A Versus K Revisited: Evidence from Selected MENA Countries

Abu-Qarn, Aamer and Abu-Bader, Suleiman

Department of Economics, Ben-Gurion University of the Negev

2005

A VERSUS K REVISITED: EVIDENCE FROM SELECTED MENA COUNTRIES

Aamer S. Abu-Qarn and
Suleiman Abu-Bader

Discussion Paper No. 05-13

July 2005

Monaster Center for Economic Research
Ben-Gurion University of the Negev
P.O. Box 653
Beer Sheva, Israel

Fax: 972-8-6472941
Tel: 972-8-6472286

A Versus K Revisited:

Evidence from Selected MENA Countries[†]

Aamer S. Abu-Qarn[*] and Suleiman Abu-Bader
Department of Economics, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Abstract

This paper reconsiders the A versus K debate, namely, which factor is the leading contributor to economic growth? productivity gains (A) or factor accumulation (K). The growth accounting analysis is conducted for ten MENA countries over the period 1960-1998. The long-run share of capital in national income is estimated using cointegration (country-specific) and panel data (region-specific) methods. As has been shown for many developing economies, we find that for most of the countries the share is much higher than the conventional share of 0.3-0.4. The growth accounting exercise conducted with the incorporation of human capital reveals that for the MENA region the contribution of productivity gains to economic growth is negligible and frequently even detrimental. Thus, we conclude that it is factor (both physical and human) accumulation that drives the economic performance of MENA economies.

Key words: Growth Accounting, Productivity and Factor Accumulation, MENA, Middle-East, Cointegration, Panel Data.
JEL classification: O47, O53, C22, C23.

---

† We thank the seminar participants at Northeastern University, and Ben-Gurion University and the participants of the Eastern Economic Association conference for their helpful comments and suggestions.
* Corresponding author. Tel.: +972-8-647-2296; Fax: +972-8-647-2941; Email: aamer@bgu.ac.il

1. INTRODUCTION

Identifying the key factors underlying sustained growth is critical for designing economic policies that lead to higher standards of living. Two main forces have been thought to play a major role in sustaining growth: accumulation of physical and human capital (referred to as K), and, the adoption of advanced technologies (referred to as A).

Economists argue on the magnitude of the contribution of each of these factors to fostering growth.[1] According to the neoclassical growth model, the returns to physical capital are assumed to diminish as more is accumulated, thus limiting its role in sustaining growth and increasing the likelihood that productivity changes become a key factor in explaining growth. Such a prediction gained ground with the emergence of the new growth theories that accentuate the role of knowledge and transfer of ideas.

The impressive growth record of the East Asian economies has provided fertile ground for analyzing of sources of growth and fueled the unending debate. Many researchers have hypothesized that the rapid growth resulted from effective adoption of new technologies coupled with accumulation of inputs. Recent studies, however, notably Collins and Bosworth (1996), Young (1995), and Krugman (1994) have ignited a new interest in growth accounting by emphasizing the key role that factor accumulation played in the rapid growth of the East Asian countries.

The economies of the MENA countries are prone to high volatility in economic activity, and therefore it is crucial to identify their sources of growth. This paper aims to use the basic growth accounting exercise to identify those factors that have determined the economic performance of selected MENA countries for the last four decades.

The contributions of this paper can be summarized as follows. First, we examine the sources of growth for selected MENA countries, emphasizing common characteristics as well as the factors that vary greatly across countries. Only a very few studies have addressed the MENA region, and often the analysis is conducted within a larger sample of countries without pinpointing the specific characteristics of MENA. The data used in our study is the latest available and goes back to 1960 allowing us a sizeable sample. Second, we survey the major methods and techniques available to researchers emphasizing their pros and cons and highlighting their applicability to our study. For the sake of sensitivity analysis, different ways of estimating the initial capital stock, several measures of depreciation rate, and human capital

[1] Three prominent economists have dominated the field: Denison, Jorgenson (often with Griliches), and Kendrick. See Norsworthy (1984) for a detailed survey of their works.

stock are employed. Third, instead of the arbitrary assumptions used in earlier studies addressing the share of capital in income, we adopt the most up-to-date econometric techniques to properly estimate it. The estimation is done in two main channels: regional and country-specific. We use panel data methods to estimate the share of physical capital in national income, by which we utilize both time and space dimensions to obtain a single estimate applicable to the region. To estimate the share of capital in national income separately for each country in our sample we use the Johansen cointegration test which identifies whether a long-term relationship exists between output per worker and capital per worker. By testing for cointegration, we obtain estimates of the share of capital in income that correspond to a stable long-run relationship and not a result of a possible spurious regression. As far as we know, cointegration test has never been applied to estimate the share of capital in income.

The paper is organized as follows. Section 2 takes on the theoretical foundations of the growth accounting exercise. Section 3 follows with a discussion of some empirical issues. A brief survey of previous empirical studies dealing with the MENA region is provided in Section 4. Section 5 describes the data used in our study and outlines its various sources. An analysis of the constructed physical capital stock series is provided in Section 6. In Section 7 we estimate the share of physical capital for the MENA region by utilizing panel data techniques to yield region-specific estimates and cointegration tests to obtain country-specific estimates. Section 8 presents the decomposition of the growth of output per worker into contributions of physical capital, human capital and total factor productivity. Section 9 ends the paper with a summary and some concluding remarks.

2. THEORETICAL BACKGROUND

The growth accounting approach, formally introduced by Solow (1957), is aimed at decomposing the growth of aggregate output into the contributions of factor accumulation and technological progress. The point of departure for growth accounting is an aggregate production function that expresses the relationship between inputs and output:

$$Y(t) = A(t) \cdot F(K(t), L(t)) \tag{1}$$

where $Y(t)$, $K(t)$, $L(t)$ and $A(t)$ represent aggregate output, physical capital stock, labor force and technology level, respectively. The term $A(t)$ that is often referred to as *Total Factor Productivity* (TFP) or *Multifactor Productivity* (MFP) is designated to capture a host of factors that affect the overall efficiency of the economy. These factors include, though they are not limited to, technology level, quality of labor (human capital), quality of management and governance, strength of institutions and property rights, and cultural factors.[2]

According to the basic growth accounting equation, the growth of output is attributed to growth in production factors and productivity as follows:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha \cdot \frac{\dot{K}}{K} + \beta \cdot \frac{\dot{L}}{L} \qquad (2)$$

where a dot on the top of a variable denotes its derivative with respect to time, and α and β are the shares in total income of payments to capital and labor, respectively. Equation (2) represents the key equation in growth accounting or *sources-of-growth* method. The growth rate of output equals the weighted average growth rates of inputs, where the shares of capital and labor, α and β, in income are the weights, plus the growth in TFP. The first term on the right-hand side in equation (2) is referred to as *Solow's Residual*, which is measured as the difference between the growth of output and the weighted average growth of inputs. Under constant returns to scale we can represent the growth accounting equation in per worker terms:

$$\frac{\dot{y}}{y} = \frac{\dot{A}}{A} + \alpha \cdot \frac{\dot{k}}{k} \qquad (3)$$

where the lower case letters stand for the respective per worker term. In equation (3) the growth of output per worker (labor productivity) is decomposed into the growth of capital per worker (capital intensity) weighted by the capital share in income, and the growth of TFP.

Researchers have long acknowledged the significance of human capital in explaining economic growth. To accommodate that, a measure of human capital is incorporated as an input in the production function, either explicitly or augmented in labor as follows:

$$Y(t) = A(t) \cdot F(K(t), L(t)H(t)) \qquad (4)$$

where *H(t)* is a measure of human capital stock that is embodied in the labor force, and the expression *L(t)H(t)* denotes a skill-adjusted measure of the labor input. The growth of output can be broken down into the contributions of physical capital stock, human capital, and factor productivity as follows:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha \frac{\dot{K}}{K} + (1-\alpha)\left(\frac{\dot{L}}{L} + \frac{\dot{H}}{H}\right) \qquad (5)$$

[2] Solow (1957) acknowledges that this term far from captures technical change solely, it is "a short-hand expression for any shift in the production function" and thus it captures "slowdowns, speed-ups, improvements in the education of the labor force, and all sorts of things".

Alternatively, we can express equation (5) in terms of output and capital per worker:

$$\frac{\dot{y}}{y} = \frac{\dot{A}}{A} + \alpha \cdot \frac{\dot{k}}{k} + (1-\alpha)\frac{\dot{H}}{H} \tag{6}$$

We use either one of the above growth accounting equations to break down the growth of output of individual sectors, industries, or countries over time into the contributions of inputs and total factor productivity. Moreover, using cross-section data, the methodology can be implemented to assess what part of cross-country differences in economic growth rates are accounted for by differences in growth rates of factor accumulation and TFP.

The sources of growth methodology deals with output and inputs as aggregates and thus ignores changes in their composition. However, labor and capital inputs are heterogeneous and aggregating them into single measures would undermine the varied relative productivity of the components. A change in the composition of an aggregated measure without altering the total would probably affect output despite the fact that using the aggregated measures alone will not show any impact on the output. For example, moving towards highly productive inputs may not be reflected in the conventional aggregate measure even though its impact on output would be unquestionable.

When applied to U.S. and European data, Solow's (1957) methodology generated large residuals and ascribed a significant role to productivity growth. Denison (1962), acknowledging the enormous input heterogeneity, accounted for changes in the quality of labor input as a result of variations in working hours, education, age and gender composition, and sectors. Incorporating elements of input quality helped to account for part of the residual but kept growth in TFP as a major factor for explaining output growth.[3]

Jorgenson and Griliches (1967), dissatisfied with Denison's approach and results, especially his handling of capital services, went further in correcting for errors in measurements of output, labor services and capital services that arise from conceptual errors in the separation of the value of transactions into price and quantity components. They decomposed output and inputs into many categories to capture differences in rates of return, tax treatment, depreciation rates, and technologies embodied in various capital goods. According to their approach, the rate of growth of real output and factor input are defined as weighted averages of the rates of growth of individual products and factors, with the weights being the relative shares of each product in the value of total output and of each individual input in the value of total inputs. Using this approach explained a great deal of the growth of output, in terms of quantity and quality changes

[3] Denison attributes the part not accounted for by inputs to "advances in knowledge."

in inputs rather than attributing the bulk of it to technology advances. Jorgenson and Griliches (1967) were able to explain more than 96% of the rate of growth of U.S. private domestic output between 1945-1965 after correcting for aggregation errors and changes in rates of labor and capital utilization. Without correction, only 52% of the growth of output could be accounted for by changes in inputs and the rest was ascribed to changes in total factor productivity.

In spite of its ease and readability, growth accounting does not explain how changes in inputs and improvements in total factor productivity are related to economic policies, preferences and technology. The method consistently decomposes the proximate sources of growth but fails to address the fundamental causes of growth. Thus, it offers few policy implications.

3. EMPIRICAL ISSUES

3.1 Output and Inputs Data

Data on output, labor, physical capital, and a measure of human capital are needed to implement the sources-of-growth exercise. Output is usually taken in monetary units at constant prices to reflect quantity changes. Real output expressed in national prices is preferred over figures given in international prices since the latter tend to overstate the share devoted to capital and skill activities (investment) in GDP and understate the share devoted to labor intensive activities (government services) in relatively rich countries.[4]

The measurement of inputs, especially physical and human capital, is somewhat problematic and involves many assumptions. As a measure of the labor input, the total hours worked obtained by multiplying employment times the average hours actually worked is used to serve as a reasonable proxy for the flow of labor services.[5] However, in the absence of detailed data on total hours worked, researchers opt to use either labor force (for example, Collins and Bosworth, 1996 and Senhadji, 2000), or the total economically active population (population between the ages 15-64) as in Nehru and Dhareshwar (1993). For capital input, the optimal measure would be expressed in terms of flow of services provided per unit of time, such as machine hours used in production at a certain year.[6] Due to limited data availability and aggregation difficulties, the stock of physical capital is used. By using this measure we assume that the flow of services is proportional to the capital stock. Because of lack of series of physical capital stocks for the MENA countries, we use data on past investment to construct a time series

[4] Collins and Bosworth (1996).
[5] This measure excludes sick leave, holidays and meal breaks. An alternative measure is hours paid for, which includes all these components. See Costello (1993).
[6] See Miller (1989) for a discussion of issues related to the measurement of capital input.

of capital stock by applying the Perpetual-Inventory Method (PIM). [7] Lack of data on intangible goods and natural and environmental resources limit us from broadening the definition of capital and confine it to fixed, tangible, durable and reproducible goods. As we indicated earlier, investment data for the MENA economies is available only on an aggregated base.

Education measures have been considered by researchers as a proxy for human capital stock that optimally should include formal and informal education, on-the-job-training, health, nutrition, and social services.[8] Early studies that compiled measures of human capital stock have taken school enrollment ratios and adult literacy rates, but these measures fail to measure the stock of human capital available for current production. While school enrollment ratios represent the flows of education that would affect future human capital stock, adult literacy ratios reflect only human capital stocks related to elementary school, and do not represent human capital formed beyond the level needed to be considered literate.[9]

The first comprehensive work on human capital stock was conducted by Barro and Lee (1993). The authors compiled a data set on educational attainment for 129 countries over five-year periods from 1960-1985 using school-enrollment data and age composition of the population. The final product is an estimate of the average years of schooling of the adult population which is assumed to capture the educational attainment of the labor force. The main drawbacks of the data set are the failure to adjust for quality of education and for the duration of school day or year.[10] In addition, taking population aged 25 and over may lead to a downward bias of human capital stock since a large segment of the population between the ages 15 and 25, especially in developing countries with high population growth, is not taken into account.[11]

A similar data set was constructed by Nehru et al. (1995), who used the perpetual inventory method to construct series of mean school years of education for 85 countries covering the period 1960-1987. Their estimates adjust for mortality, grade repetitions among school-goers, and country-specific drop-out rates for primary and secondary students.

Other studies addressed the quality of education. Using a basic earnings function attributed to Mincer (1974), Psacharopoulos (1985, 1994) compiled a detailed analysis of the returns to investment in education. Collins and Bosworth (1996) went further and constructed an

[7] This is in line with Nehru and Dhareshwar (1993) who claim that this method is applicable for assessing the role of inputs in the production process, which is a function of the level of capital services generated by the existing stock of capital.
[8] Nehru et al. (1995).
[9] Barro and Lee (1993).
[10] Teacher-student ratio and public education expenditures per student are often mentioned as possible proxies for the quality of educational attainment.
[11] Barro and Lee (2000) correct for that and extend the coverage to include population aged 15 years and above and cover the period 1960-2000.

index of labor quality using data on years of schooling and returns to education. Their method involves assigning weights to different levels of schooling attained based on rate of returns obtained from Psacharopoulos (1994). Our present study relies on Collins and Bosworth's data set, average years of schooling as obtained from Nehru et al. (1995), and a recent update of Barro and Lee's (2000) data set.

Assuming that the level of capital services is proportional to the level of capital stock, we employ the PIM to construct the capital stock series. A general PIM featuring a geometric pattern of decay can be expressed as: [12]

$$K_t = (1-\delta)^t K(0) + \sum_{i=0}^{t-1} I_{t-i}(1-\delta)^i \tag{8}$$

According to equation (8), the capital stock of the year t equals the initial capital stock net of depreciation (at an annual rate of δ) plus the sum of the stream of net investments. Thus, in order to construct a capital stock series we need an estimate of the initial capital stock, $K(0)$, an estimate of the depreciation rate of capital stocks, δ, and a series of past investments, I_t. Once we obtain an estimate of the initial capital stock, we can use a variation of equation (8) to describe how capital stock evolves as follows:

$$K_t = I_t + (1-\delta)K_{t-1} \tag{9}$$

According to equation (9), the capital stock in a certain year, K_t, equals the capital stock of the previous year, K_{t-1}, net of depreciation, plus the flow of gross investment in the current year, I_t.

Since the capital stock series is constructed from accumulation of investments, it is vital to have a reliable estimate of the initial capital stock. Preferably, such an estimate is directly obtained from a benchmark study. However, if such a study is unavailable, as is the case for the MENA countries, a rough estimate is used. In the literature, we can find several ways to generate an estimate for the initial capital stock, though none turned out to be particularly accurate. Our choice is governed by empirical convenience and data availability. Some common practices in the literature are as follows:

- Assuming initial stock of zero. Such an assumption is certain to bias the growth rate of capital stock in the subsequent years upward. The main drawback of this assumption is being a mere arbitrary estimate. However, when taking a long enough series of investments that far precedes the usable series the effect of our subjective estimate on capital stock fades away.
- Starting from initial stock of zero and using PIM to generate the series of capital stock, and then calculating the average capital-output ratio which is assumed to be fixed over time

[12] See Nehru and Dhareshwar (1993) for a discussion of the merits of such pattern.

(including at time zero). Under this assumption we can find a new estimate of the initial capital stock. This procedure is repeated until the capital-output ratio converges.

- Based on Harberger (1978), the researchers exploit the neoclassical growth model prediction of a constant capital-output ratio over time. Starting from the capital stock evolution equation (9) and rearranging it we obtain equation (10):

$$\frac{K_t - K_{t-1}}{K_{t-1}} = -\delta + \frac{I_t}{K_{t-1}} \quad (10)$$

The left side of the equation is the growth rate of the capital stock which is presumed to be constant over time and equal to the long-term growth of output, g. Thus, we can rewrite the equation to yield equation (11):

$$K_{t-1} = \frac{I_t}{(g + \delta)} \quad (11)$$

To find g, researchers frequently use the average annual growth rate of the real GDP. In addition, to avoid relying on a single observation of the investment series, we can take a longer period and use the average level of investment. Alternatively, Nehru and Dhareshwar (1993) suggest using the fitted value of initial investment from a regression of the log of investment on a constant and time. Many researchers have adopted this measure for the estimation of initial capital stock since it captures long run effects and avoids short-run fluctuations.

The above discussion shows the significance of obtaining an accurate estimate of the rate of decay. An error would lead not only to an incorrect estimate of initial capital stock, but also would be carried over for subsequent years as estimates of the series of capital stock are a function of the rate of decay. Optimally, data is obtained through surveys on the industry level or by applying depreciation rates from guidelines to tax schedules. Unfortunately, data is scarce for most countries including the MENA countries. Various depreciation or replacement rates have been used by researchers. For the aggregate capital stock a rate of 4-6% is usually assumed.[13] It is obvious that these rates differ across time and space. Since a main goal of the present paper is sensitivity analysis, various rates of decay will be considered and compared.

To capture real capital stocks, figures of gross investment are taken in constant prices. If the only available data is in current prices, a deflator specific to investment has to be used to convert the data to constant prices of a base year. In the absence of such specific deflator, the consumer price index or the GDP deflator can be used as a proxy. For many countries, series of

---

[13] Mankiw et al. (1992) assumed a depreciation rate of 3% for both physical and human capital.

investment are not available for long periods of time. In this case, backward projection is employed to extrapolate the series. In most cases, it is assumed that the evolution of investment in the past resembles a given period for which data is available.

3.2 Estimating the Shares of Inputs in Income

Since input shares are very crucial in the debates of convergence and the relative importance of input accumulation versus productivity, it is of great significance to estimate them accurately.[14] However, many ways of estimating the shares of inputs in income have been used and none has been found to be adequate.[15] The commonly used methods are as follows:

- Using national accounts to find the compensation to labor and capital out of the national income.[16] This approach is rarely employed due to unavailability of data for most developing countries. Even for developed countries there are serious difficulties in allocating income of self-employed workers between the returns to capital and labor.
- Using a priori measures in the vicinity of 30-40% for the share of capital. Some economists who have broadened the definition of capital to include human capital, externalities and R&D have taken higher values.[17] Many studies, based on either national accounts or parametric estimates, have found that the share of capital for developing countries appear to be larger than that of industrial countries and often tops 40%.[18]
- Direct estimation of the Cobb-Douglas production function parameters in a log-linear form:

$$\ln Y_t = a + \alpha \ln K_t + \beta \ln L_t + \varepsilon_t \qquad a = \ln A \tag{12}$$

  This method has the advantage of not depending on the assumption of constant returns to scale. However, it is often associated with econometric problems of simultaneity, multicollinearity, and heteroskedasticity. The violation of the assumptions of the ordinary least squares results in dubious estimators.
- Estimating the intensive form of the Cobb-Douglas production function:[19]

$$Ln\left(\frac{Y}{L}\right)_t = a + \alpha Ln\left(\frac{K}{L}\right)_t + \varepsilon_t$$

$$Ln(y_t) = a + \alpha Ln(k_t) + \varepsilon_t \tag{13}$$

---

[14] See Mankiw (1995) for details on the key role that capital share plays in the critique of the neoclassical growth model and how to respond to such a critique.

[15] See Intriligator et al (1996) for details on how to estimate the parameters of the production function.

[16] Labor compensation is measured gross of fringe benefits and other costs paid for by the employer.

[17] For example, Mankiw et al. (1992) used a share of 2/3 and Barro et al. (1995) even higher (0.75), whereas Caselli et al. (1996) imply a capital share of only 0.1.

[18] See, for example, Harrison (1996).

[19] Some researchers estimate the intensive form of the production function in first difference to eliminate possible unit root in levels. However, this approach deprives us of the valuable information embodied in levels, by removing the low frequencies in the data and emphasizing short-term fluctuations. See Senhadji (2000).

Here we incorporate the assumption of constant returns to scale. Although the method reduces heteroskedasticity and eliminates multicollinearity, it does not allow us to test the hypothesis of constant returns to scale but rather imposes it.

Another variation of the direct estimation of the intensive form of the production function is applying it to panel data rather than to time series. By combining time series and cross-section data we utilize the information embodied in both dimensions. Such a method is applicable when the countries covered share some economic characteristics and are likely to have similar production functions. Furthermore, it is possible to account for country-specific factors through the introduction of dummy variables for each country or through the adoption of panel data techniques that allow for variations among cross-section members (especially the fixed effects technique). The output of this method is a single parameter that applies to all countries in the sample. In the case of a large enough sample, we can allow that parameter to vary among countries by adding dummies for the slope (the share of capital).

3.2.1 Estimation Using Cointegration

Since inferences based on OLS are valid only in the case of stationary series, once we use time series it is essential to check for the presence of unit roots. We depart from the intensive form of the production function, with or without a measure of human capital and test for the stationarity of the output per worker (or per unit of skill-adjusted labor) and of physical capital per worker (or per unit of skill-adjusted labor). A typical unit root test is the Augmented Dickey-Fuller (ADF) test which entails running the following regression for each variable:

$$\Delta x_t = a_0 + a_1 t + \beta x_{t-1} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} + \varepsilon_t \qquad (14)$$

where a_0 is a drift, t represents a time trend, and p is a large enough lag length to ensure that ε_t is a white noise process.[20] Various methods such as the Akaike Information Criterion (AIC) or the Schwarz Information Criterion (SIC) can be applied to find the optimal p. Variable x would have a unit root in levels (integrated of order 1) if we fail to reject the hypothesis that $\beta = 0$ using the ADF significance levels. If the variables are non-stationary in levels but stationary in first differences, i.e. *I(1)*, it is possible to find a linear combination of the variables that is stationary. To find possible long-run relations among output and production factors we apply the Johansen's (1988) cointegration test. The test departs from a Vector Autoregression system in which the variables are expressed as functions of their own and other variable lags:

[20] This is the general case. Other variations of the test include no intercept and no trend. The series have to be examined to identify the need for the inclusion of trend.

$$X_t = \sum_{k=1}^{p} A_k X_{t-k} + \varepsilon_t \tag{15}$$

where p is chosen by either AIC or SBC so that ε_t is a multivariate normal white noise process with mean zero and finite variance matrix Λ, and X_t is an (*nx1*) vector of nonstationary variables of the same integration order *I(1)*. Equation (15) can be transformed into an error correction form to yield**:**

$$\Delta X_t = \sum_{k=1}^{p-1} \Gamma_k \Delta X_{t-k} + \Pi X_{t-1} + \varepsilon_t \tag{16}$$

Johansen's test focuses on the rank of matrix Π which determines the number of the long-run linear combinations that are stationary, or put differently, the number of the cointegrating vectors. The Johansen test employs one of two tests to determine the number of cointegration vectors; Maximum Eigenvalues Statistic, λ_{max} or Trace Statistic, λ_{trace}. Once the rank is determined, it is possible to partition the Π matrix which results in:

$$\Delta X_t = \sum_{k=1}^{p-1} \Gamma_k \Delta X_{t-k} + \alpha \cdot \beta' X_{t-1} + \varepsilon_t \tag{17}$$

where the β (cointegration) matrix has the property that $\beta' X_t \sim I(0)$. Each column of the β matrix represents a cointegration vector or a stationary linear combination of the endogenous variables that reflects long term equilibrium. The Johansen test results in an estimate of the long-run relationship between output and capital per worker. Thus, in our particular case we get an estimate of the long-run elasticity of output with respect to physical capital, i.e. the share of physical capital in income.

Phillips and Hansen (1990) propose another alternative to cointegration which addresses endogeneity and serial correlation. Their Fully Modified (FM) estimator is an optimal single-equation that combines OLS with semi parametric corrections for serial correlation and possible endogeneity of right-hand side variables (capital-labor ratio in our case).

After surveying all the major methods to estimate the shares of inputs in income and subject to availability of data, we find that the practical ones are limited to a priori estimates as suggested by earlier studies at the range of 30-40%, direct estimation of the production function (in regular form or intensive form), and estimation through testing for cointegration. The estimation is conducted using panel data and time series techniques.

4. PREVIOUS EMPIRICAL FINDINGS

Only a few empirical studies have dealt with the MENA region largely due to a lack of data. However, as data became available for more countries of the region, some researchers have addressed these countries in the context of a larger sample. Among the early studies to estimate physical capital stocks and analyze the sources of growth is that of Nehru and Dhareshwar (1993). They use the perpetual inventory method (PIM) to estimate physical capital from the flow of investments assuming a depreciation rate of 4%. In their analysis of the sources of growth they disregard human capital and assume an identical arbitrary share of capital in income of 0.4 for all countries. They find that for the MENA region, the contribution of capital accumulation was the major factor behind economic growth in the period 1960-90. The growth of TFP was among the lowest in the world and even turned out to be negative in the sub-periods of 1973-90 and 1980-90. The only exception was Turkey, who experienced a much higher contribution of productivity than physical capital in the period 1980-90.[21]

Another comprehensive study was conducted by Collins and Bosworth (1996).[22] They adopted Nehru and Dhareshwar's (1993) data and extended it to 1994 using PIM. Aware of the significance of human capital, they included an index of labor quality as an input in the production function. The share of physical capital was again assumed to be identical across countries at a rate of 0.35 while the weight of labor was taken to be 0.65. Their findings are in line with Nehru and Dhareshwar (1993) despite the fact that the production function they assumed differed by the inclusion of human capital and the magnitude of the shares of inputs in income. They found a negative contribution of TFP to growth in all sub-periods during 1960-1994 with the exception of 1960-73. The contribution of the human capital measure over the whole period amounts to about one third of the growth of output per worker. The results are kept intact under different assumptions of the share of capital (0.3 and 0.4) and human capital.

Bisat et al. (1997) is one of the few studies in which MENA is addressed as a region. However, like previous studies the authors pay no attention to human capital. Furthermore, they used the arbitrary assumption of zero capital stock in 1900 approximated the annual growth rate of investments during 1901-1969 by the average growth rate over the period 1971-95. With regards to the share of physical capital, the authors applied three alternatives: a priori measure of 0.3, national account estimates, and regression estimates. Using a share of capital in national

[21] The authors classified Turkey as belonging to Europe, and not the MENA region.
[22] Their focus is on the experiences of East Asia's countries. The analysis of other regions, including MENA, is marginal and was provided just for the sake of comparison.

income of 0.3, the authors find that for the majority of countries in their sample (9 out of 13), the average annual growth of TFP was negative over the period 1971-96.[23] Thus, they concluded that "Arab countries suffered from the effects of factors which reduced the aggregate production efficiency over time." When using regression estimates, the same study found that, in general, the estimated share of physical capital is larger than 0.3 with some of the estimators being negative or outside the interval (0, 1).[24] A significant difference was not detected when applying the estimated shares to find the annual growth of TFP. Most of the countries witnessed a negative growth of TFP regardless of the method or the sub-period used to estimate the share of capital. Similar conclusions were obtained using estimated shares from national accounts data.

Senhadji (2000) relied on Collins and Bosworth's data, but instead of using a priori value of the share of physical capital, they estimated it for individual countries and then used the regional averages to find the contributions of physical capital, human capital and TFP to the growth of output per worker. They applied the fully modified OLS in levels and first differences. The estimated share for the MENA regions was found to be 0.63 when estimation is done in levels and 0.54 when the production function is estimated in first difference.[25] However, within the sample of MENA countries, the range of the shares was very wide (from 0.24 in Turkey to 1.00 in Israel). When the author decomposed the growth of output per worker for the period 1960-94, he found that physical capital accumulation accounts for more than 75% of the growth, while the contribution of TFP is negative. Only in the sub period of 1960-73 there is a positive contribution of TFP to economic growth. However, the contribution of TFP amounts to a mere 1.22% of the 5.86% GDP growth.

5. DATA SOURCES

We collected data for ten MENA countries (Algeria, Egypt, Iran, Israel, Jordan, Morocco, Sudan, Syria, Tunisia, and Turkey) covering the period 1960-98. The main source of data is the World Development Indicators 2000 CD-ROM of the World Bank. However, to fill in the missing data especially with the historical investment series we used data provided by Nehru and Dhareshwar (1993), and Collins and Bosworth (1996), as well as from updated data sets

---

[23] The exceptions are Egypt, Oman, Syria and Tunisia.

[24] They applied OLS in levels with standard errors that are autocorrelation and heteroskedasticity-consistent. In addition, they estimated the intensive form of the production function in first difference with instrumental variables. Both methods resulted in similar estimates with few exceptions.

[25] In an earlier version of the article, Senhadji (1999) provides estimates based on panel data. He obtains shares in the range of 0.63-0.69 depending on the model specification. The adjusted R^2 reported is very low (less than 0.19).

available online at the World Bank (www.worldbank.org) and the Brookings Institution (www.brookings.org) websites.

All monetary values were converted from values in local currency units expressed in different base years into dollars and constant prices of 1995. We followed the procedures and the conversion factors used by the World Bank.

Two sets of human capital stock are used. First, Collins and Bosworth (1996) provide a data set that incorporates the quality of labor based on rates of return to schooling. Second, Nehru et al. (1995). Their original data of average years of schooling of population over the age of 15 covers the period 1960-87. Later periods were supplemented from a recent paper by Barro and Lee (2000). Since the data is provided for 5-year intervals, we interpolated between observations to fill in the missing values.

For the estimation of the shares of capital in income using panel data models, unit root tests, and cointegration tests we used Eviews 4.0.

6. THE PHYSICAL CAPITAL STOCK SERIES

To construct the series of physical capital stocks for the ten MENA countries we adopted the perpetual inventory method. In order to lessen the reliance on the estimates of the initial capital stock, we extended the series of investment back to 1950. Data from the World Bank's WDI 2000 CD-ROM was supplemented by two sources; Collins and Bosworth (1996) from which we acquired missing data of the 60's and data covering the 50's was taken from Nehru and Dhareshwar (1993). In case that the data did not date back to 1950 we extrapolated based on the long-term trend in the investment series over 1960-98.[26] In order to avoid reliance on single observations at the beginning and end of our sample, we obtained the long-run trend from a semi log regression in which the natural logarithm of investment is regressed on constant and time coefficient. Utilizing a long spanned data series lessens the effect of business cycles that are very likely to dominate short periods.[27]

Several methods to estimate the initial capital stock were applied and the results obtained were not significantly different. The effect of the estimate of initial capital stock is the greatest in the early years but then it fades away as time passes. Consequently, we opted to use the well

[26] Our usable sample covers only the 1960-98 period. Thus, the effect of errors in estimation of the investment series in the 50s is minimal.
[27] Extrapolation was performed for Tunisia and Sudan for the 1950-59 period and Jordan for 1950-53.

theoretically founded method suggested by Harberger (1978) as in equation (11). We estimate the long-term growth rate of the real GDP, g, using the following regression:

$$Ln(Y_t) = a_0 + a_1 t + \varepsilon_t \tag{18}$$

where g is given by the estimate a_1. Thus, we utilize the whole data set instead of using a partial set that is subject to business cycle fluctuations to uncover the average long-term growth of the real output. A similar regression was used to find the fitted value of initial investment.

With regards to the rate of decay we estimated the initial capital stock and consequently the whole series of capital using three alternative assumptions; 4%, 5%, and 6%. When applying these rates in our growth accounting exercise we found that our choice of depreciation rate doesn't seem to matter. Thus, we present our findings using 5% as our choice.[28] This is in line with many studies dealing with developing economies.[29]

In Table 1 we present the growth rates of the series of capital stocks for selected sub-periods for 1960-98. In addition, we incorporate regional averages calculated based on figures from Collins and Bosworth (1996). We divide our discussion into several sub-periods. In order to avoid relying on single observations in calculating the annual growth rates, we calculate the average growth rates based on a similar regression to that given in equation (18). We can observe some interesting pattern. For example, most of the countries in our sample experienced relatively high rates of growth in capital stocks in the 60s and 70s. In general, the growth rates during these two decades topped those of most regions. The only comparable region was East Asia, in which the growth rates exceeded 7.70% in the 60s and 11.39% per annum in the 70s. The massive accumulation of resources was spurred by the flow of income from oil. While the majority of the countries in our sample are not major oil exporters, with the exception of Iran, they benefited indirectly by the growing demand for labor in the Gulf countries. Worker remittances were channeled back to home countries and contributed to enormous investments, mainly in residential construction and small businesses. Especially in the 70s, oil exporters (Iran and Algeria), Egypt, Jordan, and Syria (countries with large number of workers in Gulf countries) were the main beneficiaries of the oil boom. In contrast, Israel and Sudan, economies that did not benefit from the oil boom, recorded relatively modest growth rates. As the prices of oil plummeted and worker remittances declined sharply in the 80s investments fell as well. However, on average, MENA countries still boasted higher capital stock growth rates than the main blocks of developing countries (Africa and Latin America), though lower than in the

[28] The same rate was chosen by Bisat et al. (1997) for seven of the ten countries in our sample.
[29] See Collins and Bosworth (1996).

preceding decades. A substantial decline is observed in the cases of Algeria, Iran, Israel, Jordan, Morocco, Syria, and Tunisia.

The good fortunes of the MENA countries took a turn for the worse during the 90s. Most of the economies entered a phase of deep recession that took its toll on the volume of investment and consequently on physical capital stock. In this decade, the average growth rates of the capital stock were well below those of other regions. There were some exceptions though. In the case of Jordan (annual growth rate of 7.2%), for example, a massive wave of workers returning back home from Kuwait with their accumulated savings following the Gulf war led to extensive investments in residential housing and infrastructure. Israel (with a growth of 6.2% per annum) constitutes another exception. Following the collapse of the Soviet Union, hundreds of thousands of Jewish immigrants settled in Israel, which required huge investments that were financed in large by American aid. The last exception is Turkey. Following a severe currency crisis in the early 1994, the economy rebounded and recorded high growth rates fueled by domestic demand.

Long-run patterns, depicted by the average growth rate of capital stock over the whole 1960-98 period, are also provided in Table 1. Growth rates of capital stock for the MENA members were of a higher magnitude than most of the regions with the exception of the East Asian region which includes the newly industrialized countries. For the period 1960-98, growth rates of physical capital stocks exceeded 4% in all countries and often ranged about above 6% per annum. Jordan stands as the country with the highest growth rate of capital stocks with a rate of 9.13%, followed by Syria (6.93%), Iran (6.91%), Egypt, and Turkey (6.71%).

Comparing the growth rates of capital stock with those of GDP reveals a significant contribution of capital accumulation and a minor role for productivity gains to economic growth. However, before jumping to such conclusions, we analyze some other characteristics of the economies as reflected from the series of capital stock and its relation to economic activity.

An important issue worth being explored is the capital-output ratio over various periods. Our calculations of this ratio are presented in Table 2. Although some volatility is observed in most countries (especially Algeria and Iran), the main picture emerging is of a ratio moving within the range 2-3 with a higher ratio recorded in sub-periods with relatively high economic growth. Thus, we see that during the70s and 80s the capital-output ratio was relatively high. The average capital-output ratio for the MENA countries in our sample seems to rise slightly from about 2 in the 60s to about 3 in the 80s and 90s. According to the neoclassical growth model a steady-state is characterized by an equal growth rate of output and physical capital, which translates into a constant capital-output ratio over time. Our findings lend no support to the validity of such a prediction and come in harmony with previous studies such as that of Nehru and Dhareshwar (1993). The average long-run capital-output ratio for the period 1960-98 seems to vary greatly among countries with Algeria, Syria, and Iran having the highest ratios and Sudan, Turkey, and Jordan featuring the lowest. A high ratio may indicate switching to capital-intensive production. However, it can also indicate low levels of capital utilization.

One of the measures that is often used to evaluate capital utilization over time is the Incremental Capital-Output Ratio (ICOR). This ratio provides a rough estimate for the net investment needed to increase output by one dollar. The lower this ratio, ceteris paribus, the higher the utilization of capital. It has been documented that ratios of 2-3 are typical for industrialized countries, whereas for underdeveloped countries with lower capital stock per worker and thus higher marginal product of capital, the ratio tends to be lower. Although useful, one has to be aware of the limitations of ICOR, mainly ignoring the effects of other variables. Lower value does not necessarily indicate highly productive capital. Value could be low also because of complementary factors such as labor, entrepreneurship, management, and knowledge. The ratio is calculated for the ten countries in our sample as well as for five groups of countries (based on results from Collins and Bosworth (1996)) and is presented in Table 3.

Analysis of the results shows that for the majority of the countries in our sample (the exceptions being Sudan and Tunisia), ICOR was on the rise in the first two decades. Such a pattern reflects the fact that these countries undertook massive investments that, ceteris paribus, lead to lower marginal productivity of capital and thus higher ICOR. During the 80s, there is no clear pattern; for six countries among the ten there was a rise in ICOR, while for the rest a decline was observed. The 90s was a period of relatively low investments that was translated into lower ICOR, i.e., higher rate of capital utilization. Among the countries under investigation, the ratio is highest in the oil exporting countries (Algeria, Iran, and Syria). From Table 3 we can observe that the average long-run ICOR for the MENA countries exceeds that of all regions with East Asia being very close. During the 1960-98 period ICOR averaged 3.28 in the MENA countries, compared with 1.64 for Africa, 1.33 for Latin America, and 1.28 for South Asia. Our findings reveal a possible low degree of efficiency of investments when compared to the rest of the world. The implications of lower ICOR should be taken cautiously. A high marginal productivity of capital (low ICOR) may indicate low levels of capital accumulation compared to the rest of the world. Yet, from the previous analysis of the capital output ratio this may not the case since the average ratio for the MENA countries seems to be in the same range of the rest of the world.

7. ESTIMATION OF THE SHARE OF CAPITAL

Several methods are employed to estimate the share of physical capital in national income. Some of the methods described earlier were inapplicable due to lack of data. We utilize two methods. First, we use panel-data techniques to estimate the share of physical capital. Such an approach assumes that the production function and the technology across countries are identical. Second, we relax this assumption and estimate the parameters of the production function separately for every country. We utilize the Johansen cointegration test to estimate the long-run share of capital.

7.1 Regional Estimates

Panel data techniques combining space and time dimensions have gained increasing popularity. Such techniques provide a larger sample, thereby increasing degrees of freedom and reducing co-linearity among explanatory variables. Furthermore, the scope of issues that can be addressed using panel data is much broader.[30]

Two specifications of the production function were taken to estimate the share of capital. The first is a production function with physical capital and labor as the only inputs. In this case the estimated regression is as follows:[31]

$$Ln(y_t^i) = a^i + \alpha Ln(k_t^i) + \varepsilon_t^i \qquad y = \frac{Y}{L};\ k = \frac{K}{L} \tag{19}$$

where lower case variables are the previously defined variables per worker and the superscript denotes country *i*. The second is a production function in which a measure of human capital stock is explicitly introduced as a labor-augmented input. The first measure of human capital we use is obtained from Nehru et al. (1995) and is supplemented by data from Barro and Lee (2000). It proxies human capital by the average years of schooling of the population aged 15 and above. Since previous research has shown that average years of schooling does not play a major role in determining economic growth, we chose to utilize an additional measure obtained from Collins and Bosworth (1996), which incorporates the average return to various levels of schooling. For both cases, the estimated production function is similar to equation (19) with one difference; The variables are now expressed per skill-adjusted worker:

$$Ln(y_t^i) = a^i + \alpha Ln(k_t^i) + \varepsilon_t^i \qquad y = \frac{Y}{LH};\ k = \frac{K}{LH} \tag{20}$$

where *H* stands for the measure of the adopted human capital.

---

[30] See Hsiao (1986).

[31] As in virtually all previous research, we assume constant returns to scale, i.e., the sum of the elasticities of the inputs with respect to national income equals one.

For each of the two specifications we estimated the production function in three different ways. First, we assumed that all cross-section members share the same intercept, i.e. a^i in equations (19) or (20) is identical among all the ten countries in our sample. Second, we estimated the model with fixed effects. Here, every country is assumed to have a different intercept to reflect country-specific characteristics. The model is estimated when there is a reason to believe that the unobserved effect a^i is correlated with k^i. Third, estimation with random effects assuming a lack of correlation of the unobserved a^i with each k^i in all time periods.

The results of our estimation of the various specifications of the production function are presented in Table 4. We conducted the estimation once with pooled annual data and then with pooled averages over five years. The latter method eliminates possible effects of business cycles and temporary shocks. Estimation is performed using Seemingly Unrelated Regression (SUR) which corrects for both cross-section heteroskedasticity and contemporaneous correlation for the common intercept and fixed effects models.

Several interesting points emerge from Table 4 with regard to regional estimates of the share of physical capital:

- As has been documented in many studies,[32] the share of capital in developing countries, the MENA region members being among them, is much higher than the frequently used share of 0.3-0.4. We observe a share that tops 0.44 in all cases and often exceeds 0.6.[33]
- The highest share estimated is obtained when we take the average years of schooling as our proxy of human capital. Such a measure has been criticized by researchers since it omits the quality dimension of human capital. Furthermore, the measure seems to feature very inflated rates of growth of human capital as opposed to the quality adjusted measure (see Table 7). The reliability of the results stemming from a production function that includes average years of schooling is somewhat shaky. The estimated shares are very high and in some specifications they exceed one, especially when the data is pooled over a 5-year span.
- Among the other two specifications, a production function that includes human capital proxied by years of schooling adjusted to average returns to schooling is preferred over the basic production function that includes no human capital measure. This preference is justified both theoretically and empirically; New growth theories have advocated the significance of human capital in determining economic growth. Additionally, our estimates are in line with

[32] See, for example, Collins and Bosworth (1996).

[33] Senhadji (1999) argues that since $\alpha = \frac{\partial Y}{\partial K} \cdot \frac{K}{Y}$ is the product of the marginal productivity of capital, which is usually higher in developing countries, and the capital-output ratio, which is usually lower in developing countries, the answer is ambiguous.

previous studies. When including quality-adjusted labor, we obtain α in the range of 0.44-0.70, while it ranges between 0.56-0.72 when no human capital is included.

- Among the three models examined, researchers seem to prefer the fixed effects model that allows for the existence of country-specific factors. Our findings are reasonable and are comparable to results obtained in other studies (Senhadji (1999), and Bisat et al., 1997).
- No significant difference is observed between pooling the data annually or over averages of five years.

7.2 Country-specific Estimates – Cointegration

It is recognized that the relationship between output and inputs as expressed in the form of a production function is a stable relationship. Investigating the existence of long-term relationship involves testing whether the variables are cointegrated or not. Finding cointegration rules out the possibility of a spurious relationship. We test for cointegration between output per quality-adjusted labor and the corresponding physical series.[34] A first step when testing for cointegration is to check whether the variables involved are integrated of the same order. The results of the Augmented Dickey-Fuller unit roots test are presented in Table 5. Our tests verify that the output and physical capital per quality-adjusted labor, *y* and *k*, have unit roots in levels and stationary in first difference, i.e. both are *I(1)*. It is worth mentioning that we have chosen the lag order based on AIC to assure that the residuals are white noise.

In the next step we conducted the Johansen cointegration test. Since it is known that the results of the Johansen test are sensitive to lag length, we determined the optimal lag length from the unrestricted VAR using AIC. Doing so assures us of the residuals being white noise, thus, eliminating possible serial correlation. Since we have two endogenous variables in our system (*y* and *k*), the maximum number of cointegration vectors is one, i.e. there is at most one long-run linear combination that is stationary. We test for the number of cointegration vectors using the trace statistic. We check whether we can reject the hypothesis of no cointegration (hypothesis HA in column 3 of Table 6). Our results reveal that for all countries in our sample, with the exception of Morocco, the hypothesis of no cointegration can be rejected at the 5% significance level. In Morocco's case we tested several lag lengths and other specifications of the model (using years of schooling as a proxy for human capital, and no measure for human capital). Our results remained intact.

---

[34] Aware of the significance of human capital, we chose not to present the results for the case where no human capital measure is included. Additionally, previous estimates showed that taking average years of schooling lead to overestimated α.

The implications of cointegrated variables are significant. Any relationship between the two variables (*y* and *k*) reflects a meaningful long-run relationship and not a spurious one. An important product of the Johansen's test is a normalized cointegration vector. Column (4) of Table 6 shows the coefficient of capital per quality-adjusted labor. The estimated share is highly significant in six out of nine cases where we identified cointegration. For Jordan and Sudan the coefficient were found to be insignificant even at the 10% significance level. For Tunisia, the estimated share of physical capital was found to be outside the acceptable interval of (0, 1) and which induced us to try a different method to discover the value of α. We applied GMM with a trend factor. The same method was used for Morocco where no cointegration was detected.

Our results reveal that the magnitude of α varies substantially across countries. Sudan stands as the country with the lowest share, 0.07. However, as mentioned earlier, the coefficient is insignificant. The significant estimates range from 0.32 (Egypt) to 0.87 (Israel). Generally speaking, for most of the countries with cointegrated variables, the share seems to be higher than what researchers typically assume it to be. The average share for the selected countries amounts to 0.54 when Jordan and Sudan (where the coefficients are not significant) are included. When excluding these two countries the share is much higher (0.60). The average is in the same vicinity of our estimates when panel data for regional estimation is applied.

8. SOURCES OF GROWTH

Before proceeding to decompose of the growth of output into the contributions of inputs and TFP, we should note that the value of α plays a key role in determining the relative contribution of the various factors. It can be shown that the contribution of A as the share of capital varies is given by:

$$\frac{\partial \widehat{A}_t}{\partial \alpha}\begin{cases}\geq 0\\ < 0\end{cases} \Leftrightarrow \begin{cases}\widehat{K}_t \leq (\widehat{L}_t + \widehat{H}_t)\\ \widehat{K}_t > (\widehat{L}_t + \widehat{H}_t)\end{cases} \qquad \hat{Z}_i = \frac{\dot{Z}_i}{Z_i};\ i = A, K, L, H \tag{21}$$

The above derivative shows that the contribution of TFP falls as the share of physical capital (α) rises if the combined growth rate of labor and human capital falls short of the growth rate of physical capital. The opposite holds if the combined growth rates are larger than the growth rate of *K*. In most countries the average growth rate of K is larger than the growth rate of skill-augmented labor. Thus, we expect to find that taking a higher α would result in a rise of the contribution of physical capital and a decline in the contribution of TFP. The two measures that we adopt to proxy for human capital significantly differ in their growth rates. In most cases, the growth rate of the labor-quality index (HCB) (adopted from Collins and Bosworth (1996)) is substantially lower than the growth rates of average years of schooling (HND) (adopted from Nehru et al. (1995) and Barro and Lee (2000)). Columns (4) and (6) of Table 2.9 indicate that the growth rates of HND are greater than the growth rates for HCB (our preferred measure of human capital) in all cases. We observe that the growth rates of HND are at least double that of HCB and in some cases even more than 15 times that of HCB. Since HCB is based on HND (being a quantity measure) but with adjustment for quality we find that HCB is a better measure of human capital. Despite this, and for the sake of sensitivity analysis, we carry out our exercises also when HND is used.

From Table 7 we see that the growth rate of physical capital stock (column 2) is always greater than the growth rate of quality-augmented labor (column 5) when HCB is taken to be our proxy of human capital. Thus, as it follows from equation (21), taking a higher share of capital would result in a higher contribution of physical capital and lower contribution of TFP to growth. When HND is considered, our conclusion holds true only for three countries; Egypt, Jordan, and Turkey. For the rest, the opposite is true.

Our growth accounting exercise is concluded by breaking up the growth rate of output per capita into the contributions of physical capital per worker, human capital, and total factor productivity. The contribution of physical capital is calculated as its share in income times its annual average growth. Likewise, the contribution of human capital is found by multiplying its share in national income ($1 - \alpha$) multiplied by its growth rate. TFP's contribution is the residual.

In our analysis we adopt the human capital series that embodies elements of both quantity and quality (the series from Collins and Bosworth, 1996). Additionally, we assume that the production function has constant returns to scale. Thus, the share of skill-augmented labor is assumed to be $1-\alpha$. Three different alternatives of the value of the share of capital are considered:

- Regional estimate obtained from panel data analysis assuming country-specific factors to exist (fixed effects).
- Same as above but with random effects.
- Country-specific estimates based on the Johansen's cointegration test.

We do not consider a priori estimate as it was done in many earlier studies, since we found that the typical share of the MENA countries is higher than the usual 0.30-0.40 range.

The results of the sources of growth exercise under a regional estimate obtained from a fixed effects model ($\alpha = 0.55$) are depicted in Table 8. We perform the exercise for several sub-periods of 1960-98. All growth rates are calculated through a semi-log regression of the natural logarithm of the respective variable on a constant and time coefficient. Such a measure frees us from reliance on single observations that are subject to business cycles. With the exceptions of Jordan and Sudan, TFP growth was positive in the 1960s and contributed to the growth of GDP. In most of the countries, the TFP growth constituted the major factor leading to growth. However, such a trend is not the norm in almost all countries over the rest of the period 1960-98. The 1970s and 1980s witnessed relatively high economic growth that was driven mainly by massive investments (mostly public) and accumulation of physical capital. During the 1970s, TFP growth declined in five of the ten countries and contributed only marginally in the rest of the countries (with the exception of Jordan and Egypt where TFP contributed about 19% of GDP growth). The trend of the 70s intensified during the 1980s. TFP growth was negative in seven countries. However, Israel, Morocco, and Turkey stand in clear contrast to the trend. Israel's TFP grew by 0.97%, contributing most of Israel GDP per worker growth (78%) while for Morocco and Turkey and TFP growth contributed 50% and 17% of the growth of GDP per worker, respectively. The evidence in the 1990s decade was mixed. However, the picture that emerges is a gloomy one. TFP is not a major factor propelling economic growth and often it undermines it.

Long-run patterns are also presented in Table 8. Over the whole period 1960-98, TFP growth was negative in six countries, positive but not significant in three countries (Egypt, Morocco, and Tunisia), and fundamental only in the case of Israel.

The drop in TFP for most of the MENA countries seems to be a major factor in the sluggish growth of GDP. The negative growth of TFP indicates that the MENA countries suffered from factors leading to lower production efficiency over time and failed to improve the efficiency of their production factors. Our findings are in line with many earlier studies covering developing countries. It has been documented that TFP did not contribute to growth in a large number of developing countries, with TFP being negative in many cases.[35]

Focusing on the long-run pattern we find that the role of human capital is essential in determining economic growth. However, the magnitude of its contribution varies substantially. During the period 1960-98, the contribution of human capital was in the range of 89% of GDP per worker growth (in Sudan H contributed 0.17% annually of the modest 0.19% of GDP per worker growth) to 10% (in Israel).

To sum up, we find that accumulation of physical capital as well as human capital have contributed considerably to growth, while TFP caused a contraction in economic activity in the whole 1960-98 period as well as in most of the sub-periods considered.

[35] See Senhadji (2000), Collins and Bosworth (1996) and Bisat et al. (1997).

To test whether out conclusions hold under different values of the share of capital, we carried out the same decomposition exercise under a share of capital of 0.44 for all countries as was obtained from a panel data analysis with random effects. According to equation (21) and Table 7, we expect that due to the fact that the growth rate of physical capital is greater than the growth rate of skill-augmented labor that the contribution of *K* declines while TFP's contribution rises. This prediction accurately reflects the emerging pattern depicted in Table 9. Despite the fact that the relative contribution of physical capital declined and the contribution of both human capital and TFP increased, the sign of TFP growth did not change and remained mainly negative. Thus, the same patterns were preserved under the lower share of physical capital.

From a presumed identical production function across the countries in the MENA region under panel data estimation, we switch to treating each country separately by estimating individual production functions. We have advocated the use of cointegration tests to estimate the "true" long-run elasticity of output with respect to physical capital. Ordinary least square regressions are plagued by severe shortcomings that deem inferences and estimates based on it unreliable. The results of the sources of growth exercise using our preferred country-specific estimates of α are depicted in Table 10. Several interesting are worth paying attention to:

1. Our estimates vary across countries and range between 0.07 (Sudan) and 0.87 (Israel). This fact should be kept in mind when we consider the relative contributions of the various factors to economic growth. A higher α, ceteris paribus, tends to raise the contribution of physical capital and lower that of human capital and TFP.
2. Over the whole period under investigation, changes in TFP do not seem to amount to a sizeable share of GDP growth. Six out of the ten countries in our sample display negative TFP growth, thus slowing economic growth. In addition, Tunisia's case represents a positive, though negligible, growth of TFP. The rest of the countries (Egypt, Israel, and Morocco) witnessed a rise in TFP over the years at varied rates. In Egypt's case, TFP growth contributes 1.07% of the annual growth of 3.15% (about 34%) of GDP per worker, while for Israel it contributes 0.65% of the 2.34% annual growth (about 28%), and for Morocco it contributes 0.35% of the annual 1.71% growth (20%). Despite all, accumulation of inputs stands as the major factor behind economic growth in the MENA countries. Not surprising is the contribution of human capital to growth. The patterns are similar to the ones we identified earlier in our discussion.
3. When dividing the 1960-98 into sub-periods, we witness some interesting trends. First, in the 1960s, TFP was a major factor in determining growth. Its contribution is positive in seven of the ten countries and exceeds that of physical capital in the cases of Algeria, Egypt, Israel,

and Morocco. For three cases (Jordan, Sudan, and Tunisia) TFP growth was negative. Second, during the 70s MENA countries experienced massive investments and rapid growth following the oil boom. Consequently, the contribution of TFP was undermined. TFP growth was negative in six countries, modestly positive in Tunisia's case, and relatively significant in Egypt, Jordan, and Sudan.[36] This trend did not change much during the 80s even though the composition of the group of countries suffering from a decline in TFP changed. The trend became positive in the cases of Israel and Morocco, while it became negative in Jordan, Sudan, and Tunisia. The picture in the 90s is mixed with no clear pattern. TFP became a major contributor to growth in Egypt, Iran, Sudan, Syria, and Tunisia.

4. Despite the fact that our choice of the proxy of human capital shows a slow growth in skill-adjusted labor as depicted in Table 7, its contribution to the growth of GDP is steady. Focusing on the whole period of 1960-98, in some cases the growth of human capital was the leading factor in determining growth. Algeria, Egypt, Iran, Jordan, and Sudan are the countries with the most beneficial effect of human capital on growth.
5. Overall, accumulation of physical and human capital was the key factor leading to growth as it emerges from our growth accounting exercise. TFP does not seem to constitute a major source of growth, which points to a contraction of production efficiency.

The results of our analysis emphasize the need to investigate the policies that may have a role in determining productivity. Instead of focusing on growth rates of GDP as most studies do, we carry out a detailed inquiry into the factors affecting productivity as it is estimated from our growth accounting exercise. These issues constitute the core of a future paper..

Several measures can be taken by policy makers to stimulate growth through the creation of an environment to promote steady growth in capital stock by increasing flows of investment. That includes both domestic savings and foreign investment. For most of the MENA countries, the private sector plays a minor role in investment. However, as most economists believe, a sustainable flow of investments is not feasible without a substantial involvement of the private sector. Reforms and stabilization efforts are essential to attract external financing for investment activities. According to Bisat et al. (1997), the following factors are essential:

- Maintaining stable macroeconomic environment (inflation, fiscal imbalances, and current account).
- Accelerating structural reforms (privatization and financial reforms).
- Investing more effectively in the social sectors (education and training).

[36] Note that Sudan's country-specific estimated α was very low. Such a modest share tends to overstate the role played by human capital and total factor productivity.

- Strengthening the institutional and information base.

9. SUMMARY AND CONCLUDING REMARKS

In this study we attempted to determine the key factors leading to economic growth for ten MENA countries over the period 1960-98. Our goal was to find out whether the experiences of the countries under investigation provide us with some new evidence concerning the recently heated debate of K versus A. On particular, we wanted to clarify whether the growth of MENA countries was driven mainly by accumulation of physical and human capital or by improvements in efficiency.

To tackle these issues we applied the sources of growth exercise which necessitates a reliable series of physical capital as well as a good proxy of human capital. Several issues were to be addressed when constructing physical capital stocks. First, we needed a long enough series of past investments. With the help of data obtained from Nehru and Dhareshwar (1993), and Collins and Bosworth (1996), in addition to extrapolation based on the long-term growth of investments, we were able to extend the investment series as far back as 1950. Second, to estimate the initial capital stock. We attempted several approaches and settled on the one that avoid extreme assumptions or random values. The long investment series contributed to lessen the effect of the initial capital stock since its impact fades away as time advances; third, several rates of depreciation were considered and the growth rates of the constructed series seem not to be significantly influenced. Hence, following previous studies, we opted to use a rate of 5%.

The value of the shares of inputs in national income is known to play a key role in determining the magnitude of the contribution of factors accumulation and productivity to growth. We surveyed the various methods and chose to implement direct estimation of the production function rather than using a priori values of the range 0.30-0.40 as most of the previous studies have done. Two methods were adopted. First, assuming an identical production function for all the countries in our sample, we use panel data techniques to find the share of physical capital in income. Second, focusing mainly on the long-run, something that the production function presumed to reflect, we tested for cointegration and uncovered the value of the elasticity of output with respect to physical capital from the normalized cointegration vector.

Overall, our estimates of α, under all methods utilized, seem to be higher than the typical range of 0.30-0.40. However, our estimates vary substantially across countries and methods. This finding is in tandem with recent studies that reveal a much higher share of physical capital in developing countries.

The analysis of sources of growth shows that for the selected MENA countries, the role of TFP in determining economic growth is not significant and often detrimental. Most of the growth of GDP per worker for the MENA countries is due to accumulation of physical capital and improvements in the quality of labor. Our evidence is robust to the estimates of α. Despite the fact that a different value of α causes changes in the relative contribution of the various inputs and TFP, our conclusions were kept intact. We found that in the whole period as well as in some of the sub-periods, the growth of TFP was negative which led to declining growth.

Table 1 – Growth of Physical Capital Stock

Country	Period				
	60-70	70-80	80-90	90-98	60-98
Algeria	1.53	9.65	4.72	0.69	5.50
Egypt	5.97	8.31	7.56	2.03	6.71
Iran	9.38	12.36	2.35	2.70	6.91
Israel	5.60	5.98	2.66	6.20	4.83
Jordan	9.68	10.73	6.39	7.24	9.13
Morocco	3.63	8.36	3.62	2.74	5.31
Sudan	4.67	5.93	3.43	3.95	4.22
Syria	5.09	11.90	4.94	1.57	6.93
Tunisia	7.19	7.42	4.25	3.75	5.83
Turkey	5.46	8.21	6.05	6.70	6.71
Africa	4.30	6.91	2.55	2.17	4.02
East Asia§	7.77	11.39	9.01	8.87	9.27
Industrial Economies	3.70	3.15	4.17	4.79	3.93
Latin America	5.21	7.33	3.27	2.70	4.67
South Asia	5.31	4.00	5.04	5.67	4.99

Notes:

- Growth rates are calculated using the OLS regression $\ln(K) = \alpha_0 + \alpha_1 t$ for the corresponding period. Regional figures are based on Collins and Bosworth (1996). The samples include: 21 countries for Africa, 7 NICs for East Asia, 5 countries for South Asia, 22 countries for Latin America, and 23 economies for industrial countries.
- § Excluding China.

Table 2 – Capital Output Ratio: Selected Sub-periods

Country	Period				
	60-70	70-80	80-90	90-98	60-98
Algeria	3.58	3.50	4.67	5.16	4.44
Egypt	1.85	1.98	2.59	2.49	2.37
Iran	1.76	2.56	4.49	3.91	3.41
Israel	2.47	2.29	2.24	2.17	2.25
Jordan	0.85	1.44	1.98	2.66	2.02
Morocco	2.06	2.25	2.67	2.70	2.52
Sudan	1.05	1.24	1.60	1.47	1.38
Syria	3.00	3.33	4.74	3.93	3.97
Tunisia	2.56	2.61	3.07	2.96	2.88
Turkey	1.17	1.40	1.78	2.18	1.78
Average§	**2.04**	**2.26**	**2.98**	**2.96**	**2.70**

Notes:

- The capital stock series is constructed under the assumption of 5% depreciation.
- § Simple arithmetic average.

Table 3 – Incremental Capital Output Ratio (ICOR)

Country	Period				
	60-70	70-80	80-90	90-98	60-98
Algeria	0.82	5.00	7.29	1.84	5.70
Egypt	2.08	2.42	3.61	1.24	2.72
Iran	1.77	3.20	2.79	2.86	4.69
Israel	1.69	2.78	1.66	2.56	2.11
Jordan	1.11	1.69	2.64	3.41	3.03
Morocco	1.51	3.48	2.19	2.33	2.99
Sudan	2.92	1.22	1.65	0.77	1.62
Syria	3.02	4.20	8.47	1.07	4.27
Tunisia	3.55	2.96	3.72	2.48	3.14
Turkey	1.10	2.34	2.07	3.24	2.56
Average	**1.96**	**2.93**	**3.61**	**2.18**	**3.28**
Africa	0.92	2.21	2.22	1.28	1.64
East Asia[§]	1.33	2.25	2.51	4.77	3.22
Industrial Economies	1.03	1.78	1.52	2.22	1.62
Latin America	0.95	1.33	1.98	1.25	1.33
South Asia	1.41	1.55	1.10	1.32	1.28

Notes:

- ICOR is given as the coefficient α_1 of the following OLS regression: $K = \alpha_0 + \alpha_1 Y$. Regional figures are based on Collins and Bosworth (1996). The samples include: 21 countries for Africa, 7 NICs for East Asia, 5 countries for South Asia, 22 countries for Latin America, and 23 economies for industrial countries.
- § Excluding China.

Table 4 - Regional Estimates of the Share of Capital

Pooled Data - Annual			
Method	**Variables**	**α**	**t-stat**
Common Intercept	K5, LF	0.70	263.92***
	K5, LF, HCB	0.68	238.33***
	K5, LF, HND	0.84	331.86***
Fixed Effects	K5, LF	0.60	90.09***
	K5, LF, HCB	0.55	68.66***
	K5, LF, HND	0.73	97.83***
Random Effects	K5, LF	0.53	31.79***
	K5, LF, HCB	0.44	20.67***
	K5, LF, HND	0.99	22.25***

Pooled Data – 5-Year Averages			
Method	**Variables**	**α**	**t-stat**
Common Intercept	K5, LF	0.72	130.10***
	K5, LF, HCB	0.70	94.37***
	K5, LF, HND	0.97	103.14***
Fixed Effects	K5, LF	0.64	52.84***
	K5, LF, HCB	0.57	48.51***
	K5, LF, HND	1.21	50.22***
Random Effects	K5, LF	0.56	15.43***
	K5, LF, HCB	0.48	10.59***
	K5, LF, HND	0.90	10.90***

Notes:

- Variables include: K5 – physical capital stock assuming a 5% depreciation; LF – labor force; HCB – human capital measure (from Collins and Bosworth (1996)); HND – human capital measure (from Nehru et al. (1995)).
- The estimated equation is: $Ln(y_t^i) = a^i + \alpha Ln(k_t^i) + \varepsilon_t^i \quad y = \frac{Y}{LH} or \frac{Y}{L};\ k = \frac{K}{LH}\ or\ \frac{K}{L}$.
- The estimation is performed using Seemingly Unrelated Regressions to correct for both cross-section heteroskedasticity and contemporaneous correlation.
- *** indicates significance at 1%.

Table 5 - ADF Unit Root Test

Country	Variable	ADF in Levels	*p*	ADF in first differences	*p*
Algeria	Y/HL	-0.47	3	-3.26**	2
	K/HL	-1.76	4	-2.79*§	0
Egypt	Y/HL	-2.07	1	-3.67***	0
	K/HL	-2.61	1	-2.78*	0
Iran	Y/HL	-2.46	1	-3.26**	0
	K/HL	-0.89	3	-5.45***	0
Israel	Y/HL	-2.40	0	-4.98***	0
	K/HL	-2.00	1	-4.12***	0
Jordan	Y/HL	-2.13	2	-2.71*	1
	K/HL	-1.35	0	-2.65*	0
Morocco	Y/HL	-1.52	1	-8.76***	0
	K/HL	-1.31	1	-3.15**	0
Sudan	Y/HL	-2.33	1	-4.29***	0
	K/HL	-2.39	1	-2.97**	0
Syria	Y/HL	-1.71	3	-2.96**	2
	K/HL	-3.17	3	-2.61*	0
Tunisia	Y/HL	-2.01	0	-6.23***	0
	K/HL	-1.44	0	-2.64**	3
Turkey	Y/HL	-1.64	0	-5.73***	0
	K/HL	-2.59	2	-2.69*	4

Notes:

- Y/HL and K/HL are the logarithms of real GDP and physical capital stock, respectively, divided by skill augmented labor. Human capital is based on Collins and Bosworth (1996).
- *p* is the optimal lag length based on AIC with a maximum of 4 lags allowed.
- *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.
- § Serial correlation was detected and igher orders were used to eliminate it with no success.

Table 6 – Johansen's Cointegration Test Results

(1)	(2)	(3)	(4)	(5)
Country	**p**	**Trace Statistic**	**α**	**t- statistic**
Algeria	2	HA: 28.58** HB: 6.92	0.67	5.00***
Egypt	2	HA: 36.76*** HB: 8.75	0.32	7.04***
Iran	4	HA: 34.89*** HB: 7.41	0.63	6.08***
Israel	5	HA: 17.70*** HB: 2.98	0.87	168.06***
Jordan	5	HA: 20.81** HB: 8.88	0.31	0.90
Morocco§	2	HA: 16.80 HB: 5.12	0.40	3.61***
Sudan	2	HA: 17.25** HB: 2.67	0.07	0.63
Syria	3	HA: 20.19** HB: 4.72	0.74	13.68***
Tunisia†	3	HA: 30.00** HB: 6.73	0.64	6.94***
Turkey	3	HA: 27.58** HB: 11.35	0.76	3.35***

Notes:

p optimal lag length in the unrestricted VAR system, determined by AIC.
Trace statistic for testing the following hypotheses:
HA: no cointegration
HB: one cointegration vector
, * for the trace statistic indicate rejection of the corresponding hypothesis at 5%, and 1%, respectively.
*** for t-statistic indicates significance at the 1% level.
§ No cointegration. α was estimated using GMM which includes a trend.
† Parameter fell outside the interval (0, 1). Replaced with a GMM estimator (with trend).

Table 7 – Growth Rates of Selected Variables, 1960-98

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	**Percentage**					
	K5	**LF**	**HCB**	**HCB+LF**	**HND**	**HND+LF**
Algeria	5.50	3.06	0.91	3.97	3.64	6.70
Egypt	6.71	2.35	1.01	3.36	2.48	4.83
Iran	6.91	2.72	0.91	3.62	5.20	7.91
Israel	4.83	2.97	0.53	3.50	3.20	6.17
Jordan	9.13	4.26	0.95	5.21	4.14	8.40
Morocco	5.31	2.61	0.46	3.08	5.89	8.50
Sudan	4.23	2.63	0.37	3.00	6.00	8.64
Syria	6.93	3.10	1.45	4.55	4.64	7.74
Tunisia	5.83	2.81	0.93	3.74	4.09	6.90
Turkey	6.71	2.00	0.72	2.72	3.13	5.12

Notes:

- Variables include: K5 – physical capital stock assuming a 5% depreciation; LF – labor force; HCB – human capital measure (from Collins and Bosworth (1996)); HND – human capital measure (from Nehru et al. (1995)).
- Growth rates of variable *x* are obtained from the following regression: $\ln(x) = \alpha_0 + \alpha_1 t$.

Table 8 - Sources of Growth – Panel Data (Fixed Effects) - α = 0.55

Country	Period	Growth of	Contribution of		
		Y/L	K/L	H	TFP
Algeria	60-70	4.26	0.46	0.20	3.60
	70-80	3.71	3.62	0.39	-0.31
	80-90	-1.16	0.49	0.51	-2.17
	90-98	-2.88	-1.87	0.38	-1.39
	60-98	1.20	1.35	0.41	-0.56
Egypt	60-70	3.05	2.11	0.15	0.80
	70-80	4.68	3.41	0.39	0.88
	80-90	2.72	2.78	0.64	-0.70
	90-98	1.32	-0.43	0.45	1.30
	60-98	3.15	2.40	0.45	0.29
Iran	60-70	7.14	4.00	0.32	2.83
	70-80	0.47	5.28	0.45	-5.26
	80-90	-1.25	-0.32	0.40	-1.32
	90-98	1.37	0.29	0.51	0.58
	60-98	1.03	2.31	0.41	-1.68
Israel	60-70	4.13	1.01	0.29	2.83
	70-80	2.05	1.85	0.41	-0.21
	80-90	1.24	0.25	0.01	0.97
	90-98	1.23	1.21	0.10	-0.07
	60-98	2.34	1.02	0.24	1.08
Jordan	60-70	0.20	2.16	0.32	-2.27
	70-80	6.18	4.61	0.39	1.18
	80-90	-2.37	0.85	0.56	-3.78
	90-98	0.04	1.11	0.31	-1.38
	60-98	0.97	2.68	0.43	-2.14
Morocco	60-70	2.90	1.00	0.16	1.73
	70-80	2.23	2.83	0.19	-0.79
	80-90	1.64	0.61	0.22	0.82
	90-98	-0.20	0.18	0.26	-0.65
	60-98	1.71	1.48	0.21	0.02
Sudan	60-70	-0.56	1.57	0.04	-2.17
	70-80	1.95	1.60	0.22	0.13
	80-90	-2.07	0.51	0.17	-2.75
	90-98	4.88	0.65	0.19	4.05
	60-98	0.19	0.88	0.17	-0.85
Syria	60-70	2.21	1.67	-0.74	1.28
	70-80	6.46	4.90	0.26	1.29
	80-90	-1.78	0.92	1.49	-4.18
	90-98	1.52	-1.48	0.98	2.02
	60-98	2.54	2.11	0.65	-0.22
Tunisia	60-70	3.74	3.27	0.32	0.15
	70-80	3.10	2.13	0.54	0.42
	80-90	0.48	0.79	0.34	-0.65
	90-98	1.46	0.47	0.37	0.62
	60-98	2.30	1.66	0.42	0.22
Turkey	60-70	4.42	2.21	0.27	1.94
	70-80	3.21	3.72	0.31	-0.82
	80-90	2.60	1.88	0.27	0.44
	90-98	1.50	2.24	0.47	-1.20
	60-98	2.62	2.59	0.33	-0.29

Table 9 - Sources of Growth – Panel Data (Random Effects) - α = 0.44

Country	Period	Growth of Y/L	Contribution of K/L	Contribution of H	Contribution of TFP
Algeria	60-70	4.26	0.37	0.25	3.64
	70-80	3.71	2.90	0.49	0.32
	80-90	-1.16	0.40	0.63	-2.19
	90-98	-2.88	-1.50	0.47	-1.85
	60-98	1.20	1.08	0.51	-0.39
Egypt	60-70	3.05	1.69	0.18	1.18
	70-80	4.68	2.73	0.49	1.46
	80-90	2.72	2.22	0.80	-0.30
	90-98	1.32	-0.34	0.56	1.11
	60-98	3.15	1.92	0.57	0.66
Iran	60-70	7.14	3.20	0.40	3.55
	70-80	0.47	4.23	0.56	-4.31
	80-90	-1.25	-0.26	0.50	-1.48
	90-98	1.37	0.23	0.63	0.51
	60-98	1.03	1.85	0.51	-1.32
Israel	60-70	4.13	0.81	0.37	2.96
	70-80	2.05	1.48	0.51	0.06
	80-90	1.24	0.20	0.02	1.02
	90-98	1.23	0.97	0.12	0.15
	60-98	2.34	0.82	0.30	1.22
Jordan	60-70	0.20	1.72	0.39	-1.92
	70-80	6.18	3.69	0.48	2.01
	80-90	-2.37	0.68	0.69	-3.74
	90-98	0.04	0.89	0.38	-1.23
	60-98	0.97	2.14	0.53	-1.71
Morocco	60-70	2.90	0.80	0.20	1.89
	70-80	2.23	2.26	0.23	-0.27
	80-90	1.64	0.49	0.27	0.89
	90-98	-0.20	0.15	0.33	-0.68
	60-98	1.71	1.19	0.26	0.26
Sudan	60-70	-0.56	1.26	0.05	-1.86
	70-80	1.95	1.28	0.27	0.39
	80-90	-2.07	0.41	0.21	-2.69
	90-98	4.88	0.52	0.23	4.13
	60-98	0.19	0.70	0.21	-0.71
Syria	60-70	2.21	1.34	-0.92	1.79
	70-80	6.46	3.92	0.33	2.20
	80-90	-1.78	0.73	1.85	-4.36
	90-98	1.52	-1.18	1.22	1.48
	60-98	2.54	1.69	0.81	0.04
Tunisia	60-70	3.74	2.61	0.40	0.72
	70-80	3.10	1.71	0.68	0.72
	80-90	0.48	0.63	0.42	-0.58
	90-98	1.46	0.38	0.46	0.62
	60-98	2.30	1.33	0.52	0.45
Turkey	60-70	4.42	1.76	0.34	2.31
	70-80	3.21	2.98	0.38	-0.15
	80-90	2.60	1.51	0.34	0.75
	90-98	1.50	1.79	0.58	-0.87
	60-98	2.62	2.07	0.40	0.15

Table 10 - Sources of Growth – Country Specific - Cointegration

Country (α)	Period	Growth of Y/L (%)	Contribution of (%)		
			K/L	H	TFP
Algeria (0.67)	60-70	4.26	0.57	0.15	3.55
	70-80	3.71	4.41	0.29	-0.99
	80-90	-1.16	0.60	0.37	-2.14
	90-98	-2.88	-2.28	0.28	-0.88
	60-98	1.20	1.64	0.30	-0.74
Egypt (0.32)	60-70	3.05	1.23	0.22	1.61
	70-80	4.68	1.98	0.60	2.10
	80-90	2.72	1.62	0.97	0.13
	90-98	1.32	-0.25	0.68	0.90
	60-98	3.15	1.40	0.69	1.07
Iran (0.63)	60-70	7.14	4.58	0.26	2.30
	70-80	0.47	6.05	0.37	-5.94
	80-90	-1.25	-0.37	0.33	-1.20
	90-98	1.37	0.33	0.42	0.63
	60-98	1.03	2.64	0.34	-1.95
Israel (0.87)	60-70	4.13	1.60	0.09	2.45
	70-80	2.05	2.92	0.12	-0.99
	80-90	1.24	0.39	0.00	0.84
	90-98	1.23	1.91	0.03	-0.70
	60-98	2.34	1.62	0.07	0.65
Jordan (0.31)	60-70	0.20	1.21	0.49	-1.50
	70-80	6.18	2.60	0.60	2.99
	80-90	-2.37	0.48	0.85	-3.70
	90-98	0.04	0.63	0.47	-1.06
	60-98	0.97	1.51	0.66	-1.20
Morocco (0.40)	60-70	2.90	0.73	0.21	1.95
	70-80	2.23	2.06	0.25	-0.08
	80-90	1.64	0.44	0.29	0.91
	90-98	-0.20	0.13	0.35	-0.69
	60-98	1.71	1.08	0.28	0.35
Sudan (0.07)	60-70	-0.56	0.20	0.08	-0.84
	70-80	1.95	0.20	0.46	1.29
	80-90	-2.07	0.07	0.34	-2.48
	90-98	4.88	0.08	0.38	4.41
	60-98	0.19	0.11	0.34	-0.26
Syria (0.74)	60-70	2.21	2.25	-0.42	0.39
	70-80	6.46	6.60	0.15	-0.30
	80-90	-1.78	1.23	0.86	-3.87
	90-98	1.52	-1.99	0.57	2.94
	60-98	2.54	2.84	0.38	-0.67
Tunisia (0.64)	60-70	3.74	3.80	0.26	-0.32
	70-80	3.10	2.48	0.43	0.18
	80-90	0.48	0.92	0.27	-0.72
	90-98	1.46	0.55	0.29	0.61
	60-98	2.30	1.93	0.33	0.03
Turkey (0.76)	60-70	4.42	3.05	0.15	1.22
	70-80	3.21	5.15	0.16	-2.10
	80-90	2.60	2.60	0.15	-0.15
	90-98	1.50	3.09	0.25	-1.84
	60-98	2.62	3.58	0.17	-1.13

BIBLIOGRAPHY

Barro, R. J. and Lee, J. (1993), "International Comparisons of Educational Attainment," *Journal of Monetary Economics*, 32(3), 363-394.

Barro, R. J. and Lee, J. (2000), "International Data on Educational Attainment: Updates and Implications," CID Working Paper no. 42, Cambridge, MA.

Bisat, A., El-Erian M. A. and Helbling T. (1997), "Growth, Investment, and Saving in the Arab Economies," *IMF Working Paper*, WP/97/85, Washington, DC.

Caselli, F., Esquivel, G. and Lefort, F. (1996), "Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics," *Journal of Economic Growth*, 1(3), 363-389.

Collins S. M. and Bosworth B. P. (1996), "Economic Growth in East Asia: Accumulation versus Assimilation," *Brookings Papers on Economic Activity*, 2, 135-191.

Costello, D. M. (1993), "A Cross-Country, Cross-Industry Comparison of Productivity Growth," *Journal of Political Economy*, 101(2), 207-222.

Denison, E. F. (1962), "Sources of Economic Growth in the United States and the Alternatives Before Us," Supplement Paper 13, New York, Committee for Economic Development.

Harberger, A. (1978), "Perspectives on Capital and Technology in Less Developed Countries," in Artis, M. J. and Nobay, A. R. (eds.), *Contemporary Economic Analysis*, Croom Helm, London.

Harrison, A. (1996), "Openness and Growth: A Time Series, Cross-Country Analysis for Developing Countries," *Journal of Development Economics*, 48(2), 419-447.

Hsiao, C. (1986), *Analysis of Panel Data*, Cambridge, UK, Cambridge University Press.

Intriligator, M. D., Bodkin, R. G. and Hsiao, C. (1996), *Econometric Methods, Techniques, and Applications*, 2nd edition, Upper Saddle River, NJ, Prentice Hall.

Johansen, S. (1988), "Statistical Analysis of Cointegration Vectors," *Journal of Economic Dynamics and Control* 12(2-3), 231-254.

Jorgenson, D. W. and Griliches, Z. (1967), "The Explanation of Productivity Change," *Review of Economic Studies*, 34(3), 249-83.

Krugman, P. (1994), "The Myth of Asia's Miracle," *Foreign Affairs*, 73(6), 62-78.

Mankiw, G. N. (1995), "The Growth of Nations," *Brookings Papers on Economic Activity*, 1, 275-310.

Mankiw, G. N., Romer, D. and Weil, D. N. (1992), "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, 107(2), 407-437.

Miller, E. M. (1989), "The Definition of Capital for Solow's Growth Accounting Formula," *Southern Economic Journal*, 56(1), 157-165.

Mincer, J. (1974), *Schooling, Experience, and Earnings*, New York, Columbia University Press.

Nehru, V. and Dhareshwar, A. (1993), "A New Database on Physical Capital Stock: Sources, Methodology and Results," *Revista de Analisis Economico*, 8(1), 37-59.

Nehru, V., Swanson, E. and Dubey, A. (1995), "A New Database on Human Capital Stock in Developing and Industrial Countries: Sources, Methodology, and Results," *Journal of Development Economics*, 46(2), 379-401.

Norsworthy, J. R. (1984), "Growth Accounting and Productivity Measurements," *Review of Income and Wealth*, 30(3), 309-329.

Phillips, P. C. B. and Hansen, B. E. (1990), "Statistical Inference in Instrumental Variables Regression with I(1) Processes," *Review of Economic Studies*, 57(1), 99-125.

Psacharopoulos, G. (1985), "Returns to Education: A Further International Update and Implication," *The Journal of Human Resources*, 20(4), 583-604.

Psacharopoulos, G. (1994), "Returns to Investment in Education: A Global Update," *World Development*, 22(9), 1325-1343.

Senhadji, A. (1999), "Sources of Economic Growth: An Extensive Accounting Exercise," *IMF Working Paper*, WP/99/77, Washington, DC.

Senhadji, A. (2000), "Sources of Economic Growth: An Extensive Accounting Exercise," *IMF Staff Papers*, 47(1), 129-157.

Solow, R. M. (1957), "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, 39(3), 312-320.

World Bank (2000), *World Development Indicators 2000 CD ROM*, Washington, DC.

Young, A. (1995), "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience," *Quarterly Journal of Economics*, 110(3), 641-80.