The Role of Total Factor Productivity in the Mediterranean Countries

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The aim of the present work is to focus attention on the role of technological progress in the economic growth of Mediterranean countries. The Mediterranean is an area that has only partially been covered by international statistics and by the specialized literature. Therefore, it has been necessary to start measuring the data of the 24 observed countries using a consistent methodology. Based on the estimated data, it has then been possible to estimate total factor productivity, which we have considered to be a synthesis of many elements that affect the overall efficiency of the economy. Estimates of the TFP also made it possible to break up the growth rate of aggregate output per worker into the contribution of physical capital, human capital and TFP.

INTRODUCTION

In recent decades there has been an explosion of empirical studies on economic growth. The new debate is characterized by the interest in the determinants of growth and, in particular, the contrast between those who consider the accumulation of capital as the key factor for growth and those who emphasize the centrality of the total factor productivity (TFP). This dispute dates back to the famous debate between Dale W. Jorgenson, Zvi Griliches and Edward F. Denison (Jorgenson and Griliches 1967; Jorgenson, Griliches, and Denison 1972) and sets the boundary line between the neoclassical approach and the endogenous growth theory.

The aim of the present work is to enter into this lively debate, focusing attention on the role of technological progress in the economic growth of a particular geographical portion of our world, the Mediterranean. According to the historian Anthony Molho (2002), the historical density, the diversity and complexity of the Mediterranean social interaction, offer an exclusive point of view, an observation point that continues to receive very little attention in economic literature.

 In this paper we choose to adopt quite a broad definition of the Mediterranean area, as it includes 24 countries: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Jordan , Lebanon, Libya, Malta, Morocco, Palestine, Portugal, Serbia and Montenegro, Slovenia, Spain, Syria, Macedonia, Tunisia and Turkey. The time frame, which we focus on, covers the period 1970–2008.

The work is organized as follows. In the next section we will focus on the concept of TFP and describe the different methods used for its estimation. In section three we will try to summarize the results of the existing literature on the Mediterranean. In the fourth section the estimates will be developed for the determination of physical capital stock, of human capital stock and the relative share of physical capital to production. These time series are essential for estimating the TFP, which will be developed in section five. Section six will provide the breaking down of growth rates of aggregate product per worker, in order to identify the key factors leading to economic growth in the Mediterranean countries. Finally, the conclusion will offer a synthesis of the study.

CONCEPTS AND ESTIMATION METHODS OF TOTAL FACTOR PRODUCTIVITY

Before addressing the estimation of the TFP, it is interesting to focus our attention on the concept of total factor productivity. Actually, there is no universally accepted concept, but rather different variations, often in contradiction with each other. Zvi Griliches (1996), for example, seems very doubtful that the TFP could be something really useful: 'all of the pioneers of this subject were quite clear about the tenuousness of such calculations and that it may be misleading to identify the results as measures of pure technical progress. Abramovitz labelled the resulting index "a measure of our ignorance."' On the contrary, Charles Hulten (2000) considers that the TFP can provide interesting information, especially about factors without market price: 'To the extent that productivity is affected by innovation, it is part of cost-technical change that it captures. This "Manna from Heaven" may reflect spillover externalities thrown off by research projects, or it may simply reflect inspiration and ingenuity.' By placing greater emphasis on the TFP, Nicholas Crafts (1996) and Robert Barro (1999) stress the importance of this measure as a proxy of technological change. Crafts, for example, writes: 'It is clear that British capabilities for the transfer and improvement of technology were strong and improving during the first industrial revolution, and this undoubtedly was central to the (otherwise surprising) steady acceleration in TFP growth.' And Barro, in one of the first issues of the *Journal of Economic Growth,* says: 'Growth accounting provides a breakdown of observed economic growth into components associated with changes in factor inputs and a residual that reflects technological progress and other elements.'

Similarly to the concept of TFP, there are different approaches used to estimate the TFP. A first non-parametric methodology, known as the Data Envelope Analysis (DEA), recently implemented by Subodh Kumar and Robert Russell (2002). The basis of the idea is to use combinations of input-output data in order to obtain an approximation of a production frontier. Based on this approach, DEA attempts to identify the contribution of technological change, the speed of technological convergence and the role of physical capital in labor productivity. The advantage of this method is that it requires no strong assumptions about the initial structure of markets nor the absence of their imperfections. However, the disadvantage of reconstruction is that the technological frontier is only an approximation of the real one, with the result that sometimes the results are not very plausible (such as the evidence of lack of technology that should be attributed to declining efficiency). A solution to the problem of the econometric estimation of TFP is suggested by Nazrul Islam (1995). Starting from the convergence proposed by Mankiw, Romer and Weil (1992), Islam introduces the idea that differences in the levels of TFP are correlated with other explanatory variables. Since the correlation does not imply the consistency of OLS estimates, Islam uses an appropriate technique to panel fixed effects. According to this specification, the TFP of a coun-

try is well represented by the sum of a first term that captures the growth rate of a technological frontier (assumed as a constant for all countries) and a second term (different for each country) which takes account of several unobserved factors such as institutions or technol-
[30] ogy. However, the main problem with this method is that, by definition, the TFP grows at the same speed in all countries (equal to the value of the first term). Consequently, the degree of heterogeneity of TFP is unchanged over time and no process of convergence can take place.

Another method of estimating the TFP, which is particularly widespread in the empirical literature (Klenow and Rodriguez-Clare 1997; Hall and Jones 1999; Aiyar and Feyrer 2002; Abu-Qarn and Abu-Bader 2007) and used in this work, is called 'growth accounting.' It was formally introduced by Robert Solow (1957) and measures the TFP in an indirect way, as a residual component of GDP that is not explained by the variations of inputs. The starting point for this method is an aggregate production function, which expresses the relationship between inputs and product aggregate. Among the different specifications, the most widespread production function is the homogeneous of first grade Cobb-Douglas, $Y = AK^{\alpha}L^{(1-\alpha)}$, where Y is the aggregate product (output), A the efficiency factor, K the physical capital stock, L the number of workers and α the relative share of physical capital to production.

PREVIOUS EMPIRICAL STUDIES

Empirical studies on growth have only marginally dealt with the Mediterranean countries. In fact, the attention of economists has focused on the MENA countries (Middle East and North Africa), a particular geographical area defined by the classifications of the World Bank and only partially referring to the Mediterranean.

Among the most recent studies, the contribution of Vikram Nehru and Ashok Dhareshwar (1993) deserves to be mentioned. It was carried out on a sample of 93 countries covering the period 1960–1990. The results for the MENA countries underline an interesting aspect: physical capital is an important factor of economic growth during the period. However, the growth rates of the TFP record the lowest values in the world, becoming negative in the periods 1980–1990 (with the exception of Turkey).

Another paper that used a large sample of countries is Susan Collins and Barry Bosworth's (1996). Their study aims to analyze the experience of the emerging Asian countries and uses the results for the other world regions (including the MENA area) for comparison. The results confirm the central role played by physical capital in the growth of income per capita in the MENA countries, while the role played by the TFP continues to appear negligible. The contribution of human capital is also equal to one third of the whole output variation.

The contribution of Amer Bisat, Mohamed El-Erian and Thomas Helbling (1997) is one of the few studies in which the MENA area is observed as a 'region.' The authors found that during the period 1971–1996, most of the observed countries (9 out of 13) showed negative growth rates of TFP, evidence that leads the authors to state: 'Arab countries suffered from the effects of factors which reduced the aggregate production efficiency over time.' Moreover, the econometric estimates reveal another element of particular importance: the relative contribution of physical capital to production is much higher than that normally used in growth accounting studies (between 0.3 and 0.4). However, the use of the highest values of the relative share of physical capital to production does not produce any significant difference in annual growth rates of TFP: the rates remain negative.

Abdelhak Senhadji (2000) performed a growth accounting exercise on 88 different countries, observed during the period 1960–1994, in order to grasp the differences in the levels of the TFP. The results show that the relative contribution of physical capital in the MENA production fluctuates between 0.63 and 0.54, depending on the different ways of expressing the explanatory variables. Repeating the methodology by panel estimates (fixed effects and random effects), Senhadji obtained values between 0.63 and 0.69. The estimates allow us to break up the output growth rate and proceed to focus attention on its very determinants. They show that the accumulation of physical capital justifies more than 75% of the economic growth of the MENA countries, while the contribution of TFP is particularly low in the period 1960–1973 and negative in the years after 1973. However, Senhadji shows that a slow process of convergence in the levels of TFP is taking place.

A similar result comes from Samir Makdisi, Zeki Fattah and Imed Limam (2000) who observed 92 countries over the period 1960–1997.

The breaking down of the aggregate GDP growth rate underlines, once again, the centrality of physical capital in the processes of economic growth in the MENA area. However, the growth rates of TFP record positive values only in countries that have experienced the highest growth rates of GDP (such as Egypt, Israel, Morocco, Tunisia and Turkey). According to the authors, the levels of TFP in the MENA countries are also weakly correlated to both the quality of institutions and human capital.

Finally, in the recent contribution by Aamer Abu-Quarn and Suleiman Abu-Bader (2007), 10 MENA countries were observed over the period 1960–1998. Although different specifications of the production function were used, the results converge in demonstrating that the relative contribution of physical capital to production in the MENA countries is greater than 0.4, reaching values that exceed unity. The role of TFP in economic growth is marginal, whereas the contribution of physical capital and improvements in the quality of the workforce seem very interesting.

DATA AND SOURCES

The statistical data on aggregate product, physical capital stock, human capital stock and the relative share of physical capital to production are indispensable elements in order to estimate the TFP and carry out a debate about the sources of economic growth.

However, the attempt to analyze 24 Mediterranean countries makes it impossible to use the physical capital and human capital database of Fischer (1993), Nehru and Dhareshwar (1994) or Easterly and Levine (1999), due to the sectional limits of the same database (for example, relative to Libya, Lebanon, Palestine, Albania, or to the new states of the former Yugoslavia). Therefore, an appropriate measure of inputs is needed, a measure that is often problematic and requires many assumptions.

In our case, the data on the aggregate product of the 24 Mediterranean countries, expressed in US dollars and 1990 constant prices, have been taken from the National Accounts Main Aggregates Database of the United Nations, a source that has the advantage of offering consistent statistical information from 1970 to over 200 countries (and, of course, for all the Mediterranean countries). Data on the work- ers have been extracted from the Total Economy Database (the Conference Board and Groningen Growth and Development Center, see http://www.ggdc.net) and integrated with those of the International Labor Organization. This integration has concerned Libya, Lebanon and Palestine, countries not included in the sample of 125 economies recorded by the Total Economy Database. The integration has been justified as a result of consistently high correlation between the two databases, which have a correlation coefficient near unity.

Table 1 shows the average annual growth rates of GDP per worker, by country. The value of the 'Mediterranean' is the average of the 24 countries observed.

The table draws attention to the time and the sectional high variability of the Mediterranean countries. The 70s seem to be the period of highest growth, followed by a slowdown in the first half of the 80s, culminating at the end of the decade. The 90s marked an economic upswing, which was particularly significant in the second half of the decade, while the first eight years of the 21st century record a moderate growth. Among the 24 countries, only Egypt, France, Israel, Malta, Portugal, Slovenia, Tunisia and Turkey have a positive growth rate of GDP per worker, in all sub-periods. Besides, the annual averages of GDP growth of Libya and Algeria are negative and closely related to the international oil market. In fact, during the 70s, the two oil producing countries had the highest average growth rates of their GDPs, followed by a long and deep recession that has attenuated only in recent years, again as a consequence of the world's increasing demand for oil.

The Measure of Physical Capital

In order to measure the physical capital stock, we have used the perpetual inventory method. The method moves from the assumption that the stock of physical capital (K) in a given year is equivalent to the cap-

TABLE 1 Average annual growth rates of GDP per worker (%)

Country	1971–1975	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000	2001–2005	2006–2008
Albania	0.0089	0.0100	−0.0060	−0.0234	−0.0042	0.0627	0.0844	0.0585
Algeria	0.0156	0.0336	0.0085	−0.0359	−0.0408	−0.0116	0.0097	−0.0079
Bosnia-Herz.					0.0630	0.1892	−0.0213	0.0176
Croatia					−0.0442	0.0136	0.0413	0.0281
Cyprus	−0.0463	0.0962	0.0428	0.0509	0.0269	0.0249	0.0017	0.0146
Egypt	0.0312	0.0527	0.0421	0.0304	0.0344	0.0221	0.0185	0.0322
France	0.0297	0.0252	0.0185	0.0231	0.0130	0.0137	0.0102	0.0058
Greece	0.0450	0.0312	−0.0120	0.0051	0.0070	0.0199	0.0278	0.0231
Israel	0.0416	0.0016	0.0088	0.0172	0.0153	0.0211	0.0003	0.0138
Italy	0.0255	0.0352	0.0139	0.0224	0.0196	0.0091	−0.0036	−0.0032
Jordan	−0.0251	0.1063	−0.0080	−0.0440	−0.0410	−0.0010	0.0219	0.0383
Lebanon	0.0012	−0.0455	0.0618	−0.1933	0.0622	0.0028	−0.0027	0.0337
Libyan Arab Jam.	0.0120	0.0455	−0.0713	−0.0498	−0.0167	−0.0253	0.0250	0.0314
Macedonia					−0.0239	0.0258	0.0157	0.0116
Malta	0.0896	0.0796	0.0318	0.0523	0.0381	0.0392	0.0023	0.0043
Morocco	0.0155	0.0238	0.0024	0.0120	−0.0196	0.0105	0.0291	0.0301
Palestinian Ter.	0.0758	0.0610	−0.0358	0.0329	0.0588	−0.0111	−0.0081	−0.0392
Portugal	0.0249	0.0409	0.0037	0.0283	0.0213	0.0192	0.0059	0.0075
Serbia-Mont.					−0.1401	0.0230	0.0596	0.0774
Slovenia					0.0035	0.0454	0.0324	0.0285
Spain	0.0475	0.0338	0.0299	0.0129	0.0228	−0.0012	−0.0072	0.0066
Syrian Arab Rep.	0.0911	0.0344	−0.0099	−0.0567	0.0271	−0.0106	−0.0017	0.0106
Tunisia	0.0477	0.0226	0.0132	0.0016	0.0070	0.0237	0.0142	0.0314
Turkey	0.0363	0.0064	0.0355	0.0347	0.0112	0.0277	0.0404	0.0254
Mediterranean	0.0299	0.0366	0.0089	−0.0042	0.0042	0.0222	0.0165	0.0200
Standard Deviation	0.0344	0.0344	0.0304	0.0565	0.0433	0.0406	0.0237	0.0227

NOTES Source: author's calculations based on data from the United Nations, the Conference Board and Groningen Growth and Development Center and the International Labour Organization.

ital stock of the previous year, net of depreciation (δ), plus investment (I) of the current year. In formula,

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

Since the reconstruction of the series is based on the investment process, the estimate of the initial capital stock is a crucial step.

TABLE 2 Correlation coefficients between different estimates

	Our data	Nehru and Dhareshwar	Easterly and Levine	Kamps	Timmer, Ypma, and van Ark
Our data	1	0.69	0.99	0.99	0.97
Nehru and Dhareshwar		1	0.61	0.99	0.99
Easterly and Levine			1	0.99	0.41
Kamps				1	0.98
Timmer, Ypma, and van Ark					1

Following Arnold Harbenger (1978), we have hypothesized that capital stock at time zero is positively correlated with investments in the following year and inversely related to the average annual growth rate of GDP and depreciation rate.

In formula,

$$K_{t-1} = \frac{I_t}{g + \delta}, \quad (2)$$

where g is the average annual growth rate of the aggregate product and δ the depreciation rate. It is interesting to note that this formulation coincides with the equation that defines the physical capital stock at the steady state in Robert Solow's model (1956).

Data on investment (gross fixed capital formation) have been extracted from the National Accounts Main Aggregates Database of the United Nations, in US dollars and 1990 constant prices. In the absence of specific micro surveys or information about various tax legislation, the depreciation rate has been set at 5%, a choice in line with other studies, such as Bisat, El-Erian and Helbling (1997) or Abu-Quarn and Abu-Bader (2007).

To test the accuracy of the measurement, we have correlated 'our data' and those of other authors, such as Nehru and Dhareshwar (1993), Easterly and Levine (2001), Kamps (2004) and Timmer, Ypma and van Ark (2005).

Because of the various timespans and the different sets of countries considered in the scientific studies, a full overlay of different sources is not possible. Therefore, the correlations presented in table 2 are only partial. The Dhareshwar-Nehru data, for example, refer to 13 countries,

those of Easterly-Levine to 15, those of Kamps and Timmer-Ypma-van Ark to only 5 (the five OECD Mediterranean countries). While the data of Nehru-Dhareshwar and Easterly-Levine cover the period 1970–1990, those of Kamps the period 1970–2002 and those of Timmer-
[36] Ypma-van Ark the period 1980–2004. Despite these limitations, the overall information that can be drawn from the table seems to validate the methodology we have used to construct the physical capital stock series.

Table 3 provides a representation of growth rates of physical capital stock per worker. A simple reading is sufficient to capture the high variability in the accumulation of physical capital in the Mediterranean countries. Of the 24 countries, 11 have a positive growth rate in all subperiods: Bosnia-Herzegovina, Croatia, Cyprus, France, Greece, Italy, Malta, Morocco, Portugal, Slovenia, Turkey. Nevertheless, it is also interesting to observe the average annual growth rate of physical capital stock per worker in France and Italy, which decrease progressively. Among the countries which have experienced a planned economy, Albania, Croatia and Slovenia stand out for having the highest Mediterranean annual average growth rates of physical capital per worker in the last eight years.

The measure of Human Capital

The object of human capital measurement is to weigh the number of workers on the basis of their specific capacity. The idea is to take into account the characteristics that influence the marginal labor productivity, such as education, age or gender, avoiding the mistake of considering employees as a consistent set.

In the majority of comparative studies on growth, however, the emphasis falls only on training because of the lack of information (which we usually have) about the labor force structure. The first empirical studies concerned with changes in the educational level of workers have frequently used the rates of school enrolment, data which only provide a reasonable estimate of the educational level if close to steady-state. More recently, empirical studies have avoided the use of school enrolment rates, using instead estimates of the average number of years of schooling of the population, as produced by Nehru, Swanson and

TABLE 3 Average annual growth rates of physical capital stock per worker (%)

Country	1971–1975	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000	2001–2005	2006–2008
Albania	0.0154	0.0157	0.0155	0.0044	–0.0066	0.0089	0.0660	0.0489
Algeria	0.0148	0.0504	0.0197	–0.0189	–0.0368	–0.0326	–0.0189	0.0037
Bosnia-Herz.					0.0821	0.1204	0.0598	0.0261
Croatia					0.0143	0.0104	0.0397	0.0443
Cyprus	0.0288	0.0320	0.0348	0.0248	0.0121	0.0134	0.0004	0.0188
Egypt	0.0538	0.1174	0.0649	–0.0047	0.0136	0.0191	0.0221	0.0499
France	0.0522	0.0328	0.0293	0.0203	0.0249	0.0086	0.0198	0.0185
Greece	0.0465	0.0308	0.0013	0.0029	0.0046	0.0079	0.0261	0.0243
Israel	0.0514	0.0140	0.0094	–0.0011	0.0133	0.0215	0.0050	0.0001
Italy	0.0325	0.0220	0.0218	0.0185	0.0274	0.0108	0.0106	0.0089
Jordan	0.0534	0.1096	0.0351	0.0009	–0.0540	–0.0039	–0.0143	0.0081
Lebanon	0.0035	–0.0247	0.0100	0.0266	–0.0412	–0.0250	–0.0331	–0.0289
Libyan Arab Jam.	0.0428	0.0535	0.0154	–0.0353	–0.0487	–0.0499	–0.0260	–0.0100
Macedonia					0.0054	–0.0073	0.0008	–0.0263
Malta	0.0309	0.0328	0.0845	0.0510	0.0470	0.0538	0.0248	0.0059
Morocco	0.0466	0.0820	0.0199	0.0068	0.0032	0.0124	0.0270	0.0400
Palestinian Ter.	0.1216	0.1143	0.0323	0.0279	0.0332	0.0248	0.0034	–0.0183
Portugal	0.0388	0.0314	0.0238	0.0060	0.0404	0.0259	0.0306	0.0190
Serbia-Mont.					–0.0219	–0.0119	–0.0048	0.0332
Slovenia					0.0279	0.0520	0.0448	0.0330
Spain	0.0665	0.0567	0.0401	0.0098	0.0426	–0.0032	0.0068	0.0258
Syrian Arab Rep.	0.0796	0.1083	0.0495	–0.0261	–0.0174	–0.0168	–0.0013	0.0095
Tunisia	0.0360	0.0428	0.0395	–0.0098	–0.0013	0.0003	0.0021	0.0077
Turkey	0.0825	0.0491	0.0283	0.0470	0.0456	0.0459	0.0350	0.0497
Mediterranean	0.0472	0.0511	0.0303	0.0080	0.0087	0.0119	0.0136	0.0163
Standard Deviation	0.0272	0.0389	0.0200	0.0224	0.0335	0.0339	0.0253	0.0228

NOTES Source: author's calculations based on data from the United Nations, the Conference Board and Groningen Growth and Development Center and the International Labour Organization.

Dubey (1995) or Barro and Lee (2000). It seems clear, however, that the direct use of the average number of years of schooling is an imprecise indicator of the quality of workers. Workers with no schooling, in fact, Would have a weight equal to zero and, consequently, small changes in levels of schooling produce large variations in the quality of work.

To avoid problems related to a direct use of the average number of years of schooling, we have followed Robert Hall and Charles Jones

(1999). Therefore, in order to estimate the stock of human capital (H) we have used the following equation:

$$H = Le^{f(scol)}, \tag{3}$$

where L is the number of workers, $e^{f(scol)}$ the human capital per worker, $f(school)$ a function specified in linear form and *scol* the average years of schooling. In particular, the slope of the function $f(school)$ was established at 0.082, that is equal to the average rate of schooling return estimated by George Psacharopulos (1994) for Europe, the Middle East and North African countries. The estimate of Psacharopulos followed the methodological approach of Jacob Mincer (1974): the logarithm of wage is linearly related to years of schooling, years of professional experience and their squares. Accordingly, the coefficient 0.082 can be interpreted as the average marginal return to an additional year of schooling in the Mediterranean countries.

Assuming perfect market competition, the wages percentage difference between workers with different years of schooling is equal to the human capital percentage difference, a factor that has led Mark Bils Mark and Peter Klenow (1998) to consider the specification as the most appropriate way of incorporating the years of schooling in an aggregate production function.

The average years of schooling required to measure human capital have been taken from Robert Barro and Jong-Wha Lee (2000), with reference to the population over 15 years old. Despite the 142 countries observed, Barro and Lee's contribution does not cover 8 Mediterranean countries, namely Albania, Bosnia-Herzegovina, Lebanon, Macedonia, Malta, Morocco, Palestine and Serbia-Montenegro. As the statistical information relating to these countries is not even available in the data set compiled by Nehru, Swanson and Dubey (1995), it has been necessary to estimate them. Accordingly, we used the following equation:

$$scol_{i,t} = scol_{W,t}\frac{HDI_{i,t}}{HDI_{W,t}}, \tag{4}$$

where $scol_{i,t}$ denotes the average years of schooling in country i at time t, $scol_{W,t}$ the world average of years of schooling at time t, $HDI_{i,t}$ the

TABLE 4 Average annual growth rates of human capital stock per worker (%)

Country	1971–1975	1976–1980	1981–1985	1986–1990	1991–1995	1996–2000	2001–2005	2006–2008
Albania	0.0028	0.0099	0.0055	0.0091	0.0009	0.0076	0.0057	0.0058
Algeria	0.0074	0.0110	0.0128	0.0130	0.0095	0.0089	0.0087	0.0094
Bosnia-Herz.					0.0027	0.0047	0.0034	0.0036
Croatia					0.0034	0.0036	0.0035	0.0035
Cyprus	0.0161	0.0051	0.0151	0.0208	0.0033	0.0039	0.0126	0.0108
Egypt	0.0028	0.0130	0.0200	0.0115	0.0118	0.0087	0.0163	0.0143
France	0.0059	0.0107	0.0041	0.0002	0.0077	0.0072	0.0038	0.0047
Greece	0.0085	0.0180	0.0043	0.0120	0.0052	0.0057	0.0107	0.0093
Israel	0.0123	0.0092	−0.0010	0.0003	0.0013	0.0025	0.0111	0.0073
Italy	0.0023	0.0039	0.0044	0.0054	0.0059	0.0054	0.0043	0.0047
Jordan	0.0085	0.0084	0.0156	0.0118	0.0085	0.0072	0.0108	0.0102
Lebanon	0.0028	0.0096	0.0046	0.0108	0.0064	0.0041	0.0064	0.0064
Libyan Arab Jam.	−0.0043	0.0280	0.0021	0.0216	0.0119	0.0119	0.0119	0.0119
Macedonia					0.0027	0.0047	0.0034	0.0036
Malta	0.0033	0.0098	0.0070	0.0137	0.0045	0.0047	0.0081	0.0076
Morocco	0.0019	0.0094	0.0069	0.0103	0.0050	0.0059	0.0052	0.0059
Palestinian Ter.	0.0027	0.0095	0.0045	0.0106	0.0024	0.0042	0.0068	0.0061
Portugal	0.0028	0.0166	0.0011	0.0174	0.0092	0.0066	0.0072	0.0080
Serbia-Mont.					0.0025	0.0044	0.0032	0.0034
Slovenia					0.0034	0.0044	0.0038	0.0039
Spain	−0.0007	0.0203	−0.0026	0.0102	0.0064	0.0074	0.0086	0.0080
Syrian Arab Rep.	0.0113	0.0133	0.0134	0.0105	0.0061	0.0048	0.0137	0.0112
Tunisia	0.0130	0.0110	0.0066	0.0098	0.0097	0.0080	0.0102	0.0097
Turkey	0.0038	0.0093	0.0046	0.0075	0.0159	0.0028	0.0061	0.0068
Mediterranean	0.0054	0.0119	0.0068	0.0109	0.0061	0.0058	0.0077	0.0073
Standard Deviation	0.0051	0.0056	0.0060	0.0055	0.0038	0.0022	0.0037	0.0030

NOTES Source: author's calculations based on data from the United Nations, the Conference Board and Groningen Growth and Development Center and the International Labour Organization.

Human Development Index in the country *i* at time *t* (or the next time t available) and $HDI_{W,t}$ the world average Human Development Index at time *t*. To test the reliability of the equation, it was applied to the other 16 Mediterranean countries and the data obtained were compared with Barro and Lee's data. The result is a correlation of 0.85. Moreover, we have estimated data up to 2008, on the assumption that the growth rate of schooling is constant during the period. Finally, to move from five-year data (reported in Barro and Lee) to annual data we have implemented linear interpolations.

Table 4 shows the average annual growth rates of human capital per worker. This allows us to focus only on the effects of schooling,
[40] regardless of employment dynamics.

Table 4 reveals a slow but steady growth of human capital per worker. The low values of standard deviation also provide us with evidence of a reduced sectional variability in the growth rates. However, this variability is lower than the variability recorded for the physical capital per worker. During the observed sub-period, the growth rates of human capital per worker have two peaks, in coincidence with two particular historical moments: the oil crisis of the late 70s and the Depression of the late 80s.

The Estimation of the Relative Share of Physical Capital to Production

A crucial step in the estimation of the TFP is the determination of the relative share of physical capital to production, that is the α parameter in the Cobb-Douglas function.

Since of the scarcity of national accounts data in developing countries and the incorrect range of α parameter obtained by Angus Maddison (1987) and Steven Englander and Andrew Gurney (1994) when applied to developing countries, we have decided to estimate directly an aggregate production function, using a logarithmic transformation of all terms. Since these estimates are frequently associated with problems of multicollinearity and heteroscedasticity, we have used the intensive form of the production function, which reduces the heteroscedasticity and eliminates the multicollinearity.

In particular, we have used two specifications of the production function, assuming both the constant returns to scale. The first takes into account (as explanatory variables) the physical capital stock and the number of workers. In formal terms, the equation in intensive form is:

$$\ln y = a + \alpha \ln k + \varepsilon, \tag{5}$$

where $y = Y/L$ (GDP per worker) and $k = K/L$ (physical capital per worker).

The second specification of the production function explicitly introduces the measure of human capital. From a formal point of view, the equation in the intensive form is identical to the previous one, that is

$$\ln \bar{y} = a + \alpha \ln \bar{k} + \varepsilon, \qquad (6)$$

but where $\bar{y} = Y/H$ is the GDP per unit of human capital and $\bar{k} = K/H$ physical capital per unit of human capital.

For each of the two specifications we have considered three different cases. They address the two-dimensional nature of the available data (relating to 24 countries observed for 36 years) which combine sectional and time characters. Known as the pooled regression, the first case moves from the assumption that the estimate contains only a constant term, valid for all observed countries. In this case, the OLS estimator provides consistent and efficient estimates, unless we experience problems of individual heteroscedasticity, autocorrelation and cross-correlation. These problems are possible in an environment where any differences between countries can be captured only by the error term (ε_{it}). Defined as fixed effects, the second case releases the hypothesis of a single constant in favour of a set of individual constants, which reflect the specific national characteristics. If the unobserved individual effects are correlated with the explanatory variables, as assumed in the case of fixed effects, the OLS estimator is biased and inconsistent. For this reason we use the LSDV estimator (least squares with dummy variables), that is able to grasp the within variability. The third case, called random effects, removes the possibility that the individual differences are not correlated with the error term. Individual constants (typical of the fixed effects) have been replaced by one constant and many stochastic differentials, one for each of the observed countries. The presence of a composite error as $\upsilon_{it} = \mu_i + \varepsilon_{it}$ (with μ_i stochastic differential of the country i) makes the LSDV estimator inefficient and requires the use of the GLS (generalized least squares) estimator. In particular, the latter is able to exploit not only the information on the within variability (as the LSDV estimator) but also information about the between variability.

Because the fundamental difference between the second and third cases lies in accepting or not accepting the hypothesis that the individual unobserved heterogeneity is correlated with the error term, we have applied the Hausman test. This tends to compare the results of the alternative estimators, just to test the null hypothesis of no correlation

between random effects and explanatory variables.

The estimations also raise a very important question about the data to be used: in levels or in first differences. In the literature there seems to be a preference for first differences data, because they reduce the problem of unit roots and therefore the problem of non-stationary series. Nevertheless, some remarks are instructive. If it is true that the first differences reduce the problem of unit roots, on the other hand they remove all the long-term information contained in the data because they cancel the low frequencies, emphasizing the short period fluctuations. In addition, due to the high variability of GDP growth rates compared with the variability of inputs (capital and labor), the fitted value of the regression (in first differences) is normally very low. For all these reasons, we have decided to use both the data in levels and in first differences, in order to provide a means of comparison.

Table 5 shows the results of regressions of the two specifications adopted in the three functional forms described (pooled, fixed effects and random effects) and this, as we have just said, using data in levels and in first differences. Altogether, 788 cases have been observed for regressions in levels and 764 for the regressions in first differences.

Several interesting insights emerge from table 5. The first outstanding issue is that the relative share of physical capital to production in the Mediterranean countries is well above the range 0.3–0.4. Evidence is in line with the previous studies on MENA countries.

Analyzing table 5, we can see that the goodness of fit of the regressions is particularly high. In such cases, the Hausman test rejects the hypothesis of absence of correlation between explanatory and random effects, emphasizing that fixed effects estimates are not only consistent but also efficient. The absolute rejection of the test to verify the absence of individual fixed effects suggests a prevalence of the fixed effects estimates also with respect to the pooled case. In fact, the use of data in levels does not remove the information contained in long-term data and exalts the individual differences that are captured by the

TABLE 5 Results of regressions

Estimation methods		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Data in levels	Pooled	$Y\,K\,L$	0.97	−0.69	0.00	0.93		
			108.23	(−7.44)				
		$Y\,K\,H$	0.97	−0.72	0.00	0.92		
			100.1	(−7.53)				
	Fixed effects	$Y\,K\,L$	0.70	2.1	0.00	0.93		0.00
			42.33	12.33				
		$Y\,K\,H$	0.67	2.24	0.00	0.92		0.00
			34.01	11.55				
	Random effects	$Y\,K\,L$	0.73	1.75	0.00	0.93	35.08	
			46.05	10.32				
		$Y\,K\,H$	0.71	1.8	0.00	0.92	35.81	
			38.11	9.5				
Data in first diff.	Pooled	$Y\,K\,L$	0.73	0.00	0.00	0.13		
			11.06	0.00				
		$Y\,K\,H$	0.74	0.00	0.00	0.13		
			11.27	−0.79				
	Fixed effects	$Y\,K\,L$	0.74	0.00	0.00	0.13		0.99
			9.68	−0.04				
		$Y\,K\,H$	0.74	0.00	0.00	0.14		0.99
			9.79	−0.80				
	Random effects	$Y\,K\,L$	0.73	0.00	0.00	0.13	0.02	
			11.06	0.00				
		$Y\,K\,H$	0.74	0.00	0.00	0.14	0.02	
			11.27	−0.79				

NOTES The *t*-statistic is reported in parentheses; in random effects regressions, the value in parentheses shows prob. $>\chi^2$ Source: Author's regression based on data from the Barro-Lee dataset (2000), the Conference Board and Groningen Growth and Development Center and the International Labour Organization.

set of individual constants. According to the fixed effects, the α parameter assumes value 0.67 when education is included and value 0.70 when it is not. Therefore, the exclusion of education seems to overestimate (although rather modestly) the relative share of physical capital to production. Shifting attention to the first differences, we can see a significant reduction in the goodness of fit of the regressions. As we already remarked, this is the result of processing data in growth rates and the greater volatility of the GDP compared to production inputs. Table 5 shows that the null hypothesis of the Hausman test cannot be

rejected. Therefore, the fixed effects give way to random effects. This is not a surprising conclusion, because the elimination of low frequencies contained in the data produces a levelling of the same and the reduction of the individual specificity. It is interesting to note that the
[44] values of α which occurred in the random effects are similar to the value estimated by the pooled regressions. That is a sign of poolability (at least partial) of statistical information. In other words, the data referring to 24 countries observed over 36 years would appear similar to the data of 24x36 different cases. Focusing attention on the estimation of α, it fluctuates between 0.74 when education is included and 0.73 when it is not. Unlike the case of data expressed in levels, here the exclusion of education does not produce any significant overestimation of the relative share of physical capital to production. The reason is once again to be found in the nature of the first differences. They eliminate the long-term information contained in the data and, Thus cancelling the effect of education on production (typically long-term effect).

ESTIMATE OF THE TFP

Using all the data, we can now try to estimate the TFP. The method chosen is growth accounting, which refers to the TFP as residual. In particular, the growth of the TFP is attributed to the growth of GDP that is not adequately explained by the growth of physical capital and human capital. Accordingly, the formula is:

$$\frac{d}{dt}\ln A = \frac{d}{dt}\ln y - \alpha\frac{d}{dt}\ln k - (1-\alpha)\frac{d}{dt}\ln h. \qquad (7)$$

Table 6 shows the average annual rates of the TFP in four subperiods. For the estimated rates, the values of the α 0.30 and 0.74 have been used. The first value is the minimum value of the relative contribution of physical capital to production normally used in studies of growth accounting. The second value is the maximum value estimated in the previous paragraph.

As we can infer from the analysis of the table, the data have a high sectional and temporal variability. Under these conditions, it is difficult to track a representative evolutionary path of the Mediterranean

TABLE 6 Average annual rates of the TFP, by countries and sub-periods (%)

Country	$\alpha = 0.74$				$\alpha = 0.30$			
	1970–1979	1980–1989	1990–1999	2000–2006	1970–1979	1980–1989	1990–1999	2000–2006
Albania	–0.0029	–0.0121	0.0094	0.0314	0.0012	–0.0107	0.0078	0.0527
Algeria	0.0038	–0.0207	–0.0049	0.0075	0.0141	–0.0234	–0.0242	–0.0020
Bosnia-Herz.			0.0572	–0.0392			0.1019	–0.0191
Croatia			–0.0283	0.0044			–0.0231	0.0183
Cyprus	–0.0012	0.0183	0.0157	0.0011	0.0063	0.0255	0.0195	–0.0005
Egypt	–0.0164	–0.0030	0.0180	–0.0044	0.0159	0.0074	0.0212	0.0028
France	–0.0052	0.0005	–0.0019	–0.0051	0.0103	0.0104	0.0035	0.0006
Greece	0.0093	–0.0078	0.0042	0.0058	0.0218	–0.0100	0.0035	0.0123
Israel	–0.0036	0.0042	0.0041	0.0053	0.0073	0.0057	0.0111	0.0030
Italy	0.0100	0.0031	–0.0032	–0.0093	0.0210	0.0101	0.0031	–0.0072
Jordan	–0.0232	–0.0391	–0.0080	0.0283	0.0069	–0.0308	–0.0248	0.0209
Lebanon	–0.0216	–0.0634	0.0410	0.0293	–0.0283	–0.0591	0.0249	0.0125
Libyan Arab Jam.	–0.0020	–0.0675	0.0142	0.0361	0.0140	–0.0730	–0.0131	0.0212
Macedonia			–0.0042	0.0230			–0.0056	0.0171
Malta	0.0638	–0.0093	0.0009	–0.0110	0.0748	0.0150	0.0217	–0.0056
Morocco	–0.0305	–0.0064	–0.0105	0.0020	–0.0033	–0.0032	–0.0110	0.0142
Palestinian Ter.	–0.0263	–0.0340	0.0277	–0.0323	0.0225	–0.0198	0.0374	–0.0339
Portugal	0.0045	0.0041	–0.0069	–0.0139	0.0169	0.0083	0.0015	–0.0054
Serbia-Mont.			–0.0610	0.0607			–0.0710	0.0632
Slovenia			–0.0066	–0.0002			0.0092	0.0159
Spain	–0.0083	0.0028	–0.0064	–0.0129	0.0151	0.0130	0.0006	–0.0113
Syrian Arab Rep.	–0.0125	–0.0457	0.0235	–0.0044	0.0238	–0.0405	0.0122	–0.0091
Tunisia	0.0027	–0.0093	0.0166	0.0142	0.0150	–0.0044	0.0116	0.0118
Turkey	–0.0266	–0.0021	–0.0169	0.0060	0.0021	0.0098	–0.0010	0.0219

NOTES Source: Author's estimates based on data from the Barro-Lee dataset (2000), the Conference Board and Groningen Growth and Development Center and the International Labour Organization.

TFP. However, some elements of homogeneity seem to be due to the period 1980–1989, which saw a concentration of the worst average performance of TFP. If we examine the first part of the data ($\alpha = 0.74$), the highest growth rate of the TFP in the 80s (in Cyprus) appears clearly below the best performance recorded in the earlier (in Malta) and later (in Serbia-Montenegro) sub-periods. Shifting attention to the data in the second part of the table ($\alpha = 0.30$), the previous conclusions remain unchanged, with average annual rates proportionately higher. In addition, it is interesting to note the moderate contraction in the gap between the maximum and minimum of the annual average growth rate of the TFP. If the range has a spread of 0.1031 in the period 1970-1979, it measures 0.0973 in the last period.

[46]

KEY FACTORS OF ECONOMIC GROWTH IN THE MEDITERRANEAN COUNTRIES

The estimate of TFP and the measure of physical capital and human capital time series justify the last step in understanding the determinants of economic growth. This step is accomplished by breaking down the growth rates of the aggregate product into the contributions of accumulation factors and productivity.

Table 7 shows the average annual growth rates of GDP per worker and the contributions of each component to GDP. The first column in the table reproduces the growth rate of GDP per worker over the period 1970–2008. The second column represents the contribution of physical capital per worker to production. In particular, it is calculated as the product of the average annual growth rate of physical capital per worker and the relative share of physical capital to production (in this case 0.74). The third column represents the contribution of human capital per worker to production. Like the previous column, it has been calculated as the product of the average annual growth rate of human capital per worker and the relative share of human capital to production (in this case equal to 0.26). The fourth column shows the average growth rates of the TFP. Finally, columns five, six and seven show once again the breakdown of GDP per worker into the three different components, assuming a value of the relative share of physical capital to production equal to 0.30 and a value of the relative share of human capital equal to 0.70. As we note, the breakdown of the GDP into the three different components is a simple exercise of calculating, where the TFP component absorbs everything that is not explained by the variation of inputs.

Table 7 gives us a framework of interesting information. Observing the production share assigned to inputs and technology, obtained by taking 0.74 as the relative share of physical capital to production, it seems correct to argue that the main determinant of economic

TABLE 7 Average annual growth rates of GDP per worker and the outputs' contribution (%)

Country		$\alpha = 0.74$			$\alpha = 0.30$		
	Y/L	K/L	H/L	A	K/L	H/L	A
Albania	0.0220	0.0145	0.0015	0.0060	0.0059	0.0042	0.0120
Algeria	–0.0034	–0.0020	0.0026	–0.0040	–0.0008	0.0071	–0.0096
Bosnia-Herzegovina	0.0671	0.0572	0.0009	0.0090	0.0232	0.0025	0.0414
Croatia	0.0077	0.0187	0.0009	–0.0120	0.0076	0.0025	–0.0024
Cyprus	0.0271	0.0153	0.0029	0.0089	0.0062	0.0077	0.0132
Egypt	0.0330	0.0308	0.0032	–0.0010	0.0125	0.0085	0.0120
France	0.0180	0.0194	0.0014	–0.0028	0.0079	0.0039	0.0062
Greece	0.0181	0.0131	0.0024	0.0026	0.0053	0.0065	0.0064
Israel	0.0150	0.0111	0.0014	0.0026	0.0045	0.0037	0.0069
Italy	0.0158	0.0145	0.0012	0.0001	0.0059	0.0032	0.0068
Jordan	0.0042	0.0128	0.0026	–0.0112	0.0052	0.0071	–0.0080
Lebanon	–0.0123	–0.0099	0.0017	–0.0041	–0.0040	0.0045	–0.0128
Libyan Arab Jamahiriya	–0.0081	–0.0053	0.0031	–0.0059	–0.0021	0.0083	–0.0143
Macedonia	0.0068	–0.0035	0.0009	0.0094	–0.0014	0.0025	0.0058
Malta	0.0442	0.0320	0.0019	0.0103	0.0130	0.0051	0.0261
Morocco	0.0121	0.0216	0.0017	–0.0112	0.0088	0.0044	–0.0011
Palestinian Territory	0.0197	0.0337	0.0015	–0.0155	0.0137	0.0041	0.0020
Portugal	0.0196	0.0203	0.0022	–0.0030	0.0082	0.0061	0.0053
Serbia-Montenegro	–0.0031	–0.0038	0.0009	–0.0001	–0.0015	0.0024	–0.0039
Slovenia	0.0273	0.0297	0.0010	–0.0034	0.0120	0.0027	0.0125
Spain	0.0188	0.0229	0.0019	–0.0060	0.0093	0.0050	0.0045
Syrian Arab Republic	0.0105	0.0177	0.0027	–0.0099	0.0072	0.0073	–0.0040
Tunisia	0.0196	0.0111	0.0025	0.0059	0.0045	0.0068	0.0083
Turkey	0.0273	0.0354	0.0018	–0.0099	0.0143	0.0050	0.0080

NOTES Source: Author's estimates based on data from the Barro-Lee dataset (2000), the Conference Board and Groningen Growth and Development Center and the International Labour Organization.

growth in the Mediterranean is the accumulation process of physical capital. Except for a few national cases, such as Algeria, Lebanon, Libyan, Macedonia and Serbia-Montenegro, the share of production attributable to physical capital per worker is always positive and prevailing compared to human capital and productivity. It should also be noted that while the TFP contribution is particularly variable, the contribution of human capital is always stable and positive, although its impact on growth seems very modest.

Shifting the emphasis on α equal to 0.30, the reality is shown in a different light. As we expected from the implemented calculation techniques, the share of aggregate production due to physical capital is reduced significantly, to the benefit of human capital and productivity. Human capital continues to offer a positive contribution to aggregate output in all countries, but its magnitude continues to be lower than the physical capital one. The only exceptions are Cyprus, Greece, Jordan, Syrian and Tunisia, which recorded higher contributions of human capital in comparison to physical capital contributions. However, the major changes occur on the TFP side. In fact, the contribution of the TFP to economic growth increases considerably. In Albania, Bosnia-Herzegovina, Cyprus, Israel, Italy, Macedonia, Malta, Slovenia and Tunisia, for example, the TFP is the main determinant of growth. In other countries, such as Egypt, France and Turkey, the TFP contributions are substantial and sometimes greater than the contribution of human capital.

CONCLUSIONS

The focus on the Mediterranean showed the advantages and disadvantages of working in an area that has only partially been covered by international statistics and by the specialized literature. Therefore, it has been necessary to start measuring the data of the 24 observed countries using a consistent methodology. Physical capital was measured by the perpetual inventory method, while human capital measurement was carried out to extend the estimates of Barro and Lee, using the human development index. The early data showed the high diversity of developments in the product and the aggregate of physical and human capital stock.

On the basis of the data, it has been possible to estimate total factor productivity, which we have understood to be a synthesis of many elements (technical, institutional, social, etc.) that affect the overall efficiency of the economy. In order to estimate TFP we have followed the growth accounting method, which attributes to TFP the residual growth rate of aggregate product that is not explained by the variations of inputs.

The average annual growth rates of TFP show high sectional and time variability. Despite these difficulties, it is nevertheless possible to indicate the 80s as the decade with the worst average performance. In addition, it has been important to point out the moderate contraction in the gap between the maximum and minimum average annual growth rates.

Estimates of the TFP also made it possible to break up the growth rate of aggregate output per worker into the contribution of physical capital, human capital and TFP. Our analysis shows that the physical capital is the key factor of economic growth. The contribution of human capital seems rather low, although it has a positive value. The role of TFP is particularly variable, but it is significant in many transition countries and in all the countries which have recorded the highest economic growth rates.

REFERENCES

Abu-Qarn, A., and S. Abu-Bader. 2007. Sources of growth revisited: evidence from selected Mena countries. *World Development* 35 (5): 752–71.

Aiyar, S. and J. Feyrer. 2002. A contribution to the empirics of total factor productivity. Dartmouth College Working Paper 02/09.

Barro, R. J. 1999. Notes on growth accounting. *Journal of Economic Growth* 4:119–37.

Barro, R. J., and J. W. Lee. 2000. International data on educational attainment: Updates and implications. CID Working Paper 42.

Bils, M., and P. Klenow. 1998. Does schooling cause growth or the other way around? NBER Working Paper 6393.

Bisat, A., M. A. El-Erian, and T. Helbling. 1997. Growth, investment and saving in the Arab Economies. IMF Working Paper WP/97/85.

Collins, S. M., and B. P. Bosworth. 1996. Economic growth in East Asia: Accumulation versus assimilation. *Brooking Papers on Economic Activity* 2: 135–91.

Crafts, N. F. 1996. The first industrial revolution: A guided tour for growth economists. *American Economic Review* 86 (2): 197–201.

Easterly, W., and R. Levine. 2001. It's not factor accumulation: Stylized facts and growth models. *World Bank Economic Review* 15 (2): 177–219.

Englander, S., and A. Gurney. 1994. OECD productivity growth: Medium-term trends. OECD *Economic Studies* 22:111–29.

Fischer, S. 1993. The role of macroeconomic factors in growth. *Journal of Monetary Economics* 32 (3): 485–512.

Griliches, Z. 1996. The discovery of the residual: A historical note. *Journal of Economic Literature* 34 (3): 1324–30.

Hall, R. E., and C. I. Jones. 1999. Why do some countries produce so much more output per worker than others? *Quarterly Journal of Economics* 114:83–116.

Harbergen, A. C. 1978. Perspectives on capital and technology in less developed countries. In *Contemporary economic analysis,* ed. M. Artis and A. Nobay, 12–72. London: Croom Helm.

Hulten, C. R. 2000. Total factor productivity: A short biography. NBER Working Paper 7471.

Islam, N. 1995. Growth empirics: A panel data approach. *Quarterly Journal of Economics* 110:1127–70.

Jorgenson, D. W., and Z. Griliches. 1967. The explanation of productivity change. *Review of Economic Studies* 34:249–80.

Jorgenson, D. W., Z. Griliches, and E. F. Denison. 1972. The measurement of productivity. Special issue of *Survey of Current Business* 52 (5).

Kamps, C. 2004. New estimates of government net capital stocks for 22 OECD countries 1960–2001. IMF Working Paper 04/67.

Klenow, P., and A. Rodriguez-Clare. 1997. The neoclassical revival in growth economies: Has it gone too far? In *National Bureau of Economic Research Macroeconomics Annual 1997,* 73–114. Cambridge, MA: MIT Press.

Kumar, S., and R. Russell. 2002. Technological change, technological catch-up, and capital deepening: Relative contributions to growth and convergence. *American Economic Review* 92 (9): 527–48.

Makdisi, S., Z. Fattah, and I. Limam. 2000. Determinants of growth in the MENA region. Paper presented at the World Bank Workshop on the Global Development Network, Prague.

Mankiw, G., D. Romer, and D. Weil. 1992. A contribution to the empirics of economic growth. *Quarterly Journal of Economics* 107 (2): 407–38.

Maddison, A. 1987. Growth and slowdown in advanced capitalist economies: Techniques of quantitative assessment. *Journal of Economic Literature* 25 (2): 649–98.

Mincer, J., ed. 1974. *Schooling, experience and earnings.* New York: NBER Books.

Molho, A. 2002. Comunità e identità nel mondo mediterraneo. In *Conflitti, migrazioni e diritti dell'uomo,* ed. M. Aymard, and F. Barca, 29–44. Soveria Mannelli: Rubbettino.

Nehru, V., and A. Dhareshwar. 1993. A new database on physical capital stock: Source, methodology and results. *Revista de Analisis Economico* 8 (1): 37–59.

Nehru, V., E. Swanson, and A. Dubey. 1995. A new database on human capital stock in developing and industrial countries: sources, methodology and results. *Journal of Development Economics* 46:379–401.

Psacharopoulos, G. 1994. Returns to investment in education: A global update. *World Development* 22 (9): 1325–43.

Senhadji, A. 2000. Sources of economic growth: An extensive growth accounting exercise. IMF Staff Papers 47.

Solow, R. 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics* 70:65–94.

———. 1957. Technical change and the aggregate production function. *Review of Economics and Statistics* 39:312–20.

Timmer, M. P., G. Ypma, and B. van Ark. 2005. IT in the European Union: Driving productivity convergence? Research Memorandum GD-67, University of Groningen.