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Convergence of North Africa countries to the level of Southern Europe income: an empirical evaluation

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ABSTRACT
The aim of this paper is to examine the issue convergence of per capita income of North Africa countries to the per capita income level of countries in Southern Europe. We have applied tests of sigma-convergence and polynomial beta-convergence of Chatterji to assess convergence. We have applied the multiple endogenous breaks test advocated by Bai & Perron (2003) in order to evaluate the sigma-convergence hypothesis. According to our results, the process of sigma-convergence is not uniform over time. There exists a movement of convergence of per capita income of NA countries towards the income level of countries of Southern Europe during the period 1980-1984. The estimate of convergence clubs can refine the results for countries that have started catching up. This test rejects the hypothesis of beta-convergence on the whole period (1980-2007). If the model is estimated for each country, then there is a movement of beta-convergence only for Tunisia and Morocco on the period 1985-2000.On the other sub-periods, the assumption of divergence is accepted. The per capita income level of countries of Southern Europe does not seem to be a target toward which converge the countries of the NA region in the long term.

Introduction

The North Africa (NA) region is rich in natural and human resources, labor, and population. Its countries vary, in some cases considerably, in economic size, population, the balance between the public and private sectors, and financial and natural resources. However, the economic performance of countries in the NA region has been much contrasted over the period 1980-2007. To face this challenge, countries in the region have radically changed their economic policy since the mid-eighties. Several countries in the region have made significant progress in adjustment and reform, and are qualified to be catching-up with developed countries. The adoption of structural adjustment programs recommended by the IMF, have led the NA countries to turn to more favorable market policies. However, the turmoil and political instability facing the region slows the transition of these countries towards more open and liberal economies where the private sector would play an important increasingly role.

Performance evaluation of these countries in terms of incomes convergence has been less studied. The aim of this paper is therefore to evaluate the process of convergence of per capita income of NA countries toward that of Southern European countries and to identify the existence and the persistence of convergence clubs.

If there are convergence clubs, then an important question is to know what levels of per capita income, the countries converge. This paper complements previous works by trying to differentiate between countries in the NA region in terms of behavior of convergence or divergence. The aim of this paper is to compare the economic performance of NA countries to Southern Europe (Spain, Greece and Portugal) in analyzing the process of convergence of per capita incomes between these two zones. The income level of the European Union seems a potential target to which the income of countries in the NA region could converge because the EU is their main trading partner and we assist to the development of trade liberalization agreements Euro-Med. To avoid biased conclusions in favor of rejecting the hypothesis of convergence, it seems wise to use Southern European countries as a benchmark for long-term income of countries in the NA region.

We used tests of sigma-convergence and the approach of convergence clubs based on polynomial functions to assess the convergence process. The first originality of our approach is to use the methodology of convergence clubs of Chatterji (1992) to test the phenomenon of convergence of 6 countries in the NA region (Algeria, Tunisia, Morocco, Egypt, Libya, Mauritania) towards the average income level of countries in Southern Europe (Spain, Greece and Portugal) over the period 1980-2007.[1] The second originality of this paper concerns applying the tests of breaks of Bai & Perron (2003) on the problem of sigma-convergence. According to our results, the process of sigma-convergence is not uniform over time.

The remainder of the paper is organized as follows: In the second section, we propose an overview of the economic growth in the NA region. In the third section, we present the various hypothesis tests of convergence. The fourth section is devoted to comments of all of our empirical results. Finally, the conclusion and possible extensions are listed in the fifth section.

North Africa Countries: An Economic Overview of the Region

[1] Chatterji & Dewhurst (1996) uses this methodology to evaluate the existence of convergence clubs in the different regions of Great Britain and Zhang (2003) in East Asia region.

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Economic Performance in North Africa Region: A Brief Review

Fluctuations in the growth rate in NA countries have been extremely volatile over the period 1980-2007. This extreme volatility is explained by a significant political instability, weak institutions, but also by the economic policies pursued by these countries. The purpose of this section is to briefly review the determinants of growth in this region.

Weak performance in terms of growth is explained by a negative growth productivity of total factors, despite gains in human capital. Traditional indicators of human capital development in the region (schooling rate in primary and secondary school of the population in schooling age) are quite satisfactory. However, the average rate of illiteracy in the region is high compared to that of other developing regions and particularly affects women (Yousef, 2004).

The NA region is marked by the predominance of public sector in economic activity. The public sector provides a large share of domestic production in most Southern Mediterranean countries. For example, this sector accounts for between 30-60% of the workforce depending on the countries (Yousef, 2004). Public companies have low performance due to weak competition. These companies remain primarily due to aid and State transfers. That causes a problem of productivity at national level which reduces incentives to invest.

The countries in the region must therefore ensure more efficient allocation of resources to improve their productivity. This requires a reduction of bureaucracy, a fight against corruption, a disengagement of the State, and an improvement of services quality. The weak performance of the NA region compared to other regions in the world can be explained largely by poor quality of its institutions.

The NA region remains as one of the least integrated regions in the world. It seems to have failed to take advantage of **trade** globalization and foreign direct investment. However, the specific characteristic of the region is not an opening ratio lower than other regions but a different composition of trade. Most exported goods are not manufactured goods like raw materials and agricultural goods. Exports of manufactured goods still account for 81% of total exportations in Tunisia and for 66% in Morocco in 2001-2003. These exports are, however, mostly in traditional sectors. In contrast, exports of raw materials account for 98% of total exports in Algeria, 54% in Egypt. Exports are mainly destined to the EU especially in the case of the Maghreb countries. The intra-regional trade has stagnated since 1970 and represents less than 10% of total trade in the region (BolBol & Fatheldin, 2005). The share of intra-regional trade of total trade in 2004 represented 6.6% in Tunisia, 3% in Algeria and 6.9% in Egypt and Morocco (Arab monetary fund).

The degree of integration of countries in the NA region to international capital markets is low. The limited access of these countries in international capital market can be explained by an insufficient development of their domestic markets (Liman, 2004). Foreign direct investment (FDI) in the region is lower than other countries in developing regions in Asia and Latin America and slightly exceeds the FDI in countries in Sub-Saharan Africa. Over the period 1995-2003, the volume of FDI received by the region represents only 1.4% of total FDI and the flows come mainly from the EU and are characterized by high volatility over time (Alya, Nicet- Chenaf & Rougier, 2007). The influx of private capital moves over to countries that have experienced macroeconomic stability through their structural adjustment programs. The countries which benefit most from these fairly diversified investments are: Egypt, Morocco and Tunisia.

Despite their differences and to face the challenges imposed by globalization, many countries in the NA region have engaged many programs to restructure their industrial sectors and have revised their strategies and industrial policies. Thus, the Euro-Med signed in Barcelona in 1995 which provides for the creation of a free trade zone between the two shores of the Mediterranean strongly encourage the governments of the NA countries to choose a trade policy with clear direction and should modify the performance of these countries in terms of growth and income convergence.

Economic Growth

Economic activities for the period 2000-2004 have been more flourishing than in the period 1995-1999, when the regional average rate of growth was only 3.8% and the growth rates of countries varied between 1.52% and 5.52%. Indeed, for the period 2000-2004, the lower limit is higher, and the average around 4%. However, it is to be noted that this growth rate remains at a level far below what is required for an effective reduction of poverty and unemployment, and indicates the need for greater rigor in the implementation and evaluation of economic, social and institutional reforms.

Behind these statistics, a relative decline in performance could be observed in Egypt and Tunisia, stagnation in Mauritania, and an increase in the remaining countries, with strong growth for Morocco, which almost doubled its rate, rising from 2.04% to 3.8% between the two periods under review.

These different performances can be explained by specific factors. Egypt has seen a sharp drop in its growth rate, which might be explained by the monetary difficulties it has been experiencing. Algeria's improvement of 0.9% can be attributed to higher oil prices. The fall observed in Tunisia can be traced mainly to the severe drought of 2002, which brought the growth rate down to 1.7%, its lowest level for a decade. The accelerated growth of Morocco can be explained by better climatic conditions during the period 2000-2004.

It can be concluded from the above that the region did not show structurally stronger growth in 2002-2004 than in 1995-1999. Therefore, the most immediate issue to be addressed is how to sustain the economic growth experienced. An attempt is first made to examine private and public consumption and investment rates.

With regard to the GDP by utilization, private consumption represents an average of 63% of GDP during the period 2000-2004, while public consumption was about 16%. A change in the distribution of GDP utilizations is observed, compared to 1995-1999. The share devoted to household spending decreased compared to its level in 1995-1999, which was estimated at 66%. It was only possible to maintain public administration consumption at almost the same level as 1995-1999 (15.9%). This led to improvement in the domestic savings rate in relation to the GDP by at least 3 points since 1996. This was reinforced by net foreign revenues of about 1% of the global GDP, leading to a small increase (less than 1%) in average living standards, measured by the value at constant prices of per capita consumption.

National investment rates have varied between 18% (Egypt, Libya) and 29% (Mauritania). Libya, Morocco, Mauritania are all seeing increases in their investment rates, the reasons for these increases vary. In Libya, the increase is due to the lifting

of the embargo, which allowed some foreign investment flows to come in. As for Mauritania, its public investments are rising sharply because of the foreign aid it has being granted. Morocco registered a rise in investment rates due to an improvement in public investment (including public institutions and enterprises), following the active policy adopted by the Government. Tunisia has seen stabilization of its investment rate, which, nevertheless, is still the highest in the region after that of Mauritania. Algeria has seen a decreasing investment rate, partly due to a decrease in public investment, but above all, caused by strong GDP growth, unaccompanied by a similar rise in investment values. In Egypt, the decrease is assumed to be the result of the difficulties encountered by the country's exchange market. In sum, significant action should be taken to dampen public spending and return growth to a more sustainable range.

Strong Export Concentration

The analysis of the regional commodity structure of exports shows diverging trends between a group of countries (Algeria, Egypt, Libya), which are developing their specialization in fuel, and another group (Morocco and Tunisia), which are increasingly focusing on manufactured goods.

In Algeria, Egypt, Libya, fuel exports account for more than a quarter of total exports in all three countries during 2000-2004 forming the first exporting sector. The rise in oil prices over this period resulted in an increase in the share of fuel in Algeria and Libya's exports, from 95% to 98% and from 94.8% to 95.7% respectively. This concentration is likely to increase over the years as the expected exploitation of more deposits will lead to more fuel exports. For two other countries, Morocco and Tunisia, exports have relied on manufactured goods according to their share in total exports, and with regard to their contribution to export growth. Mauritania's specialization lies in minerals, but with an increasing shift to fuel exports.

The evolution observed in all countries reveals an export structure concentrated mainly in two sectors (oil or manufactured goods) as shown by the strong specialization they exhibit. For oil-exporting countries, the specialization in fuel could be accentuated under the current rising oil prices. On the other hand, the export structure in Morocco and Tunisia, mainly concentrated on textiles and clothing (labor-intensive industries with low costs), might find it difficult to change in the absence of inward-processing infrastructure.

Policy Challenges and Prospects

The above analysis has shown that over 2000-2004 the economic and social performances of North African economies have been mixed, even for countries such as Tunisia that have become integrated with the world economy. There are a number of reasons for this situation, including the modest pace of structural reforms and weak macroeconomic policies. A major contributing factor has been the slow progress made by these countries in opening their economies to trade and investment. North African economies continue to be constrained by their narrow export base. Moreover, bilateral trade between them is limited and well below potential; it accounts for only a small fraction of each country's total trade.

In the foreseeable future, the major determinants of the North African economic performance will continue to be based on the outturn of the two exogenous factors - weather conditions and integration in the external economic environment-. In addition to this, the pursuit of strong economic reforms will continue to be an important domestic determinant of performance.

A second issue related to regional approaches and initiatives relates to the diversification of the North African economies. Almost all the countries of the region suffer from a lack of diversification, which leads to high dependence and constitutes a hindrance in the search for alternative sources of growth. This has many policy implications at the national and regional levels such as: Encouraging greater expansion of the productive bases with the targeting of leading sectors, developing specialization strategies, which could encourage the development of exchanges between countries, allowing them to escape the concentration of trade with Europe, their major economic partner, ordination of statistical activities between the different actors at regional level, technical assistance to countries carrying out analyses, publication of the data obtained from household surveys, setting up of an observatory of economic integration to serve as a tool for incorporating the collection and organization of interdependent data, focused mainly on questions of regional integration.

Tests of Income Convergence Hypothesis

The Existence of Convergence Clubs: An Approach Based on Polynomial Functions

The concept of convergence clubs has been introduced by Baumol (1986). It refers to a notion of polarization of the world economy into several groups because of the existence of multiple equilibria.[2] Similar countries converge in the long run towards each other if their initial conditions move towards the same stationary equilibrium (Galor, 1996).[3] The existence of multiple equilibria implies consequences on the convergence tests since in this case the estimated parameters of a regression are not stable. According to Bernard and Durlauf (1996), cross-sectional regressions do not account the existence of multiple equilibria. Indeed, if we estimate a negative correlation between average growth rate and initial per capita income, it is impossible to know if all the countries of the sample are converging or only some of them. In the case where no correlation is found, it may still exist some convergence between some countries, but the share of this convergence in the total sample is too small so that the data may reveal a negative correlation.[4]

The hypothesis of the existence of convergence clubs can be tested using nonparametric methods (Quah, 1996). Chatterji (1992) proposes a simple but efficient method for estimating the convergence clubs: the introduction of polynomial functions in the growth equation proposed by Barro.[5]

To test the proposition that the per capita income of a number of countries converges to the level of per capita income

[2] According to Berthélemy (2005), if the econometric definition of the existence of convergence clubs dates back to Baumol (1986), the theoretical intuition appears from the work of Young (1928) and Rosenstein-Rodan especially (1943) with the theory of "Big Push".

[3] We can see Azariadis & Drazen (1990) and Berthelemy & Varoudakis (1994) for growth models with multiple equilibria and Galor (1996) for a review of the work.

[4] Hall and St. Aubyn (1995) using Monte Carlo simulations show that it is sufficient that only one third of the sample converge to obtain a negative correlation between growth rates and initial per capita income.

[5] This method has first been proposed by Baumol and Wolff (1988). It was then extended by Chatterji (1992).

of a country "leader" (Y_L), Chatterji (1992) and Chatterji & Dewhurst (1996) propose to estimate the following regression:

$$ln\left(\frac{Y_{Lt}}{Y_{Lo}}\right) - ln\left(\frac{Y_{it}}{Y_{io}}\right) = b[ln(Y_{L0}) - ln(Y_{i0})] + \mu_i \quad (1)$$

Thus:

$$ln\left(\frac{Y_{Lt}}{Y_{it}}\right) = (1+b)[ln(Y_{L0}) - ln(Y_{i0})] + \mu_i \quad (2)$$

To model the possibility of multiples equilibria, Chatterji included in the above equation variables measuring powers of gap between the initial income of the country "leader" and that of a country. Noting this gap by: $GAP_{GDP_0} = \ln(Y_{L0}) - ln(Y_{i0})$. Then the convergence model of Chatterji becomes:

$$GAP\_GDP_t = \sum_{k=1}^{k} b_i (GAP\_GDP_{t-1})^k + \mu_i \quad (3)$$

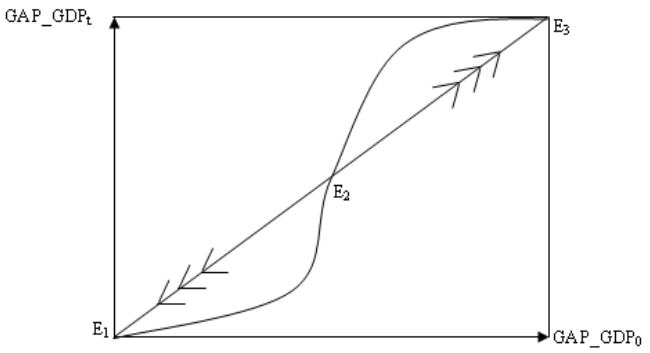
This model allows a modeling of the convergence process much more complex than that resulting from the estimation of convergence equation proposed by Barro. According to Chatterji, the number of convergence clubs will depend on the value K. Based on models of technology transfer of Nelson & Phelps (1966), he retains a cubic convergence equation (K = 3) of the type:

$$GAP\_GDP_t = b_1(GAP\_GDP_{t-1}) + b_2(GAP\_GDP_{t-1})^2 + b_3(GAP\_GDP_{t-1})^3 + \mu_i \quad (4)$$

With this nonlinear growth equation, two cases may appear:

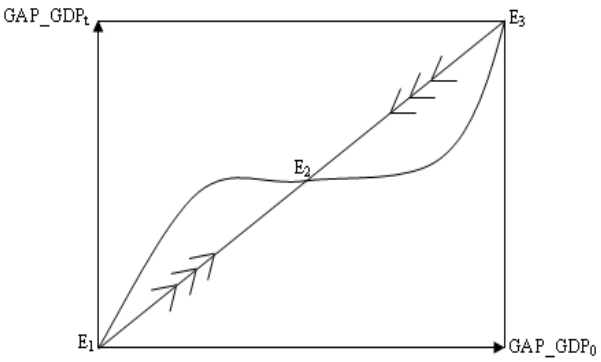
If $b_1 < 1$, the solving of equation (4) leads to three different equilibria, two stable and one unstable (Figure 1). E2 is the unstable equilibrium: countries that have a per capita income gap with the country "leader" below the level E2 will converge towards the income level E1. In this case the countries will converge to the same income level as the country "leader" in the long term. In contrast, when the income gap with the country "leader" is too large (above the level E2), then countries will diverge from the level of income of the country "leader" and converge to a lower income level. This type of model supposes that the growth rate of technical progress in a country depends on the gap between technology prevailing in the country and that of the country "leader". The diffusion of technical progress at the international level depends on this gap but also on the country's ability to assimilate foreign technology (Nelson and Phelps, 1966). This ability would depend on the initial level of development of countries.

Figure1. Case b_1<1



In case where $b_1 > 1$, then the only stable equilibrium of the system becomes E2 (Figure 2). All countries that have an income gap with the country "leader" below the level E3 will converge to the level E2 (figure 2). We are witnessing a process of convergence among countries in the sample to the equilibrium level E2, but divergence from the country "leader". Countries that have a level of initial income between E2 and E3 receive temporarily a growth rate higher than that of the country "leader", but it is insufficient for them to catch up the same income level as the country "leader". In contrast, the poorest countries in the sample (per capita income higher than E3) know as much a divergence in level and growth rate relative to country "leader". In this case, there is no catching up and they are caught in a trap of underdevelopment. This type of model implies that knowledge transfers are supposed to follow an inverted-U function because countries with low technology gap are not incited to imitate the country "leader", while countries where the gap is high are incited to imitate the country "leader" but are not able to do it. Only countries that have medium technology gaps relative to the leader will engage in an activity of imitation. But this activity is insufficient to enable them to catch up income of country "leader" (Chatterji, 1992).

Figure2. Case b_1>1



Sigma-Convergence Test

Quah (1993) criticized the method of cross-sectional regressions, showing that this type of regression suffered from so-called "Galton" errors. According to him, the best way to assess the convergence hypothesis is to exploit the temporal information included in the cross-sectional variance. Friedman (1992) argues that the convergence hypothesis is verified if the variance of observations is decreasing over time. Indeed, in this case, there is a reduction of disparities between countries in terms of levels of per capita incomes. Barro & Sala-i-Martin (1991) introduce the concept of sigma-convergence to interpret this idea. Noting σ_t the cross-sectional standard deviation at time t of $ln(Y_{it})$, (i=1,2,….N), sigma-convergence hypothesis means the following equation:

$$\sigma_t = N^{-1}\sqrt{\sum_{i=1}^{N}\left(Ln(Y_{it}) - (M^{-1}\sum_{k=1}^{M} ln(Y_{kt}))\right)^2} \quad (5)$$

A major outcome of Guetat & Serranito (2005) has been to show that exogenous shocks affecting the countries in the NA region are an essential determinant of their growth process. It therefore seems appropriate to complete the analysis of convergence clubs by a study of sigma-convergence between these countries and Southern European countries. We are going in the rest of the paper to present all of our empirical results.

Empirical Applications

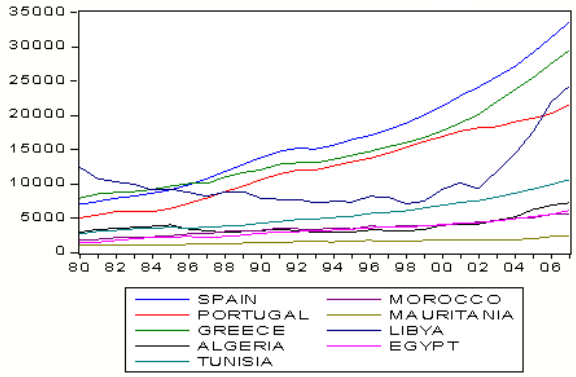
Database

First we use the 6.3 version of Summers–Heston Penn World Tables for annual per capita income. The sample includes data of the six countries of North Africa (Algeria, Tunisia, Morocco, Egypt, Libya, Mauritania) over the period 1980-2010.

The aim of this paper is to test the convergence of incomes of countries in North Africa region towards average of income level of countries in Southern Europe. This region is composed of Spain, Greece and Portugal. The average income level of Southern Europe is the weighted average of per capita income of these three countries.

From Figure 3, we find that the real per capita income of Southern Europe is higher than that of any country in the North Africa region over the entire study period. Southern Europe could thus be considered as target for countries in the NA region.

Figure 3. Real Per Capita Income



We retain this assumption because the exchanges of countries in the NA region are mainly with the industrial countries and especially with EU countries. For example, in 2002 the share of exports to EU represented 62.3% of total exports in the case of Algeria, 70.4% for Morocco, Tunisia for 78.9%. This is explained by geographical proximity but also by the favorable trade policy of the EU towards the Mediterranean countries.[6]

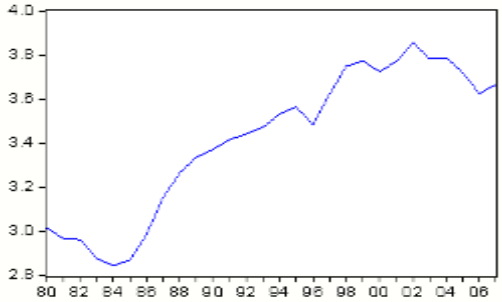
Test of Sigma-Convergence Hypothesis

We first present the evolution of the cross-sectional standard deviation between the countries of the NA region and Southern European countries in order to examine the issue of reducing disparities between countries. We introduced the weighted average of per capita income of Southern Europe countries and per capita incomes of countries in the NA region in the calculation of the cross-sectional variance. Studies on the NA region show some heterogeneity among most countries of the region (Liman, 2004 and Hakura, 2004).

Graphical Analysis

The results of the calculation of the sigma-convergence are shown by the graphic in Figures 4.

Figure 4. Sigma Convergence



The evolution of the standard deviation in cross section between the per capita incomes of countries in NA region and those in Southern Europe could be divided into three distinct periods (Figure 4). The first period covers the years 1980-1984, which is characterized by the effects of oil shock in 1979. There is in this period a strong tendency to converge because the variance decreases sharply. The second period covers the years 1985-2001, it shows that the phenomenon of convergence has stopped and divergence begins to increase since the variance again shows a rising profile. The third and final period which goes from 2003 to 2007 shows that the phenomenon of divergence has stopped in favor of convergence as the variance again shows a descending profile. However this period is characterized by a movement not uniform: the standard deviation is a decreasing function over the period 2002-2005 and an increasing function over the period 2006 -2007. The trend towards convergence between 1980 and 1984 could be explained by weak economic performance of Southern European countries following different oil shocks, but mainly due to good performance in terms of growth in countries of NA region.

The period of divergence of incomes that begins at the mid-eighties can be explained by the economic crisis that hit the countries of the region following the sharp drop in oil prices. At the same time, the governments of these countries have discouraged private investment and prevented the development of export industries by creating barriers to international integration. The decline of government incomes has led to the emergence of large macroeconomic imbalances. This has prompted countries such as Morocco and Tunisia to adopt at the mid-eighties structural adjustment plans. Another explanation of the divergence trend is the fast growth in some Southern European countries, Spain and Portugal in particular, through their membership in the European Economic Community and the process of catching up in these countries to incomes levels of Northern European countries.

Test of Sigma-Convergence: Segmented Trends Approach

To continue the previous descriptive analysis, we test directly the hypothesis of sigma-convergence by estimating the trend of variance series. Indeed, we say that the disparities between per capita incomes decrease if the coefficient of time trend is negative and significant in the following equation:

$$\sigma_t = \alpha + \gamma t + \epsilon_t \qquad (6)$$

$\gamma < 0$ and ϵ_t is an error term

The results of estimation of parameters of equation (6) are presented in table 1:

According to the evolution of variance, it seems difficult to suppose that the convergence process appears to be linear over time. This implies therefore that in equation (6) the coefficients should not be stable.[7] Therefore, we propose to test the hypothesis of sigma-convergence by introducing segmented breaks in equation (6).

To assess the number of breaks, we use the approach of Bai & Perron (2003) which identify the presence of multiple breaks.[8] The advantage of this approach is that it can test both the number of breaks (a total of m) and locate these breaks in time.

[6] For a review of various trade agreements between the EU and Mediterranean countries, one can see Péridy (2005) and Rey (2005).

[7] Le Bihan (2004) offers an excellent literature review on tests of endogenous breaks.

[8] Indeed, the presence of four different periods in the process of convergence / divergence of countries in the NA region suggests the existence of multiple breaks in equation (6).

Indeed, for each number of fixed breaks "m", the dates of breaks (T1.....Tm) are selected by minimizing the sum of squared errors of estimation. Bai & Perron (2003) develop a sequential testing procedure to determine the number of breaks. Another approach to determine the number "m" of breaks is based on the minimization of a certain number of information criteria. In a recent article, Wang (2006) estimated via Monte Carlo simulations which measure the performance of the approach by information criteria. He shows that the use of these information criteria can effectively choose the correct number of breaks. Furthermore, among all the tested information criteria, the criterion BIC is the one which gets the best results. We hold, therefore, this approach to determine the number of breaks and we calculated the BIC criterion for the model.[9]

The model is estimated with a number of breaks between 0 and m. Based on the graphic evolution of the sigma-convergence, the process of convergence could be divided into three times at most. Therefore, we assumed that the number of breaks may vary between 1 and 3. We reported in Table 2 the different values of BIC. The optimal number of breaks is then given by the model that minimizes the BIC criterion.

We note that according to the values of the BIC selection criterion, the optimum number of breaks would be m = 3.

The estimated coefficients of the segmented trends using the dates of breaks are given in table 3:

Estimated dates of breaks are respectively 1984, 2001 and 2005. The estimated coefficient of the trend is negative and significant on the first period, positive and significant on the second, negative and significant on the third period and finally a positive and significant effect on the fourth period. The hypothesis of income convergence of the NA countries to levels of Southern Europe is only granted on the periods 1980-1984 and 2002-2005, on the other periods the assumption of divergence is accepted.

Test of Convergence Clubs Hypothesis from a Polynomial Function

In this section we will use the model of Chatterji (1992) to evaluate the hypothesis of the existence of convergence clubs in the NA region. Indeed, the results of sigma-convergence showed that there could be differences between countries of NA region and countries of Southern Europe. We have estimated the model of Chatterji (equation 4) on our sample of 6 countries in the NA region and using as a country "leader" average income level of countries of Southern Europe (Spain, Greece and Portugal). The estimation method is OLS and the results are reported in Tables 4:

The assumption of convergence of countries in the NA region to the Southern of Europe on the global period (1980-2007) could not be confirmed because the coefficient of GAP_GDP is greater than 1.

This result of divergence could be explained by the fact that, as was shown concerning the evolution of the variance, the convergence process is not uniform over the entire period. As we will show, the results are much more interesting if we allow the movement of convergence to be unstable during the period. We have estimated the model of Chatterji on several sub-periods (Table 5).

Concerning the sub periods 1980-1984 and 2005-2007, the assumption of convergence is rejected because the estimated coefficient of initial income gap is greater than 1.

Over the period 2001-2004, the coefficient b_1 is less than one and negative, it could imply a process of convergence between the countries of the NA region and those of Southern Europe. However, when we simulate the model, we find that the income of countries in the NA region does not move to an equilibrium to which converge the Southern European countries, that is because the coefficient is not significant.

The most interesting results are obtained on the period 1985-2000. Indeed, again the coefficient b_1 is positive and estimated slightly greater than one (1.732391).

The conclusion is that the countries of the NA region do not converge to those of Southern Europe. However economies in each country function very differently. It has therefore been found necessary to analyze the economies individually to determine precisely which country have the most growth potential that allow it to possibly converge towards income of Southern Europe.

We try now to test if each country of NA region taken separately could converge to Southern Europe. To test this hypothesis we simulated the same model estimated by Chatterji. For Algeria, the coefficient b_1 is always either greater than 1 or non significant. Thus, there is not any convergence club between Algeria and Southern Europe. For Tunisia, the coefficient b_1 is less than one over the period 1985-2000. So we can say that Tunisia has ability to converge to Southern Europe countries. The simulation of model shows clearly that Tunisia is detached from NA region to converge to Southern European income level in the long term.

For Morocco, the coefficient b_1 is slightly greater than one over the period 1985-2000. So we can say that Morocco has some possibility to converge to Southern Europe countries. For Egypt, the coefficient b_1 is not significant over all periods. For Mauritania the coefficient b_1 is not significant over all periods. For Libya, the coefficient b_1 is either greater than 1 or non significant.

Conclusion

The aim of this paper was to examine the issue of convergence income between countries in the NA region and Southern Europe countries. The recent integration of countries in the NA region in the globalization movement and the signing of the Euro-Med agreements with the EU, naturally led us to test the hypothesis of convergence towards the countries of Southern Europe.

We estimated the sigma-convergence through tests of endogenous breaks of trends (tests of Bai & Perron (2003)). It appeared that the process of sigma-convergence is not uniform in time. There is a convergence trend of income of countries in the NA region towards the income level of countries of Southern Europe, only during the periods 1980-1984 and 2002-2005, on the other periods the assumption of divergence is accepted.

The estimate of convergence clubs according to Chatterji leads to the rejection of the hypothesis of beta-convergence on the whole period (1980-2007). If the model is estimated over sub-periods, then one can show that there is a possibility of beta-convergence only on the period 1985-2000. On the other sub-periods, the assumption of divergence is accepted. The income level of countries of Southern Europe would not represent the equilibrium level to which incomes of countries of NA region would converge in the long term. Over the period 1985-2000,

[9] As an illustration, the BIC criterion is defined as follows: BIC = ln (SCR/T)+ln (T)*m*n/T, where SCR is the sum of squared residual, T is the number of observations, n is the number of estimated parameters and m is the number of breaks.

Tunisia and Morocco seem to detach from NA region: in fact the gap between income in these countries and that of Southern Europe is located just at limit of income that separates the two equilibria. Tunisia and Morocco could therefore converge to European income levels in the long term.

Chatterji's approach is interesting because it allows estimating the different convergence clubs with relatively simple way. However, it cannot identify the economic determinants of these clubs. It would be interesting to complete this work and try to understand what are the economic policies or institutional variables that have allowed Tunisia for example to get out from the convergence club with low incomes in order to begin the process of catching up.

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Table 1. Estimation of Parameters of Equation 6

Variable	Coefficient	Std.Error	t-Statistic	Prob
C	-70.88768	6.085761	-11.64812	0.0000
Time	0.037273	0.003053	12.20958	0.0000

Table 2. Test of Number of Breaks

	M=1	M=2	M=3
BIC	-3.43	-3.67	-3.90

Table 3. Estimated Coefficients of Segmented Determinist Trend (m=3)

	BIC			
Year	1980-1984	1985-2001	2002-2005	2006-2007
Trend Coifficient	-0.042658	0.052585	-0.040480	0.042377
T-Statistic	-4.062658	13.57251	-3.777746	-----
Prob	0.0556	0.0000	0.00635	-----

Table 4. Income Gap

	1980-2007		
	Coefficient	T-statistic	Prob
GAP_GDP	1.127950	5.213188	0.0000
$(GAP\_GDP)^2$	-0.014911	-0.035242	0.9722
$(GAP\_GDP)^3$	-0.068095	-0.339394	0.7373

Table 5. Income Gap

	GAP_GDP		
	Coefficient	T-statistic	Prob
1980-1984	3.70567	3.017596	0.0569
1985-2000	1.732391	2.477249	0.0684
2001-2004	-1.067454	-0.070364	0.9473
2005-2007	9.490040	0.212558	0.0421

Table 6. Income Gap

	Algeria				Tunisia		
	GAP_GDP				GAP_GDP		
	Coefficient	T-statistic	Prob		Coefficient	T-statistic	Prob
1980-1984	0.737097	0.689964	0.9795	1980-1984	2.785968	-0.293026	0.8880
1985-2000	1.262538	2.250676	0.0013	1985-2000	0.531052	-1.185961	0.0571
2001-2004	-17.17942	0.114516	0.9080	2001-2004	521.3808	-2.493264	0.0280
2005-2007	10.01890	----	----	2005-2007	-20.02899	----	----

Table 7. Income Gap

	Morocco				Egypt		
	GAP_GDP				GAP_GDP		
	Coefficient	T-statistic	Prob		Coefficient	T-statistic	Prob
1980-1984	-124.6127	-2.976357	0.1341	1980-1984	8.425583	2.834582	0.4332
1985-2000	1.038553	0.807743	0.0640	1985-2000	-0.567021	0.961921	0.8457
2001-2004	-61.05833	1.559148	0.5186	2001-2004	-152.8342	0.123242	0.1254
2005-2007	-171.2407	----	----	2005-2007	-37.95477	----	----

Table 8. Income Gap

	Libya				Mauritania		
	GAP_GDP				GAP_GDP		
	Coefficient	T-statistic	Prob		Coefficient	T-statistic	Prob
1980-1984	-0.122830	-0.241006	0.9079	1980-1984	-170.3357	-0.057332	0.3848
1985-2000	2.446545	2.068663	0.0034	1985-2000	0.902973	-1.544204	0.6826
2001-2004	-13.01971	-0.140579	0.5324	2001-2004	-7.022149	0.749993	0.9090
2005-2007	1.721063	----	----	2005-2007	203.7032	----	----