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DETERMINANTS OF THE GROWTH SLOWDOWN IN GREECE DURING THE PREVIOUS GROWTH CYCLE

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ABSTRACT

The Greek economy was growing at high rates during the post-war period and up until the middle of the 1970s, while afterwards real GDP growth rates fell significantly and remained on average very low during the 1980s. Using a generalised production function approach, this paper aims at assessing the importance of various factors in explaining this slowdown, in an attempt to isolate factors that could still be at play during the current cycle. More specifically, emphasis is placed on the share of the public sector, capital accumulation, education, the impact of international developments in productivity growth, and the ability of the Greek economy to exploit technology transfer. Main findings include the negative relationship between the size of the public sector and growth and the fact that during that period Greece seemed unable to take advantage of accumulated knowledge and R&D capital in other parts of the world. Causality tests are performed in order to verify the robustness of these findings. Also, a potentially appropriate economic policy mix is evaluated accordingly.

Keywords: economic growth, technology transfer, knowledge diffusion, generalized production function, R&D

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INTRODUCTION

The growth record of Greece since the end World War II and up until the beginning of the 1990s† is characterized by a distinct break in 1973 or 1974, when consistently high growth rates were followed by a significant slowdown. This paper aims at identifying potential factors explaining this slowdown; this would be interesting in its own right but, additionally, it could provide some insight and policy implications for the current phase of the business cycle.

Based on recurring findings of the empirical growth theory, the paper places emphasis on technological development. Given, however, that Greece displays a poor record of domestic R&D intensity and innovation, we assume that countries such as Greece basically take advantage of technological developments originating in other countries. The methodology is thus based on incorporating technology transfer and knowledge spillovers in a generalized production function approach in order to explore the relevant significance of various factors in explaining the growth record of Greece. Following some recent contributions to the literature, the size of the public sector is also incorporated in the equation.

Identifying the factors that have been at play in the past (during the previous growth cycle) can be very useful in drawing conclusions for the present and the future, given the fact that Greece may now be entering a cycle of lower growth. According to forecasts and projections of the E.U. Commission, OECD and the I.M.F.‡, following the period of high growth rates (1996~2004), the Greek economy may be returning to growth rates close to or below its growth potential (approximately 3.8%). The study of a recent growth cycle and the determinants of growth may provide useful analytical conclusions and / or policy implications.

† Following other researchers, in this paper we consider that the beginning of the 1990s highlights a change of the business cycle phase (and not 1996 when high growth rates actually reappear). It is in the beginning of this decade that we observe a shift in economic policy objectives, towards nominal convergence and the participation in the EMU; however, there was a time lag for the corresponding policy mix to bar fruit in terms of growth.

‡ See, for example, European Commission, 2006 Spring Forecasts and OECD Economic Outlook no 79, June 2006.

LINKS TO THE EXISTING LITERATURE

During the 1980's and following the articles by Romer (1986) and Lucas (1988) the interest in growth theory rekindled and, soon after, the first attempts to empirically test the new theories took place. The relevant literature contains many references to the difficulties, pertaining both to the formulation of models and to tackling specific econometric problems (Temple 1999, Cameron 1996). Comprehensive surveys include De la Fuente and Vives (1997), Jones and Manuelli (1997), Durlauf and Quah (1998) and Ahn and Hemmings (2000). There also were attempts to explore specific aspects of the growth theory, inter-alia, convergence, the adaptation of growth accounting to the new developments of the theory, technology transfer and knowledge spillovers as drivers of growth.

In the case at hand we are interested in the latter, namely, the strand of the literature that encompasses technology transfer and the role of R&D as well as in the empirical literature on the determinants of growth.

One of the founding pillars of the literature on technology transfer and diffusion is the book by Grossman and Helpman (1991), where emphasis is placed on the openness of economies and the distinction between diffusion at the national and international level. Along the same lines, important contributions include those of Wolff and Nadiri (1993) at the microeconomic level, Jaffe, Trajtenberg and Henderson (1993) and Branstetter (1996).

Two seminal empirical papers on technology transfer and diffusion at the international level are those of Coe and Helpman (1993 and 1995). Their main assumptions include:

- Technological progress is not exogenous but is based on innovation efforts
- The productivity level and its rate of growth depend on R&D expenditure by agents both within the country and in other countries with which trade has been established
- The stock of knowledge is approximated by the aggregation over the years of R&D expenditure, both domestically and abroad. This aggregation results to the domestic and the international R&D capital respectively

The sample of this paper includes 21 OECD countries and Israel; for each of those countries two R&D capital stocks are constructed as described above. As for the international R&D capital stock, weighting is performed using bilateral trade flows.

The main conclusions of the papers are:

- Both capital stocks affect Total Factor Productivity growth
- The more open an economy is (measured by the share of imports in GDP) the stronger the impact of international R&D capital is

Coe Helpman and Hoffmaister (1997) focus on less developed countries that do not spend a lot on R&D. Explanatory variables in their model include international R&D capital, the share of imports from industrial countries in GDP, the participation rate of the population in secondary education and a time trend. They also tried a variable to account for a "convergence" effect. The main conclusion of the paper is that technology transfer from the "north" to the "south" is a very significant explanatory factor, accounting for the developments in the productivity of less developed countries.

Keller (1997 and 1997a) criticized Coe and Helpman (1993 and 1995) by questioning the emphasis on international trade. More specifically, he estimated that the total impact of the latter in productivity growth was in the order of 20%. Keller was one of the first to introduce Foreign Direct Investment (FDI) as an alternative channel for technology transfer.

Engelbrecht (1997 and 1997a) uses the basic Coe-Helpman model (1993) in order to measure technology transfer and diffusion at the national level. He also included a "convergence" variable and one to account for the phase of the business cycle.

A very interesting conclusion of these papers is that that for many countries, including Greece, technology transfer has a negative impact on productivity growth. This is not an intuitive result and the author proposes the explanation that a minimum R&D expenditure level is required in order to secure a country's ability to absorb and take advantage of technological developments stemming from international R&D.

Muller and Nettekoven (1999) are proposing the random coefficients method for estimating the basic model of Coe and Helpman (1993) and add a dummy variable for G7 countries. The most striking result is that the average elasticity of international R&D capital is negative.

Coe and Moghadam (1993) attempt to explain the growth slowdown in France during the 1970s by extending the Coe-Helpman model. More specifically, they use hours of work, physical capital, R&D capital and a variable measuring economic integration as explanatory variables. The last two prove to be statistically significant, while the same does not hold for other variables they also tried, such as demographic variables, inflation, international R&D capital.

Rensman and Kuper (1998) attempt to explain differences in growth productivity, both cross sectionally and over the years. For this purpose they use a model with three sectors (R&D, intermediate products and final products). This is a variation of a model with an expanding variety of products, where in the empirical analysis they use data for patent applications.

Keely and Quah (1998) and Eaton and Kortum (1996) also use patent applications to measure the output of the R&D process. Keely and Quah argue that patents result to ex-ante incentives but ex-post inefficiency. Eaton and Kortum (1996) estimate a system of equations and conclude that the impact of technology diffusion between countries is about half compared to the one within a country. The explanation lies in the existence of institutional impediments. The authors also attempt to explain the big differences in productivity levels and growth rates, both between countries and regions and over the years. In their second article Eaton and Kortum (1997) expand a growth model by introducing variables related to R&D (employment in the sector and patents). Their main conclusions are that R&D performed abroad is not as important as domestic R&D intensity and that the US and Japan are the engines of productivity growth internationally.

Hejazi and Safarian (1999) attempt to measure the impact of FDI as an additional channel for technology transfer. They conclude that R&D expenditure is important, but the introduction of FDI results to a higher "volume" of technology transfer and a reduction of the relative importance of international trade.

Lichtenberg and Van Pottelsberghe (1996) also place emphasis on FDI and conclude that the R&D expenditure elasticity of output diminishes if we include FDI in the model.

Frantzen (1998) implemented a different econometric approach to the Coe-Helpman model, as he proceeded to test his panel dataset for stationarity and co-integration. Also, he estimated an error correction model and tried the Engle-Yoo approach (1987).

Park (1995) made two significant distinctions: first, whether R&D expenditure is financed by the public or the private sector and, second, whether knowledge diffusion pertains to the R&D or the productive sector. His main conclusion is that public sector R&D mainly affects the research sector, while private sector R&D accounts for productivity growth in the productive sector.

Lichtenberg (1992) essentially expanded the Mankiw-Romer-Weil (1992) model in order to incorporate investment in R&D. The impact of the latter compared to physical capital is small but increases over time and has a higher social return because of knowledge spillovers (although this process takes time). His main conclusions are that:

- Private sector R&D affects productivity growth in a sizeable manner (contrary to public sector R&D)
- The long-run return of investment in R&D is seven times that of physical capital
- The GDP elasticity regarding R&D capital is approximately 7%
- The distinction between basic and non-basic research is not quantitatively important

De la Fuente and Vives (1997) attempt to account for the growth record of Ireland in the 1960~1996 period. They base their analysis on a growth accounting exercise, but they enrich the traditional technique by introducing investment in human as well as in physical capital, R&D expenditure as a ratio to GDP, the participation rate of the labor force, the unemployment rate and public expenditure.

Marchionatti and Usai (1998), on the other hand, attempt to explain the growth record of Italy, where high post-war GDP growth rates cannot be accounted for by physical capital accumulation or investment in research. The authors propose technology transfer as a potential explanation and proceed to estimate a generalized production function including physical capital, labor, domestic and international R&D capital stock.

Ligthart (2000) also estimates a generalised production function for Portugal in order to measure the impact of public capital on total factor productivity. She also estimates a Vector Autoregression model and performs Granger causality tests, impulse response and variance decomposition analysis.

THE MODEL

Mainly based on the work of Coe and Moghadam (1993), Marchionatti and Usai (1998), and Ligthart (2000) but adding elements from other papers in the literature, an equation including potential determinants of growth was estimated for the Greek economy.

$$Y_t = \Theta_t^{\gamma} u_t^{d} (EL_t)^{a} K_t^{b} FR_t^{c} PR_t^{e} \quad (1)$$

where Y = the real product of the economy,

EL = efficient labour units
K = physical capital
FR = international R&D capital
U = the unemployment rate
PR = international productivity index
Θ = the relative size of the public sector

The last variable is included following De la Fuente and Vives (1997). It is defined as the ratio of public expenditure over GDP and is expected to capture potential distortions imposed by the participation of the public sector in the productive process. The reason to include it is that it significantly augmented the explanatory power of the model in the aforementioned article; on the other hand, there are serious indications that in Greece the size of the public sector is also inversely related to growth in the long-run.

The unemployment rate is used as a proxy for the rate of capacity utilisation of capital, in order to capture business cycle effects. As is customary in the literature, no restrictions are imposed on the coefficients.

DATA SOURCES

Main data sources include the National Statistical Service of Greece, The Ministry of Economy and Finance, OECD and the Barro-Lee (1993 and 2000) database for data concerning education (used to construct the efficient labour variable). Real GDP, employment and unemployment rate data are taken from the Historical Series Publication of the Ministry of Economy and Finance, while for physical capital two series were alternatively used: one from OECD (Stocks and Flows of Capital – various editions) and one constructed and published by Easterly and Levine (1999) which gave better results. As far as the size of the public sector, the Heston-Summers database was used. In order to approximate the rate of growth of international productivity, an index was used referring to the growth in productivity in all OECD countries (source: the Source OECD database). Source for R&D data is again OECD (details for the construction of the International R&D capital stock variable are given in the Appendix).

EMPIRICAL RESULTS

Results for the estimation of equation (1) in logarithms are presented below using OLS. The issue of non-stationarity of relevant time series is taken up in section 6.

This estimation was tested for the presence of autoregression up to the second degree through an LM test but this hypothesis was rejected at the conventional levels of statistical significance.

The overall explanatory power of this model is satisfactory, either measured by the corrected R^2 or by the F-statistic. All coefficients have the expected signs and are statistically significant at the 5% or 10% level (with the exception of the index of international productivity[§], which turns out to be significant at higher levels).

We should note here that the negative sign of the international R&D capital is not intriguing. As we mentioned above, there is at least one more paper with internationally comparable data (Englbrecht 1997), in which the same conclusion for Greece is reached and a potential explanation is offered (see section 2). The explanation about the minimum level of domestic R&D seems to be also corroborated by recent research (Guellec and Van Pottelsberghe de la Potterie 2001).

One could safely argue that this precondition does not hold for Greece for many years of the sample period. In addition, it is obvious that R&D expenditure in some developed countries could be directed to sectors which in Greece were not (and maybe still are not) adequately developed. For example, knowledge accumulated in high technology sectors in the US, even if available at no cost, would not be useful in a country where the manufacturing sector was dominated by textiles or where the primary sector is still relatively significant.

We should also not ignore that rigidities and distortions in the financial sector in Greece may have prevented adequate financing of investment projects in specific sectors. The tangible guarantees system is a good example in this respect, while venture capital is

[§] Possibly due to multicollinearity. The variable is not excluded in order to avoid inserting bias to the model.

even now used to a negligible extent. At the same time, it is not obvious that the "output" of the educational system has always been qualified to a satisfactory degree so as to take advantage of advanced technological developments.

However, one could argue that these proposed explanations do not suffice to explain the strong (not simply zero but negative) effect of the relevant variable on output. In addition to all factors listed so far, a "terms of trade effect" could also be at play: if Greece cannot take advantage of knowledge accumulated elsewhere but its competitors can, relative prices could gradually be worsening for Greece (e.g. as a result of the adoption of cost-saving technologies by firms in other countries). This could result to a gradual deterioration of its competitive position and a declining contribution of the external sector to GDP.

Table 1. OLS Estimates

Independent variables	Coefficient	t-statistic	
Constant	-6.019133	-2.179018	
Unemployment rate (u)	-0.066485	-4.485588	
Efficient labour units (EL)	0.324856	2.455614	
Physical capital (K)	0.646320	4.751855	
Public expenditure (Θ)	-0.470808	-4.360922	
International R&D capital E&A (FR)	-0.414658	-1.901287	
International productivity index (PR)	0.757777	1.553694	
AR(1)	0.305607	1.642974	
	Statistics		
R^2	0.997061	Akaike criterion	-4.977369
$\overline{R}^2$	0.995978	Schwarz criterion	-4.593417
F-Statistic	920.6975		
Log-likelihood	75.19448		
D-W Statistic	2.067415		

Dependent variable: Real GDP
Sample period: 1965-1991
Number of observations: 27
Convergence reached after 10 iterations

The variable pertaining to the size of the public sector has the expected negative sign and is statistically significant at the 5% level. The inclusion of this variable, along with the one for international productivity, can provide for at least one explanation for the slowdown of the Greek economy after 1974: the average of the public sector variable for the 1960 – 1973 and 1974 – 1992 periods is 10.6% and 13.6% respectively. This increase over time could result to certain distortions, such as a crowding out effect (due, *inter alia* to higher interest rates) or a mitigation of competitive forces in markets where public enterprises operate[**].

The slowdown in the rate of growth of international productivity also worked in the same direction: the average growth rate for the 1960 – 1973 and 1974 – 1992 periods is 3.74% and 1.73% respectively. On the other hand, the R&D capital stock kept on growing at significant rates throughout the whole sample period but, as noted above, this did not contribute to the acceleration of the GDP growth in Greece.

UNIT ROOT TESTS

OLS results based on time series such as those used in this paper should be evaluated with caution. If these time series are not stationary, as is usually the case, a spurious relationship may be present and, in this case, test statistics are not valid. If, on the other hand, the time series are cointegrated the OLS results are acceptable, since estimators are super-consistent (see, among many others, Enders, 1995). In this paper, Augmented Dickey-Fuller (ADF) and Phillips–Perron (PP) tests were performed for the variables included in the equation.

Table 2. Stationarity Test Results

Variable (in logs)	Augmented Dickey-Fuller statistic	McKinnon critical values	Phillips-Perron statistic	McKinnon critical values
Real GDP	-1.64	-3.5386	-2.05	-3.5348
Efficient labour units	-2.30	-3.5386	-1.83	-3.5348
Physical capital	-0.54	-3.5614	0.58	-3.5562
Size of the public sector	-1.87	-3.5670	-1.81	-3.5614
International R&D capital	-2.12	-3.5731	-0.52	-3.5670
Unemployment rate	-2.44	-3.5386	-1.69	-3.5348
International productivity index*	-3.81	-4.21	-4.00	-4.20

* Results at the 1% level are presented, as those at 5% were marginal.

[**] We should not forget, however, that especially at that time the public sector was solely responsible for the construction and servicing of physical infrastructure that is a vital input to the production of the private sector.

As far as ADF tests are concerned, in the relevant equation we opt for the inclusion of a constant, a time trend and a lag of the first difference of the series. In the PP test equation, a constant, a time trend and 3 lags (truncation lag q=3) are included.

The results of these tests are presented in Table 2. We must also note that the conclusion on the presence of a unit root was robust to different specifications of the test equations: more specifically, in all cases the hypothesis of a unit root can not be rejected at conventional levels of statistical significance.

COINTEGRATION

Given the result that the time series are not stationary, it is critical for the evaluation of OLS estimators to conclude whether the series are cointegrated or not. The method most often used in the literature is the one described in the Engle-Granger paper (1987).

According to their methodology, we must check the OLS estimation series of residuals for stationarity. If we reject the hypothesis of non-stationarity, we cannot reject the hypothesis that our time series are cointegrated. In the case at hand, we tested the hypothesis that the coefficient of u_{t-1} in equation (2) below is statistically significant.

Table 3. Co-integration Results

ADF statistic	-5.483603	**1% Critical value***		-2.6522
		5% Critical value		-1.9540
		10% Critical value		-1.6223
Variable	**Coefficient**	**Standard error**	**t-statistic**	**Probability**
Residuals lagged once	-1.066421	0.194474	-5.483603	0.0000
R^2	0.536115	**Dependent variable mean**		0.000426
$\overline{R}^2$	0.536115	**Dependent variable standard deviation**		0.022162
Standard error of regression	0.015094	**Akaike criterion**		-5.512699
Sum of squared residuals	0.005924	**Schwarz criterion**		-5.464705
Log likelihood	75.42144	**Durbin-Watson statistic**		2.004892

* McKinnon critical values
Augmented Dickey-Fuller test equation
Dependent variable: First differences of the residuals
Method: OLS
Sample period: 1966-1992
Number of observations: 27

$$\Delta ut = (a\text{-}1)\ ut\text{-}1 + et \qquad (2)$$

where u_t is the series of residuals in the equation (1) estimated above.

The results of this test are presented in Table 3, where the MacKinnon critical values are also depicted. However, taking into account the fact that the dependent variable is one of estimated residuals, we cannot use these critical values. In the relevant literature more appropriate values have been proposed (for example, Davidson and McKinnon 1993 or Engle and Yoo 1987). Using the critical values from these sources (-2.86 and -4.86 for 5% and 1% statistical significance levels), we can safely reject the hypothesis of non-stationarity of residuals and, consequently, we can conclude that our time series are cointegrated. Given this conclusion, we can accept the OLS results and proceed to test for Granger causality.

GRANGER CAUSALITY

One finding of the section 5 which is of particular interest is that the size of the public sector bears a negative relation to GDP. In this section we proceed to check whether this finding is robust by performing causality tests. The method chosen is that of Toda and Yamamoto (1995) as elaborated by Dolado and Lutkepohl (1996). The main advantage of this method is that the results are valid irrespective of whether variables are stationary or not; in addition, the existence of cointegration is also immaterial.

The fact that we can draw conclusions about causality regardless of stationarity issues is very important, given that when using alternative tests/specifications for stationarity one can have contradictory results. The only preliminary test that must be conducted is the one concerning the number of lags to be included in the autoregressive scheme: more specifically, the methodology is based on the estimation of a VAR with a number of lags exceeding the one that criteria such Schwarz, Akaike or a log-likelihood test (LR test) would dictate.

If *dmax* is the maximum degree of integration of variables and *k* the number of lags that we would normally choose (on the basis of Schwarz, Akaike or LR tests), the VAR system must be estimated with a *dmax+k* number of lags using the Seemingly Unrelated Regressions method (SUR). The causality test consists of testing the statistical significance of the *k* lags using the Modified Wald test. As is shown in the relevant literature, in this case the tests and conclusions of the asymptotic theory are valid.

In the specific case at hand, the minimization of the Schwarz criterion would dictate the estimation of a VAR with three lags. Using the findings of Section 6, we know that *dmax* is 1 and, consequently, we proceed to estimate a VAR with 4 lags for the endogenous variables of the model (real GDP, effective labour, physical capital, size of the public sector). The test consists of testing whether the coefficients for the first three lags for the size of the public sector are statistically significant. The statistic of the modified Wald test is distributed according to the X^2 distribution with 3 degrees of freedom (i.e. equal to the number of constraints we are testing). The test results in the rejection of the null hypothesis that the size of the public sector does not "affect" real GDP at the 1% level of statistical significance (the value of the test is 13.71). Therefore, in the sense of causality, we conclude that the size of the public sector matters for GDP growth over time. As far as the reciprocal causality is concerned, we cannot reject the null hypothesis at any conventional level of statistical significance. Our conclusion is that there is an inverse relationship between the size of the public sector and GDP, with the former "causing" the latter.

We also conducted causality tests for the relationship between real GDP on one hand and effective labour and physical capital on the other. Our conclusion is that effective labour does not "cause" real GDP (test statistic: 1.91) but is "caused" by it (test statistic: 7.01 at the 10% level of statistical significance). On the contrary, there is a two-way relationship between real GDP and physical capital (test statistics: 25.08 and 254.12 respectively).

INTERPRETING RESULTS UNDER THE LIGHT OF ECONOMIC POLICY MAKING

The above mentioned results could be readily interpreted in the context of ongoing discussions about the appropriate economic policy mix, given the current phase of the business cycle and the restriction of a highly globalized international environment. More specifically:

- Since the size of the public sector is inversely related to real GDP, the fiscal consolidation process underway could be pro-growth in the medium to long-term. It is usually the case that fiscal consolidation efforts are considered contractionary, at least in the short-term, since they are demand containing (through either decreasing public expenditure or increasing the tax burden). However, as shown above if the public sector introduces distortions in the operation of the economy, or is less productive than the private sector, there are productivity gains should the public sector be contained to a more or less "regulatory" rather than "productive" role.
- Emphasis on enhancing domestic R&D intensity (as expressed, for example, by the ambitious goal of R&D expenditure over GDP reaching 1.5% by 2010), could also contribute to higher growth. Apart from the empirically well documented relationship between innovation and productivity, the increased R&D intensity could activate the technology transfer channel: as explained above, a minimum level of domestic expenditure is required in order to be able to take advantage of technological progress originating abroad and so far this does not seem to be the case in Greece. Also, emphasis on improving the educational system along with the training, re-training and life-long learning systems would be beneficial, in the sense of upgrading human capital (and thus efficient labour units).
- The emphasis on investment and the accumulation of physical capital is more or less self-explanatory. We should additionally stress, however, that investment is also the way to incorporate innovative processes in the production line or new products, since "new" units of capital do not necessarily substitute one to one for existing ones. We should be careful, though, in making a distinction between private and public investment. Unconditionally advocating public investment, without reference to containing public consumption, could run contrary to limiting the role and significance of the public sector: actually, a re-allocation of public expenditure is required, with more weight on investment rather that public consumption expenditure. In this way we could take advantage of the positive relationship between physical infrastructure and productivity, bearing in mind as well that the former is a prerequisite for attracting FDI (which is an alternative channel for

technology transfer). In the case of spurring private investment, what is needed is reforms aiming at creating a more favourable business environment. This could entail, among many others, simplifying the tax system, reducing the tax and administrative burden, cutting red-tape and fighting corruption.

- Last but not least, the policy option to enhance the outward orientation of the economy and ensure conditions to attract FDI could improve channels for technology transfer and provide incentives for maintaining the competitive position of firms and the economy as a whole.

CONCLUSION

Focusing on some recent contributions to the growth literature and using a generalised production function approach, this papers attempts to provide some insight on the determinants of growth in the Greek economy along with relevant policy implications for the current business cycle and international environment. Main findings include (a) an inverse relationship between the size of the public sector and real GDP, which could be explained by the distortions that the participation of the public sector in the production process introduces (e.g., higher cost of financing, less competition in the markets). The policy implication is that the state should gradually be limited to a "regulatory" role, while placing emphasis on public investment rather than consumption (b) the impact of productivity growth developments internationally. The implication is for an economic policy mix that advocates the outward orientation of the economy and encourages FDI in order to keep the technology transfer channels open (c) the inability of the Greek economy to take advantage of the accumulated stock of knowledge in developed countries. Emphasis should be placed on enhancing domestic R&D intensity, as a minimum level of domestic expenditure is required even for "imitation" purposes.

In general, the policy mix that is compatible with these findings is one that places emphasis on reforms to improve the business environment, support private sector investment and growth, enhance human capital accumulation, stimulate domestic R&D and innovation and find ways to achieve a more outward orientation of the economy.

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APPENDIX

The construction of the international R&D capital stock variable was based on OECD data. The main assumption is that G7 countries perform most of the R&D internationally and countries such Greece can take advantage of their technological development (through the various channels of technology transfer). We have opted not to use weights for each country's contribution to international R&D capital, mainly because there are widely diverging views on the choice of weights, while many researchers argue that using improper weighting can result to inconsistent results.

The variable we use is Gross Domestic Expenditure on R&D (GERD) from the R&D Database (DSTI/EAS Division) of OECD and data from the Sourceoecd database. GERD is provided in nominal terms and was deflated using GDP deflators. Conversion to a common currency was performed using concurrent exchange rates. We did not use Purchasing Power Parities, as our principle objective is not to compare across countries. Having constructed time series for all countries in real terms and a common currency, we applied the perpetual inventory method. The first observation (1964) was calculated by dividing that year's total R&D expenditure by the average growth rate of expenditure for the whole period (following Coe-Helpman 1995). Also, linear interpolation was used in order to fill for some missing observations for Italy, Germany and the U.K.