Innovation, Growth and Convergence in the Euro-Mediterranean Area: Implications for MENA Countries[1]

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Abstract

This paper focuses on the innovation gap between countries in the Euro-Mediterranean (Euromed) area and its implications in terms of growth and convergence. Using a large set of innovation variables, we first provide a picture of innovation performance at country level in the Euromed area. Second, we estimate a growth model *à la Barro* which shows that differences in innovation between countries explain differences in growth of per capita GDP within this area. The model relies on specific estimators which address the endogeneity problem.These are the fixed effects decomposition variable (FEDV) estimator, the Hausman and Taylor estimator (HT) as well as the error component two-stage least squares instrumental variables estimator (EC2SLQ IV). Finally, the implications for MENA countries are investigated through the estimation of a convergence model, which shows that differences in innovation between MENA countries explain differences in the convergence process of these countries toward EU GDP per capita. These results have important policy implications which are discussed in the conclusion.

Keywords: Innovation, Convergence, EU, MENA countries, Panel data

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Introduction

Over the past 50 years, Middle East and North African (MENA)[3] countries have experienced moderate growth rates compared with some other emerging countries, especially in Asia. As a matter of fact, from 1961 to 2008, the annual average growth rate amounted to 4.7% in MENA countries (World Bank, 2010). This is close to the percentage observed in Central and South America but lower than that recorded in most South and East Asian countries, which generally exhibit more than 6% annual growth.

Although the average growth performance of MENA countries is slightly greater than that of EU-15 countries (about 3%), several authors argue that some MENA countries have not clearly started their convergence process toward EU per capita levels (Guétat and Serranito, 2010; Péridy and Bagoulla, 2010), except Tunisia, Turkey as well as Egypt to a lesser extent. In this respect, the Barcelona process which aims at creating a Euro-Mediterranean free trade area (FTA) is also questioned about its ability of achieving a real convergence process within this area.

One crucial issue related to growth and convergence concerns innovation and research. Since Robert Solow, economists and policy makers have stressed the fact that persisting disparities can be explained by the innovation gap between countries, in terms of research and development, patents, etc.

Given the lack of literature concerning the role of innovation in the growth and convergence process within the Euro-Mediterranean area, especially MENA countries, this paper aims at providing new insights into this issue. In particular, it addresses the following questions: to what extent is there an innovation gap within this area, especially between the EU and MENA countries? This first question will be overviewed in the first section, through the analysis of a large set of innovation indicators.

Secondly, to what extent country differences in innovation performance can explain growth differences for the countries which belong to this area? This question will be investigated in the second section, through the estimation of a growth model *à la Barro* which includes the alternative innovation indexes defined in the previous section. One original contribution is the use of specific estimators which address the endogeneity problem. These are the fixed effects decomposition variable (FEDV) estimator, the Hausman and Taylor estimator (HT) as well as the error component two-stage least squares instrumental variables estimator (EC2SLQ IV).

Finally, what are the implications of these results for MENA countries? In other words, to what extent can their convergence process toward EU standards of living be speeded up through supplementary innovation efforts in these countries? To answer this last question, a convergence model specific to MENA countries will be estimated by using the EU per capita income as a benchmark. The same estimators are implemented for correcting endogeneity problems. Finally, policy implications will be discussed in the conclusion.

[3] They include Algeria, Morocco, Tunisia, Egypt, Jordan, Syria as well as Turkey.

1. Innovation in the Euromed area: some stylized facts

This section provides a short overview of differences in innovation between countries which belong to the Euromed area. For that purpose, seven alternative innovation indicators have been selected:

- Research and Development expenditures as a percentage of GDP (source: World Bank, 2010)
- High-tech exports as a percentage of manufactured exports (source: World Bank, 2010)
- Patents applications, residents and non-residents (data from 1985 to 2007); source: UNCTAD, 2009)
- Number of researchers per million inhabitants (last year available); source: UNESCO, 2010 (Unesco Institute for Statistics)
- The UNCTAD Technological Activity Index (TAI); Source: UNCTAD (2005). It is calculated as the unweighted average of three variables: R&D, patents and scientific publications per million inhabitants.
- The UNCTAD Innovation Capability Index (ICI); Source: UNCTAD (2005). It is measured as the simple average of the TAI and the Human Capital Index, defined below.
- Human Capital Index; Source; UNCTAD (2005). It is calculated as the weighted average of the literacy rate as a percentage of the population (weight of 1), the secondary enrolment rate as a percentage age group (weight of 2) and tertiary enrolment as a percentage age group (weight of 3)

Some other (and often more precise) indicators are available for OECD countries, such as business enterprise expenditures on R&D, technology balance of payment and many other indicators at industry level (OECD, 2009). However, these data are unavailable for MENA countries, except Turkey.

Figure 1 shows the values of the selected indicators in the Euromed area. Significant differences across countries are recorded for R&D expenditures. Three country groups can be identified. The first includes Northern European countries (plus Israel as an exception), with R&D expenditures which generally exceed 2% of GDP. In this respect, Scandinavian countries show the greatest percentages (above 3%). An intermediate group involves Southern EU countries (Spain, Italy and Portugal) with a corresponding percentage generally above 1% (except Greece with 0.6%). The last group includes MENA countries which generally exhibit R&D shares below 1%, except Tunisia (1.1%).

Looking at patents, 74% of the applications within the Euromed area concern Germany, the UK and France. An additional 19% includes Southern EU countries as well as small Northern EU countries. Israel alone accounts for 4.5% of the applications (essentially from non residents). Finally, the other MENA countries only account for 2.7%, of which 1.6% for Egypt and Turkey alone. It must also be observed that patent applications in MENA countries mostly concern non residents in Egypt, Morocco, Tunisia and Algeria, whereas they mainly concern residents in Turkey and Syria.

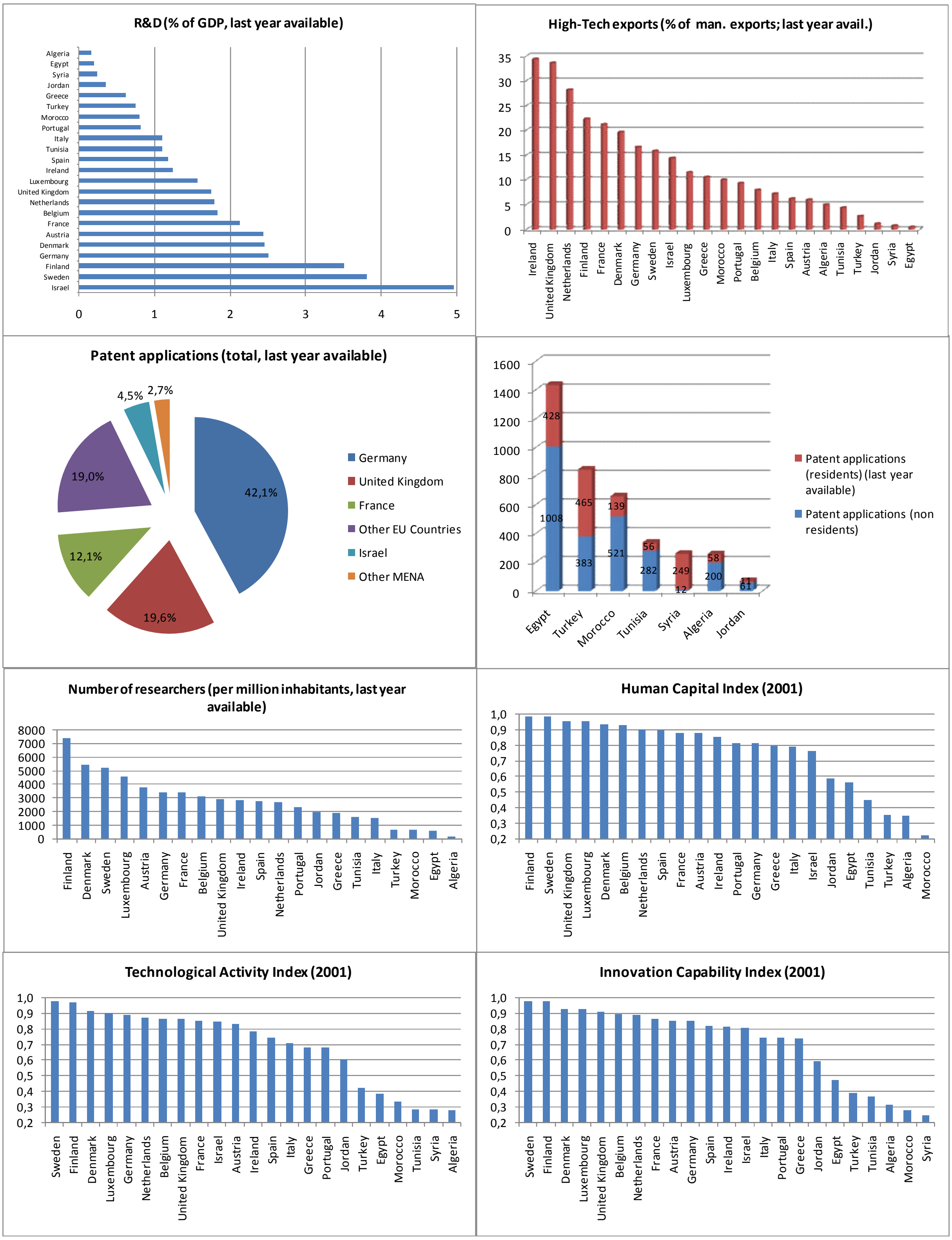
A significant gap is also observed when examining high-tech exports. Basically, the share of these exports in overall manufactured exports generally exceeds 15% in Northern EU countries (up to more than 30% in Ireland and the UK). On the other hand, Southern EU countries as well as MENA countries generally exhibit percentages below 10% (except Israel 14%). However, there are still significant differences between, on the one hand, countries which are close to 10% (Morocco, Portugal) and, on the other hand, some other countries which are below 5% (especially Egypt, Syria and Jordan but also Tunisia and Turkey).

The last four indicators show a very similar country classification with three categories: Northern EU countries with the best performance, Southern EU countries and Israel with an intermediate performance and MENA countries as the last group. For instance, the number researchers amounts to more than 7000 per million inhabitants in Finland, more than 5000 in Sweden and Denmark, more than 3000 in Germany and France whereas it ranges between 1500 and 3000 in Southern EU countries and it is less than 1000 in most MENA countries except Jordan (1952) and Tunisia (1588).

The technological activity index follows the same pattern. It exceeds 0.8 in Northern EU countries (plus Israel); it ranges between 0.6 and 0.8 in Southern EU countries and is generally below 0.4 in MENA countries (except Jordan: 0.61). The same scale also applies to the Human Capital Index and the Innovation Capability index.

Summing up, the analysis of the various innovation indicators highlights a significant innovation gap in the Euromed area between Northern countries on the one hand and MENA countries on the other (except Israel), with Southern EU countries as an intermediate case. One crucial question is to what extent this innovation gap can explain differences in growth between the countries in the whole Euromed zone (section 2) and to what extent this gap is a determinant of the convergence of MENA countries toward EU GDP per capita levels (section 3).

Figure 1: Selected innovation indicators in the Euro-mediterranean area



Sources: UNESCO (2010) UNCTAD (2005), World Bank (2010)

2. Innovation as a determinant of growth within the Euromed area

This section aims to highlight the role of innovation on the growth process in the Euromed area. The model presented here is based on the following Barro (1991) regression:

$$\Delta y_{it} = \alpha + \gamma_1 INNOV_{it} + \gamma_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \qquad (1)$$

Where Δy_{it} corresponds to the rate of growth of GDP per capita in country i at year t, *INNOV* reflects the alternative innovation indexes defined previously. X_{it} is a vector of the other variables which are expected to influence growth. As it is often pointed out in the literature, the problem with this vector is to identify the appropriate variables. Following a Bayesian Averaging of Classical Estimates (BACE) approach, Sala-i-Martin (2004) identifies a set of variables which explains growth across countries. These include education, trade, geography, demography as well as specific economic variables (share of government consumption in GDP, investment price, etc...). Based on this approach, we have selected the following variables in the X vector: trade (measured by openness and specialisation), communication (number of telephones per 1000 inhabitants), the share of government consumption in GDP as well as GDP per capita during the previous period. All these variables are described in the Appendix with the corresponding sources.

It must be emphasised that this model focuses on the specific role of innovation. It is not aimed at identifying all growth determinants. In this regard, the country and time specific effects at the end of the equation are designed to capture the effects of omitted variables.

Equation 1 is estimated for the Euromed area, including EU15 plus the MENA countries defined above (including Israel) for the period 1961-2007[4]. The total number of observations is equal to 1081[5]. Given that some variables are time-invariant or almost time-invariant (especially the innovation variables), we suggest using the fixed-effects vector decomposition (FEVD) estimator developed by Plümper and Troeger (2007). This three stage fixed-effects model makes it possible to produce efficient and less biased parameters of time-invariant variables compared to random effects models. Basically, the first stage estimates a pure fixed effects model to obtain an estimate of the unit effects. The second step implements an instrumental regression of the fixed effects vector on the time invariant variables. This makes it possible to decompose the fixed effects vector into a first component explained by the time-invariant variables and a second component, namely the unexplainable part (the error term). It also makes it possible to address the endogeneity problem. In the last stage, the model is re-estimated by pooled OLS, including all explanatory variables, the time-invariant variables and the error term. This third step ensures the control for collinearity between time-varying and invariant right hand side variables.

As a sensibility analysis, we present two other estimators corrected for endogeneity. The first is based on a random-effects estimator with instrumental variables, namely the Hausman and Taylor (HT) estimator, described in Egger (2004). The second is the the error component two-stage least squares instrumental variables estimator (EC2SLQ IV) (Baltagi, 2005). Indeed, endogeneity is a crucial problem in this type of regression. For example, trade can explain growth but can also be explained by growth. The same remark also potentially applies to

[4] Given the bias due to the particular political and economic situation of Central and Eastern European countries until their integration into the EU, these countries are disregarded.

[5] Except with the variable "patents" for which data are available from 1985 onward. This limits the number of observations to 529.

innovation (and communication variables) which is expected to be stimulated by economic growth. In the estimations presented below, the endogenous variables include innovation, openness, specialization and communication.

Finally, these estimators are also controlled for cross-sectional heteroskedascticity and serial correlation of the error term by using respectively the Huber-White Sandwich estimator and the AR1 Cocrane-Orcutt transformation.

Estimation results are presented in Table 1 for each estimator and for each alternative innovation variable. The most important feature which emerges from this Table is that the innovation parameters are positive and significant at a 1% level whatever the index considered and whatever the estimator[6]. This result shows that innovation plays a crucial role in the Euromed area for explaining differences in growth across countries. From a policy point of view, this conclusion reinforces the argument that research and innovation must be promoted in the EU (and Euromed) as a means of promoting growth in this area.

Table 1: Estimation results (dependent variable: percentage growth in GDP per capita in Euromed countries)

	Fixed Effects Vector Decomposition (FEDV)							HT	EC2SLQ IV
Technological Activity Index	4.99194***							5.06092***	5.133861***
Innovation capability index		4.67092***							
Human capital index			3.73386***						
R&D				.90718***					
patents					.00004***				
research						.00039***			
high tech exports							.06792***		
initial income	-.00012***	-.00012***	-.00012***	-.00012***	-.00029***	-.00014***	-.00011***	-.00013***	-.00014***
openess	.02397***	.02397***	.02397***	.02425***	.02383***	.02443***	.02244***	.02397***	.02444***
specialisation	-.01708***	-.01907**	-.02654***	-.03323***	-.13286***	-.03679***	-.04974***	-.01720**	-.01766**
government spending	-.23055***	-.23055***	-.23055***	-.23388***	-.56594***	-.32650***	-.22529***	-.20277***	-.23044***
communication (telephone)	-.00138	-.00138	-.00138	-.00054	.00284*	.00080	-.00279	-.00136	-.00082
intercept	4.09177***	4.2776***	5.06404***	6.69982***	17.87037***	8.25733***	7.92900***	3.67792***	4.08799***
nb observations	1081	1081	1081	529	1081	1081	1081	1081	1081

Note: *** significant at 1%; ** significant at 5*; *significant at 10%; otherwise: insignificant.

Most of the other variables are also significant. For example, the initial income, which reflects GDP per capita in the previous period shows a negative parameter. This means that the lower the previous income, the higher the growth. This supports the hypothesis of beta-convergence in the countries belonging to the Euromed area.

Openness also exhibits a positive sign. This result supports some empirical findings on the positive trade-growth relationship, although there is a debate in the literature which generally points out the fact that trade and regional integration are not a sufficient condition for growth (for example, refer to Milanovic (2006), Frankel and Romer (1999) as well as Baier et al. (2009) for a survey). Interestingly, inter-industry specialization is detrimental to growth. This can be explained by the new trade theory (Krugman, 1995) which stresses the role of intra-industry trade for additional welfare gains due to scale economies and product varieties.

[6] It must be observed that the innovation indexes are presented one by one in Table 1. In fact, additional tests have been implemented with two or more variables simultaneously. However the parameters are biased due to multicolinearity problems. Moreover, concerning the HT and EC2SLQ estimators, Table 1 only presents the results for the TAI variable in order to save space. All the other innovation variables are also significant. The complete estimation results are available from the author upon request.

The share of government spending in national consumption exhibits a negative and significant sign. This can be explained by the fact that public consumption is financed by distortionary taxes which reduce the growth rate (Sala-i-Martin, 2004).

However, the communication variable proxied by the number of telephones per 1000 inhabitants is not significant. Additional tests have been implemented through the use of two other proxies, namely the percentage of roads paved and the percent of internet users in the population (source: World Bank, 2010). None of these variables show a significant impact on growth. One explanation can be found in the fact that there are few time and cross-country differences in this area in terms of communication networks, especially in EU countries. Additional insights into this issue will be provided in the next section, when examining the specific differences in communication between MENA countries on the one hand, and the EU on the other.

To sum up, our estimation results highlight the importance of innovation as well as other variables, such as trade, initial income and government spending to explain growth in the Euromed area. The next section goes further by investigating the implications of these results for MENA countries.

3. Implications for MENA countries: the role of innovation in their convergence process toward EU standards of living.

This section focuses on the innovation gap between MENA countries and the EU. It aims to see to what extent a better innovation performance in MENA countries can help them to converge toward EU per capita income level. For that purpose, we estimate the following conditional beta-convergence model which results from the Barro regression:

$$\Delta y_{it} - \Delta y_{EUt} = \alpha + \beta\left(\log y_{it-1} - \log y_{EUt-1}\right) + \gamma_1 INNOV_{it} + \gamma_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \qquad (2)$$

The left hand side of the equation reflects the growth difference (in GDP per capita) between MENA countries and the EU (EU15). In this equation, we have excluded Israel from the MENA countries' group because of its difference in GDP per capita compared to the other countries. On the right hand side, we find the difference in GDP per capita between MENA and EU countries. The sign of the corresponding parameter provides an indication of the existence of beta-convergence between MENA countries and the EU. The other variables are similar to those presented in section 2. They include the innovation indexes described previously, as well as a vector X which includes control variables, such as openness, specialization, government spending and communication, measured by the number of telephone users per 1000 inhabitants.

The estimation procedure is similar to that described previously. As a matter of fact, the estimators implemented are respectively FEDV, HT and EC2SLQ. Results are presented in Table 2 for the period 1961-2007. A first feature concerns the parameter estimate corresponding to beta. It is significantly negative whatever the estimator and the model specification. This means that overall, MENA countries have started a convergence process toward EU per capita levels of the EU[7].

Table 2: Estimation results (dependent variable: differences in growth of per capita income between the EU and MENA countries)

	Fixed Effects Vector Decomposition (FEDV)							HT	EC2SLQ IV
Technological Activity Index	4.34806**							4.16723**	4.31092**
Innovation capability index		3.88799**							
Human capital index			3.31291***						
R&D				5.74310**					
patents					.00261				
research						.00176**			
high tech exports							.08192**		
initial income	-7.13831***	-7.13831***	-7.13831***	-7.53792***	-9.56255***	-5.52126*** .	-7.10596***	-7.13831***	-7.81012***
openess	-.02238	.-.02238	.-.02238	-.02489	-.02487	-.01101	-.02228	-.02238	.00883
specialisation	-.028652**	-.01562	-.01245	-.01768	-.07939***	.03313	-.02793*	-.02120*	-.02428*
government spending	-.12227	-.12227	-.12227	-.14417*	-.19893**	-.17413**	-.12227	-.20277***	-.18521***
communication (telephone)	.00336	.00336	.00336	-.00212	.02171**	.00528	.00316	-.00136	.00160
intercept	-7.15001**	-10.29185***	-11.07142***	-9.08873***	-4.51875***	-8.33347***	-7.06444***	-8.93837***	-3.72669**
nb observations	329	329	329	329	162	329	329	329	329

As a second result, it is interesting to observe that all innovation indicators are also positive and significant, except patents. Consequently, innovation is a key variable for feeding the convergence process of MENA countries. In this regard, the countries which show the best innovation performance have been identified in section 2. They essentially include Tunisia, Morocco and Turkey (R&D, high tech exports) as well as Jordan (TAI, number of researchers) and Egypt (Patents). On the other hand, Algeria and Syria exhibit a much poorer performance. According to our estimation results, this difference in the innovation performance between MENA countries explains the difference in the convergence process toward EU GDP per capita levels.

Amongst the other variables, openness is not significant in explaining convergence. This suggests that for these specific countries, openness is not a sufficient condition for convergence. This can be explained by the fact that these countries are generally specialized in low-value added industries (see low high-tech export levels in Figure 1). As a result, the specialization process is expected to be detrimental to convergence, as shown in Amable (2000). As a matter of fact, Table 2 shows a negative parameter estimate for the specialization variable. This confirms the previous expectation. It follows that openness itself cannot explains convergence of MENA countries toward EU standards.

The share of government spending in consumption has a negative sign and is generally significant. This suggests that MENA countries face distortions due to the involvement of the State in the national economy which is detrimental to growth. However, this feature is not specific to MENA countries, since it is also identified at Euromed level (section 2) and at world level (Sala-i-Martin, 2004).

Finally, the communication variable is positive but barely significant. This means that cross-country differences in communication networks measured by phones (and alternatively by roads and internet) barely explain the convergence process of MENA countries.

[7] However, this does not mean that this process concerns all MENA countries taken individually. As shown by Péridy and Bagoulla (2010) as well as Guétat and Serranito (2009), this process mainly involves Tunisia and Turkey as well as Egypt and Morocco to as lesser extent.

3. Conclusion and policy implications

This paper highlights the innovation gap in the Euromed area. On the one hand, Northern EU countries exhibit the best performance in terms of innovation while MENA countries still lag well behind. Southern EU countries are ranked in an intermediate position. Using alternative measures of innovation, we have shown that differences in innovation across countries explain differences in growth of per capita GDP within this area. We have also shown that differences in innovation across MENA countries explain differences in the convergence process of these countries toward EU GDP per capita. Although these results seem to be rather intuitive, estimations show that it is robust whatever the innovation index considered and whatever the estimator implemented.

The policy implications are straightforward. Indeed, innovation is a key variable for feeding growth in the whole Euromed area. Moreover, if the integration process within this area is designed at achieving an economic area with a real convergence of standard of livings, considerable efforts are needed in MENA countries in terms of innovation as a means of bridging the innovation gap compared with EU countries. This can be implemented with several appropriate policies, such as 1) national public policies in terms of education and research; 2) EU support through EIB loans in R&D projects (MEDA program); 3) private policies which can be fed by appropriate fiscal policies as well as technological spillovers through FDI.

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Appendix: Measurement, data and sources.

- GDP per capita: measured in PPP (source: Penn World Tables)
- Specialization. Following Amable (2000), the following inter-industry specialization is used to capture the impact of specialization on convergence:
    - Inter-industry specialization: $I_j = \frac{1}{2}\sum_i \left| \frac{X_{ij}}{X_{.j}} - \frac{M_{ij}}{M_{.j}} \right|$ with $0<I_j<1$

The higher I_j, the more trade balances are dissimilar across industries, and then the higher inter-industry trade (source: own calculations from UNCTAD, 2009, Handbook of Statistics)

- Openness: Trade in goods and services as a percentage of GDP at constant price (Heston et al. (2006))

- Communication: telephone lines per 1000 inhabitants (Source: World Bank, Global Development Network Growth database). As an alternative proxy, we also used the “internet users” (per 100 people, source: World Bank, 2010).

- Government consumption: share of government consumption in GDP. It is measured as a percentage of GDP in PPP (Heston et al. 2006).