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## Openness and Human Capital as Sources of Productivity Growth : An Empirical Investigation from the MENA Countries

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# **Openness and Human Capital as Sources of Productivity Growth: An Empirical Investigation from the MENA Countries**

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## ABSTRACT

### **Openness and Human Capital as Sources of Productivity Growth: An Empirical Investigation from the MENA Countries**

This paper investigates the impact of openness to trade and higher levels of human capital on the economies of some MENA countries. To answer the question: whether either human capital or openness can be shown to cause productivity, we use panel data on 16 countries spanning the 1965-2000 period. Controlling for fixed effects as well as endogeneity, the results show a significant impact of openness on productivity growth. We find also an effect, significant at the ten per cent level, of the level of human capital on the level of income but no effect on underlying productivity growth. Our preferred estimator combines high and low frequency differences of the data. We discuss reasons why this estimator is well suited for empirical analysis of economic growth.

JEL Classification: F43, O11, O53

Keywords: productivity, openness, human capital, growth, panel data, MENA countries

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## 1. INTRODUCTION

Growth performances vary across countries and regions. The determinants of growth are not unique for all countries to such variations. The growth pattern is linked to characteristics of countries such as economic base, population growth, unemployment rate, and investment in physical and human capital, flow of foreign investment, industrial growth, inflation, and development of financial institutions.

Much of the large literature on growth stemming from the work of Barro (1991, 1997) has focused on some measure of human capital as a determinant of growth. However, as noted by Temple (2001, p.905), “the empirical evidence that education matters for growth is surprisingly mixed”. Pritchett (1999) shows that variation in the change in average schooling plays little role in explaining cross-country variation in growth rates. In contrast Gemmell (1996) finds both the levels of human capital and their growth rates to be important in explaining growth. Benhabib and Spiegel (1994) investigate whether education influences rates of technological progress and Temple (1999a) shows that their inability to produce a significant coefficient on human capital may be due to the influence of outliers. Temple (2001) revisits the data and for two of his empirical investigations concludes that it is hard to reject the Pritchett view that large investments in education have yielded a very small pay-off in developing countries. Pritchett is not alone. Bils and Klenow (2000) ask if the observed correlation between school enrolments in 1960 and growth over period from 1960 to 1990 can be interpreted as causal. They argue that it cannot.

The evidence relating trade to growth has been equally contentious. Dollar (1992), Sachs and Warner (1995), Edwards (1998), Frankel and Romer (1999), Irwin and Terviö (2002) and Greenaway et al. (2002) all argue that trade, or trade reform, is an important determinant of differences in either incomes or growth. Krugman (1994), Rodrik (1995) and Rodriguez and Rodrik (1999) question whether much of the empirical evidence is convincing.

Our objective in this paper is to test whether human capital and trade impact causally on the rate of technological progress of some MENA countries. That they do is a key implication of several versions of endogenous growth theory. One obvious difficulty we are faced with in this investigation is that human capital and trade are likely to be endogenous. The two most common ways of attempting to deal with endogeneity in the context of growth equations is instrumental variable estimation and panel data methods. Finding valid instruments for growth regressions is a difficult task (see Durlauf and Quah, 1999, pp. 281-3). Krueger and Lindahl (2001) focus on measurement errors in the cross-country education data as one possible source of bias, but do not address other forms of endogeneity arising due to, for instance, unobserved labour quality. As recognised by these authors, the practice common in the microeconomic literature for forming instruments based on natural experiments does not carry over easily to macro equations. In the trade literature, Frankel and Romer (1999) and Irwin and Terviö (2002) use measures of countries’ geographical characteristics as instruments for trade share. Durlauf and Quah (1999, p. 281) criticise this procedure, arguing that geographical characteristics may be correlated with factors omitted from the income equation, in which case the instrumental variable approach breaks down.

If the endogeneity is such that the part of the residual that is correlated with the explanatory variables is constant over time within countries, then standard panel data estimators such as the within or the differenced estimator are attractive (Harrison, 1996; Milner and Upadhyay, 2000). If the time varying part of the error term is correlated with the regressors, then there

remains an endogeneity problem even with controls for fixed effects. This is recognised by Caselli et al. (1996), Bond et al. (2001), Hoeffler (2002) and Beck (2002) who estimate growth equations using instrumental variable estimators for panel data. Panel data methods, however, have problems of their own, as discussed by Barro (1997, pp. 36-42) and Temple (1999b, p. 132). There is much empirical evidence that the use of differencing can take away by the increase in measurement error what is gained in terms of eliminating fixed effects. Further, even if measurement error bias is a negligible problem, the differencing procedure is often associated with a considerable efficiency loss.

Our basic model is a production differenced over five year intervals. We estimate the parameters of the model using an instrumental variable estimator that allows for unobserved heterogeneity across countries in underlying rates of technological progress and other forms of endogeneity. Our preferred econometric results are based on an estimator proposed by Griliches and Hausman (1986), which combines high and low frequency differences of the data. We argue that this estimator is well suited for empirical analysis of economic growth. The remainder of the paper is structured as follows. The next section outlines the growth, human capital and openness patterns in the MENA region. Section 3 presents the analytical framework and how we propose to model the growth rate. Section 4 discusses the sources of data. Section 5 presents the results for a growth equation. A final section concludes.

## **2. GROWTH, HUMAN CAPITAL AND OPENNESS PATTERNS IN THE MENA COUNTRIES**

Over the last two decades economic growth in the Middle East and North Africa (MENA) region has been weak (Table 1)<sup>1</sup>. Between 1980 and 2000, real per capita GDP in the MENA region stagnated, compared to average annual growth of 4.1 percent in East Asia and 0.3 percent in all other developing countries over the same period. The MENA region's poor growth performance during the 1980s and 1990s also contrasts sharply with the 1970s, when annual per capita GDP growth averaged 2.3 percent, exceeding that of other developing countries (excluding East Asia) by nearly two-thirds of a percentage point. The lack of growth has been a cause of concern to policymakers because it exacerbates the problems posed by the generally high unemployment rates and the relatively strong labor force growth in the region.

Drawing on the evidence in the empirical growth literature, recent studies have identified a diverse set of potential structural causes behind the poor growth performance in the MENA region<sup>2</sup>. Dasgupta, Keller, and Srinivasan (2002) suggest that the MENA region lags behind other regions in macroeconomic and trade reforms. Sala-i-Martin and Artadi (2002) argue that while the level of investment in the region has remained high by international and historical standards, too large a fraction of this overall investment has been unproductive public investment. In addition, they assert that private investment has been held back by political instability, excessive government intervention, protection and regulation, and inadequate human capital. Abed (2003) attributes the region's weak growth to five key structural factors: weak institutions, dominance of the public sector, underdeveloped financial markets, highly restrictive trade regimes, and inappropriate exchange rate regimes.

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<sup>1</sup> Taken from Hakura (2004). Her paper defines the MENA region as including: Algeria, Bahrain, Egypt, the Islamic Republic of Iran, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, the United Arab Emirates, and Yemen. See Data Appendix for the definitions of the GCC, other oil, and non-oil MENA country groups.

<sup>2</sup> Earlier studies include IMF (1996), Alonso-Gamo, Fedelino, and Paris Horvitz (1997), and Page (1998).

The MENA region's overall weak growth during the 1980s and 1990s primarily reflects the poor performance of the oil-exporting countries. The GCC countries (members of the cooperation council of Arab states of the Gulf) experienced a contraction of real per capita GDP by 1.1 percent per year on average between 1980 and 2000. In the other MENA oil countries the decline averaged 1.2 percent per annum over the same period. By contrast, in the non-oil MENA countries per capita GDP increased on average by 1.4 percent per year. However, while growth in non-oil MENA countries exceeded that of other developing countries excluding east Asia, it fell well short of what was needed to avoid a sustained rise in unemployment given these countries' relatively strong growth of the labor force<sup>3</sup>.

Using a broader measure of trade integration- including nonfactor service trade as a share of GDP, in contrast to using only merchandise trade- shows an increase in openness for all regions since the late 1980s or early 1990s, except for MENA (Nabli and De Kleine, 2000). In other words, both goods and services trade integration in MENA has deteriorated. After a period of continuous declines in the early 1980s, the MENA region did witness an increase in integration in the mid-1980s, much of which it lost after the Gulf War.

The performance by country within the MENA region varies. Largely reflecting the impact of civil strife and /or regional conflict, trade volume ratios for Algeria, Syria, Kuwait, Iran, and Iraq show stark downward trends. Bahrain and Egypt's ratios have also deteriorated markedly. Morocco, Tunisia, Saudi Arabia, the UAE, and Jordan have, in contrast, expanded real goods and services trade as a share of national output. Morocco, Tunisia, and Jordan have reaped these gains in large part as a result of market reforms introduced in the 1980s and early 1990s. In the case of Saudi Arabia, expansion of trade integration stems in part from significantly increased petroleum export volume following the sanctions imposed on Iraq in 1990. The UAE's growth in integration are due to its greatly expanded port and free trade zone activity.

Human capital is generated by formal education and formal training as well as by informal learning mechanisms. Each time someone develops the ability to do something new; he or she increases his or her human capital. Of course, measuring human capital in its full dimension is an impossible task. For this reason, the literature usually confines itself to measuring the years of schooling in the working population and using the outcome as a proxy for all human capital in the country.

The MENA region is home to 130 million children who constitute 50 percent of the population (World bank, 2004). Most governments have made tremendous strides toward extending access to basic education to all children. Nevertheless, the region is characterized by great variation. For example, Egypt, Jordan, and Tunisia have achieved near universal enrollment. NERs amongst primary school aged children have increased significantly in Morocco in recent years, from 65% in 1997/98 to 92% in 2002/2003. In 2001, at the start of a Bank-supported operation in Djibouti, the Gross Enrollment Rate (GER) for primary education was 39%. In less than 3 years of project implementation, the GER has increased to 52%. In Yemen, net primary enrollments for boys and girls, at 65% and 41% are amongst the

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<sup>3</sup> See, for example, Gardner (2003) and Keller and Nabli (2002). The latter study shows that, in the 1990s, in Jordan, Morocco, and Yemen the labor force grew faster than employment, resulting in the current high unemployment rates of about 20 percent on average in these three countries; and in Egypt and Tunisia, employment grew at about the same pace as the labor force, keeping the unemployment rates at about 13 percent on average. Keller and Nabli also show that the problem of labor force growth exceeding employment growth resulting in high unemployment rates is present in other MENA countries as well.

lowest in the world and 40% of children of basic education age are still out of school. The situation is worse in rural areas with a 30% female enrollment rate. Recognizing the importance of achieving universal enrollments, the Government of Yemen developed a basic education strategy in a model participatory manner in 2002. After receiving endorsement from the international donor community for its strategy under the Education For All Fast Track Initiative (EFA FTI) in March 2003, Yemen was among the first group of countries to be awarded additional financing under the EFA FTI Catalytic Fund.

### 3. EMPIRICAL MODEL AND ESTIMATION

The starting point for our analysis is the Cobb-Douglas production function common in the literature:

$$[1] \quad \ln Y_{it} = \ln A_{it} + \alpha \ln K_{it} + \beta \ln L_{it},$$

where  $i, t$  denote country and time period, respectively,  $Y$  is real income,  $K$  is physical capital,  $A$  is technology,  $L$  is the number of workers and  $\alpha$  et  $\beta$  are technology parameters. Drawing on theories of endogenous growth we hypothesise that technological progress, defined as  $g_{it} \equiv \Delta \ln A_{it}$ , is driven by openness, the average level of human capital, a set of unobserved country specific and time invariant characteristics captured by a fixed effect  $\mu_i$ , and a set of time varying factors represented by a residual  $v_{it}$ :

$$[2] \quad g_{it} = \omega_1 \cdot \Delta T_{it} + \omega_2 \cdot T_{i,t-1} + \omega_3 \cdot \Delta h_{it} + \omega_4 \cdot h_{i,t-1} + \mu_i + v_{it},$$

where  $T_{it}$  denotes openness,  $h_{it}$  is the average years of education and  $\omega_1 - \omega_4$  are coefficients<sup>4</sup>. We allow both the changes and the levels of openness and human capital to affect technological progress. Given that  $g_{it}$  is a growth rate, the coefficients on  $\Delta T_{it}$  and  $\Delta h_{it}$  are interpretable as effects of openness and human capital on the *level* of technology. The coefficients on  $T_{it}$  and  $h_{it}$ , on the other hand, are interpretable as effects of openness and human capital on the *growth* of technology. Specified in this way, a permanent change in the trade share or human capital will have a permanent effect on the growth rate, while a temporary change will have a temporary effect on the growth rate but a permanent effect on income. Taking first differences of the production function [1] and rewriting the equation in per capita terms yields

$$[3] \quad \begin{aligned} \Delta \ln(Y/L)_{it} = & \alpha \cdot \Delta \ln(K/L)_{it} + (1 - \alpha - \beta) \cdot \Delta \ln L_{it} + \omega_1 \cdot \Delta T_{it} + \omega_2 \cdot T_{i,t-1} + \omega_3 \cdot \Delta h_{it} \\ & + \omega_4 \cdot h_{i,t-1} + \mu_i + v_{it} \end{aligned}$$

This specification forms the basis for our empirical analysis. Before turning to estimation issues we discuss alternative approaches for modelling growth. Our purpose here is not to review the large empirical growth literature (see Durlauf and Quah, 1999, and Temple, 1999b,

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<sup>4</sup> Feenstra (2003) provides an exposition of how trade can have endogenous growth effects (see also Krugman, 1987; Rodrik, 1988, 1991; Grossman and Helpman, 1991). Lucas (1988) and Romer (1990) discuss the roles of human capital for endogenous growth.

for excellent surveys), but rather to establish how our empirical framework links to previous work in the area.

### 3.1. Alternative Models of Growth

The most widely used framework for analysing growth is the Solow (1956) model, and an often-cited paper adopting this framework is that by Mankiw et al. (1992). Under the assumptions that the production function is

$$\ln Y_{it} = \gamma_1 \ln(AL)_{it} + \gamma_2 \ln(hL)_{it} + (1 - \gamma_1 - \gamma_2) \ln K_{it},$$

that the depreciation rate for physical and human capital is constant both over time and across countries at  $\theta$ , and that the rate of technological progress is exogenous and constant across countries and over time, Mankiw et al. derive a convergence equation of the following form:

$$\begin{aligned} \ln \frac{Y_{it}}{L_{it}} - \ln \frac{Y_{i,t-1}}{L_{i,t-1}} = & \theta \ln A_{i0} + g \cdot (t - (t-1)e^{-\lambda}) - \theta \cdot \ln \frac{Y_{i,t-1}}{L_{i,t-1}} + \theta \frac{\gamma_1}{1 - \gamma_1 - \gamma_2} \ln s_{it}^k \\ & + \theta \frac{\gamma_2}{1 - \gamma_1 - \gamma_2} \ln s_{it}^h - \theta \frac{\gamma_1 + \gamma_2}{1 - \gamma_1 - \gamma_2} \ln(\delta + n_{it} + g), \end{aligned}$$

where  $s_{it}^k$  and  $s_{it}^h$  are the savings rates for physical and human capital,  $n$  is the growth rate of  $L$ ,  $\theta = 1 - e^{-\lambda}$  and  $\lambda = (n + g + d)(1 - \gamma_1 - \gamma_2)$  is the rate of convergence to the steady state<sup>5</sup>. In this model the productive effect of human capital is reflected in the coefficient on  $\ln s_{it}^h$ .

Some economists focus on identifying the factors driving international differences in initial technology, and rewrite  $\ln A_{i0}$  as a function of explanatory variables. This is known as the ‘augmented cross-section’ approach (Durlauf and Quah, 1999). Levine and Renelt (1992) consider measures of trade, or trade policy, as arguments of  $\ln A_{i0}$ . Other authors treat  $\ln A_{i0}$  as an unobserved country specific effect and use panel data techniques to estimate the parameters of the model (Caselli et al., 1996; Bond et al., 2001; Hoeffler, 2002).

There are two reasons why we choose not to rely on the Solow model. First, because the model is derived under the assumption that technological progress is exogenous and constant it does not constitute a natural framework for the analysis of long run productivity growth effects of the kind implied by endogenous growth models. Second, because data on factor inputs are available (see Section 4) one may just as well estimate the production function directly (Temple, 1999b, pp. 124-25). Relying on the Solow model identifies no new parameters.

Some economists eschew the use of both the Solow framework and the differenced production function approach in favour of more parsimonious specifications. Analysing the effect of schooling on growth, Krueger and Lindahl (2001) argue that the inclusion of physical capital in the regression aggravates measurement error bias to such an extent as to

<sup>5</sup> Following Durlauf and Quah (1999), and unlike Mankiw et al., we write the convergence equation assuming panel data are available.

outweigh the reduction in omitted variable bias. They conclude that ‘...unless measurement error problems in schooling are overcome, we doubt the cross-country growth equations that control for capital growth will be very informative insofar as the benefit of education is concerned.’ (Krueger and Lindahl, 2001, p. 1126). Analysing the effects of trade on income, Frankel and Romer (1999) model per capita income solely as a function of trade, population and land area. The authors acknowledge that there are many other variables that may affect income, but argue that ‘...if we included other variables, the estimates of trade’s impact on income would leave out any effects operating through its impact on these variables. Suppose, for example, that increased trade (...) increases the saving rate. Then by including the saving rate in the regression, we would be omitting trade’s impact on income that operates via saving.’ (Frankel and Romer, 1999, p. 386). However, because the theoretical prediction that we wish to test for is whether human capital and trade have causal effects on *technological progress*, as distinct from overall effects on income levels or growth rates, for our purposes it is necessary to control for the factor inputs of the production function.

### 3.2. Estimation

In estimating the differenced production function [3] we are faced with the potential problem that the explanatory variables are endogenous, that is correlated with  $\mu_i + \nu_i$ , the unobserved part of the equation. For instance, high values of  $\mu_i + \nu_i$  imply a high marginal product of capital and may therefore be associated with high physical capital investment. As a first step towards dealing with endogeneity we eliminate the time invariant component of the error term by differencing [3], yielding a double-differenced equation. Rather than limiting ourselves to high frequency (that is short) differences, we consider different orders of differences of the growth equation:

$$[4] \quad \Delta_s \Delta_1 \ln(Y/L)_{it} = \alpha \cdot \Delta_s \Delta_1 \ln(K/L)_{it} + (1 - \alpha - \beta) \cdot \Delta_s \Delta_1 \ln L_{it} + \omega_1 \cdot \Delta_s \Delta_1 T_{it} \\ + \omega_2 \cdot \Delta_s T_{i,t-1} + \omega_3 \cdot \Delta_s \Delta_1 h_{it} + \omega_4 \cdot \Delta_s \Delta_1 h_{i,t-1} + \Delta_s \nu_{it},$$

$s = 1, 2, \dots, S$ , where  $\Delta_s \chi_{it} \equiv \chi_{it} - \chi_{i,t-s}$ . Thus, [4] is a system of  $S$  first differenced growth equations,  $S-1$  second differenced growth equations, and so on up to one differenced growth equation with order of differencing equal to  $S$ . We estimate the equations of the system simultaneously, and therefore refer to the model as a difference combinations (DCOMB) estimator.

If the time varying residual,  $\nu_{it}$ , is correlated with the regressors, we need to use instruments to obtain consistent estimates. Following Griliches and Hausman (1986) we adopted a generalised method of moments (GMM; Hansen, 1982) framework. Provided there is no non-contemporaneous correlation between the regressors and the error term  $\nu_{it}$ , the explanatory variables in levels and first differences dated  $t-2$  or earlier are potential instruments for first differenced equations ( $\Delta_1 \chi_{it}$ ). For the longer differenced equations  $\Delta_s \chi_{it}$ ,  $s = 2, 3, \dots, S$ , potential instruments are the explanatory in levels and first differences prior to  $t-s$ , and lags dated between  $t-s$  and  $t$ . Any non-contemporaneous correlation between the regressors and the error term  $\nu_{it}$ , perhaps caused by serial correlation of  $\nu_{it}$ , would limit the set of potential instruments considerably. Standard tests for the validity of the overidentifying restrictions

shed some light on whether instruments are orthogonal to the equation residual<sup>6</sup>. For more details on the GMM estimator, see Appendix 1<sup>7</sup>.

There are two potential advantages of exploiting the information in the longer differences  $s = 2, \dots, S$ . First, there may be gains in efficiency since long differences are likely to exhibit a higher sample variance than short differences<sup>8</sup>. Second, attenuation bias caused by measurement errors will be less severe if, which seems likely, the serial correlation in these errors is lower than that of the explanatory variables<sup>9</sup>. These are potentially important advantages, as lack of efficiency and severe attenuation bias are common problems in standard panel data applications. For instance, Barro (1997, pp.36-42) thinks these problems are so severe as to make the cross-sectional results preferable to first-difference ones when estimating convergence equations<sup>10</sup>.

#### 4. THE DATA

We follow Miller and Upadhyay (2000) in combining data from the PENN World Tables (Heston et al., 2002) for income and the Barro and Lee (2000) data set on human capital. Our only data innovation is the creation of a physical capital stock measure where we follow the methods proposed by Klenow and Rodríguez-Clare (1997), see Appendix 2. Using the most recent versions of these data sets it is possible to obtain a set of 16 countries for which there is information on output and human and physical capital inputs every five years from 1965 to 2000, giving us up to eight observations on each of the 16 countries (the countries included are given in Appendix 3). Table 2 shows the key variables on which we will focus averaged across regions for the years 1965 and 2000, Table 3 gives means for the whole sample to be used in the regressions reported below.

The key facts shown by the data are well known. Openness as measured in the PWT data as the shares of export and imports in GDP grew from an average of 57.54 to 78.78 per cent over the period 1965 to 2000. The average levels of openness differ markedly across regions and some authors have allowed for this by seeking to purge the trade share variable of the time invariant dimension of openness. Our procedure is to allow for fixed effects in the growth rate equation which will allow for those aspects of economic structure which cause small economies to have a higher trade share. Thus our method of estimation exploits the changes in

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<sup>6</sup> The procedure outlined here of using different instrument sets for different equations has long been used for estimating dynamic panel data models (Arellano and Bond, 1991). It is likely that for some of the equations in [4] only a small number of instruments are available while for other equations the instrument set is richer, and clearly the more instruments that can be exploited, the more efficient is the estimator.

<sup>7</sup> An alternative instrumental variable panel data model that has become increasingly popular in recent years is the system GMM estimator developed by Blundell and Bond (1998). This involves forming a two-equation system consisting of the first differenced equation and the original levels equation, and estimating the two equations simultaneously, subject to appropriate cross-equation restrictions that constrain the coefficient vectors in the two equations to be identical. Typically, lagged levels are used as instruments for contemporaneous differences and lagged differences are used as instruments for contemporaneous levels. Monte Carlo experiments reported by Blundell and Bond (1998) indicate that the system GMM estimator performs much better than the standard first differenced GMM estimator when the data are highly persistent. In the empirical growth literature the system GMM estimator has been used by Hoeffler (2002) and Beck (2002).

<sup>8</sup> Whether or not there will be such efficiency gains hinges, *inter alia*, on the degree of serial correlation in the regressors relative to that of the error term. Notice that if the error term  $\nu_{it}$  is serially uncorrelated and homoskedastic then the variance of differences of  $\nu_{it}$  will not vary with the order of differencing.

<sup>9</sup> See for instance Krueger and Lindahl (2001, p. 1115) for a derivation of this result and a discussion of the role of measurement errors in the context of estimating the effects of schooling on growth.

<sup>10</sup> Similar estimation problems have been encountered in the literature on production function estimation based on micro data (Griliches and Mairesse, 1997; Blundell and Bond, 2000).

the trade share to establish if these had an effect of the changes in underlying productivity growth. Human capital as measured in Barro and Lee (2000) as the average years of schooling in the population aged over 15.

## 5. EMPIRICAL ANALYSIS

### 5.1. Levels results

In this section we present our empirical results. We begin by showing that our data can give similar results to that based on previous work exploiting only the cross sectional dimensions of the data. Table 4 column [1] is a regression of the log of per capita income on the trade share, the log of population and a constant using data for 1985. This specification is similar to that adopted by Frankel and Romer (1999), Table 3, columns 1 and 3, p. 387<sup>11</sup>. Our results are in line with theirs. The estimated coefficient on the trade share is equal to 0.56, and highly significant, and the population coefficient is positive although not significant at conventional levels. The point estimate of 0.56 on the trade share implies that a one percentage point increase in the trade share results in an increase in per capita income of about 0.6 per cent. This is a very large effect indeed

In Column [2] we add to the model the log of the capital-labour ratio and the average years of education in the population over 15 years of age. As a result the trade coefficient gets very close to zero and is far from significant. This is primarily driven by the capital-labour ratio, however the capital-labour coefficient is most likely upward biased. Capital's share in most countries is about 0.3 (Krueger and Lindahl, 2001), so if the technology is Cobb-Douglas and factor markets are competitive the coefficient on the capital-labour ratio in the income equation should equal its share. We obtain a point estimate of 0.46, which is not atypical compared to similar studies (for example, Harrison, 1996) but clearly a long way from 0.3. The conventional explanation for this discrepancy is that capital is endogenous, and clearly the openness coefficient could be downward biased as a result. The estimated coefficient on education in this regression is 0.07 and significant at the ten per cent level.

In Columns [3]-[6] we report regressions based on the panel of observations spanning every fifth year during the 1965-2000 period for 16 countries. Columns [3]-[4] show the same specifications as columns [1]-[2] and the results are largely consistent across the respective models. In column [5]-[6] we consider the effects of using the log of the trade share rather than the level. We do so because that the distribution of the trade share is highly skewed to the right, and because it is possible that a given change in the trade share may matter more at relatively low shares. The estimated coefficient on the log of the trade share in column [5], interpretable as an elasticity, is 0.38 and highly significant. As before, when we include education and the capital-labour ratio in the model, column [6], the openness coefficient becomes very small and insignificant. The estimated education coefficient is 0.07 and significant. Testing for the presence of unobserved country effects using the method proposed by Wooldridge (2002), pp. 264-5, we reject in all cases at the one per cent level of significance the null hypothesis that there are no unobserved country effects.

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<sup>11</sup> The only difference compared to Frankel and Romer is that we do not include a measure of country area as an explanatory variable. It is noted that the coefficient on country area is not significant in the regressions reported by Frankel and Romer.

## 5.2. Growth results

Our investigation thus far confirms that the capital-labour ratio is highly correlated with per capita income and that there is strong evidence for unobserved country effects. Because the estimated coefficients on the capital-labour ratio are most likely upward biased we do not interpret the regression results in Table 4 as reflecting causal mechanisms. In Table 5 we probe the data further in order to assess the evidence on the causal effects of openness and human capital. We begin by estimating the differenced production function [3]. Results, reported in column [1], are similar to the previous regressions in that the capital coefficient is about 0.3 and that the trade effect is insignificant, and different in that the estimated human capital levels effect is 0.015. There is no evidence of growth effects from either openness or human capital, as measured by the coefficients on the levels terms. Further, the test for presence of country effects suggests there is unobserved heterogeneity across countries in the underlying growth rates.

In column [2] we report fixed effects results, obtained by means of the standard within estimator. Rather surprisingly controlling for fixed effects has virtually no effect on the point estimate of the capital coefficient. The coefficient on the lagged trade share, however, increases dramatically in size and is now significant at the five per cent level. We interpret this as evidence that trade share *levels* vary across countries partly for reasons that have little to do with aspects of openness conducive to productivity growth. The point estimate on education collapses both in size and significance, and there is no evidence for a growth effect of lagged education. The country fixed effects are jointly significant at the one per cent level.

In columns [3]-[6] we treat the capital-labour ratio as endogenous and combine short and long differences of the data to form the GMM difference combinations estimator discussed in Section 3. In column [3] the remaining regressors in the model are treated as exogenous. As a result of allowing for the endogeneity of the capital-labour variable, the associated estimate of the coefficient shrinks to 0.28. This is a much more plausible estimate of the capital-labour coefficient for reasons already discussed. The coefficient on lagged trade share rises marginally to 0.03 and is now significant at the five per cent level. It thus seems the upward bias in the capital coefficient obtained in previous regression was accompanied by a downward (but moderate) bias in the openness coefficient. Recall that the latter coefficient is interpretable as the effect of the *level* of openness on the growth of productivity. In contrast, the coefficient on the contemporaneous difference of openness, interpretable as the effect of the level openness on the level of income, is small and insignificant and so are the human capital coefficients.

In column [4] we allow for endogeneity of the trade and the human capital variables. As expected this reduces the  $t$ -value associated with the lagged openness coefficient, but there is virtually no change in the point estimate. The coefficient on the contemporaneous difference of openness collapses from 0.02 with a  $t$ -statistic of 0.97 to 0.004 with a  $t$ -statistic of 0.03, which suggests there may be some contemporaneous correlation between openness and the residual. The two education coefficients are now negative but neither has a  $t$ -value larger than one so too much should not be made of this. There is a marginal increase in the estimated capital coefficient but at 0.3 it is still much lower than what we obtained when capital was assumed exogenous.

The human capital coefficients have been insignificant in all our specifications that control for fixed effects. We proceed by dropping the lagged education term in order to see if we can

obtain a precisely estimated coefficient on the change of human capital, reflecting a levels effect. Results are reported in columns [5]-[6] and the coefficients on openness and the capital-labour ratio are much the same as in columns [3]-[4] so we focus on the human capital coefficient here. In column [5] we treat the capital-labour ratio as endogenous and the remaining explanatory variables as exogenous. The resulting coefficient on human capital is 0.012 and significant at the ten per cent level. The implication of the point estimate is that a one year increase in education raises income by 1.2 per cent, which is a small effect. It is possible that the total effect on growth is considerably larger if human capital impacts positively on physical capital. This would not be interpretable as a productivity effect, which is what we are looking for. Further, some part of the productive effects of human capital is probably absorbed by the country fixed effects. However the human capital coefficient is relatively low in column [1], where there are no controls for fixed effects, so it appears the correlation between the fixed effects and human capital is not overly strong. In column [6] we allow for endogeneity in the openness and human capital variables. As a result the human capital coefficient collapses to  $-0.008$  and is far from significant.

One possible reason the expansion in education has not had the expected growth effect at the macro level is that schools might be a very poor quality. While it is certainly true that greater attention needs to be given to school quality, there are two arguments against this being the reason for education's smaller than expected contribution to output growth.

First, there is some direct micro evidence from MENA countries about the magnitude of learning. Unlike some countries where the answers on tests of school children appear no better than random children do appear to have learned something. There is evidence both from Morocco (Lavy, Khandker and Filmer, 1995) and Egypt (Hanushek and Lavy, 1995) about the magnitude of achievement gains per year of schooling. These gains, while not overwhelming, are significant and positive. Second, there are differences across individuals in non-market outcomes by level of education that would be difficult to explain if schooling were so poor that little or nothing was learned. A third possible argument against the explanation of low growth impact of education on the basis of low quality is that there is an observed wage increment at the individual level, individuals with more schooling do make more money. If quality was so low that individuals learned little or nothing from school, then why would the market be rewarding schooling with higher wages?

## **6. CONCLUSION**

The question posed by this paper is whether either human capital or openness can be shown to cause productivity growth. We have posed this question by using a growth equation which can be derived directly from the production function and our assumptions as to the determinants of technical change. The advantage of such an approach is that it is possible to model the determinants of technical progress controlling for time invariant but country specific factors. We have used a panel to create the possibility of using past values of the variables as instruments for both physical and human capital and openness.

The use of panel data estimation techniques has proved problematic in previous studies. If differencing is used to remove fixed effects, and endogeneity is allowed for by instruments, a common finding has been that the resulting parameter estimates have large standard errors. The reasons for this are well understood. The importance of measurement error increases with differencing so there is no assurance that estimates that allow for fixed effects are an improvement on those that do not. We have used an estimator developed by Griliches and Hausman (1986) which addresses this issue by allowing information on different levels of

differences to be combined. In the context of this paper, where we wish to distinguish between the roles of human capital and openness on both the growth and the level of income allowing for the possibility of fixed effects in underlying growth rates, this estimator has great appeal.

Proceeding by estimating a growth rate equation and allowing for both fixed effects and the endogeneity of the variables we find that greater openness causes faster rates of productivity growth. If the level of openness of an economy is doubled the underlying rate of technical progress will increase by 0.6 per cent per annum. We find no evidence, using these estimators, that human capital has any effect on productivity growth. Human capital has a small, and not statistically significant causal effect, on the level of output. Further, the results suggest that by exploiting the information in long differences we obtain large efficiency gains and considerable reduction in the attenuation biases caused by measurement errors. We would therefore argue that the DCOMB estimator used in this paper is a useful empirical tool for researchers in this area. These results suggest that the growth pay-off of education in the MENA countries depends critically on the economic environment in which the more educated labor is employed and the adaptation of education to the changing demands of the economy. Indeed, under the previous economic strategy of development, many educated worker demanded and received higher wages in the government sector. These wages did not reflect either higher productivity of the worker or the contribution of increased government employment to growth. Also, quality of education, not quantity, is the key to creating human capital. So the quality of education must be continually improved if MENA countries are to enjoy dynamic gains in productivity.

By being explicit as to the differing roles of trade on the level of income and underlying growth rates we have also been able to investigate the respective roles of technical progress and factor accumulation in growth. The analysis implies that time invariant differences in productivity growth are an important factor in determining differences in growth rates across countries. Models such as many specifications of the Solow model which assume this rate to be constant cross countries may be misleading in any analysis of the determinants of growth. Clearly the results leave open the question as to what determines the growth of physical capital. While we have allowed for its endogeneity in the growth process we may well be understating the role of either human capital or openness in so far as these variables affect investment in physical capital. We would argue that capturing the full effects of human capital and trade requires models of growth which allow for the importance of fixed effects in growth rate equations and do not ignore this important source of heterogeneity in cross country outcomes.

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Table 1. Regional Comparison of Growth and Growth Determinants:  
 MENA Subgroups Compared with Other Developing Countries, 1980–2000 1/

	All MENA countries	GCC countries	Other MENA oil countries	Non-oil MENA countries	East Asia excluding E. Asia	Developing countries
Real per capita GDP growth (in percent)	0.0	-1.1	-1.2	1.4	4.1	0.3
Institutional quality (index) 2/	6.5	6.9	6.1	6.2	7.3	5.6
Institutional quality 2 (index) 3/	7.0	7.4	6.5	6.7	8.1	6.4
Government stability	7.7	7.7	7.5	7.9	7.7	6.6
Control of corruption	5.6	5.2	6.5	5.5	6.1	5.4
Bureaucracy quality	5.6	6.5	4.6	5.3	7.6	4.9
Law and order	7.2	8.4	5.8	6.7	7.6	5.6
Internal conflict	8.1	8.8	7.0	8.0	9.5	7.4
External conflict	8.3	8.7	8.0	8.0	10.1	9.2
Trade (imports and exports in percent of GDP)	77.5	113.6	33.4	66.1	110.0	61.6
Qualitative trade restrictiveness index 4/	5.7	2.6	8.8	7.0	3.9	4.4
Qualitative tariff assessment 4/	3.0	1.1	4.6	3.9	1.7	2.6
Qualitative nontariff barrier assessment 4/	1.9	1.5	2.5	2.1	1.8	1.6
Terms of trade volatility 5/	18.4	23.0	26.3	11.0	6.6	13.7
Inflation rate	7.5	2.1	15.9	8.4	6.6	24.4
Real exchange rate overvaluation (index) 6/	113.5	97.1	154.3	117.0	87.3	119.0
Government consumption (in percent of GDP)	20.8	25.8	15.6	17.7	12.4	13.5
Growth of economically active population minus total population growth (in percent)	0.5	0.3	0.9	0.6	0.6	0.3
Initial income, 1980 (log of per capita PPP GDP)	8.3	9.4	8.5	7.4	7.5	7.2
Secondary education enrollment ratios, 1980 7/	48.2	50.6	50.3	44.7	45.7	30.6

1/ Simple averages across countries over the 1980–2000 period, except initial income and secondary education enrollment for which the value in 1980 is shown.

2/ The institutional quality index is an average of bureaucratic quality, control of corruption, government stability, and rule of law indicators reported in the International Country Risk Guide. Each component ranges from 0 to 12, where higher values indicate stronger quality institutions.

3/ The institutional quality 2 index is an average of bureaucratic quality, control of corruption, government stability, rule of law indicators, internal and external conflicts. Each component ranges from 0 to 12, where higher values indicate stronger quality institutions.

4/ The tariff and nontariff barrier assessments range from 0 to 5, where a higher number represents a more restrictive trade regime. The overall restrictiveness index is the sum of the two components.

5/ Terms of trade volatility is the standard deviation of the annual percentage change in the overall terms of trade.

6/ A value of the index above (below) 100 indicates that the real effective exchange rate was above (below) its equilibrium value and hence that the currency was on average overvalued (undervalued) during the period.

7/ Secondary education is the number of students enrolled in secondary education in percent of the secondary school age population at the beginning of the sample period (1980).

**Table 2**  
**Summary statistics:**  
**Openness, Human capital, Income and Physical capital, 1965 and 2000**

	Openness (means)		Years of Education (means)		Capital per capital <sup>(a)</sup>		GDP per capital (a)	
	1965	2000	1965	2000	1965	2000	1965	2000
Middle East	46.84	76.04	2.98	5.02	3.86	14.54	2.43	5.39
North Africa	68.24	81.53	3.73	6.35	7.35	12.89	3.97	5.51
<b>Total</b>	<b>57.54</b>	<b>78.78</b>	<b>3.35</b>	<b>5.68</b>	<b>5.60</b>	<b>13.71</b>	<b>3.2</b>	<b>5.45</b>

(a) Both capital and GDP per capita are the exponential of the mean of the logs of the variables.

**Table 3**  
**Summary Statistics for whole sample**

	Ln (Income per capita) <sub>t</sub>	Ln (capital per capital) <sub>t</sub>	Human capital <sub>t</sub>	Ln (Trade share) <sub>t-1</sub>	Human capital <sub>t-1</sub>
Middle East	0.09 (0.15)	0.20 (0.16)	0.58 (0.18)	4.12 (0.47)	3.86 (1.36)
North Africa	0.07 (0.22)	0.10 (0.12)	0.39 (0.58)	4.21 (0.92)	4.81 (1.67)
Countries = 16 N = 128					

*Note:* The figures in parentheses are standard deviations.

**Table 4**  
**Trade, human capital and Income: Levels results**

	Cross-Section OLS: 1985		Pooled OLS			
	[1]	[2]	[3]	[4]	[5]	[6]
Trade share/100	0.562 (2.54)**	0.019 (0.78)	0.457 (2.65)***	0.011 (0.28)		
Ln population	0.064 (1.12)	-0.011 (0.03)	0.047 (0.86)	0.002 (0.08)	0.241 (1.54)	-0.008 (0.18)
Ln capital/labour		0.465 (4.12)***		0.484 (5.28)***		0.387 (6.87)***
Education		0.074 (1.98)*		0.071 (1.76)*		0.070 (1.81)*
Ln trade share					0.378 (3.57)***	-0.013 (0.29)
R-squared	0.13	0.71	0.09	0.84	0.09	0.87
Country effects (p-value) <sup>12</sup>			0.000	0.001	0.000	0.001
Observations	16	16	128	128	128	128
Countries	16	16	16	16	16	16

*Note:* The dependant variable is the log of per capita income. t-statistics based on standard errors robust to heteroskedasticity and, where applicable, autocorrelation are reported in parentheses. Significance at 1%, 5% and 10% level is indicated by \*\*\*, \*\* and \* respectively. All specification includes a constant. Time dummies are included in the specifications reported in columns [3]-[6].

<sup>12</sup> Test for the presence of an unobserved country effect (Wooldridge, 2002; pp. 264-5). Under the null hypothesis that there are no unobserved effects, the test static is distributed asymptotically as standard normal.

**Table 5**  
**Trade, Human capital and Income: Growth results**

	[1] OLS	[2] Within	[3] DCOMB- GMM <sup>(1)</sup>	[4] DCOMB- GMM <sup>(2)</sup>	[5] DCOMB- GMM <sup>(1)</sup>	[6] DCOMB- GMM <sup>(2)</sup>
$\Delta$ Ln trade share	0.011 (0.34)	0.018 (0.76)	0.022 (0.97)	0.004 (0.03)	0.017 (0.76)	0.008 (0.06)
Ln trade share <sub>t-1</sub>	0.002 (0.96)	0.027 (1.87)*	0.034 (2.04)**	0.037 (1.86)*	0.31 (1.96)**	0.031 (1.74)*
$\Delta$ Ln population	-0.107 (1.07)	0.241 (0.76)	0.154 (0.56)	0.218 (0.82)	0.184 (0.68)	0.236 (0.94)
$\Delta$ Ln capital/labour	0.304 (6.49)***	0.325 (6.14)***	0.284 (4.23)***	0.301 (4.86)***	0.287 (4.25)***	0.321 (4.87)***
$\Delta$ Education	0.015 (1.96)**	0.009 (0.87)	0.006 (0.82)	-0.011 (0.63)	0.012 (1.68)*	-0.008 (0.74)
Education <sub>t-1</sub>	0.002 (1.17)	-0.008 (0.76)	-0.011 (1.02)	-0.009 (0.38)		
Fixed effects?	No	Yes	Yes	Yes	Yes	Yes
Capital/labour endogenous?	No	No	Yes	Yes	Yes	Yes
Trade and Education endogenous?	No	No	No	Yes	No	Yes
Country effects (p-value)	0.04	0.00				
Observations	128	128	128	128	128	128
Countries	16	16	16	16	16	16

*Note:* The dependant variable is the five-year growth rate of the log of income per worker. t-statistics based on standard errors robust to heteroskedasticity and autocorrelation are reported in parentheses. Significance at 1%, 5% and 10% level is indicated by \*\*\*, \*\* and \* respectively. All regressions include time dummies and a constant.

<sup>(1)</sup> The instrument set consists of a constant and time dummies, the differenced log of the capital-labour ratio dated as follows: first differences, t-2; second differences, t-1; third differences, t-1, t-4; fourth, fifth and sixth differences, t-1; and contemporaneous values of the remaining explanatory variables in the model. The reported coefficients are one step estimates.

<sup>(2)</sup> The instrument set consists of the differenced log of the capital-labour ratio, the differenced log of population, the differenced log of the trade share, differenced education, dated as follows: first differences, t-2; second differences, t-1, t-3; third differences, t-1, t-4; fourth, fifth and sixth differences, t-1. A constant and time dummies are also included in the instrument set. The reported coefficients are one step estimates.

## Appendix 1 : The difference Combinations GMM Estimator (DCOMB)

This appendix provides a description of the difference combinations GMM estimator. Consider

$$[A.1] \quad y_{it} = x_{it}'\beta + \mu_i + v_{it} \quad t= 1,2,\dots,\dots,T,$$

where  $i$  and  $t$  are firm and times indices,  $y_{it}$  is the dependent variable,  $x_{it}$  is a row vector of order  $k$  of explanatory variables,  $\beta$  is a column vector of parameters of order  $k$ ,  $\mu_i$  is a fixed effect potentially correlated with  $x_{it}$  and  $v_{it}$  is a residual potentially correlated with  $x_{it}$ . The fixed effect is eliminated by taking differences:

$$[A.2] \quad \Delta_s y_{it} = \Delta_s x_{it}'\beta + \Delta_s v_{it}, \quad s= 1,2,\dots,\dots,(T-1)$$

If  $x_{it}$  is correlated with the residual  $v_{it}$ , OLS estimation of (A.2) will yield biased and inconsistent results. Assume that a set of instruments is available that enable us to form a vector of moment conditions, expressed as

$$[A.3] \quad E(z_i' u_i) = 0,$$

where  $u_i$  is a  $n$ -dimensional column vector of stacked differenced residuals:

$$u_i = [\Delta_1 v_{i2}, \Delta_1 v_{i3}, \dots, \Delta_1 v_{i4}, \Delta_2 v_{i3}, \Delta_2 v_{i4}, \dots, \dots, \Delta_{T-1} v_{iT}]$$

and

$$z_i = [\tilde{z}_i \tilde{z}_i']$$

is a  $n \times q$  matrix of instruments. The instrument matrix consists of:  $\tilde{z}_i$ , which is a block diagonal matrix diagonal elements,

$$\tilde{z}_i = \left\{ z_{i2}^1, z_{i3}^1, \dots, z_{iT}^1, z_{i3}^2, z_{i4}^2, \dots, \dots, z_{iT}^{T-1} \right\}$$

where  $z_{it}^s$  is a row vector of instruments orthogonal to  $\Delta_s v_{it}$ ; and  $\tilde{z}_i$ ; which is a matrix of strictly exogenous variables included in the estimated equation. Provided  $q \geq k$ , we can obtain a consistent GMM estimator of  $\beta$  by minimising the quadratic

$$[A.4] \quad J(\hat{\beta}) = \bar{g}(\hat{\beta})' W_N^{-1} \bar{g}(\hat{\beta}),$$

where  $\bar{g}(\cdot)$  is the sample average of the moment conditions and  $W_N^{-1}$  is a weight matrix (Hansen, 1982). An efficient two-step GMM, denoted  $\hat{\beta}_2$ , is based on

$$W_N(\hat{\beta}_1) = \text{Asy.Var}(\sqrt{N\bar{g}(\hat{\beta}_1)}),$$

where  $\hat{\beta}_1$  is a consistent one-step GMM estimator for  $\beta$  based on some known weight matrix  $W_N$ . Weight that satisfies  $p \lim_{N \rightarrow \infty} W_N = \Psi$ , where  $g_i(\hat{\beta}_1)$ .

A common procedure in instrumental variable estimation of panel data models is to use lags of  $x_{it}$  as instruments for contemporaneous differences (for example, Holtz-Eakin et al., 1988; Arellano and Bond, 1991). If  $v_{it}$  is non-autocorrelated, values of  $x_{it}$  not dated  $t$  or  $t-s$  will be orthogonal to  $\Delta_s v_{it}$  and hence be valid instruments. Different instruments are available for different equations and the number of potential instruments, and here  $q$ , grows rapidly with the time series dimension of the panel. It is well known from finite-sample theory and Monte Carlo results that if the number of instruments becomes 'large' instrumental variable estimators tend to become more and more biased, eventually approaching the OLS estimator as  $q$  approaches the total number of observations (Davidson and MacKinnon, 1993, p.222). We therefore use only a sub-set of the available instruments, see notes to Tables 3 for details.

## Appendix 2: Constructing a measure of physical capital

The PWT6.1 data set contains no information on the stock of physical capital. Following Klenow and Rodriguez-Clare (1997) we construct such data using the capital accumulation equation

$$K_{it} = (1 - \delta)K_{i,t-1} + I_{it}, \quad t = 1966, 1967, \dots, 2000$$

where  $I$  is investment in physical capital and  $t$  denotes year. This procedure requires data on investment, initial capital ( $K_{i,1965}$ ) and the depreciation rate.

1. We obtain investment data by using the following equation

$$I_{it} = ki_{it} \cdot rgdpl_{it} \cdot pop_{it} \cdot 1000,$$

where  $rgdpl$  is the PWT6.& for the real GDP per capita (Laspeyres);  $ki$  is the investment share of  $rgdpl$ ; and  $pop$  is the population divided by 1000.

2. For each country we define the initial capital-output ratio as

$$\left(\frac{K}{Y}\right)_{1965} = \frac{i}{g + \delta + n},$$

where  $i$ ,  $g$  and  $n$  are country averages of the averages of the investment to output ratio ( $ki$ ), the growth rate of the per capitaincome (based on the PWT6.1 variable  $rgdpch$ ) and the population growth rate (based on  $pop$ ), respectively, for all observations available in the 1950-1965 period. The depreciation rate is set as explained in the next paragraph. The above expression is the Solow equation for the capital-output ratio in the steady state. A similar procedure for estimating the initial capital-output ratio has been used by Klenow and Rodriguez-Clare (1997). We then obtain an estimate of the initial capital stock by multiplying the estimated  $(K/Y)_{1965}$  by 1965 real GDP:

$$K_{1965} = (K/Y)_{1965} \cdot rgdpch_{1965} \cdot pop_{1965}$$

3. Following Klenow and Rodriguez-Clare (1997) we set  $\delta = 0.03$ , but we have also experimented with higher depreciation rates. Using  $\delta = 0.07$  tends to give slightly lower estimates of the coefficients on population and the capital-labour ratio, but only marginally different coefficients on openness and human capital.

### Appendix 3

#### Countries included in the sample

	<b>Country</b>
<b>North Africa</b>	Algeria – Egypt- Libya - Morocco – Tunisia Jordan – Iran – Kuwait – Lebanon – Oman –
<b>Middle East</b>	Qatar – Saudi Arabia – Syria – Turkey – United Arab Emirates – Yemen