical capital, imports, and exports of goods and services positively affect GDP per capita. However, the economic growth is negatively linked to the distance of the technology frontier and human capital. Indeed, the negative effect of human capital can be explained by: i) human capital indirectly affects economic growth through the improvement of the labor productivity, ii) the structure of the economies in MENA countries, in which economic growth rate is mainly driven by the public investment in physical capital, does not allow to human capital to be profitable, and thereby increasing the use of human capital in the production process leads to faster long-run economic growth rate. Results further show that entrepreneurship does not appear significant over time, which may indicate that the entrepreneurial activities do not yet reached the critical threshold after which it begins to affect economic growth positively.

The author declare no conflict of interest.

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