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AN EMPIRAL INVESTIGATION FROM MOROCCO AND TUNISIA

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Summary:

One of the principles debates in the old economic thinking is relating on whether liberalization is the engine of economic growth. International trade is considered as the key element in the knowledge diffusion and in the nations performing. Beside its active participation to the technology transfer issued from R&D activities by industrialized countries, trade policy can influence on the economic capacity to mobilize human capital and benefice to economic growth. However, the literature of economic theory shows that the relations among openness, economic growth and productivity still remain bad established. We try to illuminate this debate from the point of view of the Moroccan and Tunisian available data. We analyze the macroeconometric long term behaviour of the openness variables to imports, exports and of human capital based on school gross enrolment rate. We had completed this approach by integrating a decomposition of human capital (the structure of labor qualification) in the perspective of an aggregate production function in a manner analogous to the augmented Solow model. The econometric tests allow considering the human capital for economic growth in these countries. The human capital stock appears to contribute to the long term economic growth. It shows that the strong mobilization of labor qualification appears in the Tunisian case.

Keywords: technological spreading, endogenous growth, human capital, developing countries.

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1. Introduction

The theoretical literature on openness - growth relation underlines the uncertain effects of international trade as development strategy for emerging countries. If new growth theories present international trade as a key element in the technological spreading effect, they put forward the role of the economic agents in the knowledge spreading process. Growth opportunities for the technological level a nation are from then on dependant on the tacit knowledge spreading that takes place with the openness processes.

The human capital effect on growth thus appeared like phenomena that can be modified by openness and international trade. It is not here about debating the role of international trade and openness in the development of the countries, but to concentrate on the idea that education-growth relationship can be modified by the improvement of the country's insertion into international trade.

The failure of the import substitution strategy during the 1960's has involved a trade reform both in Morocco and Tunisia. The increased insertion of theses economies in the international division labour is characterised in the last decade by a stagnation of the long-term funds volumes bound to a slowing down in the traditional partnerships. This orientation to the decrease of the foreign direct investments (FDI) is in shift with trade progression. Technological transfers that take place with input imports are more uncertain, the diffusion of the tacit knowledge being more difficult than the ones that take place with the FDI. The organisation of the technological transfer is from then on governed by the adequacy between foreign technologies needs in factors and the local availabilities. This technological acquirement is essentially dependent on the country productivity level and upon higher educational quality. The improvement of the efficiency level of the local firms is conditioned by educational policies and the institution of a national innovation system (NIS) that permit the trade-off between the import of modern technologies or the use of more routine technologies.

For all that, the stake obviousness of the channels by which the levels of openness and human capital encourage technological transfer, notably in the case of Southern countries is not easy to establish. First of all, the correlation between education and growth doesn't seem universal: the lack of homogeneity in the results well underlines that the impact of the educational progress on countries' economic development is mixed (Temple [1999]). The ambivalence of the empirical results as for the opening-growth-education relation ensues because the existence of a positive relation between these variables is sensitive to the method of used evaluation, to the specification of the model, to the chosen educational variables and is strongly dependent on the used sample. We stress therefore the need to restrict the range of data and we will concentrate on the cases of Morocco and Tunisia.

At the same time, few studies have analysed the impact on growth of productivity for the Mediterranean economies. The work achieved by Senhadji [2000] allows comparison of this impact for several regions; it demonstrates that from 1960 to 1994, the rise in total factor productivity (TFP) associated to more elevated investment levels had globally only very little impact in the South Mediterranean countries, or even sometimes a negative impact during the 1990's. It can be explained by the fact that these gains have been achieved in the setting of a market that was not in expansion and therefore the productivity had a more important impact on the margins than on the economy's growth.

Another explanation of the weakness of the relation results from the fact that the used indicators to estimate the human capital only take in account the quantitative progress of the education without considering the qualitative aspect. However, if the levels of education, measured in number of years, increased, the quality of teaching could deteriorate, reducing then the impact of the investment in term of human capital. The issue of quality teaching is even more important at the time of international comparisons, since heterogeneity is even more important between nations than between individuals of a same country. Yet this element is not hardly taken in account in the empirical analyses.

Therefore, it seems necessary to sum up these analyses in order to specify what the ambiguities are. Because the impact of education constitutes on a theoretical plan the endogenisation engine of both technological spillovers endogenisation and growth, the economic development passes through various channels. In particular, the impact on growth of education seems especially to be stronger as the countries are deeply integrated in the world economy. Human capital represents a proxy of appropriation capacities of the technology and of the productivity improvement and the innovation output that stays still subordinate to the nations' openness.

Our objective in this paper is to test whether human capital and trade have a causal impact on the rate of technological progress of Morocco and Tunisia. It will even more especially be about knowing if the economic openness of these countries can trigger an acceleration of growth through an efficient use of the stock of human capital. Taken from a relatively near development level on their independence following days, these economies knew divergent economic dynamics, so that today the Tunisian GDP per head is superior on average 1.5 times to the Moroccan one.

To better analyse the dynamics of education, openness policies and their impact on the productivity factors growth, we are conducting macro-econometric long-term analysis of behaviour variables of import and export openness, education and growth. Before conducting the tests of the causality links that settle between these variables, we are checking the stationary sets to avoid "spurious" relations that can settle between the macro-economic statistical sets. We approach the education variable through the rates of schooling as proxy of the human capital. These rates of schooling are considered as flows. This first set of empirical analysis is completed by a second one integrating a decomposition of human capital determined according to the stock of education (by level) in an increased Solow type production function.

2. Technological absorption in the emerging economies

Do the Maghreb countries succeed in taking advantage of their openness ? Is their economic openness a source of growth ? Firstly, as for what concerns the relationship between trade and growth, the economic openness is often presented as an important engine of growth. If openness is supposed to generate only a positive effect on economic development, several theoretical and empirical aspects militate in favour of a deep analysis as for the nature of the openness - growth – human capital relation that can settle in these economies.

The theoretical analysis doesn't always determine either similar results as for the associated effects on growth of openness and human capital stock nor for the causality links that settle between these variables in the determination of a nation's wealth level.

- Luca's patterns of growth models demonstrate that the economic impact of education essentially concentrates on labour productivity (Young [1991], Rebelo [1991]). The weakness of international externalities may notably confront Southern countries to hysteresis phenomena. The structure and orientation of trade play an important role in the diffusion and in the adoption of new technological know-how. The diffusion of technology is thus contingent on the level of technology that has already been reached by the country on the one hand and the nature of the technologies to be traded on the other.

The impact on countries having a strong technological disadvantage of a deeper integration in the IDL remains indeterminate due to the presence of negative externalities bound to a bad specialisation of the economy.

- For the theoretical works that opt for Romer's patterns of growth formalisation, human capital has more important and complex impact than its simple effect on labour productivity. Because education plays an important role in the expansion of the productive structure, it is primordial to analyse the effects of human capital on technological development.
These models quite often permit validating free trade efficiency because of the openness positively acts on technological spreading and of a direct manner. Thus, an open country, especially in the case where it presents an important technological gap in relation to his neighbours, benefit of the technological progress of most advanced countries through trade[1].

Because this technological diffusion is characterised by its uniformity and its homogeneity for the countries set trade partners, the openness will only generate this positive impact. This national technological level is going to underline the technological repercussions to the basis of increasing scales outputs. Openness then allows trade participating countries to be nearer to the "technological border" and so, to put the accent on the innovation, the creativeness and Research & Development (R&D), the only strategy permitting the improvement of the economic performances and explaining an uninterrupted pursuit on the long term growth path. The innovation can also be set in motion out of the strict setting of the R&D via the imitations of the manufacture processes (by reverse engineering way) or the use of the goods or equipment incorporated technology. Even if open markets economies cannot automatically benefit from the supply of foreign know-how, the importation of technology from abroad represents the surest way of gaining access to the knowledge developed in innovative economies.

In this type of models, and under the hypothesis of local capacity adaptation of the technologies adopted, openness has a necessarily positive (indirect) impact on the countries faculty to face competition and competitiveness constraints.
If these works are of a major contribution to analyse the causality links between the technological performances and the economic performances, their main limit resides in the fact that the innovation is located on the "technological border". They prove to be from then on little auspicious to explain the mechanisms to the basis of the construction of a technological capacity in the countries which are not observing revealed technological comparative advantages.
For the sample countries, and in the absence of imitation of intermediate inputs, the competitive pressure on the export markets drives the firms to import some inputs likely to improve their production processes. It indeed seems that if the competitive pressures on export markets drive the firms to acquire the most competitive technologies abroad, then the

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[1] The technological performances represent technologies' set and useful information related to production process and that can be reached by national economic agents.

applicable variables to explain growth certainly consist in the import openness (that permits to widening the range of the inputs) but also export openness (that translates an assimilation of the imported technologies).

Because on the theoretical point of view it constitutes the engine of growth and of technological spillovers endogenisation, human capital represents in the Southern countries the technological appropriation capacities proxy (or even of the innovation proxy[2]). It leads us to consider human capital as the key element of all growth - openness relationship analysis. This takes in account the role of human capital in the production, the assimilation and management of innovation permits passing the strict setting of the direct impact of education on labour productivity.

Thus, the economic openness and growth link can be analysed from the survey of a necessary condition: to have at our disposal a minimal stock of human capital. Barro [1990] is one of the pioneers that established that for a given level of wealth, a country growth rate is positively bound to the initial level of human capital. It thus agrees to determine the doorstep from which human capital is likely to permit an appropriation of the technology incorporated in the imported goods. If the educational development can encourage the economic modernization while making new techniques emerge, new firms, or new activities, these effects will be especially even stronger than the number of qualified people will have reached a critical size[3]. If the strengths of technical progress and the evolutions of the productive structures don't develop themselves in an interactive manner, countries can then know important unbalances situations of inbalance.

Two stages in the constitution of this stock appear as reflecting mechanisms of creation of different knowledge.

a) Indeed, in order to obtain a global factors productivity growth, imported technologies must be incorporated in the production processes. It is about key "handled technologies". It has been set in motion in many developing countries from the sixties and led to import substitution policies. This incorporation can only be achieved if the country has a relatively qualified human capital stock. It requires indeed a certain knowledge and know-how of technology absorption capacities by human capital and organisational capacities.

b) Another further stage can be considered. It is added to the constitution of a minimal stock of human capital. On this basis, countries' enterprises are capable to analyse and to decompose the imported technologies and to develop by an effect of imitation and transposition the related activities taking support on the imported technology (it allows the importing country to look up the fundamental R&D but not on processes of research and incremental innovations).

It supposes a superior level of human capital qualification to the first stage: the acquired cognitive and organisational capacities at the initial processes time must be of a sufficient level for technological transpositions. In other words, the objective is to generate informational externalities.

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[2] Innovation is meant to be the incremental one i.e. the marginal improvements of existing technical processes according to a discreet process.

[3] In their survey of the education role in the development of the European productive structure, Anderson & Bowman [1976] sustain that the agglomeration effects cannot be grasped regardless of the productive structure.

From then on, the impact on growth of openness is especially raised since both stages described above are developed in the different countries.

The empirical studies that try to identify the existence of innovative international spillovers identify a positive and meaningful relation between total factor productivity growth and openness. For all that, the developing countries capacity to pull substantial advantages of the R&D put in work by Northern countries is not clearly established from a statistical point of view. The reasons for which trade promotion generates productivity gains via this channel remain yet very uncertain[4].

To the macroeconomic level, the different tests show that the results depend on the used sample. Thus, numerous empirical studies affirm that the weakness or even the absence of relation between education and growth in some countries is due to a bad use of the graduate workers. One of the arguments developed by Pritchett [1996] is that if a developing country doesn't sufficiently modify its productive structure to be able to integrate the most qualified workers, then educational output is going to strongly decrease. For Temple [1999], one of the explanations one can bring to this situation stays bound to the heterogeneity relation between human capital and growth. It is indeed difficult to think that we can face the same education impact in all countries. It permits the explaination of why the cross-country tests are strongly dependent on the sampling or why the panel analysis try to take the countries specificity more into account.

We attempt for our part to clarify the debate while examining in what measure the available temporal information for Morocco and Tunisia contributes to analyse trade openness policies and education on growth processes. Firstly, we analyse openness and growth linked together with the different rates of schooling by level of the available human capital in these economies. Secondly, we refine this relation through a better approximation of the active population by a qualification degree. These two sets of empirical tests permit verification of the two stages of the previously definite condition.

3. Growth, human capital and openness relations in Morocco and Tunisia

The simultaneity of the variables touching to growth requires a meticulous analysis of causality to put in evidence the technological changes effects at the macro-economic level. Therefore, and in accordance with the theoretical mechanisms relating the human capital role in the absorption of the international knowledge externalities, it seems applicable to analyse the manner with which this human capital interacts with trade openness.

It is therefore about clarifying the debate while examining in what measure the available temporal information for Morocco [1960-2001] and Tunisia [1964-2001] permits to verify the contribution on growth of trade openness and education policies[5]. We place the human capital role to the heart of the mechanism while analysing its impact on growth and the manner with which it interacts with these economies' openness. To this effect, the econometric equations

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[4] See Harrison [1996], Edward [1998] for an exhaustive review of the literature on this point. For Islam [1995], Caselli & al. [1996] and Berthélémy & al. [1997], one of the main critic is about the weakness of the cross section analyses in the representation of the dynamic phenomena. The positive results that are reported in the cross-country growth regressions sometimes have few significance or, more frequently, become of weak negative significance.

[5] The choice of the periods is dictated by the data availability. The relative data to enrolment rates come from the UNESCO directories. Those relative to GDP, exports and imports derive from the International Financial Statistics/ IMF database.

that puts in relation GDP, human capital and trade openness are going to be tested. The objective is to verify the short and long-term Granger causality relations between these variables. The results are obtained thanks to three different methodologies: the causality tests, the cointegration tests and the estimated correction model.

a) The variables

The used variables used are the following ones:
- LGDP: GDP in log.
- LOPENX: Exports openness in log (X/PIB).
- LOPENM: Imports openness in log (M/PIB).
- LSCOL: Global schooling rate of the population in age to be schooled (in log).
- LSCOL1:   Primary schooling rate in log.
- LSCOL2:   Secondary schooling rate in log.
- LSCOL3:   High degree schooling rate in log.

The macro-econometric analysis of openness and education in Morocco and in Tunisia first proceeds by the properties specification of the temporal sets used. This previous statistical treatment is done before any formalisation of the inter-temporal adjustments and the determination of the GDP growth evolution in relation to long term variables.

To this effect, we conduct the sets stationary survey. The integration order is going to allow us to give account of the variables stationary levels. This first stage is going to permit estimating cointegrated relations in the same way on variables order. These works permit, in a second time, while integrating the specification of cointegrated relations, studying causality links between the variables through the determination of Error Correction Model.

b) Stationary sets survey

The macroeconomic sets generally integrate stochastic tendencies (Hénin [1989], Levasseur & Serranito [1996]). However, the presence of unit roots or random walks in the macroeconomic variables make inoperative the traditional tools of evaluation based on the permanence of the variance. All econometric survey of the auto-regressive detection processes becomes a previous. We test the existence of unit roots in data. These tests appear more suitable than the auto correlations tests to study the stationary of the temporal sets used. We will first use the test put to the point by Dickey-Fuller [1979] in its initial version, DF, and its increased version, ADF (correcting the problems of auto correlations errors). We present the results of the tests as considering an optimal lag determined using Schwartz Information Criteria (SIC)[6].

The descended tests are consigned in table 1 of the annex. They show, while comparing the calculated values of the statistical F to the critical value in the doorstep of 1% corresponding to a number of T observations (equal to 42 in the Moroccan case and 38 in the Tunisian case), that the hypothesis of uselessness of the unit root is not rejected since no integrated process of order 0 follows the considered variables. The set not being stationary, we conducted the first differentiation and achieved the same test on the new set. The results of these tests show that the hypothesis of uselessness of the unit root is now rejected and therefore all differentiated sets prove to be stationary.

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[6] The use of AIC criteria does not modify our results.

These stationary tests therefore allow keeping the set of the variables for possible cointegrated relations.

c) Survey of the cointegrated relations

Having integrated variables of the first order, it is about identifying long term relations balance from the evaluation of cointegrate relations binding the GDP growth rate to the openness and education variables. We apply the Johansen cointegration method [1991, 1995]. This operation entails a dwindling of information on the long-term relations binding these variables. While using the Granger representation theorem for the set of the variables integrated of order 1 and cointegrated between them, it is possible to remedy this problem by ECM of the GDP growth in Morocco and in Tunisia. Thus, it agrees to determine the existence of cointegrated relations between the variables that are the testimony of a long term balance between the different economic variables.

On the retained periods, [1960-2001] for Morocco and [1964-2001] for Tunisia, the tests underline the existence of a certain number of cointegrated relations. The results of Johansen cointegration tests on the variables, the GDP logarithm, the logarithm of openness feared by the report of imports and exports to the GDP and the logarithm of the population in age to be schooled are consigned in tables 2 to 5 in annex. The application of cointegration method permits insuring that our variables, expressed in yearly log-linearised data well verify the same order of integration.

First of all there exist long term relations between the human capital (measured by the proxy of rate of global schooling of the population in age to be schooled), the opening and the growth (cf. table 2). This result is fundamental and confirm the results of theoretical and empiric studies according to which the education is a major explanatory factor of growth.

While using the Granger representation theorem for the set of the variables integrated of order 1, and cointegrated between them, this initial result is going to allow evaluations of the causality Granger relations. These conditions allow introducing the error term of the cointegrated relations and to identify, therefore, the error correction models (MCE)[7]. For that, human capital is decomposed according to the levels of primary, secondary and superior education. The underlying idea to this decomposition is to know what is the human capital that seems the most adequate to the economic growth.

- The relative results of the primary human capital consigned in table 3 only indicate one cointegration relation in the Moroccan case as using the test of the maximum likelihood value and three relations in the Tunisian case whatever is the adopted test. According to table 6, the lag error term is meaningful for the set of the regressions which implies the existence of long term relations in any case. The F Tests, in the case of Morocco, on the first lag differences on every variable show that imports and exports openness and the primary human capital cause the GDP to the Granger sense. On the other hand, in the Tunisian case, no causality relation is made evident.
This result demonstrates that human capital plays an important role in these economies and confirms those already put in inscription for other emerging economies.

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[7] The specificity of these models relates to the determination of a diagram of dynamic adjustment of an economic variable to a target or long-term balanced value (Maurel [1989]).

- The relative results of the secondary level human capital (table 4) show a growth differentiated impact since three cointegrated relations exist in the Tunisian case and two in the Moroccan one. In the case of Tunisia, this result is confirmed what is by the trace test that the maximum likelihood estimator. The results of table 7 indicate that the secondary type human capital doesn't have a growth and openness impact (and vice versa) in the case of Morocco. On the other hand, the imports, the exports and the human capital cause to the Granger sense the Tunisian growth.

This result seems to underline that growth is more sensitive to secondary level human capital investment, at least in Tunisia. This kind of result is expected from the moment where the primary schooling rate is close to 100% in this country.

- The relative results of the third degree human capital consigned in table 5 indicate that this post-secondary education level seems also to play a differentiated role in these economies. The results show the existence of three long term relations in Tunisia and a unique one for Morocco. In both cases, the Table 8 indicates few short term causality relations between GDP growth and openness (safe to consider the error term in the Moroccan case).

With similar openness economic policies (implementation of the Structural Adjustment Program under the aegis of the IMF), it seems that the inherent differences to the educational policies in Morocco and in Tunisia play an important role in the differentiated growth levels obtained.

The issued results of the cointegrated relations between GDP growth rate, openness and schooling rates allow to get the long term equations for both economies. The estimated errors correction models (ECM) are the following ones:

In the Moroccan case:

C_1 : $LogPIB = -2.270 + 0.651\ LogX + 0.001\ LogM + 1.799\ LogTxScol$
C_2 : $LogPIB = 3.585 + 0.382\ LogX + 0.121\ LogM + 0.438\ LogTxScol3$
C_3 : $LogPIB = 2.682 + 0.637\ LogX + 0.539\ LogM + 0.557\ LogTxScol2$
C_4 : $LogPIB = 0.442 + 0.915\ LogX + 0.794\ LogM + 0.967\ LogTxScol1$

In the Tunisian case:

C'_1 : $LogPIB = -8.495 - 0.060\ LogX - 0.126\ LogM + 4.263\ LogTxScol$
C'_2 : $LogPIB = 6.335 + 0.624\ LogX - 0.779\ LogM + 1.313\ LogTxScol3$
C'_3 : $LogPIB = -1.785 - 0.143\ LogX - 0.299\ LogM + 2.554\ LogTxScol2$
C'_4 : $LogPIB = -23.287 + 2.205\ LogX - 1.059\ LogM + 7.518\ LogTxScol1$

The results of the long term equations demonstrate a positive and meaningful effect of trade on the Moroccan economic development. These results indicate the existence of a long term relation between the GDP, openness (to exports and to imports) and the human capital stock. This result is robust since it is confirmed whatever is the openness variable taken. It is also observed with the human capital stock variables set differentiated according to the educational degrees.

The introduction of the schooling variable shows that the impact on growth of openness is differentiated according to the various instruction levels took into account. It also shows that imports and exports openness mobilize a different human capital stock.

For both countries, it is the least qualified human capital stocks that better contribute to growth.

This result seems in adequacy with the analysis of the educational system and the working of the labour market. Indeed, the disconnection between the job market and the educational sphere is genuine so that the graduates of the last degrees are unable to fit into the labour market.

The long-term evolution of the Imports variable and of the Schooling rate variable is different in the two countries. In the case of Morocco, these two variables positively play on the GDP growth whereas the imports negatively act on Tunisian growth whatever is the schooling rate to which this variable is associated.

It therefore seems that, on the long term, Morocco takes advantage of the informational externalities as imports produce-joint. This country knew how to develop an appropriation capacity of the imported technologies. Although having bet on a volontarist schooling policy, it appears that Tunisia makes a relatively lower profit of the technological externalities bound to the imports.

4. Growth, human capital qualification level and trade openness relations in Morocco and in Tunisia

In the endogenous growth theories, the human capital concept can embody multiple facets. It is feared by turns like being the R&D, the acquired capital through the convenient training but also as the more general capital acquired through the education system. In the case of Morocco and Tunisia, the previous results allow specifying a positive impact of human capital a priori differentiated according to the qualification level. This differentiation according to the qualification levels can prove to be potentially one of the driving forces of the growth.

The object of this section is to show that the fragilities of the education-growth relation doesn't come from the education itself, but rather of the tie that settle between the education system and the economic system: the human capital non-rational use. It can be attributed to two origins: a bad distribution of education within the population or a bad allowance of skilled labour within the productive system.

The impact of the educational distribution within the population has been raised by the work of Lopez & al. [1998]. Numerous empirical studies use the schooling rate or the means of educational years as human capital variables without taking into account distribution by educational level within the population. Pritchett [1996] establishes that one can not directly estimate human capital educational variables. There is no reason to believe that one year of education generates a unit of human capital[8].

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[8] An alternative solution to fully measure the education investment effects would be by integrating the schooling rates variables with a 15 to 20 years lag to be able to measure the profits of the long-term education. We do not keep this solution into consideration because it will lead to a reduction of data.

Thus, to refine the results of the previous section on the openness-growth-human capital relation, a decomposition[9] of this capital through the qualification of the active population is proposed in order to grasp the interaction on growth between human capital and openness. The data used relative to the active population and its studies level structure and diplomas cover the [1976-2001] period (cf. framed data sources).

a) The production function specification

We use a neoclassical production function of increased Solow type[10] while using several data sources. This production function is of following shape:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} H_{it}^{\gamma} u_{it} \qquad [1]$$

- i,t denote country and time period,
- Y is the real income,
- A is the constant term and is interpreted as the measure of the "non integrated technological change rate", i.e. the economic growth non-bound to the growth of the variables representing the explicit technological inputs,
- K is the physical capital stock,
- L is the number of workers,
- H is the human capital stock,
- u is an error term,
- α, β, γ, are the technology parameters to estimate.

We obtain by the log-linearization of the function:

$$y_t = y_t + \alpha k_t + \beta l_t + \delta h_t + u_t \qquad [2]$$

with $y_t = log\ Y_t,$ $a_t = log\ A_t\ ;$ $k_t = log\ K_t\ ;$
         $l_t = Log\ L_t$ t $h_t = Log\ H_t$

If $\gamma = a + bz_t$
         $y_t = a_t + \alpha k_t + \beta l_t + (a + bz_t)\ h_t + u_t$
         $y_t = a_t + \alpha k_t + \beta l_t + a\ h_t + bz_t\ h_t + u_t$

with

$z_{1t} = log\ (X/PIB);$
$z_{2t} = log\ (M/PIB).$

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[9] This decomposition permits a finer analysis of the human capital in terms of stock in spite of information dwindle as regards length (some educational investments will never turn into human capital stock growth).
[10] See Mankiw, Romer & Weil [1992].

We thus linearize the evolution of the variables so the interpretation of the coefficients associated to these variables will be more comfortable[11].

The relative evaluations to the total active population are about the "economically active population". In our evaluations, the variable L is measured by the economically active population to the ILO sense. It includes all gender people aged of more than 15 years and that provide, during one specified reference period, the necessary labour for the goods and services production.

We set the hypothesis that the qualification of the active population is primordial to the capacity building for technology assimilation through trade in intermediate inputs.

It indeed seems that the absorption of the embodied technology in traded intermediate inputs for the Southern countries is confronted to a human capital threshold effect. The human capital stock at the disposal of an economy can prove to be a determining lever to the growth trajectory change. The structure of qualification of the active population can prove to be an indicator of the endogenisation capacity of the embodied technology. To measure it, the human capital variable must reflect the capacity of the active population to absorb the technological knowledge. The education stock seems an applicable "proxy". We are inspired by Psacharopoulos' works [1993] to construct a human capital proxy determined according to the education stock. This capital variable especially seems applicable to a good account of the assimilation capacity for the embodied technology. We thus can take into consideration the fact that an imitation capacity building in the Southern countries to a human capital threshold. The idea is to determine a proxy of human capital stock that permits to seize the adoption capacities for foreign technology. This qualification variable permits to assimilate the acquired technology.

$$H_t = \sum_1 l_{it} h_{it} \qquad\qquad [3]$$

H is like a proxy of the local endogenous innovation. We propose a measure of the human capital stock while based on the works of Barro & Lee [1993] and on the indicator of Benhabib & Spiegel [1994] and on the methodology of Arriagada & Psacharopoulos [1986]. This human capital stock is expressed as follows:

■ H_i is the synthetic index of the educational duration for the active population. The school levels indexed by i and the years by t.
■ l_i is the proportion of active population having reached the school level i at the t period[12].
■ The level-headedness h_i affected to l_i corresponds to the cumulative lengths (expressed in years) of the corresponding school level achieved.

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[11] A major inconvenience associated to a Cobb-Douglas production function is that the production factors are considered to be substitutes to each other. However, this hypothesis has been discussed, notably with regard to the complementarity between capital and qualified work. The translog production function widens the current hypotheses of the traditional Cobb-Douglas production function. It does not impose a stationary substitution flexibility between the production factors and due to this fact, capital and labour can imperfectly be substituted to each other or even be complementary.

[12] i consists of the illiterate and of people having benefitted from a complete or incomplete primary schooling, those having benefitted from a complete or incomplete secondary schooling, those having frequented an establishment of higher education.

This human capital stock formulation is more appropriated than the other indicators developped in the literature. These indicators are founded on the presumption of a positive correlation between the school fluxes and the human capital stock.

b) Variables description and results

Two variables of openness are kept:
- a variable of exports rate openness: OPENX = X/PIB;
- a variable of imports rate openness: OPENM = M/PIB.

We test the hypothesis according to which the parameter characterizing the effect of the human capital on the growth is function of the trade openness. This effect is measured by the introduction in the regression of an interactive term, in this case the crossing variable of Human Capital multiplied by the degree of exports and imports openness (Hi.OPENX and Hi.OPENM)[13].
This proxy represents the technological spread direct effect. Thus, the effect of catching-up not only depends on the human capital proxy to disposition of the economy but also of the degree of the opening of the economy. This interactive variable gives simultaneously account of the attributable technological accumulation improvement to the improvement of the education and the opening. This indicator permits to grasp a possible reallocation of the human capital due to the trade moreover and to the opening (Berthélémy & al. [1997]).

Tables 9 and 10 of the annex drive to the following results. In both cases, the evaluation of an increased Solow type production function in which the index of human capital input is decomposed according to the level of qualification gives the robust results that confirm the macro-econometric analyses on growth of openness and educational policies behaviour through the cointegrated relations method (section 3). The human capital variable exerts a positive effect over growth that whatever it is defined through schooling rate or human capital stock. However the significance of the impacts are differentiated according to the landed openness mode tackled and the human capital grasped.

b1 Analysis of the human capital-exports openness combination[14] (see Tables 9 and 11 of the annex)

- Case of Morocco: the combination human capital/exports openness indicates that the exports openness has globally a negative impact on growth whatever the level of qualification of the human capital is. This result has a tendency to indicate that the human capital is not adapted to allow an evolution of the parts of export markets via a positioning on gaps carriers.
- Case of Tunisia: along the [1976-1988] period the exports openness impact measured by the human capital-openness combination is a lot more important than to Morocco since it mobilizes the human capital having an intermediate qualification degree. The exports openness has a negative impact on growth rate for weak and elevated qualifications levels.

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[13] H1 is the part of the active population having benefitted from a complete or incomplete primary schooling, H2, the part of the active population having benefitted of a complete or incomplete secondary schooling, H3, the part of the active population having benefitted a complete or incomplete formation in an establishment of higher education.

[14] Firstly the test using Durbin-Watson statistics test is asymptotically close to 0 in the Tunisian case (and contrary to Morocco) what can let foretell that the disruptions follow a random walk. To avoid problems bound to the existence of "spurious regressions" in the sense of Granger and Newbold [1974], we thereafter proceed to an analysis of the residual auto regressive correlation that allows us to determine two sub-periods: [1976-1988] and [1989-2001]. The retained specification is thus only adapted to the sub-periods.

For the period between [1989-2001] the superior human capital is the one which is the more mobilized in the growth process.

These results can notably be explained by evolutions in the exports composition within both economies:
- if the Tunisian as well as Moroccan exports stay intensive in low qualified labour and to weak added value, the orientation of their specialization in the manufacturer sector appears to be more marked in the Tunisian case that observes a reduction on behalf of the energizing exports and the mining products to the profit of manufactured products.
- the exports diversification, which is faster in Tunisia, allows this country to increase its parts of market, notably in its trade with the European union. The sectorial reallocations following a better insertion in the IDL seem underlying to the promotion of a more important training effect.

These results reinforce therefore those shown in section 3, i.e. the nature of the labour that is more solicited through the exports is more qualified in Tunisia than in Morocco. This result can find an explanation in the fact that the essential of the Moroccan exports growth rests on the downstream of the export paths whereas Tunisia has tried an upward path within the manufactured activities toward productions where the added value is better remunerated.

b2 Analysis of the combination human capital-imports openness (cf. tables 10 and 12 of the annex).

- Case of Morocco: the human capital of weak and intermediate level combined to imports openness variable has a statistically meaningful negative effect (to 15%) on growth. On the other hand, the effect on growth of human capital of an elevated qualification level is not statistically verified. These results can appear contradictory with those found in section 3. Nevertheless, the major weight of the primary products in the total of the imports is a possible explanation of this situation.

- Case of Tunisia: the crossing variable (Hi.OPENM) must be studied on the two sub-periods [1976-1988] and [1989-2001]. The results indicate that the impact on growth level of intermediate human capital is meaningful for the first sub-period. During the second under period, it is the superior human capital that has a meaningful impact on growth level. On the [1976-2001] period, the absence of the role of primary level human capital is confirmed. These results therefore reinforce those obtained in section 3 relating to the mobilization of the most qualified active population.

Thus, these tests done from stocks variables bring to vary the impact of the human capital investment in both economies. It globally comes out that, in the case of Morocco and Tunisia, the available human capital is in the structural inability to exploit the embodied informational externalities. In other words, the local capacities, as revealed by the embodied knowledge externalities in the human capital stock, do not permit taking any advantage of openness in the view of growth acceleration.

5. Conclusion

The educational policy plays an important role in explaining the divergence in terms of growth between the Moroccan and Tunisian economies.

All the regressions show that the human capital variable meaningfully contributes to the economic growth process (with the exception of the primary human capital in Tunisia that negatively weighs on the GDP growth). According to the levels of education this impact is however differentiated. So, the Moroccan growth is only truly sensitive to the primary education. In Tunisia, it is the secondary and superior education that most efficiently contributes to the growth.

In the same way to this direct impact on growth of human capital, we introduced in a second time an analysis in terms of interaction of the trade openness and the human capital on the growth. It's evident from this second analysis that human capital continues to play a non negligible role in the process of growth but its efficiency remains insufficient to pull profit of a stronger manner of the economic effects bound to the opening (appropriation of the technological spillovers).

It has been shown that an educational policy is even more efficient in growth terms that its diffusion is relatively egalitarian within the population and that the country comes with its educational policy a modernisation of its productive activity. It is thus about integrating the most qualified people in the jobs which more act on the economic dynamics.
However it proves to be that numerous distortions to the educational sphere level exist as well as in Morocco and Tunisia. These distortions explain the weakness of the relation opening - education - growth in this kind of economies. Thus, when the variable of human capital is refined, it appears that the only economic openness is not sufficient to place the mechanisms of technological spread in the core of the positive external effects that cause growth: it neither permit replacing the lack of dynamism of the local activities of production and imitation nor to fulfill to the structural inability of this kind of economies to exploit the informational externalities bound to the opening.

Thus, these economies' stock of human capital seems to be a brake to the informational externalities endogenisation and therefore presents itself like a doorstep to the backing of the capacities absorption technology.

6. Bibliographical references

ANDERSON AC. & BOWMAN MJ. [1976], « Education and Economic Modernization in Historical Perspective » in STONE L. & HOPKINS J., *Schooling and Society: Studies in the History of Education*, University Press Baltimore

ARRIAGADA A. & PSACHAROPOULOS G. [1986], « The Educational Composition of the Labour Force : An International Comparison », *International Labour Review*, Vol. 125, n° 5, Septembre - Octobre, pp 561-574.

BARRO R.J. (1990), « Government Spending in a Simple Model of Endogeneous Growth, *Journal of Political Economy*, 98 (5) Part 2, S103-S126.

BARRO R .J. & LEE J.W. [1994], « Sources of Economic Growth », *Carnegie-Rochester Conference Series on Public Policy*, n° 40, pp. 1-46.

BENHABIB J. & SPIEGEL M.M. [1994], « The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data », *Journal of Monetary Economics*, Vol. 34, n° 2, Octobre, pp. 143-173.

BERTHELEMY J.C., PISSARIDES C. & VAROUDAKIS A. [1997], « Capital Humain et Croissance : le Rôle du Régime Commercial », *Revue Economique*, Mai 1997, Vol. 48, n° 3, pp. 419-428.

CASELLI F., ESQUIVEL E. & LEFORT F. [1996], « Re-opening the Convergence Debate: A New Look at Cross-Country Growth Empirics », *Journal of Economic Growth*, n° 1, pp. 363-389.

DICKEY D.A. & FULLER W.A. [1979], « Distribution of the Estimators for Autoregressive Time Series with a Unit Root », *Journal of the American Statistical Association*, Vol. 74, n° 366, pp. 427-431.

EDWARDS S. [1998], « Openness, Productivity and Growth: What do we Really Know ? » *Economic Journal*, Vol. 108, N° 447, Mars, pp. 383-398.

GRANGER J. [1986] : « Developments in the Study of Cointegrated Economic Variables », *Oxford Bulletin of Economics and Statistics*, Vol. 48, n° 3, pp. 213-228.

HARRISON A. [1996], « Openess and Growth, A Times-series, Cross-Country Analysis for Developping Countries », *Journal of Development Economics*, Vol 48, n° 2, pp. 419 -447.

ISLAM N. [1995], « Growth Empirics: A Panel Data Approach », *Quarterly Journal of Economics*, Vol. 110, n° 4, Novembre, pp. 1127-1170.

LEVASSEUR V. SERRANITO F. [1996] : « Y a-t-il Formation d'une Zone Yen dans la Région Asie-Pacifique », *Économie Internationale*, Revue du CEPII, n° 66, Trimestre 2.

LOPEZ R., VINOD T. & WANG Y, (1998), « Addressing the Education Puzzle », *World Bank,Policy Research Working Paper (WPS2031)*, pp. 7-8.

MANKIW N.G., ROMER D. & WEIL D.N. [1992], « A Contribution to the Empirics of Economic Growth », *Quarterly Journal of Economics*, Vol. 107, n° 2, pp. 407-437.

MAUREL F. [1989], « Modèles à Correction d'Erreurs, l'Apport de la Théorie de la Cointégration », *Economie et Prévision*, n° 88-89.

PRITCHETT L. [1996], « Forget Convergence : Divergence Past, Present and Futur », *Finance and Development*, vol. 33, Juin, pp. 40-43.

PSACHAROPOULOS G. [1993], « Returns to Investment in Education: A global Update », *Policy Research Working Papers*, n°1067, Banque Mondiale, Janvier.

REBELO S. [1991], « Long-Run Policy Analysis and Long-Run Growth », *Journal of Political Economy*, Vol. 99, n° 3, pp. 500-521.

ROMER P.M. [1986], « Increasing Returns and Long-run Growth », *Journal of Political Economy*, Vol. 94, n° 5, pp. 1002-1037.

ROMER P.M. [1990], « Endogenous Technological Change », *Journal of Political Economy*, Vol. 98, n° 5, Partie 2, pp. S71-102.

SENHADJI A. [2000], « Source of Economic Growth: an Extensive Growth Accounting Exercise », IMF Staff Paper, vol. 47, n°1, pp. 129-157.

TEMPLE J. [1999], « A Positive Effect of Human Capital on Growth », *Economics Letters*, vol. 65, n°1, pp. 131-134.

YOUNG A. [1991], « Learning by Doing and the Dynamic Effect of International Trade », *Quaterly Journal of Economics*, vol. 106, n°2, pp. 369-405.

7 Annexes

Table 1. Augmented Dickey-Fuller unit root tests results (DF et DFA)

		Optimum lag (SIC)	ADF Test	ADF Z-tests
M O R R O C O	Levels			
	LPIB	1	-1,553	-0,499
	LOPENX	0	-1,304	-1,151
	LOPENM	0	-1,064	-1,840
	LOPEN	0	-1,183	-1,072
	LSCOL	0	-1,586	-1,604
	LSCOL1	3	-1,231	-5,009
	LSCOL2	0	-2,084	2,961
	LSCOL3	7	-2,442	5,499
	1st differences			
	LPIB	0	-6,481***	-40,886***
	LOPENX	0	-6,572***	-41,817***
	LOPENM	0	-6,853***	-42,817***
	LSCOL	0	-6,834***	-44,211***
	LSCOL1	4	-3,463**	160,434
	LSCOL2	0	-5,646***	-36,814***
	LSCOL3	6	-4,324***	-9,573***
T U N I S I A	Levels			
	LPIB	0	-0,586	-0,148
	LOPENX	1	-2,265	-12,030
	LOPENM	1	-1,471	-5,524
	LSCOL	0	-2,393	-1,121
	LSCOL1	0	-0,291	-0,417
	LSCOL2	0	-8,536	-2,461
	LSCOL3	2	-0,400	-0,396
	1st differences			
	LPIB	9	-1,953***	40,332***
	LOPENX	0	-4,638***	-28,651***
	LOPENM	0	-4,969***	-31,458***
	LSCOL	0	-6,354***	-40,783***
	LSCOL1	0	-8,159***	-50,918***
	LSCOL2	0	-3,457***	-15,970***
	LSCOL3	0	-41,670***	-29,168***

*** significance at 1 %*

Table 2. Growth, openness and rate enrolment relationships

	Hypothesis	r = 0	r ≤ 1	r ≤ 2
MOROCCO	$\lambda_{trace90}$	90.72**	35.60**	17.27
	λ_{max90}	55.12**	18.33**	12.87**
	Eigenvalues	0.812	0.426	0.323
TUNISIA	Hypothesis	r = 0	r ≤ 1	r ≤ 2
	$\lambda_{trace90}$	80.34**	48.11**	23.67**
	λ_{max90}	32.24**	24.44**	15.73
	Eigenvalues	0.562	0.466	0.332

r is the number of cointegrating vectors under the null hypothesis
** significance at 10%

Table 3. Growth, openness and primary rate enrolment relationships

	Hypothesis	r = 0	r ≤ 1	r ≤ 2
MOROCCO	$\lambda_{trace90}$	40.20	16.93	6.03
	λ_{max90}	23.28**	10.89	6.03
	Eigenvalues			
TUNISIA	Hypothesis	r = 0	r ≤ 1	r ≤ 2
	$\lambda_{trace90}$	86.72**	50.73**	21.78**
	λ_{max90}	35.99**	28.95**	12.87**
	Eigenvalues	0.603	0.524	0.281

r is the number of cointegrating vectors under the null hypothesis
** significance at 10%

Table 4. Growth, openness and secondary rate enrolment

	Hypothesis	r = 0	r ≤ 1	r ≤ 2
MOROCCO	$\lambda_{trace90}$	82.91**	36.02**	15.07
	λ_{max90}	46.89**	20.95**	10.90**
	Eigenvalues	0.759	0.470	0.281
TUNISIA	Hypothesis	r = 0	r ≤ 1	r ≤ 2
	$\lambda_{trace90}$	80.34**	48.11**	23.67**
	λ_{max90}	32.24**	24.44**	15.73**
	Eigenvalues	0.562	0.466	0.332

r is the number of cointegrating vectors under the null hypothesis
** significance at 10%

Table 5. Growth, openness and superior rate enrolment

	Hypothesis	r = 0	r ≤ 1	r ≤ 2
MOROCCO	$\lambda_{trace90}$	65,76**	29,31	14,06
	λ_{max90}	36,45**	15,25**	9,25
	Eigenvalues	0.669	0.370	0.244
TUNISIA	Hypothesis	r = 0	r ≤ 1	r ≤ 2
	$\lambda_{trace90}$	112.18**	62.79**	28.48**
	λ_{max90}	49.39**	34.31**	21.60**
	Eigenvalues	0.718	0.585	0.425

r is the number of cointegrating vectors under the null hypothesis
** significatif à 10%

Table 6. Primary rate enrolment in Morocco and in Tunisia.

	Regressions	Endogenous Variables	Ct-1	FLPIB	FLExports	FLImports	FLH1	F1	F2	F3
M O R O C C O	1	LPIB	2.121 [0.04]	[0.002]	[0.72]	[0.58]	[0.23]	[0.04]	[0.03]	[0.03]
	2	LOPENX	0507 [0.02]	[0.11]	[0.58]	[0.97]	[0.38]	[0.19]	[0.16]	[0.020]
	3	LOPENM	1.160 [0.06]	[0.62]	[0.68]	[0.64]	[0.28]	[0.38]	[0.39]	[0.30]
	4	LScol1	0.371 [0.239]	[0.26]	[0.99]	[0.98]	[0.18]	[0.79]	[0.81]	[0.28]
T U N I S I A	5	LPIB	1.948 [0.015]	[0.430]	[0.197]	[0.479]	[0.015	[0.094]	[0.125]	[0.02]
	6	LOPENX	0.210 [0.062]	[0.004]	[0.086]	[0.407]	[0.204]	[0.065]	[0.149]	[0.248]
	7	LOPENM	0.117 [0.380	[0.004]	[0.634]	[0.241]	[0.823]	[0.600]	[0.243]	[0.871]
	8	LScol1	0.142 [0.167]	[0.145]	[0.379]	[0.528]	[0.023]	[0.441]	[0.469]	[0.045]

The p-values are in square brackets. H1 : primary rate enrolment. The optimal lag is determined using SIC and is equal to 3 in each equation.

Table 7. Secondary rate enrolment in Morocco and Tunisia.

	Regressions	Endogenous Variables	Ct-1	FLPIB	FLExports	FLImports	FLH2	F_1	F_2	F_3
M O R O C C O	1	LPIB	-0.624 [0.675]	[0.48]	[0.98]	[0.97]	[0.72]	[0.98]	[0.97]	[0.15]
	2	LOPENX	-0.05 [0.945]	[0.91]	[0.96]	[0.61]	[0.37]	[0.94]	[0.49]	[0.06]
	3	LOPENM	1.790 [0.354]	[0.55]	[0.79]	[0.57]	[0.83]	[0.80]	[0.72]	[0.60]
	4	LScol2	-0.597 [0.767]	[0.80]	[0.91]	[0.78]	[0.59]	[0.95]	[0.89]	[0.63]
T U N I S I A	5	LPIB	-0.020 [0.871]	[0.765]	[0.024]	[0.005]	[0.000]	[0.04]	[0.011]	[0.000]
	6	LOPENX	-0.009 [0.940]	[0.005]	[0.21]	[0.40]	[0.90]	[0.32]	[0.56]	[0.96]
	7	LOPENM	0.038 [0.789]	[0.003]	[0.34]	[0.12]	[0.81]	[0.49]	[0.20]	[0.90]
	8	LScol2	0.819 [0.026]	[0.62]	[0.004]	[0.008]	[0.000]*	[0.01]	[0.002]	[0.000]**

* $F_{LTxScol3} = 0.00000005$; ** $F_4 = 0.00000000$. The p-values are in square brackets. H2 : secondary rate enrolment. The optimal lag is determined using SIC and is equal to 3 in each equation.

Table 8. Superior rate enrolment in Morocco and Tunisia.

	Regressions	Endogenous Variables	Ct-1	FLPIB	FLExports	FLImports	FLH3	F_1	F_2	F_3
M O R O C C O	1	LPIB	-0.624 [0.675]	[0.87]	[0.98]	[0.98]	[0.35]	[0.97]	[0.98]	[0.23]
	2	LOPENX	1.607 [0.007]	[0.20]	[0.08]	[0.96]	[0.56]	[0.05]	[0.06]	[0.04]
	3	LOPENM	-1.982 [0.204]	[0.98]	[0.93]	[0.69]	[0.21]	[0.65]	[0.48]	[0.31]
	4	LScol3	-3.530 [0.278]	[0.99]	[0.98]	[0.95]	[0.36]	[0.79]	[0.81]	[0.48]
T U N I S I A	5	LPIB	2.452 [0.438]	[0.599]	[0.947]	[0.770]	[0.457]	[0.939]	[0.857]	[0.613]
	6	LOPENX	-0.143 [0.655]	[0.01]	[0.015]	[0.535]	[0.003]	[0.02]	[0.602]	[0.007]
	7	LOPENM	-0.514 [0.128]	[0.000]	[0.147]	[0.616]	[0.000]	[0.072]	[0.398]	[0.001]
	8	LScol3	1.186 [0.612]	[0.620]	[0.958]	[0.814]	[0.424]	[0.977]	[0.912]	[0.534]

The p-values are in square brackets. H3 : superior rate enrolment. The optimal lag is determined using SIC and is equal to 3 in each equation.

Table 9. Exports openness, human capital and growth [1976–2001])

	MOROCCO		
	i=1	i=2	i=3
C	2,021 (7,116)	1,975 (6,102)	2,211 (8,165)
K	0,117** (2,057)	0,093 (1,621)a	0,091** (1,646)
L	0,852*** (5,541)	0,908*** (5,615)	0,882*** (5,291)
Hi	0,152 (1,557)a	0,908 (1,440)a	0,060 (1,119)
Hi.OPENX	-0,118 (-0,602)	-0,180 (-1,140)	-0,025 (-0,200)
Standard deviation	0,036	0,037	0,040
Adjusted R²	0,978	0,977	0,973
Fisher	269,249***	258,967***	216,220***
D-W	1,987	1,849	1,866

*Significance : *** at 1%, ** at 5%, * at 10%, a at 15%*

Table 10. Imports opennes, human capital and growth [1976–2001]

	MOROCCO		
	i=1	i=2	i=3
C	1,996 (11,186)	2,069 (9,564)	2,276 (8,202)
K	0,133*** (2,743)	0,105* (2,128)	0,112* (1,877)
L	0,837*** (6,420)	0,839*** (6,162)	0,815*** (4,463)
Hi	0,147** (2,293)	0,170* (2,235)	0,085** (2,210)
Hi.OPENM	-0,204** (-1,998)	-0,189 (-2,271)*	0,047 (0,857)
Standard deviation	0,033	0,034	0,040
Adjusted R²	0,981	0,981	0,974
Fisher	318,155***	306,793***	223,886***
D-W	1,709029	1,644374	1,932

*Significance : *** at 1%, ** at 5%, * at 10%, a at 15%*

Table 11. Exports openness, human capital and growth ([1976-1988] and [1989-2001])

	TUNISIA		
	i=1	*i=2*	*i=3*
1976 - 1988			
C	1.817 (0.184)	1.995 (0.436)	1.561 (0.46)
K	0.098*** (0.041)	0,141*** (0.037)	0.116*** (0.43)
L	1.070*** (0.169)	0,890*** (0.267)	0,109*** (0.227)
Hi	-0.104 (0.148)	0,32 (0.103)	-0.042 (0.084)
Hi.OPENX	0.060 (0.079)	0,061** (0.036)	-0,029* (0,16)
Standard deviation	0.019	0,021	0,021
Adjusted R²	0.985	0,983	0,981
Fisher	199.497***	170,232***	158.834***
D-W	2.068	2,046	2.122
1989 - 2001			
C	1.083 (0.237)	2.283 (0.662)	2.166 (0.851)
K	0.148*** (0.029)	0.167*** (0.030)	0.059 (0.061)
L	1.373*** (0.161)	0.661** (0.325)	1.119*** (0.405)
Hi	-0.337*** (0.133)	0.171* (0.122)	0.243*** (0.059)
Hi.OPENX	-0.066 (0.081)	-0.022 (0.039)	0.056 (0.043)
Standard deviation	0.016	0.019	0.015
Adjusted R²	0.993	0.988	0.993
Fisher	378.396***	278.01***	456.525***
D-W	1.873	1.553	2.19

*Significance : *** at 1%, ** at 5%, * at 10%, a at 15%*

Table 12. Imports openness, human capital and growth ([1976 – 1988] and [1989–2001])

	TUNISIA		
	i=1	*i=2*	*i=3*
1976 – 1988			
C	1.817 (0.184)	1.941 (0.333)	1.644 (0.35)
K	0.098*** (0.041)	0,127*** (0.031)	0.128*** (0.035)
L	1.070*** (0.169)	0,92*** (0.212)	1.015*** (0.187)
Hi	-0.104 (0.148)	-0,179*** (0.077)	-0.071 (0.053)
Hi.OPENX	0.06 (0.079)	-0,492*** (0.199)	-0.025*** (0.013)
Standard deviation	0.019	0,018	0.020
Adjusted R²	0.985	0,987	0.985
Fisher	199.497***	220.561***	209.815***
D-W	2.069	2,127	2.067
1989 – 2001			
C	2.073 (1.309)	2.511 (0.732)	1.831 (0.874)
K	0.383*** (0.146)	0.134*** (0.043)	0.036*** (0.05)
L	0.566 (0.889)	0.621* (0.394)	1.319*** (0.415)
Hi	-0.956** (0.465)	0.215* (0.135)	0.24* (0.054)
Hi.OPENX	0.257 (0.283)	0.175 (0.186)	0.059 (0.035)
Standard deviation	0.012	0.021	0.014
Adjusted R²	0.991	0.985	0.994
Fisher	214.637***	248.58***	507.907***
D-W	1.576	1.865	2.198

Significance : *** at 1%, ** at 5%, * at 10%, a at 15%

8 Data sources

The data used come from several sources.

• The data relative to Gross Domestic Product, exports and imports derive from the International Financial Statistics/ IMF database.

• The human capital indexes are our own calculation. The data relative to active population and its educational and its repartition relative to diplomas levels come from several sources :

MOROCCO

- the differents census [1971, 1982 et 1994] ;
- different statistical survey edited by « Direction de la statistique » : Enquêtes Annuelles sur la Population Active Urbaine [1976-1982] and [1984-1993], « Enquête Nationale sur la Population et l'Emploi » (ENPE [1995]) and « Enquête Nationale sur les Niveaux de vie des Ménages » [1990/91].
- DIRECTION DE LA STATISTIQUE DU MAROC, [1999 & 2000], *Rapport de Synthèse de l'Enquête Nationale sur l'Emploi*, Royaume du Maroc.
- ILO (International Labor Organization), [1996], *Yearbook of Labour Statistics*, Genève. Available at http://www.ilo.org
- KHROUZ D. HAJJI A. & BOUSSETTA M. [2000] « The Development Research Environment in Morocco: Situations and Prospects », in Eglad R & Craissati D, *Research for Development in the Middle East and North Africa*, The International Development Research Center, The IDRC Publications, Ottawa, Canada.
- Ministère de l'Enseignement Supérieur.
Available at http://www.enssup.gov.ma/statistiques/EvoEnseig.htm,Maroc
- QASSEM S. [1998a] *The Higher Education Systems in the Arab States : Development of Science and Technology Indicators*, UNESCO and ESCWA, Le Caire, Janvier.
- QASSEM S. [1998b] *R&D Systems in the Arab States : Development of S&T Indicators*, UNESCO, Le Caire, Janvier.
- SESRTRIC (Centre de Recherches Statistiques, Economiques et Sociales et de Formation pour les Pays Islamiques). Available at http:// www. Sesrtcic.org

TUNISIA

- ENQUETE NATIONALE SUR L'EMPLOI [1997 & 1999], Institut National de la Statistique, République tunisienne.
- ENQUETE NATIONALE POPULATION-EMPLOI [1980, 1989, 1999], Institut National de la Statistique, République tunisienne.
- RECENSEMENT GENERAL DE LA POPULATION ET DES LOGEMENTS [1966, 1975], Institut National de la Statistique, République tunisienne.
- RECENSEMENT GENERAL DE LA POPULATION ET DE L'HABITAT [1984, 1989 & 1994], Institut National de la Statistique, République tunisienne.
- ENQUETE NATIONALE SUR LE BUDGET ET LA CONSOMMATION DES MENAGES [1990], Institut National de la Statistique, République tunisienne.
- BANQUE MONDIALE, World Development Indicators.
Available at http://www.wbln0018.worldbank.org/mna/mena.nsf/
- BARRO R. & LEE J-W. [2000] : « International data on educational attainment: updates and implications », *Center for International Development, Working Paper*, n° 42, Avril, Available at http://www.worldbank.org/research/growth/ddbarle2.htm
- BARRO R. & LEE J-W. [1994] : « Data Set for a Panel of 138 Countries », mimeo, Harvard University, Cambridge, Massachusetts, Janvier. Available at http:// www.nber.org/pub/barro.lee/

- INS (Institut National de la Statistique) : http://www.ins.nat.tn

- ILO (International Labor Organization), 1996, Yearbook of Labour Statistics, Genève. Available at http://www.ilo.org

- QASSEM S. [1998a], *The Higher Education Systems in the Arab States : Development of Science and Technology Indicators*, UNESCO and ESCWA, Le Caire, Janvier.

- QASSEM S. [1998b], R&D *Systems in the Arab States : Development of S&T Indicators*, UNESCO, Le Caire, Janvier.

- SESRTIC (Centre de Recherches Statistiques, Economiques et Sociales et de Formation pour les Pays Islamiques), www. Sesrtcic.org

- UNESCO [1999a], Division of Statistics. Data Available at http://unescostat.unesco.org/Index.asp. March, April, May.

- UNESCO : www2.unesco.org/wef/countryreports/tunesia