Does Investment in Knowledge and Technology Spur "Optimal" FDI in the MENA Region? Evidence from Logit and Cross-Country Regressions

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Abstract: UNCTAD data reveal that most Middle East and North African (MENA) countries have failed to attract levels of Foreign Direct Investment (FDI) that correspond with their *potentials.* Generally, FDI flows to the MENA region have been consistently abysmal, compared with other regions. While there is anecdotal evidence that knowledge, technology, and human capital are becoming more salient than factor accumulation in international competitiveness and capital flows, most studies on FDI flows to the MENA region have not systematically explored the interconnection between knowledge and FDI flows. In this study I use logit and cross-country regressions, with data from 61 MENA and non-MENA countries, to investigate whether inadequate investment in knowledge, technology, and human capital by MENA countries explains their sub-optimal FDI profile. Results from both models suggest that investment in knowledge and technology is not significant for a MENA country's ability to attract an optimal level of FDI. To the contrary, openness of the economy, GDP per capita and political risks are more important for FDI flows. One implication for MENA countries is that, despite their poor science and technology infrastructure, they could still attract FDI by promoting openness and political rights/civil liberties.

Paper for Presentation at the African Economic Conference Organized by the African Development(AfDB) Bank and the United Nations Economic Commission for Africa (UNECA), Tunis, November 12-14, 2008.

I. INTRODUCTION

One of the numerous paradoxes about the MENA region is the fact that MENA countries have the potentials to attract a substantial inflow of Foreign Direct Investment (FDI), but have not been able to do so. Apart from being the bastion of the world's largest oil reserves, the MENA region features abundant natural resources, a fairly skilled workforce, and proximity to European markets. Yet, in ranking after ranking, MENA countries have been consistently listed as among the countries that have not attracted the level of FDI commensurate with their capabilities. In UNCTAD's 2000-2002 classification of countries according to their levels of FDI vis-à-vis potentials (see Table 1), only four MENA countries were classified as either "Front-Runners" or "Above-Potential." The rest were classified as "Below-Potential" or "Under-Performers."[1]

This ranking is consistent with data on FDI flows to the MENA region, which show that MENA countries receive less FDI than most countries in the developing world. During the 1990s, for instance, the average FDI/GDP ratio for MENA was 1.76%, compared to 2.28% and 2% in East Asia and Latin America, respectively (Bisat, 1996, p.9). The situation got worse afterward; between 1995 and 2003 the average FDI/GDP ratio in MENA countries was 1.51%, compared to 2.8% in developing countries.[2] Table 2 shows that the FDI/GDP ratio in the MENA region was a mere 0.35 percent in 1996, the lowest of all the regions in the developing world. Although the FDI/GDP ratio in the MENA region increased to 1.27 percent in 1998, it has been declining ever since, and has remained below 1 percent. Notice from Table 2 that Sub-Saharan Africa (SSA), which is often regarded as one of the poorest regions in the world, attracted substantially more

[1] As Table 1 shows, nearly 40 percent of the countries listed as "Below-Potential" are MENA countries.
[2] Computed from data in *World Development Indicators* database for 2005.

FDI than the MENA region during the past decade. SSA received about 10 times more FDI than MENA in 1999. In addition to having a very low share of FDI in developing countries, MENA countries' share of net private capital flows has also been abysmal, as Table 3 indicates. In 1990, MENA countries accounted for a mere 1.35 percent of net capital flows to developing countries, slightly above SSA's share of 0.68 percent. By 1996, however, MENA countries had become the lowest recipients, with 2.85 percent of the total.[3]

FDI flows to the MENA region are highly skewed, both across countries and sectorally. First, much of the flows is concentrated in a few countries such as Saudi Arabia, Egypt, Tunisia, Bahrain, and Morocco. The least recipients include Libya, Kuwait, and Yemen (Eid and Paua, 2002, p.110). Second, a preponderance of FDI in the region has gone into petroleum-related (particularly hydrocarbons) and other primary activities. Non-petroleum FDI (especially to countries such as Bahrain, Egypt, Morocco, Tunisia, and Lebanon) has gone into tourism, banking, telecommunications, manufacturing, and construction (Eid and Paua, p.111). Third, the meager flow of FDI to MENA countries reflects a historical trend.[4] Of developing countries' 65.7 percent share of the global stock of FDI in 1938, MENA's share was 2.6 percent, compared to Africa's at 7.4 percent. In 1960, developing countries' share was 32.3 percent, while MENA received 2.8 percent and Africa 5.5 percent (Dunning, 1981, pp.224-235). Lastly, FDI in

[3]FDI flows to the MENA region has been abysmal despite the adoption, by some MENA countries, of the European Union policies and regulations designed, among other things, to promote FDI. Many MENA countries have also implemented structural adjustment programs that have led to the privatization of inefficient public enterprises, fiscal reforms and reform of the banking system. These countries have also introduced FDI policies designed to create an enabling environment for FDI [see, for instance, Eid and Paua (2001), Rivlin (2001) and Noland and Pack (2007)]

[4] This historical trend suggests that endemic institutional constraints may also be responsible for the abysmal flow of FDI to the MENA region.

the region has not been proportional to the size of MENA economies. In 1999, the MENA region's GDP totaled $591.6 billion, almost twice SSA's at $320 billion. Per capita Gross National Investment (GNI) in the region was $2000 in 1999, which amounted to over four times that of SSA at $490. Paradoxically, SSA received five times more FDI than the MENA region in 1999 (World Bank, 2002). In addition, six of the bottom 10 countries in UNCTAD's Inward FDI Performance Index in 2003 are MENA countries.[5] What is surprising about FDI flows to the MENA region is that "inward flows are not only low as might be expected on the basis of the fundamentals but also below the norm" (Noland and Pack, 2007, p.262).

The question, therefore, is: what is wrong with MENA countries? Why have they not lived up to expectations with regard to FDI? Although various studies have explored why MENA countries have not attracted an optimal level of FDI, none has undertaken a systematic empirical analysis of the role played by investment in knowledge and technology. This is despite the fact that there is circumstantial evidence that foreign investors are becoming *less* sensitive to political and macroeconomic instability, and *more* concerned about the availability of a well-developed science and technology "infrastructure" in the host country. The massive inflow of FDI to China and India – two high-tech developing countries – during the past decade is often used as anecdotal evidence of the salience of knowledge and technology for FDI flows. The Republic of Ireland has also attracted large inflows of FDI during the past decade largely because of the existence of a cluster of high-tech firms such as Intel and Microsoft in that country.

[5] The Inward FDI Performance Index ranks countries by the FDI they receive relative to their economic size, computed as the ratio of a country's share in global FDI inflows to its share in global GDP. For details about this index, see UNCTAD (2003).

This paper uses logit and cross-country regressions, with a sample of 61 MENA and non-MENA countries, to investigate whether the ability of MENA countries to attract levels of FDI commensurate with their potentials depends on their levels of technological development. Based on the empirical results, the paper proposes policy measures that MENA countries need to undertake in order to move from "Below-Potential" to "Above-Potential" and "Front-Runner." The paper is divided into seven sections. Following the introduction in Section I, Section II is a review of the literature, and Section III sketches out an endogenous growth theoretical framework for the paper, followed by the empirical model in Section IV. Section V discusses the results from logit and cross-sectional OLS regressions, while Section VI considers the policy implications of the results. Section VII focuses on the conclusions and recommendations for further research.

II. LITERATURE REVIEW

When investigating why FDI to the MENA region has been abysmal, most researchers tend to focus on macroeconomic, and sometimes institutional, variables such as economic growth, openness, real interest rates, rate of return on investment, infrastructures, natural resources, corruption, and political stability [see, for instance, Kamaly (2002), Eid and Paua (2002), Rivlin (2001), and Richards and Waterbury (1996)]. The empirical papers typically use fixed effects panel regressions, and a small sample of MENA countries. These studies often conclude that macroeconomic stability, openness, and political stability are important for FDI flows to the MENA region. Kamaly (2002), for instance, used a dynamic panel model covering the period 1990-1999 to identify the determinants of FDI flows to the MENA region, and concluded that the lagged value of FDI/GDP and economic growth were the only significant factors amongst a multitude of macroeconomic indicators. In a study that used fixed effects panel regressions, Onyeiwu (2004) found that openness and corruption/bureaucratic red tape were the only significant variables for FDI flows to the MENA region.

However, rarely do empirical studies on FDI flows to MENA countries explicitly model science and technology indicators. This is despite the increasing importance of technological innovation in the new global economy, and anecdotal evidence that it may even have become a key determinant for attracting FDI. Mytelka (1987, p.43), for instance, notes that if R&D, design, engineering, advertising, and marketing are regarded as part of "knowledge," then "present trend suggests that knowledge inputs may be displacing capital, land, and labor as the primary defining feature of the production process." According to Paus (2005, p. 193):

> The absolute number of skilled and educated workers in a developing country is one factor that ceteris paribus influences the amount of high-tech FDI a developing country can attract. One of the reasons Ireland was able to attract large inflows of high-tech FDI was the relatively large number of engineers and other highly trained people it could provide.

In his interviews with R&D managers of foreign corporations operating in China, Chen (2008, p.628) notes that "the primary motives underlying the establishment of advanced R&D centres in China concerned not the cost, but the availability of the required skilled labor." Corroborating this point, the director of IBM China Research Labs pointed out that:

> ……the migration is not just about outsourcing for low labour rates.

> If it were just about low labour rates, we'd probably have R&D centres in places like Romania and the Philippines. China's advantage is not in low production costs. Production costs are even lower in India. China's advantage lies in the availability of the best talent (Chen, 2008, p.628)

Investigating whether knowledge and technology play an important role in FDI flows to the MENA region is warranted, given the region's poor Science and Technology (S&T) infrastructure. Table 4 shows that Gross Domestic Expenditure on Research and Development (GERD) in Arab States (most of which are in the MENA region) as a percentage of world GERD is about 0.4%, the lowest amongst the regions reported in the table. GERD as a percentage of GDP in Arab States is 0.2%, again the lowest of all the regions ---lower in fact than Sub-Saharan Africa (SSA). Only a paltry 1.6% of researchers in the world are located in Arab States, lower than every other region except SSA. Additionally, the number of patents granted to firms in the MENA region during the period 1989-1996 was a paltry 200, compared with 11, 302 for Korea, 1, 725 for Singapore, 1,510 for India, and 1,081 for Hong Kong (Statistical Abstract of the World, 1996). Trade data also show that MENA countries export predominantly low-tech products, reflecting their lack of investment in technological innovation. The volume of scientific publications by MENA scientists in international journals is also considered to be unimpressive (Radwan and Kassem, 2002, p.415).

As a further evidence of the poor S&T infrastructure in the MENA region, Table 5 shows that most of the researchers in the MENA region are employed in the public sector and higher education, rather than in business enterprises. Of the four MENA countries for which data were available, only Israel had a significant portion (82%) of its R&D personnel employed in business enterprises, followed by Turkey with about 30%.

Incidentally, these countries have also attracted a significant amount of FDI compared to other MENA countries. All of Algeria's and Tunisia's R&D personnel were employed in the public sector and in higher education. By contrast, China and Ireland, two large recipients of FDI, had about 78% and 62% of their R&D personnel employed in business enterprises, respectively. Studies have shown that firms tend to locate in a region with a cluster of businesses engaged in R&D. Location in such a cluster enables firms to reap the benefits of agglomeration economies in the form of availability of researchers, diffusion of technical and scientific knowledge, and a strong S&T infrastructure.

Beyond these anecdotes and circumstantial evidence, does economic theory lend credence to the notion that knowledge and technology are salient for FDI flows? This question is addressed in the next section.

III. TECHNOLOGY AND FDI: A THEORETICAL FRAMEWORK

Investment in science and technology affects FDI indirectly through its effect on output, per capita income, and growth (Lai, et al., 2006, p.314).[6] Most empirical studies on the determinants of FDI have shown a significant relationship between economic growth and FDI flows [see, for instance, Zhang (2001) and Chakrabarti (2001)]. Thus, variables that affect growth can also influence FDI flows. In this section, I use a simple endogenous growth model to show how technology affects output, and subsequently influences FDI flows. The Romer (1986) growth model[7] is often written as:

$$Y = K^{\alpha} (AL_Y)^{(1-\alpha)} \qquad (1)$$

[6] Lai et al. found that there is a direct correlation between human capital investment, domestic R&D and China's economic growth.

[7] The version of the Romer model used in this paper was adapted and modified from Audretsch and Keilbach (undated).

Per capita income can therefore be denoted as:

$$Y/L_Y = K^{\alpha} (A)^{(1-\alpha)}$$

where Y represents output, K capital stock and L_Y is the labor force required for the production of Y, while A is the stock of knowledge capital in the economy. The capital accumulation function is adapted from the Solow (1956) model:

$$\acute{K} = s_K Y - \Delta K \qquad (2)$$

where S_K is the saving rate and Δ is the rate at which capital is depreciated. The R&D sector can be modeled as:

$$\acute{A} = ðL_A \qquad (3)$$

where ð represents the discovery rate of innovations, with

$$ð = \delta L_A^{1-\lambda} A^{ø} \qquad (4)$$

L_A stands for the number of workers involved in the production of new knowledge (i.e. scientists and engineers involved in R&D), λ denotes returns to scale in R&D, while Ø $(0 <= Ø <= \infty)$ is a parameter that measures the magnitude of knowledge spillovers. All other things constant, if Ø = 0, the rate of knowledge diffusion will be small and output will be less. Conversely, if Ø = ∞, the rate of diffusion will be very large and out output will be high as well. The rate of knowledge creation (or the rate of endogenous technical change) can be obtained by substituting equation (4) into (3):

$$\acute{A} = \delta L_A^{\lambda} A^{ø} \qquad (5)$$

It can be seen from equation (5) that the stock of knowledge (and hence economic growth and FDI flows) in the economy depends on the number of workers actively engaged in R&D, returns to scale in R&D, and the rate at which knowledge diffuses in the economy. Contrary to most neoclassical models that assume Arrow-type learning in which knowledge diffusion is costless and automatic, the rate of technological diffusion depends on the availability of human capital, as well as a strong absorptive capacity (Lai, 2006, p.302).[8] If the knowledge generated in the economy is fully commercialized, economic growth will be faster and:

$$A = A_C \qquad (6)$$

However, growth will be slower if:

$$A - A_C > 0 \qquad (7)$$

Equation (7) implies that some of the knowledge generated in the economy is not being commercialized. A number of factors may explain the non-commercialization of knowledge in an economy. First, if most of L_A is concentrated in government labs and other public institutions, much of the knowledge generated will be "basic knowledge," rather than "applied knowledge" or applied research. Thus, a country may have a large number of scientists and engineers engaged in R&D, but still experiences slow growth and poor FDI performance. Second, if property rights are not well-protected in a country, firms will be reluctant to make knowledge available to the public through patenting and other contractual forms in the technology market. Consequently, Ø will tend toward zero, leading to both a lower A and Ac. Third, if firms in an economy lack absorptive capacity, they may not be in a position to assimilate and commercialize new knowledge. Again, this will slow down the growth process and reduce FDI flows.

[8] Cohen and Levinthal (1990, p.128) define absorptive capacity as the "ability of a firm to recognize the value of new, external information (or knowledge), assimilate it, and apply it to commercial ends."

IV. THE EMPIRICAL MODEL

The previous section has shown that there is a theoretical link, albeit an indirect one, between technology and FDI. In this section, I investigate whether science and technology indicators explain why FDI flows to the MENA region do not reflect their capabilities. As discussed earlier on, UNCTAD classifies countries into four categories according to their abilities to attract different levels of FDI. Two of these categories, “Front-Runner” and “Below-Potential” are of particular interest in this study because most MENA countries fall under the latter category. My goal is to use the logit model to determine whether a MENA country’s investment in science and technology increases its probability of becoming a front-runner. The dependent variable in this model is a binary-choice variable called “Country Category,” which assigns the number 1 to “front-runners” and zero to “below-potentials” for the countries listed in Table 1. The model is specified as:

$$\text{Country Category} = ß_0 + ß_1 \mathit{R\&D} + ß_2 \mathit{BUSR\&D} + ß_3 \mathit{NRES} + ß_4 \mathit{TECHEX} + ß_5 \text{GDPCAP} + ß_6 \mathit{POLR} + ß_6 \mathit{OPEN}$$

Explanatory Variables

There are two sets of explanatory variables in this model: *Science and Technology indicators* and *Control Variables.* The science and technology indicators include the following variables:

R&D Expenditure (R&D): Most innovative activities take place in public and private Research and Development (R&D) laboratories. Although there is controversy about whether R&D labs are the most important sources of technical change, it has become customary for economists to measure the level innovative activity by expenditures on R&D as a percentage of GDP. I expect the coefficient on this variable to be positive because a higher R&D expenditure would increase the propensity of a country to become a front-runner.

Business R&D (BUSR&D): Expenditure on R&D *per se,* while necessary, is not a sufficient condition for attracting an optimal level of FDI. A preponderance of that expenditure must occur in the private sector for it to be an effective tool for attracting FDI. A large share of business R&D in a country's total R&D expenditure indicates that the private sector is not only vibrant, but also the driving force of the economy. Thus, the larger the proportion of business R&D in total R&D expenditure, the more likely that a country would attract an optimal level of FDI, and hence become a front-runner.

Number of Researchers (NRES): In addition to being a S&T indicator, this variable also serves as a proxy for human capital. Countries such as South Korea, China, and India with large stocks of human capital also have a very high number of scientists, engineers, and researchers. In the new economy, skills, knowledge, and human capital have become very important competitive factors. As indicated in section II of this paper, some studies suggest that corporations tend to locate in countries with abundant supplies of scientists, engineers, computer programmers, etc. In a recent *Wall Street Journal* article, Lohr (2005, p. C1) noted that multinational corporations now regard "the quality of scientists and engineers and their proximity to research centers as crucial." India and China have become popular destinations for foreign investors partly because of the availability of a skilled workforce at affordable wage rates. Because the number of researchers in a country may be affected by the country's population, I measure this variable by the number of researchers per million of the population. The coefficient on this variable is also expected to be positive, as an increase in the number of researchers will enhance the ability of a country to attract more foreign investors.

High-Technology Exports (TECHEX): Countries that have invested significantly in science and technology typically export high-tech products. Conversely, countries that have not invested enough in science and technology tend to rely on primary products, natural resources, and light/assembly-type manufactured products. This variable is measured as a proportion of manufactured exports, and is expected to be positively correlated with a higher propensity to attract FDI.

The following *control* variables that influence FDI flows are included in the model:[9]

GDP Per Capita (GDPCAP)

Nearly every study on FDI has found a positive relationship between, GDP per capita, economic growth and FDI (Zhang 2001; Chakrabarti 2001; Ramirez 2000). One reason for the positive relationship is that growth increases living standards and thus creates a large market for foreign investors. Apart from having large domestic markets, high-growth economies typically implement stable and credible macroeconomic policies that

[9] There is a long list of potential control variables, including natural resources, infrastructures, fiscal indicators, and rate of return on investment. Some of these variables were not included in the model because of the non-availability of data for some of the MENA countries in my sample. Since there is no microeconomic theory of FDI, analysts have tended to include in their models only variables of their choice.

attract foreign investors. I expect GDP Per Capita to be positively correlated with a higher propensity to attract FDI.

Political Risk (POLR): Analysts have established a link between political risks and FDI. Other things constant, democratic and politically stable economies attract more FDI than despotic and unstable countries (Shneider and Frey, 1985). Democratic regimes are also more likely to respect civil liberties, the rule of law and property rights –features that are more conducive to the flow of FDI. Ngowi (2001) argues that many developing countries have attracted little FDI because they are regarded as "high risk and are characterized by a lack of political and institutional stability and predictability." I measure political risk by Freedom House's *Indexes of Political Rights and Civil Liberties*. For each country in my sample, I calculated the average of these two indexes. Because the indexes measure political rights and civil liberties on a scale of 1 to 7 (with 1 representing the highest levels and 7 the lowest), *POLR* is expected to be negatively correlated with a higher propensity to attract FDI..

Openness of the Economy (OPEN)

Additionally, the ease with which investors can move capital in and out of a country (the openness of the economy) is also an important determinant of FDI flows (Chakrabarti 2001: 91-92). That is, countries with capital controls and restrictive trade policies discourage inflows of FDI, compared to countries with liberal policies. Most of the studies on FDI in developing countries have identified a positive relationship between openness and FDI (Morisset, 2000). I measure openness by (imports + exports) as a percentage of GDP, and expect its coefficient to be positive *a priori*.

The Logit Model

The model is given as:

$$\ln [P/1\text{-}P] = \alpha + \beta X + \mu \qquad (1)$$

where P represents the value of the dependent variable between 0 and 1, while X represents a vector of the regressors, in this case the science and technology indicators, as well as the control variables. Following Ramanathan (1992), both sides of the equation can be exponentiated before solving for P:

$$P = 1/(1 + e^{-\ \alpha + \beta X + \mu}) \qquad (2)$$

In other words, the probability that a country will be a “front-runner” is given by:

$$P(Y_i = 1) = \log\text{it}(X\beta) = \frac{e^{X_i\beta}}{1 + e^{X_i\beta}} \qquad (3)$$

and the probability that a country will be “below-potential” is:

$$P(Y_i = 0) = 1 - \log\text{it}(X\beta) = \frac{1}{1 + e^{X_i\beta}} \qquad (4)$$

Following Maddala (1983), the marginal effect of a particular independent variable $\mathbf{X}_i$ on the probability of the occurrence of the response P(Y=1) is expressed by:

$$\frac{\partial P(Y=1)}{\partial X_i} = \frac{e^{X_i\beta}}{\left[1 + e^{X_i\beta}\right]^2}\beta_k \qquad (5)$$

The marginal effects represent the incremental change in the predicted probability caused by a unitary change in the independent variable under consideration. I use the marginal effects to ascertain the relationship between the ability to attract an optimal level of FDI and a country's investment in science and technology.

Data Sources and Descriptive Statistics

Data on the science and technology indicators (except High-Technology Exports), as well as GDP per capita were collected from UNESCO's statistical database. Data on the control variables, including High-Technology Exports were collected from *World Development Indicators* published by the World Bank. Data on civil liberties were from the Freedom House *Index of Political Freedom*, while data on FDI were from UNCTAD's FDI database. Finally, information on gross domestic product was from the US Energy Information Administration. All of the data used in the model are for 2002, except otherwise stated. The descriptive statistics for the explanatory variables are summarized in Table 6.

V. RESULTS AND DISCUSSIONS

The logit model was estimated for the 61 countries (including 11 MENA countries) listed under "Front-Runners" and "Below-Potential" in Table 1.[10] The dependent (or dummy) variable was regressed on both the science and technology indicators and the control variables. The results are summarized in Table 7. It can be seen from the table that none of the science and technology indicators is significant, suggesting that the propensity for a country to attract an optimal level of FDI is unrelated to the country's investment in

[10] Some of the countries were excluded because of the non-availability of data.

science, technology and human capital. This implies that foreign investors consider mainly non-technological factors when making investment decisions.

The control variables, Openness, Political Risk, and GDP Per Capita, are the only significant variables in the regression results (Table 7).[11] The positive sign on the coefficient of OPEN implies that the probability of attracting an optimal level of FDI increases with the openness of an economy. Likewise, the negative sign on the coefficient of POLR suggests that the more stable and democratic a country is, the higher its probability of attracting a level of FDI commensurate with its potentialities.

Although significant, the coefficient on GDP Per Capita appears with the wrong sign, suggesting that a country's probability of attracting optimal FDI decreases with an increase in GDP per capita. This result is consistent with the behavior of non "tariff-jumping" FDI, i.e. investors who use the host economy as a platform for exporting to other countries. This category of investors may be attracted to a country with low GDP per capita because of locational advantages such as natural resource availability, low labor cost, geographical proximity to export markets, and financial incentives. Thus, as GDP per capita increases in that country, probably due to rising wage rates, the country loses its low-cost advantage and hence witnesses FDI outflows. This may explain why foreign investors often find rich economies to be too expensive, both in terms of their wage rates, raw material prices, and taxes. They instead prefer to invest in poor countries with low wages, abundant raw materials, low taxes, and moderate energy prices. It is, therefore, not surprising that the United States is ironically classified, along with MENA countries, under "below-potential" in Table 1.

[11] These variables are significant at the 5 percent level.

It is pertinent, however, to point out a shortcoming of the logit model. Notice from Table 8 (the Correlation Matrix of the explanatory variables) that some of the science and technology indicators are highly correlated, with a correlation coefficient as high as 70-80 percent for some of the variables. GDPCAP is also correlated with R&D, NRES, and BUSR&D –a correlation predicted by the theoretical model in section III. This correlation may have resulted in biased and inconsistent estimates. To address this problem, GDPCAP was dropped and the model re-estimated. However, the S&T indicators continued to be insignificant. One solution would be to drop a couple of the science and technology variables and replace them with other indicators such as the number of patents granted to a country, the number of scientific publications, and other S&T indicators.[12] A second solution to this simultaneity problem is to re-specify the model as a system of simultaneous equations. A third method is to use the lagged values of the S&T indicators and GDPCAP. Assuming that the lagged variables are uncorrelated with the error term, using lagged values of the endogenous variables can ameliorate simultaneity bias (Liu, 2008, p.191). These alternative methods will be attempted in a future revision of the paper.

To test the robustness of the notion that science and technology indicators have no significant effects on the propensity to attract an optimal level of FDI, I re-estimated the model as a cross-country OLS regression, with FDI (as a percentage of GDP) as my dependent variable. All the explanatory variables remain the same, but the year 2003 FDI data were used because the explanatory variables typically affect FDI flows after a time

[12] Unfortunately, data on these indicators are not available for most MENA countries. Researchers that are undertaking empirical research on MENA countries are often frustrated by the spotty nature of data on key economic variables. The lack of data on S&T indicators is also indicative of the poor S&T infrastructure in the MENA region.

lag. An additional proxy for human capital, was included in the model. It measures human capital in terms of government expenditure on education as a percentage of GDP.[13] The results are summarized in Table 9, and they confirm that science and technology indicators are not important for FDI flows across countries. As with the logit model, openness and political risks are the only significant variables in the OLS model. Surprisingly and contrary to conventional wisdom, GDP per capita is insignificant in the OLS model.[14] This may be interpreted as meaning that cross-country variations in FDI flows are not primarily explained by differences in market size. The intuition behind this result is that, as long as a country is open to trade and capital flows, foreign investors could still patronize the country despite the small size of its market. And as indicated earlier on, FDI could be non "tariff jumping," in which case investors are using the host country as a platform for exporting to other countries or as a base for producing intermediate inputs for its subsidiaries.

What are the implications of some of the regression results for FDI flows to MENA countries? How might insights from the key results be used to enhance the capacity of MENA countries to attract FDI? These issues are addressed in the next section

VI. POLICY IMPLICATIONS FOR MENA COUNTRIES

Openness and FDI Flows: The regression results from the preceding section has shown that what drives FDI flows globally is not how much countries spend on R&D and other technology indicators. What seems to be more important is how open an economy is to

[13] This variable can also be interpreted as measuring government commitment to education. The data source for this variable for the sample countries in this study is the *Human Development Report 2007/2008* published by the United Nations. The data used is the average public expenditure on education as a percentage of GDP for the period 2002-2005.

[14] I replaced GDP per capita with GDP, but the latter turned out to be insignificant as well.

trade, investment and capital flows. This contention is supported by Jordan's classification as a "front-runner" in Table 1 –with both a high FDI potential and High FDI performance. One reason for Jordan's classification under this category is because of its openness compared to other MENA countries. Following its implementation of economic reforms in the 1990s, Jordan's central bank removed all foreign exchange controls in its attempt to attract foreign investment and to also encourage Jordanians to repatriate to Jordan foreign exchange held in foreign banks (Elguindi, 1998, p. 4). By contrast many MENA countries are still closed, as manifested by high trade barriers in these countries. Table 7 summarizes the various trade protection indicators of developing countries, and shows that trade protection in MENA is on the average the highest in the developing world. MENA's trade barriers have not only been the highest, they are also the slowest to come down (Srinivasan, 2002, p.1). Another manifestation of the protective nature of MENA economies is the fact that trade flows to the region have declined dramatically for the past 20 years. For instance, trade flows to the Middle East represented about 21 percent of the flows to developing countries in 1980, but fell to 13 percent in 1990 and a meager 9 percent in 1997 (IMF, 1999). MENA's declining openness contrasts with the increasing openness of Asia, whose share of trade flows increased from 28 percent in 1980 to 52 percent in 1997.

MENA countries can ameliorate their poor science and technology infrastructure by promoting a policy of openness. As Grossman and Helpman [(1991), quoted in Lai et al. (2006, p.301)] point out, "the higher a country's degree of openness, the more chances it will have of imitating and learning from outside." In other words, foreign investors could import technologies, skills, and expertise from elsewhere, as long as the economy is open. We live in an information society where technical knowledge can be transferred relatively easily from one country to another. For instance, results of R&D conducted in Europe can be disseminated to the subsidiaries of multinational corporations in the MENA region.

Political Risks: The logit regression results show that the propensity of a country to attract a level of FDI commensurate with its potentials decreases with political risks. Likewise, the cross-country regression results imply that differences in FDI flows across countries can be explained by differences in political risks. Incidentally, MENA countries are perceived as some of the most unstable and risky countries in the world. The risks and uncertainties in the region stem from two major sources. First, the existence of sectarian regimes in most countries in the region have circumscribed the ability of individuals to exercise their civil rights and liberties. Second, most of the regimes in the region are oligarchic, authoritarian, and undemocratic. In other words, political rights, political freedoms, freedom of expression, etc. are constrained. This is particularly true of countries such as Saudi Arabia, Kuwait, Iran where the media and Western influence are severely controlled. Consequently, a pre-condition for boosting FDI flows to the MENA region is for countries in the region to grant political rights and civil liberties to their citizenry, as well as democratizing the political process.

Science and Technology Indicators: Does the insignificance of science and technology indicators in both the logit and OLS regressions imply that investment in science and technology is a waste of money? As indicated earlier on, the insignificance of these variables may be due to the imperfection of the variables used in this paper to proxy science and technology. If interpreted broadly, however, this result is not inconsistent with the notion that science and technology are important for FDI flows. It could be that foreign investors are attracted to open economies because these countries have liberal policies not only toward trade and capital flows, but also toward factor movements. Thus, foreign investors are able to attract scientists, engineers, and experts from other countries easily in open economies. Open economies can overcome their disadvantage in science, technology, and human capital by making it easier for domestic and foreign firms to attract skills and expertise from other countries.

VII. CONCLUSIONS AND FURTHER RESEARCH

This paper investigates whether the classification of most MENA countries as "Below-Potential" with regard to their ability to attract optimal levels of FDI is related to their inadequate investment in science and technology. Results from both logit and cross-country regressions find no evidence to support the notion that investment in science and technology plays an important role in the ability of MENA countries to attract optimal levels of FDI. To the contrary, the results show that openness and political stability are perhaps more important in explaining why some countries are "front-runners" and others "below-potential." Given the imperfection of the variables used to proxy science and technology, as well as the correlation between some of the explanatory variables, these results are necessarily provisional.

These results have very important policy implications for MENA countries. Most MENA countries are not as open as they ought to be, and the region in general is known to be politically unstable and very risky do business. With regard to their lack of openness, there is evidence that MENA economies are some of the most protected in the world. To attain “front-runner” status, MENA countries need to be more open, democratize their polities, as well as promote political rights and civil liberties.

Further research that uses other measures of science/technology and a different model specification (such as a system of simultaneous equations) is needed for more definitive conclusions.

Table 1
Matrix of Inward FDI Performance and Potential, 2000-2002

	HIGH FDI PERFORMANCE	LOW FDI PERFORMANCE
HIGH FDI POTENTIAL	*Front-runners* Bahamas, Belgium and Luxembourg, Botswana, Brazil, Brunei, Bulgaria, Canada, Chile, China, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Estonia, Finland, France, Germany, Guyana, Hong Kong, Hungary, Ireland, Israel, Jordan, Latvia, Lithuania, Malaysia, Malta, Mexico, Mongolia, Netherlands, New Zealand, Panama, Poland, Portugal, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, Trinidad and Tobago, United Kingdom, and Viet Nam.	*Below-Potential* Australia, Austria, Bahrain, Egypt, Greece, Iceland, Iran, Italy, Japan, Kuwait, Lebanon, Libya, Norway, Oman, Philippines, Qatar, Korea, Russia, Saudi Arabia, South Africa, Taiwan, Thailand, UAE, and United States.
LOW FDI POTENTIAL	*Above-Potential* Albania, Angola, Armenia, Azerbaijan, Bolivia, Colombia, Ecuador, Gambia, Georgia, Honduras, Jamaica, Kazakhstan, Mali, Morocco, Mozambique, Namibia, Nicaragua, Republic of Congo, Republic of Moldova, Sudan, TFYR Macedonia, Togo, Tunisia, Uganda and Tanzania.	*Under-Performers* Algeria, Argentina, Bangladesh, Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Democratic Republic of Congo, El Salvador, Ethiopia, Gabon, Ghana, Guatemala, Guinea, Haiti, India, Indonesia, Kenya, Kyrgyzstan, Madagascar, Malawi, Myanmar, Nepal, Niger, Nigeria, Pakistan, Papua New Guinea, Paraguay, Peru, Romania, Rwanda, Senegal, Sierra Leone, Sri Lanka, Suriname, Syria, Tajikstan, Turkey, Ukraine, Uruguay, Uzbekistan, Venezuela, Yemen, Zambia, and Zimbabwe.

Source: UNCTAD FDI Database.

Table 2: Net FDI as a Percentage of GDP in Developing Countries

Region	1996	1998	1999	2001	2002
MENA	0.35	1.27	0.25	0.79	0.34
SSA	1.57	2.01	2.47	4.40	2.19
S. Asia	0.68	0.64	0.53	0.66	0.76
E. Asia		4.1		2.88	3.17
Latin Amer./ Caribbean	2.28	3.5	5.02	3.63	2.47

Source: Computed from *World Development Indicators*, 2002.

Table 3: Net Capital Flows to Developing Countries (US $ billions)

	1990		1996	
Region	Amount	Percentage	Amount	Percentage
Latin America & the Caribbean	12.5	28.15	74.3	30.50
Middle East & North Africa	0.6	1.35	6.9	2.85
South Asia	2.2	4.95	10.7	4.41
East Asia & Pacific	19.3	43.47	108.7	44.61
Europe & Central Asia	9.5	21.40	31.2	12.80
Sub-Saharan Africa	0.3	0.68	11.8	4.84
Total	44.4	100	243.8	100

Source: World Bank (1997)

Table 4: Regional Science and Technology Indicators

Regions/Countries	GERD as % World GERD*	GERD as % of GDP	GERD per Inhabitant (PPP $)	Researchers as a % of World Total	Researchers Per Million Inhabitants	GERD Per Researcher (thousands of PPP$)
Developing Countries	15.6	0.6	20	28.4	347	57.9
Developed Countries	84.4	2.2	377	71.6	3,033	124.2
Asia	27.9	1.3	46	34.5	537	85.1
Latin America & the Caribbean	3.1	0.5	34	6.7	715	48.2
SSA (excluding Arab States)	0.5	0.3	6	1.0	113	49.1
Arab States (in Africa)	0.2	0.2	7	1.5	489	14.9
Arab States (in Asia)	0.1	0.2	11	0.1	52	211.4
Arab States (All)	0.4	0.2	8	1.6	356	23.6
China	3.9	0.6	17	10.6	454	38.3
India	2.0	0.7	11	2.8	151	75.8

*GERD stands for Gross Domestic Expenditure on Research & Development
Source: Computed from UNESCO statistics published in *The State of Science and Technology in the World,* Paris, UNESCO Institute of Statistics, 2001, p. 7.

Table 5: Total R&D Personnel by Sector of Employment, 2005

Country	Business Enterprises	Government	Higher Education	Private Non-Profit Institutions	Total	R&D personnel in Business Ent. as % Total
Algeria	-	1,225	6,106	-	7,331	0
Egypt	N/A	N/A	N/A		N/A	5.8 (1986)*
Jordan	N/A	N/A	N/A		N/A	6.7 (1985)*
Kuwait	N/A	N/A	N/A		N/A	11.7 (1984)*
Libya	N/A	N/A	N/A		N/A	18.2 (1980)*
Sudan	N/A	N/A	N/A		N/A	35.0 (1978)*
Tunisia	-	3,428	12,861	-	16,289	0
Turkey	14,993	8,825	25,436	-	49,254	30.4
Israel	40,970	-	9,011	-	49,981	82.0
China	883,130	254,506	227, 163		1,137,636	77.6
India (2001)	53,408	242,935	22,100	-	318,443	16.8
Ireland	10,338	1,132	5,220	-	16,690	61.9
Mexico	48,044	14,837	25,218	1,299	89,398	53.7
Brazil (2004)	37,542	10,479	108,182	1,392	157,595	23.8
Argentina	7,155	21,688	15,507	1,011	45,361	15.8

Source: UNESCO Statistical Database, 2008 (www.unesco.org).

* UNESCO (1992, p.143)

Table 6: Descriptive Statistics of the Explanatory Variables

	NRES	R&D	BUSR&D	OPEN	TECHEX	RISK	GDPCAP
Mean	1989.93	1.28	40.79	77.92	15.62	2.57	17,178.70
Median	1570	0.90	41.50	62.50	11.95	1.50	15,615
Maximum	7431	5.10	74.00	272.71	74.14	7.00	37148
Minimum	73.00	0.10	10.20	18.16	0.00	1.00	1624
Std. Dev.	1690.48	1.09	17.81	49.45	16.34	1.90	9695.41
Skewness	1.10	1.38	0.25	2.02	1.65	1.11	0.32

Table 7: Results From the Logit Model
Dependent Variable: Country Category

Variable	Coefficient	Std. Error	z-Statistic	Prob
Constant	2.77	1.65	1.67	0.09
NRES	-0.00022	0.00041	-0.55	0.58
R&D	0.70	0.90	0.78	0.43
BUSR&D	0.01	0.04	0.41	0.67
OPEN	0.03*	0.01	2.83	0.004
TECHEX	-0.04	0.03	-1.47	0.13
RISK	-1.05*	0.29	-3.51	0.0004
GDPCAP	-0.0001**	5.98E-05	-2.22	0.02
R-Squared	0.29		Obs.	61

*Significant at 1% **Significant at 5%

Tables 8: Correlation Matrix

	NRES	R&D	BUSR&D	OPEN	TECHEX	RISK	GDPCAP
NRES	1.0	0.8	0.6	-0.02	0.2	-0.5	0.7
R&D	0.8	1.0	0.8	-0.1	0.2	-0.4	0.7
BUSR&D	0.6	0.8	1.0	0.02	0.5	-0.5	0.6
OPEN	-0.02	-0.1	0.02	1.0	0.3	0.09	0.02
TECHEX	0.2	0.2	0.5	0.3	1.0	-0.2	0.2
RISK	-0.5	-0.4	-0.5	0.09	-0.2	1.0	-0.5
GDPCAP	0.7	0.7	0.6	0.02	0.2	-0.5	1.0

Table 9: Dependent Variable: FDI/GDP

Variable	Coefficient	Std. Error	t-Statistic	P-Value
Constant	4.21	3.45	1.21	0.23
NRES	4.1E-05	0.0005	0.07	0.94
R&D	-0.92	1.01	-0.91	0.37
BUSR&D	0.02	0.06	0.37	0.71
OPEN	0.04*	0.01	3.67	0.0006
TECHEX	-0.05	0.04	-1.11	0.27
RISK	-0.83**	0.37	-2.28	0.03
GDPCAP	7.7E-06	8.61E-05	0.09	0.93
HUMCAP	-0.12	0.46	-0.26	0.80
R-Squared	0.29		Obs.	61
Adjusted R-Squared	0.18			

*Significant at 1% **Significant at 5%

Table 10: Trade Protection Indicators for MENA and Selected Regions
(Most recent year in late 1990s)

Country/Region	Simple Average (percent)	Weighted Average (percent)	Standard Deviation (percent)	NTB Coverage (percent)	Aggregate Measures		
					Sharer	Oliva	AN
MENA	22.3	17.1	30.1	15.9	6.1	22.8	20.7
Europe & Central Asia	9.8	6.7	11.0	10.9	3.5	10.4	11.6
East Asia	13.1	8.7	16.8	9.9	3.9	13.2	11.3
Latin America	13.1	11.9	8.5	17.1	3.6	12.9	14.7
Sub-Saharan Africa	17.7	14.2	13.3	4.5	3.8	13.1	18.9
South Asia	19.7	18.8	11.7	8.2	4.2	14.6	27.7

Source: Srinivasan (2002, p.9).

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