THE WILLIAM DAVIDSON INSTITUTE
AT THE UNIVERSITY OF MICHIGAN

Institutions, Governance and Technology catch-up in North Africa

By: Imed Drine

William Davidson Institute Working Paper Number 1017
May 2011

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Imed Drine

UNU-WIDER

World Institute for Development Economics Research

Helsinki-Finland.

Abstract

This paper aims to analyse the effects of institution quality on technology catch-up in five North African countries (Algeria, Egypt, Morocco, Sudan and Tunisia) compared to 3 groups of developing and emerging countries (Sub Saharan Africa, Asia, and Latin America) over the period 1970-2005. The study adopts a two-stage methodology. In the first step we estimate the technology gap using the matafrontier approach. In second step we test the relationship between the technology gap and the quality of governance. The empirical results show that institutions (corruption, law and rules and investment climate) are very important in closing the technology gap and speeding up the technology catch-up. Other determinants of the technology gap are also identified: foreign direct investment, human capital and trade.

JEL Classification: C33, O47, O57, K49, O1.

Keywords: Keywords: metafrontier, technology gap, catching-up, efficiency, stochastic frontier, governance, North Africa.

1. Introduction

During the 1970s, most North African states implemented post-colonial development programmes, including major infrastructure projects in education and public health. However, many factors indicate that the development process applied since the 1970s, has failed to deliver its promise. Despite massive investments in infrastructure, in schools and in health, the North Africa region in general still suffers from major shortcomings and from development results that are far below expectations.

The recent crises concerning food and finances highlight the extreme fragility of the North African countries and question the sustainability of the development processes. The economic and social impacts of these crises on the economies of the region signal the magnitude of the challenges facing the region and the need to reorient its development policies. The social stress and economic instability caused by these challenges give a good indication of what might be expected in the future.

Many experts highlight the necessity for the North African countries to transform their commodity-based economy to knowledge-based economies. Indeed, the recent developments in the world economy confirm that knowledge, innovation and technology are the main drivers of economic growth. In more competitive international enviornment improving productivity by bridging the technology gap becomes a priority if the economies of the region are to remain viable in the global economy.

However, as a consequence of the excessive reliance on raw material exports for foreign exchange earnings and on foreign markets as a source of industrial products and food items, the economies of the region have accumulated an important technology lag. While many developing countries are constantly upgrading their own technological capabilities and become increasingly competitive, the North African countries still lack the ability to create and adopt new technologies. Moreover, low social capital, security and social tensions, conflicts, deteriorated business environment, due to excessive public intervention, and low quality of human capital are additional bottlenecks handicapping technology progress in the region.

In 2008 a report by the World Bank[1] says that the capacity of a country to absorb new technology depends on its overall economic status and governance. Indeed, the economic and institutional environments as well as quality of education affect risks for entrepreneurs taking on new technologies. In addition, the experiences from many emergent economies confirm that good governance can improve legitimacy, engage citizens and spark commitments and further innovation.

A substantial literature points out that to a large degree, the ability of any economy to grow and to continue to function in the face of unexpected events depends on the institutional structure and the operational systems in place, and the resilience of these. Moreover, it is widely accepted that social relations and institutions contribute to the effective functioning of the economic system. The role of institutions and good governance in promoting economic growth is confirmed by many recent studies (see Rodrik, Subramanina and Trebbi, 2002; Easterly and Levine, 1997; Kormendi and Meguire, 1985; Knach and Keefer 1995; Mauro 1995). For instance, the *Global Competitiveness Report 2009-2010*, considers important pillars of economic development to be the institutional environment and solid institutions that play a crucial role during economic crisis.

Using a sample of 140 countries, Rodrik, Subramanina and Trebbi (2002) show that governance explains cross-country income differences. They point out that institutions matter more than openness and geography in determining income level. Meon and Weill (2005) test the relationship between governance and technical efficiency for a sample of 62 countries and find that rule of law are affects economic efficiency. Adkins et al. (2002) test the relationship between efficiency and economic freedom and find that lack of economic freedom results in lower efficiency.

In general empirical studies on productivity differences use growth regressions based on the traditional neoclassical growth model (Solow, 1956) with extended specifications. A proxy variable for productivity differences is added directly to the right hand side of standard growth regressions. Solow (2001) criticizes this methodology because it regroups in the same regression variables that have very different theoretical status. He suggests for studying productivity to take

[1] Global Economic Prospects 2008, the World Bank.

these additional variables as right hand side variables of regressions that have productivity as the dependent variable.

On the other hand, in the new growth theory models, the productivity term does not have to represent technological progress, because these models have alternative avenues for technological progress. In this new growth theory models *productivity term* stand for non-technological components which may obviously vary across countries.

To be more acquit than studying the determinant of a Solow residual which have a very large definition, we estimate the economic efficiency. Production efficiency is an allocative component of TFP in addition to a technical one according to Fare *et al*. (1994). This definition makes insightful contributions to exiting literature on growth theory. Zachariadis, (2004) conclude that efficiency have been significant in determining the growth trajectories of many developed economies. In addition, we estimate the technology progress to measure the technological capability of the region compared to the more preferment emerging countries. The main contribution of the paper is to focus on the competitiveness of the North African region by studying the technology catch-up and its main determinants.

The objective of this paper is to study the link between the technological capability and institution quality in North Africa. To measure the technological capability in the region we use the metafrontier approach. The main advantage of the metafrontier technique is that it is able to separate technological change from efficiency change. Another advantage of this approach is to provide a measure for the technology gap for each country each year. This measure will be used to investigate the determinants of the technological catching-up process. More precisely, we analyze the impacts of the economic and institutional environment on the technology progress.

The paper is structured as follow. Section two provides a general overview of knowledge and institutional deficiencies in North Africa. Section three explains the methodology used in this paper. Section four presents and discusses the empirical results. Section five concludes and gives the main policy recommendations.

2. Knowledge and institutional deficiencies

Weak governance and knowledge deficiencies in the region handicap human progress and impede the development of successful entrepreneurs. Indeed, North Africa experiences a wide knowledge deficiency as a result of low public investment in 'research and development' and the failure to promote human resource development and technology transfers. The 2009 United Nations Human Development Report points out that only 0.2 per cent of the Middle East and North Africa region's GDP is at present spent on scientific research, compared to Denmark, France, Switzerland and the United States where the corresponding figure is between 2 and 3.6 per cent. According to UNDP (2009) the annual expenditure on scientific research per capita in the region is less than $10 compared to a corresponding figure of $575 and $1304 for Ireland and Finland, respectively.

Table 1: Knowledge Economy Index[2]

	Economic Incentives and Institutional Regime	Innovation System	Education and Human Resources	Information and communication technology	Knowledge Economy Index
Ranking among 135 countries					
Algeria	109	91	94	99	96
Egypt	91	71	80	93	83
Jordan	55	55	57	73	62
Morocco	87	88	109	78	92
Sudan	131	122	120	96	120
Tunisia	65	69	88	65	72
Performance scores compared with the developing regions (index)[3]					
MENA (including North Africa)	3.8	4.4	3.4	5.1	4.2
Sub Saharan Africa	2.8	5.3	1.5	2.6	3
East Asia and the Pacific	5.7	8.8	5.3	7	6.7
South Asia	2.7	7.2	1.9	1.8	3.4
Latin America	4.7	6.5	4.3	5.3	5.2

Source: Knowledge Assessment Methodology Data Base, World Bank (2008)

[2] The Knowledge Economy Index is the simple average of the normalized performance scores of a country; for more details refer to the World Bank. The methodology used by the World Bank is based on the supposition that the knowledge economy comprises four pillars: economic incentive and institutional regime, education and human resources, the innovation system, and ICT.

[3] Higher value indicates better performance.

Compared to East Asia and Latin America, the most performant developing regions, North Africa scores lower with respect to the four indicators (table 1). In addition, the region scores lower than the four regions with respect to innovative system indicator. The important deficit in the innovative system that contributes to the technology gap is mainly explained by the scarcity of entrepreneurship and innovative human resources. Indeed, because of poor expenditures on R&D and week institutional support, the business environment in the region in not effective enough to promote entrepreneurship and innovation. Investment in R&D is extremely low (less than 1/7 of the world average) and access to information and sources of knowledge is still limited (only 6.5% of the population uses internet).

Moreover, over the last two decades braindrain in the region has increased and millions of highly skilled people have immigrated to developed countries, causing a massive economic and social loss in addition to significant development opportunities being missed. According to estimations by the Arab Labor Organization, losses in Middle East and North Africa have increased twentyfold, currently totaling 200 billion dollars versus 11 billion dollars in the 1970s. The region accounts for 31 per cent of the braindrain from developing to developed countries (contributing approximately 50 per cent of the doctors, 23 per cent of the engineers and 5 per cent of the scientists who migrate from the third world). According to many experts, this critical situation is also explained by the region's restrictions on freedom as well as its bureaucracy and corruption.

Table 2: Institutional development in North Africa

Political Stability			
Country	Year	Percentile Rank[4] (0-100)	Governance Score (-2.5 to +2.5)
ALGERIA	2009	12.7	-1.2

[4] Percentile ranks indicate the percentage of countries worldwide that rate below the selected country. Higher values thus indicate better governance rate.

EGYPT	2009	24.5	-0.63
LIBYA	2009	68.9	0.62
MAURITANIA	2009	13.7	-1.17
MOROCCO	2009	30.2	-0.43
SUDAN	2009	1.4	-2.65
TUNISIA	2009	53.3	0.23
Government Effectiveness			
Country	Year	Percentile Rank (0-100)	Governance Score (-2.5 to +2.5)
ALGERIA	2009	34.8	-0.59
EGYPT	2009	44.3	-0.3
LIBYA	2009	11.9	-1.12
MAURITANIA	2009	21	-0.9
MOROCCO	2009	51.4	-0.11
SUDAN	2009	7.1	-1.32
TUNISIA	2009	65.2	0.41
Control of Corruption			
Country	Year	Percentile Rank	Governance Score
		(0-100)	(-2.5 to +2.5)
ALGERIA	2009	37.6	-0.49
EGYPT	2009	41	-0.41
LIBYA	2009	13.8	-1.1
MAURITANIA	2009	30.5	-0.66
MOROCCO	2009	51.4	-0.23
SUDAN	2009	6.2	-1.24
TUNISIA	2009	57.6	0.02

Source: Kaufmann D., A. Kraay, and M. Mastruzzi (2010), The Worldwide Governance Indicators: Methodology and Analytical Issues

Weak governance and corruption are additional bottlenecks handicapping the human and institutional development of the region. Familialism is still important in the region, and favours and kin reciprocities often govern people's interaction (Abu-Laban & Abu-Laban , 1987). As is shown in table 2, most MENA countries suffer from bad governance and political instability. Indeed, with a few exceptions, the region is below the world average in terms of government effectiveness and political stability. Moreover, most countries rank poorly in terms of corruption; Corruption Index consistently ranks these nations below the world median.

Table 3. Human Development in North Africa

	Life expectancy at birth, females (2000-2005)	**Literacy rate, all adults (2007)**
ALGERIA	72.2	75.4
EGYPT	72	66.4
LIBYA	75.7	86.8
MAURITANIA	64	55.8
MOROCCO	71.8	55.6
SUDAN	57.8	60.9
TUNISIA	75.1	77.7

Source: Earth Trends, World Resources Institute.

As is shown in table 3, in terms of human development, many of the region's nations have achieved higher levels than other developing countries, as indicated by the relatively higher life expectancy for females and literacy rates. However, the recent gains in human development are fragile, insufficient (especially for Morocco and Mauritania), and are not built on long-run government policies (Arab NGO network for Development, 2009).

3. Empirical Methodology

The first step of our analysis consists to determine the stochastic production frontier for each group of countries, as they are supposed to be endowed with different production technologies. We use the stochastic production frontier method with variable inefficiency as proposed by Battes and Coelli (1995). This method is increasingly used in the literature for analyzing productive inefficiency at the macroeconomic level (Adkins et al. (2002), Meon and Weill (2005), Mastromarco (2008)). It consists of using the best practices of the countries under consideration to construct a production frontier that makes it possible to calculate for a given country at a given date, the potential output for a technology and a given quantities of inputs. Productive inefficiency is defined as the ratio of actual output to potential output. If it is equal to one, then the country is making a perfect use of its factors of production relative to other countries of the group.

It is assumed that each country *i*, belonging to group k=1,2, 3, 4 makes use of its factors of production (capital , labour, and human capital) according to group specific technology.

$$Y_{it} = A_{it}K_{it}^{\alpha_k}L_{it}^{\beta_k}\mathbf{H}_{\mathbf{it}}^{\gamma_k}\mathbf{exp}(V_{it} - U_{it}), where\ i = \mathbf{1}, \ldots\ldots, N\ and\ t = \mathbf{1}, \ldots\ldots, T \quad \mathbf{(1)}$$

where,

Y_{it} is the output (GDP)

K_{it} the stock of physical capital,

H_{it} the stock of human capital,

L_{it} the economically active population

A_{it} the total factor production, expressed as : $\mathbf{exp}(\delta_k + \tau_k t)$, where, δ_k is a scaling parameter, and τ_k the Hicks-neutral technical progress ratio.

The term V_{it} is an error term identically and independently distributed according the normal process $N(0, \sigma_{\mathbf{1}}lcv^{\mathbf{1}}\mathbf{2}$). The term U_{it} is a non-negative error term independent from V_{it} , which represents the productive inefficiency. U_{it} is distributed independently as a zero-truncated normal process.

Technical efficiencies which allow us to examine the performance of the *i*-th country relative to the individual group frontier cannot be used to measure the technological capability as countries from different regions operate under different production technologies. Bettes et al. (2004) propose an approach where the productivity in a given region or group, may be estimated relative to a metafrontier. Compared to the regional frontier which represents the state of technology in the region, the metafrontier represents the state of technology at the global level. The metafrontier function is therefore a frontier function that envelops all frontiers of individual countries or groups. The main advantage of the metafrontier approach is that to distinguish between efficiency and technological change.

The metafrontier production function model for the county *i*, is expressed by:

$$Y_{it}^{*} = A_t^{*}K_{it}^{\alpha^{*}}L_{it}^{\beta^{*}}H_{it}^{\gamma^{*}} \qquad (2)$$

Where α^{*}, β^{*} and γ^{*} denotes the vector of parameters for the metafrontier function and resulting from solving the following linear program (Battes et al. (2004)):

$$\begin{cases} Min_{\alpha^*,\beta^*} \sum_{i=1}^{I}\sum_{t=1}^{T} \left| lnY_{it} - lnY_{it}^{*} \right| \\ Subject\ to\ \ln\left(A_t^{*} K_{it}^{\alpha^*} L_{it}^{\beta^*} H_{it}^{\gamma^*}\right) \geq \ln\left(A_t^{k} K_{it}^{\alpha_k} L_{it}^{\beta_k} \mathbf{H}_{\mathbf{it}}^{\gamma_k}\right) \\ for\ all\ k = 1, 2, 3 \end{cases} \quad (3)$$

The technology gap for country i is defined as the ratio between the potential production Y_{it} that is achievable using the technology of the group to which country i belongs, and the potential production Y_{it}^{*} in the hypothetical case where country i has access to the better technology. The technology gap ratio for the i-th country (in the k-th group) at the t-th period is defined as:

$$\phi_{it}^{k} = \frac{Y_{it}}{Y_{it}^{*}} = \frac{A_{it}}{A_{it}^{*}} K_{it}^{\alpha_k - \alpha^*} L_{it}^{\beta_k - \beta^*} \mathbf{H}_{\mathbf{it}}^{\gamma_k - \gamma^*} \quad (4)$$

The ratio is equal to one when the country technology frontier coincides with the metatechnology frontier. Countries closer to the metfrontier have higher technology gap ratio and considered as more advanced technologically. An increase over time in the technology gap ratio indicates a technological catch-up that we want to test the main determinants.

The technical efficiency relative to the metafrontier function, however, is defined as:

$\varphi_{it}^{*} = \varphi_{it}\phi_{it}$

where,

φ_{it}: the technical efficiency relative to the stochastic frontier for the given group,

ϕ_{it}: the technology gap ratio for that group.

4. Empirical Results

We consider four groups of countries[5]. The first group includes five North African countries: Algeria, Egypt, Morocco, Sudan, and Tunisia. The second group includes seven Asian countries: Bangladesh, India, Indonesia, Malaysia, Pakistan, Sri Lanka and Thailand. The third group includes ten Latin American countries: Brazil, Columbia, Costa Rica, Dominique Rep.,

[5] Because the lack of data on human capital and the initial level of stock of capital, only limited number of countries of each group could be included.

Equateur, Guatemala, Mexico, Panama, Paraguay and Uruguay. The fourth group includes 5 African countries: Cameroon, Kenya, Malawi, Mali and Senegal.

The analysis uses data from a balanced panel observed over the period 1970-2005. The output variable is defined as the GDP at constant price. We follow Bosworth and Collins (2003) and we define the human capital indicators as $H_{it} = h_{it}L_{it}$ where $h_{it} = (1.07)^{s_{it}}$, s is the average number of schooling years (Barro-Lee, 2000). As Bosworth and Collins, we use the perpetual inventory method to calculate the stock of physical stock series; the depreciation rates (*di*) are assumed to be 4 per cent. Data for GDP, investment, and labour is extracted from the World Bank data base. The initial stock of capital is from Nehru and Dhareshwar (1993).

4.1. A metafrontier estimates

The estimation of the frontier model is presented in Table 3 and the Limdep 8 package was used to estimate the frontier model. In general, the t-values show that almost all coefficients are significant at the 1 per cent level.

Table 3: Estimates for parameters of the stochastic frontier models[6]

VARAIABLE	NORTH AFRICA	ASIA	AFRICA	LATIN AMERICA	POOLED FRONTIER	META FRONTIER
CONSTANT	-1.253	-0.007	1.255	1.538***	1.097***	3.196
	(1.77)	(0.313)	(1.19)	(0.029)	(0.11)	
TREND	-0.246***	-0.043***	-0.100***	-0.043***	-0.075***	-0.067
	(0.009)	(0.003)	(0.004)	(0.002)	(0.004)	
PHYSICAL CAPITAL	0.494***	1.088***	0.943***	0.852***	0.882***	0.869
	(0.035)	(0.045	(0.012)	(0.002)	(0.021)	
LABOUR	0.841***	0.045***	0.143*	0.537***	0.161***	0.167
	(0.076)	(0.003)	(0.08)	(0.04)	(0.035)	

[6] Standard errors are given in parentheses. *,**,*** represent the respective significance at 1%, 5% and 10%.

HUMAN CAPITAL	0.244***	-0.013***	0.022***	-0.385***	-0.042	-0.179
	(0.009)	(0.002)	(0.005)	(0.004)	(0.101)	
σ^2	0.143***	0.309**	0.94**	0.69***	0.34***	
	(0.02)	(0.162)	(0.55)	(0.312)	(0.083)	
γ	0.97***	0.85***	0.99***	0.99***	0.99***	
	(0.004)	(0.028)	(0.008)	(0.001)	(0.012)	
LOG-L	380.85	288.89	111.5	575.06	137.35	

The generalized likelihood-ratio test for the null hypotheses, that the regional frontiers do not differ is LR[7] = 2438. This has a p-value of 0.00, so we reject the null hypothesis that the regional frontiers are identical. As the stochastic frontiers across regions differ, it is not possible to use the pooled stochastic frontier and we have to estimate a metafrontier. We use Shazam program given by Battes et al. (2004) for the estimation of the metafrontier parameters and the technology gap ratio[8].

Table 4: Technical efficiency scores and technology gap for North Africa

	Technical Efficiency $[(\varphi]_{it})$	**Technology Gap Ratio** $[(\phi]_{it})$	**Technical efficiency relative to metatechnology** $[(\varphi]^*_{it} = \varphi_{it}\phi_{it})$
1970	0.9615	0.1273	0.1224
1971	0.9613	0.1367	0.1314
1972	0.9613	0.1467	0.1411
1973	0.9612	0.1583	0.1521
1974	0.9611	0.1685	0.1620
1975	0.9610	0.1745	0.1677
1976	0.9609	0.1797	0.1726
1977	0.9608	0.1871	0.1798
1978	0.9606	0.1946	0.1869
1979	0.9604	0.2044	0.1963

[7] The LR Statistic is defined by $\lambda = -2 \ln [L(H_0) - \ln L(H_1)]$. Where $L(H_0)$ is the value of the likelihood functions for the stochastic frontier estimated by pooling the data for all groups, and $L(H_1)$ is the sum of the values of the likelihood functions for the regional stochastic production functions estimated separately.

[8] Technology gap scores by countries are presented in the appendix.

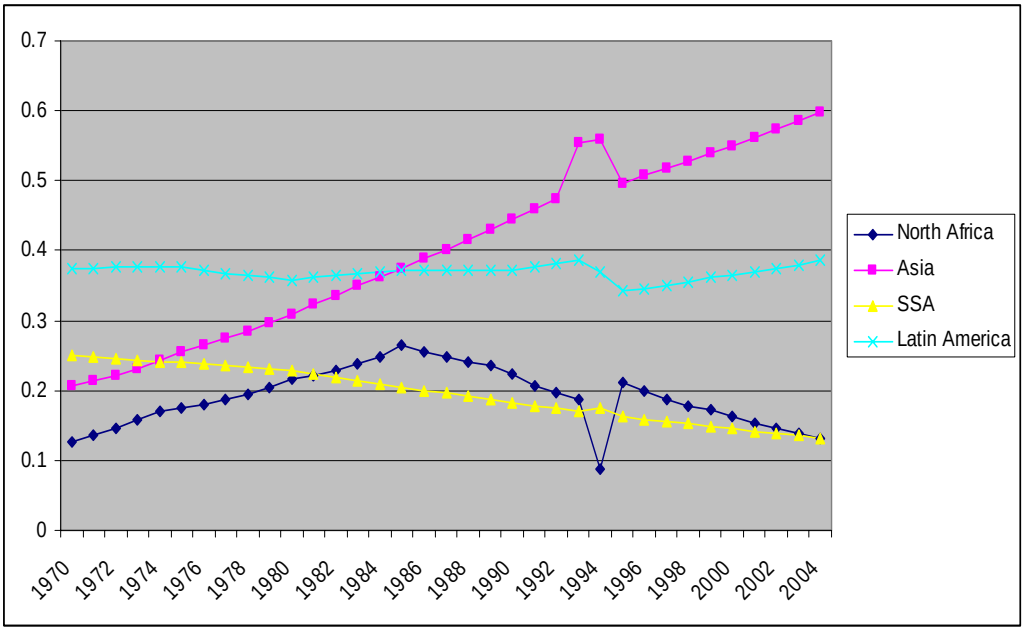
1980	0.9602	0.2173	0.2087
1981	0.9600	0.2200	0.2112
1982	0.9600	0.2283	0.2191
1983	0.9598	0.2394	0.2297
1984	0.9597	0.2488	0.2388
1985	0.9596	0.2657	0.2550
1986	0.9596	0.2547	0.2444
1987	0.9597	0.2472	0.2372
1988	0.9597	0.2413	0.2316
1989	0.9598	0.2364	0.2269
1990	0.9599	0.2240	0.2150
1991	0.9601	0.2060	0.1977
1992	0.9602	0.1958	0.1880
1993	0.9603	0.1882	0.1807
1994	0.9592	0.0870	0.0834
1995	0.9594	0.2108	0.2022
1996	0.9597	0.1993	0.1912
1997	0.9600	0.1879	0.1804
1998	0.9603	0.1772	0.1702
1999	0.9605	0.1725	0.1657
2000	0.9608	0.1625	0.1562
2001	0.9611	0.1525	0.1466
2002	0.9614	0.1450	0.1394
2003	0.9616	0.1384	0.1331
2004	0.9619	0.1312	0.1262
2005	0.9621	0.1242	0.1195

Table 4 provides average technical efficiency and technology gap scores for North Africa over the period 1970-2005. The average technical scores is about 0.96 indicating that effective output is about 96 per cent of its potential, suggesting the possibility for only modest improvements using the current technology.

As is shown in table 4, after a continuous decrease during the 1970s, the average technical efficiency scores have showed a progressive increase since the last 1980s. However, the high technical efficiency scores from the regional model mask an important gap relative to the metatechlogy. Indeed, over the period 1970-2005, the average technical efficiency of the region relative to the metatechnology is only about 0.19. These suggest that North African countries are

highly inefficient relative to the metafrontier. Among the five countries, Egypt has the better performance with a technology gap ratio of 0.51 on average (table 1 in the appendix).

Figure 5: Technology gap ratio variations for the four groups



As is shown by figure5, the slight increase in technical efficiency during the last decade has not compensated for the widening technology gap relative to the most performing developing countries (Asia and Latin America). The technology used in the region lags behind the global technology and the technology gap continues to widen over time. Wile many developing countries are constantly upgrading their own technological capabilities and become increasingly competitive, North African countries still lack the ability to create and adpt new etchnologies. The increasing technology gap relative to the global technology in the last decade suggests that the capacity of the region to absorb the new technology is very limited. This confirms once again that the region lacks of real engines for economic growth and that its economic performance depends on the international conditions

The main conclusion from the technical efficiency analysis is that North African countries cannot expect an improvement in economic performance unless they succeed to improve their ability to acquire and adapt to new technologies. This confirms that the development processes in the region is distorted and essential reforms are needed if these are to remain viable in the global

economy. So what are the main conditions for the region to catch up and to fill the technology gap?

4.2. Economic and intuitional reforms and technology catch-up in North Africa

A substantial literature shows that good institutions are essential for higher economic performance and help to foster innovation and diffusion of new technologies. It is argued also that openness to foreign market and high skilled people facilitate the absorption of new technology and help to faster technological catch-up. For instance, Iyer, Rambaldi and Tang (2006) confirm that developing countries can speed up their technological catch up by opening up to trade and foreign direct investment. The authors consider that countries with the widest technological gaps can rapidly catch up through higher FDI inflows, trade liberalization and mobility of human capital.

The following step is to ask if economic and institutional reforms may contribute to enhance efficiency and facilitate the absorption of new technologies. We propose to regress the technology gap of the region relative to the metatechnology on human capital, financial development, trade openness, foreign direct investment, external debt and the quality of governance. A panel of five North African countries is used to test the relationship between the technology gap and its determinants. The data used is annual and cover the period 1984-2004.

The general model to be estimated is defined as follows[9]:

$$\phi_{it} = \alpha_i + \beta_1 trend + \beta_2 Education_{it} + \beta_3 FinDev_{it} + \beta_4 Openness_{it} + \beta_5 FDI_{it} + \gamma Inst_{it} \quad (5)$$

where,

ϕ_{it}: is echnology gap ratio between the country technology and the metatechnology.

trend: is time trend.

Education: is an indicator of human capital as defined previously.

[9] We test a first model where only macroeconomic variables are included. In the second and third model we include both macroeconomic and institutional variables.

FinDev: is an indicator of financial development and approximated by the ratio credit to the private sector over GDP.

Openness: is an indicator of trade liberalization and defined as the ratio of total exports and imports over GDP.

FDI: is defined as the total flows of FDI over GDP.

Inst: is an indicator of the quality of the institutional environment in the region and captured by five variables[10]: an indicator of democratic accountability, an indicator of corruption[11], an indicator of bureaucracy, an indicator of investment profile, and an indicator of law and order[12].

Table 5: Estimates for the determinants of the technology gap[13]

	MODEL 1	MODEL 2	MODEL 3
TREND	0.015	-0.032	-0.035**
	(0.012)	(0 .011)	(0.011)
EDUCATION	0.852*	0.645	0.762**
	(0.468)	(0.377)	(0.370)
CREDIT/GDP	-0.0003	0.095	
	(0.0002)	(0.069)	
TRADE LIBERALIZATION	0.001*	0.008	0.002**
	(0.0009)	(0.001)	(0.001)
FDI /GDP	0.011**	0.010	0.011*
	(0.005)	(0.008)	(0.006)
INVESTEMNT PROFIL		0.004	-0.003
		(0 .005)	(0.005)
CORRUPTION		-0.064*	-0.073**
		(0.034)	(0.018)

[10] The data for the institutional variables are available only for 1985-2004.
[11] This variable proxies for the degree in which government agents use their political power for private gain. Data is extracted from International Country Risk (ICR) Guide (2005).
[12] The data is extracted from the International Country Risk (ICR) Guide (2005).
[13] Standard errors are given in parentheses. *,**,*** represent the respective significance at 1%, 5% and 10%

LAW AND ORDER		0.028***	0.026***
		(0.008)	(0.007)
BUREAUCRCY		-0.038*	-0.028*
		(0.015)	(0.01)
DEMOCRTAIC ACCOUNTABILITY		0.024***	0.019**
		(0.009)	(0.068)
N OBSERVATIONS	100	100	100

The results of our econometric analysis are presented in table 5 and suggest that, first, human capital, trade openness and foreign direct investment contribute positively and significantly to bridge the technology gap in the region. Second, except from investment profile, all the institutional variables contribute significantly to technology gap. Moreover, the sign of the coefficient are as expected: higher level of corruption and bureaucracy impact negatively technology gap, and better enforcement rules and democratic accountability help the region to reach higher production frontier.

Therefore, the low scores in terms of institution quality recorded in the region may be considered as the main causes of the large and widening technology gap. This means that the political commitments from the governments in the region to address insecurity and uncertainty into economic relationships are still insufficient. In addition, despite the different strategies to attract foreign direct investment, the investment climate and country's policies toward the free capital flows seems still ineffective to favour technology transfer in the region. The ability and the facility to start and operate a business seem to be limited by the malfunctioning of the administrative and fiscal systems.

The positive and significant coefficient confirm that international trade improve total factor productivity in the region through the transfer of technology and/or the use of higher quality intermediate input (Rivera-Razin and Romer , 1991). Moreover, results show that FDI is not merely the means of opening new markets for multinational companies but also a way for achieving higher productivity through technology transfers. In other hands, higher quality of education system contributes significantly to reduce the technology gap through higher ability to create and adapt new technologies and favors technology transfer.

Finally, we used different indicators to measure financial development in the region and we find no significant coefficient. This result shows that the financial sector, which supposed to support technology catch-up by providing financial resources, seems playing no role in improving the capacity of the local economy to absorb new technologies. This confirms financial system's inability to allocate capita efficiently. Therefore, more effort needed to make local financial sectors meet international standards for capital.

5. Conclusion

North Africa finds itself at a crossroad, faced with new opportunities but also challenged by real social and economic debacles. Development programmes implemented by the different states have failed to deliver significant results, and essential reforms are needed if these are to remain viable in the global economy.

In North Africa, governance and institutions deficiencies is proved to greatly explain the low economic performance of the region during the 1990s and the early 2000s. This paper shows that improvement in governance and institutions is a key issue for the region to catch-up. It proves that the disappointing governance quality in the region causes inefficiency. But institutional variables have not been the only reason of low efficiency performances; the deficit in structural reforms constitutes another major explanatory factor (financial development). This has been the case over the whole period 1970-2005. This makes reforms an important question that governments in North Africa have also to address if the region wants to catch up with more successful developing economies. However the reforms have to be supported by good governance and institutions which helps the region to access to a higher development horizon. Improvements to macroeconomic management as well as institutional reforms are essential to enhance efficiency and facilitate the absorption of new technology.

An effective reform approach in North African countries can be based on the following actions: building market institutions, developing political institutions, ameliorating the investment climate, strengthening the rule of law and combating corruption. The North African countries have also to encourage the private sector to improve youth employment, develop the financial sector which is shown to be very important in increasing the economic efficiency.

To reach such goal North Africa needs a new social contract that will make better governance possible. Past reform efforts were not only selective and incomplete, but above all lacked participatory quality. Top-down policies were pursued by the ruling elites and foreign technocrats, which contributed to the feeling of disconnect between the reformers and society at large. The region needs country-specific institutional reforms that come out of local solutions built up from a local knowledge, conviction and experimentation. The region needs clearly a political will.

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Appendix

TABLE 1. : TECHNOLOGY GAP RATIOS FOR NORTH AFRICAN COUNTRIES

	Algeria	Egypt	Morocco	Sudan	Tunisia	Average
1970	0.093	0.223	0.155	0.020	0.146	0.127
1971	0.094	0.233	0.168	0.021	0.167	0.137
1972	0.096	0.245	0.182	0.022	0.188	0.147
1973	0.097	0.257	0.199	0.023	0.216	0.158
1974	0.097	0.263	0.216	0.022	0.244	0.169
1975	0.098	0.259	0.219	0.021	0.275	0.174
1976	0.099	0.294	0.217	0.021	0.268	0.180
1977	0.100	0.334	0.214	0.022	0.266	0.187
1978	0.100	0.374	0.213	0.022	0.263	0.195
1979	0.100	0.423	0.215	0.023	0.262	0.204
1980	0.101	0.485	0.219	0.022	0.259	0.217
1981	0.102	0.542	0.208	0.020	0.229	0.220
1982	0.100	0.624	0.196	0.017	0.204	0.228
1983	0.102	0.715	0.185	0.015	0.180	0.239
1984	0.104	0.788	0.179	0.013	0.160	0.249
1985	0.106	0.898	0.170	0.011	0.145	0.266
1986	0.105	0.858	0.162	0.010	0.138	0.255
1987	0.106	0.834	0.157	0.009	0.131	0.247
1988	0.107	0.814	0.152	0.009	0.125	0.241
1989	0.108	0.801	0.147	0.008	0.118	0.236
1990	0.110	0.747	0.142	0.008	0.112	0.224
1991	0.106	0.679	0.133	0.007	0.105	0.206
1992	0.102	0.648	0.124	0.007	0.098	0.196
1993	0.098	0.628	0.117	0.007	0.092	0.188
1994	0.072	0.247	0.061	0.006	0.049	0.087
1995	0.175	0.599	0.147	0.015	0.118	0.211
1996	0.168	0.564	0.141	0.014	0.111	0.199
1997	0.161	0.529	0.134	0.012	0.104	0.188
1998	0.154	0.496	0.127	0.010	0.098	0.177
1999	0.148	0.492	0.121	0.009	0.093	0.173
2000	0.142	0.465	0.110	0.008	0.087	0.163
2001	0.136	0.436	0.101	0.007	0.082	0.153
2002	0.130	0.417	0.094	0.006	0.077	0.145
2003	0.124	0.400	0.090	0.005	0.072	0.138
2004	0.118	0.381	0.084	0.005	0.068	0.131
2005	0.112	0.362	0.079	0.004	0.064	0.124
Average	0.113	0.510	0.155	0.013	0.150	

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