Growth, Convergence and Macroeconomic Performance in OECD Countries: A Closer Look

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D-93003
May 1993

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We are grateful to Juan Miguel Ponz for his help in building the database. We have benefited from discussions with Clara Ponsati, Leandro Prados de la Escosura and David Taguas. Any errors are our own responsibility.

En el cuarto trimestre de 1991 la Dirección General de Planificación abrió una línea de estudio sobre el crecimiento comparado de la economía española y la convergencia con las economías más desarrolladas. Los trabajos elaborados dentro de esta línea se publican en inglés para que puedan ser leídos por los estudiosos de esta materia de más allá de nuestras fronteras. En breve tiempo estará disponible una traducción castellana.

Hasta la fecha se han publicado otros dos documentos de trabajo dentro de este programa:

D-92006 : "Long-Run Economic Growth in Spain Since the Nineteenth Century: An International Perspective"

Leandro Prados de la Escosura, Teresa Dabán y Jorge Sanz.

D-93002 : "Spain's Gross Domestic Product 1850-1990: A new Series".

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ABSTRACT

The purpose of this paper is twofold. First, we carry out an empirical analysis of convergence patterns among the OECD countries, paying special attention to the adequacy of the augmented Solow model to explain growth and convergence in different subperiods and groups of countries. Second, we look at the relation among medium term macroeconomic performance and the rate of growth and the speed of convergence among the sample countries. We have devoted particular efforts to the construction of a convenient database. We provide nonlinear estimates of the basic technological parameters and the convergence rate in a cross section of the average values of variables over the 24 OECD countries for the sample period 1960-1990, and for six subperiods, using pooled data of five years averages. The human capital augmented Solow model explains reasonably well growth and convergence among OECD countries over the whole 1960-1990 period. However, a closer look reveals many features which deserve further attention. In particular, estimated parameters are not fully stable across countries and along subperiods. Convergence occurs at different speeds among different groups of countries, depending on their income levels. Convergence seems a feature of fast growth times. During recessions, convergence is much slower or inexistent. The model does not fit very well in shorter time periods of macroeconomic turbulence. Variables related to medium term macroeconomic performance affect the rate of growth and convergence; however their effect is not stable along the sample period. In periods of recession they even outperform growth related variables.

I. Introduction.

Increasing economic integration among the European countries is expected to bring about faster average growth. Less advanced countries hope to narrow the gap with the richer ones in terms of per capita income; however, whether or not this distributional effect will work is still an open issue. From a theoretical viewpoint, growth theory is the appropriate framework to deal with these issues. In the long run, two basic features determine a country's economic achievement. One of these are the preferences of households, firms and governments for current consumption as opposed to future consumption. The other is the technological capability (in a broad sense) of the society to use the resources not devoted to current consumption.

The purpose of this paper is twofold. First, we carry out an empirical analysis of convergence patterns among the OECD countries. Second, we look at the relation among the medium term macroeconomic performance and the rate of growth and the speed of convergence among the sample countries. Unlike previous works which use Summers-Heston data set, most data in our sample are taken from OECD statistics and are expressed in 1985 international dollars. We have extrapolated 1990 PPPs for private and public consumption, and investment from 1960 to 1989, obtaining the purchasing power parities for GDP trough the Geary-Khamis aggregation method.

Convergence regressions are carried out in the way popularized by Barro and Sala-i-Martín (1991), Mankiw, Romer and Weil (1990) (MRW thereafter), Durlauf and Johnson (1992) and others[1]. Our interest is not merely to asses

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[1] An alternative method to contrast the convergence hypothesis, based upon the notion of stochastic convergence and cointegration among per capita incomes across countries, has been suggested by Bernard and Durlauf (1991). Alternatively, the one-factor neoclassical growth model could be tested on the basis of its long run implications about the evolution of some aggregate time series (Neusser (1991)).

whether or not convergence has taken place among the sample countries, but also to see whether if the long run evolution of these economies can be explained in the theoretical framework of the Solow (1956) model. We provide estimates of the basic technological parameters and the convergence rate in a cross section of the average values of variables over the 24 OECD countries for the sample period 1960-1990.

This procedure imposes though, too many restrictions; in particular, the aggregate analysis assumes that technological parameters (and hence the convergence rate) are stable across countries and along the sample period. To asses to what extent this can be maintained, we split the sample in more homogeneous country groups to find that the estimation results are non robust to the exclusion of some countries. We have also estimated the model, using six shorter periods (five years) averages of the variables to take the advantage of the time series dimension of the information set. Pooling model estimates reveal some differences in the relevant parameters and, most important, display a clear pattern of convergence which breaks down between 1975 and 1985.

Growth theory must be amended somehow when dealing with convergence among countries off their balanced growth paths. There are many macroeconomic features of OECD economies that are difficult to introduce in the narrow margins of growth models (either of the 'endogenous' or the 'exogenous' type[2]). Unemployment is, just to mention one of these, high enough as to cast reasonable doubts about the market clearing assumption. Few theoretical analysis are available, at this stage, bringing together short run and long run analysis; and even these (see for instance Aghion and Howitt (1991), Bean and Pissarides (1992)) have not produced clear cut empirical propositions yet. The analysis in this field has proceeded mainly through empirical estimates without solid theoretical foundations.

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2 See Sala-i-Martín (1990a) and (1990b) for a survey and discussion ofthese models.

The analysis of the impact of variables related to medium term macroeconomic performance on growth and convergence focuses in three main sets of variables: public consumption (as a percentage of GDP), nominal variables, and the rate of growth of exports. The reasons to choose this variables are discussed latter. The estimated elasticities present the expected sign although the results are not robust to alternative specifications.

The model and the theoretical arguments are sketched in Section II. According to MRW's findings, the Solow model augmented to account for the accumulation of human capital can explain much of the variance of growth rates at the OECD level. We follow their suggestion and develop our empirical analysis in the context of this model. In Section III we introduce the data discussing in some detail the choice of the appropriate PPP index for the different series. A first descriptive look at the most relevant variables is also carried out in this section. Sections IV and V present the estimation results for the cross section and the pooled sample.

Section VI concludes with the main findings and their interpretation, as well as with suggestions for further research. The overall picture that can be drawn from this exercise can be summarized as follows. The human capital augmented Solow model explains reasonably well growth and convergence among the OECD economies over the 1960-1990 period; however, a closer look reveals many features that remain to be explained Convergence occurs at different speeds among different groups of countries, depending on their income levels. Convergence seems a feature of fast growth times. During recessions, convergence is much slower or inexistent. The model does not fit very well in shorter time periods of macroeconomic turbulence. Variables related to medium term macroeconomic performance affect the rate of growth and convergence; however their effect is not stable along the sample period. In periods of recession they even outperform growth related variables.

II. The 'augmented' Solow model.

According to the augmented Solow model, (MRW (1990) and Durlauf and Johnson (1992)) the economy produces one good Y using a constant returns to scale technology and three productive factors, *efficient* labour (AL), physical (K) and human capital (H),

$$Y_t = \theta K_t^{\alpha} H_t^{\gamma} (A_t L_t)^{\beta} \qquad \alpha+\beta+\gamma=1 \tag{1}$$

the evolution of different inputs follow the accumulation equations (2) to (5)

$$A_t = A_0 e^{\phi t} \tag{2}$$

$$L_t = L_0 e^{nt} \tag{3}$$

$$\frac{dK_t}{dt} = s_k Y_t - \delta^k K_t \tag{4}$$

$$\frac{dH_t}{dt} = s_h Y_t - \delta^h K_t \tag{5}$$

where n and ϕ are the exogenous rates of growth of population and labour augmenting technical progress respectively. The parameters s_k and s_h represent the share of output devoted to accumulate physical and human capital respectively. Finally we shall assume that both types of capital depreciate at the same rate so that $\delta^k=\delta^h=\delta$.

Solving the model, the unique steady state input combinations can be shown to be:

$$\left[\frac{K}{AL}\right]^{*} = \left[\frac{\theta s_k^{1-\gamma}\ s_h^{\gamma}}{n+\phi+\delta}\right]^{\beta^{-1}} \qquad (6)$$

$$\left[\frac{H}{AL}\right]^{*} = \left[\frac{\theta s_h^{1-\alpha}\ s_k^{\alpha}}{n+\phi+\delta}\right]^{\beta^{-1}} \qquad (7)$$

plugging (6) and (7) into (1) we can write the expression for the steady state per capita income as follows:

$$\left[\frac{Y}{L}\right]^{*} = A^{*}\left[\frac{\theta s_k^{1-\gamma}\ s_h^{\gamma}}{n+\phi+\delta}\right]^{(\alpha/\beta)}\left[\frac{\theta s_h^{1-\alpha}\ s_k^{\alpha}}{n+\phi+\delta}\right]^{(\gamma/\beta)} \qquad (8)$$

The main implication of this model is the so called *conditional convergence proposition*, which means that in an economy of this kind, per capita growth between two periods of time (T and T+τ) can be expressed as a fraction of its distance to the steady state at period T. In particular, it may be shown that this growth can be expressed as (for a detailed discussion of this proposition see Sala-i-Martín (1990a and 1990b)),

$$\ln\left[\frac{Y_{T+\tau}}{(AL)_{T+\tau}}\right] - \ln\left[\frac{Y_T}{(AL)_T}\right] = (1-e^{-\lambda\tau})\left[\ln\left[\frac{Y}{AL}\right]^{*} - \ln\left[\frac{Y_T}{(AL)_T}\right]\right] \qquad (9)$$

where λ is the rate of convergence that can be written as

$$\lambda = \beta(n^{*}+\phi+\delta) \tag{10}$$

For a given τ, the larger λ the closer the economy gets to its steady state. Similarly, for a given λ the economy approaches its steady state as τ increases.

Equations (8) and (9) and (10) fully characterize the long run and the medium term evolution of the economy. As long as they can be written in terms of observable variables they constitute the basic exogenous growth model that has been the focus of a great amount of empirical research in recent years. For the i_{th} country, the empirical counterpart of (8) and (9) are the following expressions:

$$\ln y^{i}_{T+t}{}^{*} = B_{i1}+\phi_i T+\beta_i^{-1}\left[\alpha_i \ln(s_k^{i*})+\gamma_i \ln(s_h^{i*})-(\alpha_i+\gamma_i)\ln(n^{i*}+\phi_i+\delta_i)\right] \tag{11}$$

$$\ln y^{i}_{T+\tau} - \ln y^{i}_{T} = \phi_i \tau + \left(1-\exp(-\lambda_i \tau)\right)\left[B_{i2}+\phi_r T-\ln y^{i}_{T}+\ln y^{i}_{T+t}{}^{*}\right] \tag{12}$$

where starred variables represent their steady state values, and

$$y = \left[\frac{Y}{L}\right]$$

$$B_1 = (1-\alpha-\gamma)^{-1}\ln\theta + \ln A_0 + \phi t^{*}$$

$$B_2 = (1-\alpha-\gamma)^{-1}\ln\theta + \ln A_0$$

The main purpose of this paper is to investigate the size of the parameter λ. This can be done in several ways according to data availability. A natural approach is to estimate the parameter set $\{B_1, B_2, \alpha, \gamma, \phi, \lambda\}$ using time series for a single country; nevertheless the expressions (10) and (11) focus on long run issues that can hardly be tackled with annual data. The usual procedure in the literature consist on taking some sort of time average of variables letting τ be large enough (30, 10 or even 5 years) as to remove the contamination of short run fluctuations in the economy. In such case we can suffer severe degrees of freedom limitation.

The alternative way to increase the number of observations is to enlarge the data set to consider several countries (or regions) simultaneously. In this case we must further assume that all countries in the data set share the same parameter values in the production function[3]:

$$\alpha_i=\alpha,\ \beta_i=\beta,\ \gamma_i=\gamma,\ \phi_i=\phi,\ \theta_i=\theta,\ A_{0i}=A_0 \qquad \forall i$$

so that the empirical model becomes[4].

$$\ln y^i_{T+t}{}^* = B_1+\phi T+\beta^{-1}\left[\alpha\ln(s_k^{i\,*})+\gamma\ln(s_h^{i\,*})-(\alpha+\gamma)\ln(n^{i*}+\phi+\delta)\right]+\nu_i$$

$$\ln y^i_{T+\tau} - \ln y^i_T = \phi\tau + \left(1-e^{-\lambda\tau}\right)\left[B_2+\phi T-\ln y^i_T+\ln y^i_{T+t}{}^*\right]+\eta_i \qquad (13)$$

3 This assumption is not usually tested. The proper approach in this case would be to estimate the time series for each country (taking into account the presence of common shocks and estimating by SURE) and testing the null of common parameters across countries or groups of countries.

4 We could calculate a different λ_i for each country. However, upon the imposition of the same technological parameters, this would lead to the unattractive result that economies with faster population growth mechanically present higher speed of convergence. This is the reason why we compute λ from average population growth. When we partially relax this assumption we shall be able to compute different convergence rates across countries or group of countries.

$$(14)$$

$$\lambda = \beta\sum_i(n^i+\gamma+\delta)/I \qquad (15)$$

Most previous work has proceeded to estimate a linear version of (14) as the so called *convergence equation.* It should be noticed that the parameter λ can be recovered from the parameter π_1 in

$$\ln y^i_{T+\tau}-\ln y^i_T=\pi_0+\pi_1\ln y^i_T+\pi_2\ln(s^{i*}_k)+\pi_3\ln(s^{i*}_h)+\pi_4\ln(n^{i*}+\phi+\delta)+\varepsilon_i \qquad (16)$$

Our aim is not only to contrast the convergence hypothesis but also to asses the relevance of the augmented Solow model to describe the long run behaviour of the OECD economies. The estimation of the relevant parameters of the production function can shed some light on the legitimacy of the technological restrictions imposed. We will proceed to estimate directly the technological parameters imposing as many theoretical restrictions as possible. In particular we shall estimate jointly (13) and (14) and compare the fit with the unrestricted linear model (16). The overall loss of explanatory power of the more restricted model will be taken as a measure of the adequacy of the Solow model for the OECD countries during the sample period.

Finally we shall also compare the model with and without controlling for the steady state. The *absolute, or unconditional, convergence* hypothesis implies that all countries move towards the same steady state or at least that there is not correlation among the steady state and the initial conditions. In this case, λ can be consistently estimated in the convergence equation (14') or in its linear version (16'):

$$\ln y^i_{T+\tau} - \ln y^i_T = \phi\tau + \left(1-e^{-\lambda\tau}\right)\left[B'_2+\phi T-\ln y^i_T\right]+\eta'_i \qquad (14')$$

$$\ln y^i_{T+\tau}-\ln y^i_T=\pi'_0+\pi_1 \ln y^i_T+\varepsilon'_i \qquad (16')$$

Absolute convergence is a natural hypothesis to test among the OECD countries most of which share their *steady state* properties (in terms of technology, saving rates and population growth). For that purpose we shall estimate also the model in (14') and (16') to compute the rate of absolute convergence and to analyze to what extent the steady state varies across countries and how it is related with the initial conditions at T.

III. The Data.

Most data in our sample are taken from OECD statistics. In particular, GDP and its composition (current investment, consumption, public expenditure, exports and imports) are drawn from *National Accounts, 1960-1991*, that uses the System of National Accounts (SNA) definitions. In order to use this information, we need first to convert nominal values in real terms and to use a unique currency in order to homogenize all magnitudes. The use of exchange rates (usually $USA) is misleading because they are subject to fluctuations in exchange markets (e.g.: the appreciation of dollar in the mid 80s) and they do not take into account the price level in each country.

In previous works, Gilbert and Kravis (1954 and 1958), Kravis, Heston and Summers (KHS, 1978 and 1982), Summers, Kravis and Heston (1980) Summers and Heston (SH, 1984 and 1991), and several international institutions (OCDE and Eurostat) have proposed the use of the **purchasing power parities** (PPP) in international comparisons of real income. The construction of these parities is based on samples of prices of thousands of goods and services. In this paper we use the latest OECD publication of PPP, that uses 1990 as benchmark year and includes all 24 OECD members. All nominal variables have been transformed in real terms using its price index from national accounts and expressed in **international dollars** of 1985 using estimated PPPs from 1990 for each aggregate (for exports and imports, the exchange rate to US dollar)[5]. As in earlier works of KSH, there is a strong positive correlation between the ratio of a country's PPP to its exchange rate (the comparative price level), and its *per capita* income using exchange rates.

5 Extrapolation of PPPs from 1990 to 1985 uses the following expression:

$$PPP^{90}_{i,USA} = PPP^{85}_{i,USA}\,(I^{i}_{85,90}/I^{USA}_{85,90}) \qquad i = 1,\dots, 24$$

where $I_{85,90}$ is the ratio between price level in 1990 and 1985.

Empirical growth studies have trditionally used the Summers and Heston data set, known as Penn World Table mark 5. Data covers a wide rage of countries from 1950 to 1988. However, there are several reasons that justify the use of a different data set. First, we are interested in using all recent OECD information, updating the data set until 1990. That can be done applying rates of growth to SH variables but this would disregard 1990 PPPs. Also, it has to be noted that SH variables for countries with more than one benchmark have slightly modified national accounts data, which are obtained using a consistentization procedure, and that makes more difficult to assembly the series from different sources. Moreover, this problem is aggravated because national accounts data have been revised in recent years.

Second, SH do not maintain the *fixity* convention in PPP agreed by OECD, which allows the original results of OECD countries multilateral comparisons to remain unchanged, when these countries are included in a wider group. *EKS* and Geary-Khamis aggregation methods are affected by inclusion of countries with different GDP composition. In general, the larger the number and differences in included countries, the larger the divergences in comparisons within the initial group with respect to the original results.

Third, SH data set does not contain variables we were interested in, such as exports and imports[6]. Consistency with other variables of national accounts recommends the use of a unique source of data.

Our first attempt was to use the latest data from OECD, with revised information, and to construct a new series of PPPs, taking into account the original calculations involving OECD members in 1970, 1975, 1980, 1985 and 1990, and maintaining the *fixity* convention as close as possible. However, preliminary estimations with this data set reveal not negligible differences with previous empirical growth studies, complicating comparisons with their

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6 The ratio of the sum of both variables to GDP is included in SH data set as a series termed OPEN.

results. We are currently working in this area, making a sensitivity analysis of how changes in PPPs affect convergence and macroeconomic performance results.

Comparing OECD results for PPP in 1990 with the estimates obtained from 1985 as benchmark year (22 countries only), we have detected a big discrepancy in the case of Turkey[7]. For that reason, we estimate Turkey's 1990 PPP for consumption, investment and public expenditure, and use the standard Geary-Khamis method[8] to obtain a 1990 PPP estimation of GDP. After these estimations, we have extrapolated 1990 PPPs for private and public consumption, and investment from 1960 to 1989 for all 24 OECD countries, obtaining the purchasing power parities for GDP by using the mentioned Geary-Khamis aggregation method[9].

As it has been noted by several authors, the ratio Investment over GDP (I/Y) is a measure of *nominal* efforts in investment. However, in growth literature what is required is a measure of *real* investment. The reasons of the discrepancies between both measures is the following. Two countries with the same nominal ratio I/Y can face different price levels for investment goods. In general, an empirically robust finding is that poor countries have higher investment prices in relative terms than rich ones[10]. In what follows,

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7 This discrepancy is corroborated comparing the 1990 GDP data and its composition in the publication *Purchasing Power Parities* with *National Accounts* for the same year. While *Purchasing Power Parities* publication in 1992, for 1990 PPPs, uses a GDP of 390083 billions of liras, while *National Accounts* publication, also in 1992, uses a GDP of 283187 billions.

8 See Dabán and Doménech (1993).

9 Following Summers and Heston (1984) we have estimated an equation in which relative per capita income in PPP is explained among other variables by relative per capita income in US dollars (Table III.4). In contrast to Summers and Heston we also includes GDP composition and the squared of GDP deflator. This equation is used to estimate Turkey's PPP in 1990 given the explanatory variables.

10 As an example, in average for 1960-1990, Japan had a nominal and real I/Y ratio of 31,3% and 25,7% respectively, while USA had 18,7% for both measures.

every country's ratio of its main aggregates to its GDP is expressed in real terms, i.e., we use different PPPs for each component.

Table III.1 shows the 1960 to 1990 averages of the main variables used in the following sections. Comparing each country's GDP per capita in 1960 and 1990 expressed as percentage of USA, most OECD members have narrowed their gap with the richest country in the sample. Tables III.2 and III.3 show these variables for different subperiods. Per capita GDP growth was higher in 1960-75 and in 1985-90 than in 1975-85, while we observe the opposite result comparing inflation. Furthermore, exports rates of growth were smaller on average for almost all countries from 1975 to 1985.

In Figure 1 we represent the scatter of average rates of growth for 1960-90 against the initial level of per capita income in 1960. There is a strong negative relationship. This is the basic representation of what is called unconditional convergence: poor countries have higher rates of growth than rich ones. However, this result for the whole period does not hold for different subperiods. For all variables we have obtained five year averages for 1960-65, 1965-70 and son on, until 1990. Figure 2 represents the scatter of average rates of growth against the initial level of per capita income in 1960, but now for periods 1960-75 and 1985-90 -panel (a)- and 1975-85 -panel (b)-. As panel (b) confirms, convergence does not hold for the whole sample. However, excluding the poorest countries in 1975 (Turkey, Portugal, Greece, Ireland and Spain), it seems to be again a negative correlation between initial GDP per capita and its rate of growth.

Using the standard results of the partitioned matrix estimation we can display the partial correlation of two variables in presence of other explanatory variables as in Figures 3 to 10. Figure 3 is similar to Figure 1 but it takes into account the basic differences in steady states. Both initial per capita income and its rate of growth are regressed on I/Y and population growth. The scatter of their residuals shows a strong negative correlation that can be interpreted as a first approximation to conditional convergence.

Figure 4 shows the positive correlation between real investment share as percentage of GDP and per capita income rate of growth, after controlling by initial income and population growth, while Figure 5 represents the correlation between growth in per capita income and human capital, including in this case the ratio I/Y as a regressor. Human capital corresponds to estimated average years of schooling in the labour force from Kyriacou (1991)[11]. As table III.1 displays, there is a strong correlation between this measure of human capital and initial per capita income in 1960. However, even taking into account this fact, figure 5 exhibits a positive correlation between human capital and growth in per capita income.

All these features are related to the long run performance of OECD economies and must be analyzed in the context of growth models; however, the long run influence of medium term macroeconomic indicators cannot be disregarded. Some interesting features of the macroeconomic performance in the OECD along the sample period can be drawn from simple regression analysis. Figure 6 displays a positive correlation between growth in exports and in income after controlling by I/Y, 1960 per capita income and population growth, as some growth models predict. Figure 7 shows a slightly negative correlation (higher excluding some countries) between real government consumption as percentage of GDP and income growth, after controlling by the same variables as before.

Figure 8 (a) shows the effects of money growth into income growth

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11 We used also enrollment rates in secondary education from MRW, obtaining worse results. In general there is a strong correlation between both measures of human capital, although we have observed severe discrepancies for some countries (e.g.: Switzerland). Kyriacou estimates are available for 1965, 1970, 1975, 1980 and 1985, but for Austria, Belgium, Finland, Netherlands, Norway and Switzerland there are some missing values we have interpolated.

controlling by the saving rate (*I/Y*), initial income and population growth, while panel (b) includes inflation as a regressor[12]. In the later case we can interpret the slightly positive correlation as the effects of unanticipated changes in money into growth. However, the large variance suggests that there is a little evidence.

Figure 9 exhibits a negative correlation (excluding Iceland) between inflation and growth. Inflation has been measured as the rate of growth of GDP deflator. This results seems to be even more robust when we use first differences of inflation (acceleration) as Figure 10 shows: increasing inflation has negative effects on growth.

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12 Following Kormendi and Meguire (1985), data correspond to money definition in FMI *International Financial Statistics* (line 34). We have detected some breakpoints for some countries. To avoid this cumbersome problem, we have reconstructed those series using information of different yearbooks which allows to compute the rate of growth of money for those years, with the exception of New Zealand where we use also OCDE data. For all countries money stock in 1990 correspond to original data from FMI.

IV. Cross Section Estimation.

In this section we estimate the model in (13), (14), (15), (14') and (16'), setting T to 1960 and τ equal to 30. This means that we consider only the cross section variability to analyze the convergence hypothesis over the very long run. Steady state values of the variables are then approximated by their thirty years averages. This procedure (common to much of the work in this field) also makes less relevant the endogeneity problem in estimating the convergence equation, which would otherwise make pretty difficult to obtain consistent estimates given the difficulty of finding suitable instruments.

Alternatively we could find lagged values as instruments cutting the sample at some intermediate date. The reasons for not proceeding in this way will become clear in the next section, when we analyze the sample taking shorter period averages. As we shall see, the differences across subperiods are large enough so that splitting the sample is not a trivial decision.

4.1 Results for the whole sample

In Table IV.1 we present different versions of the linear model in (16) and (16'). In column 1 a first test of unconditional convergence displays a strongly significant negative parameter for per capita income in 1960. Both the parameter size and the equation fit are similar to the results reported by MRW. As in their case, the poor fit suggests the convenience of controlling for steady state variation across countries. In columns 2 and 3 the model includes the ratio of investment to GDP (I/Y) as well as the 'augmented rate of population growth' ($n+\phi+\delta$). Following the convention in many studies of this kind we impose, at this stage[13], the values of 0.02 and

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[13] Nevertheless, in some non linear specifications we shall explicitly estimate ϕ; as we shall see, the point estimate does not differ very much from the restricted value 0.02.

0.03 for ϕ and δ respectively. The inclusion of these variables improves the fit substantially, producing a 25% fall in the standard error. The coefficients $\hat{\pi}_2$ and $\hat{\pi}_3$ have the expected sign and the imposition of theoretical restrictions ($\hat{\pi}_2=-\hat{\pi}_3$) is not rejected by the data.

Most important tough, is that the negative coefficient of the initial per capita income stands up consistently negative and becomes even more significant in the conditional model. In fact, $\hat{\pi}_1$ increases over a 30%. This suggests that conditional convergence has taken place at a faster rate than the unconditional one[14]. Steady states are different and positively correlated across countries with their initial per capita income. Richer countries in 1960 still point towards higher steady state per capita incomes. The omission of these variables biases the convergence parameter downwards.

Comparing these results with MRW's, we get a better fit as well as faster convergence speed. This could be explained by the different homogenization method (as explained in section III) as much as by the enlarged time span in our sample, that includes the period 1985-1990 in which faster growth has brought about faster convergence than in 1975-1980 and 1980 1985.

In columns 4 and 5 the convergence equation is augmented to include a proxy for the share of output devoted to accumulate human capital (s_h). Many of the criticisms to the Solow model focus on the extremely simple technological structure incorporated in the two inputs constant returns to scale production function. What these results show is in accordance with MRW's suggestion that isolating human capital as an accumulable factor in the production function can greatly improve the explanatory power of the basic

[14] We call unconditional rate at the one obtained in the model without steady state variables. This is not strictly correct as these equations may be misspecified. Still, we carry out this exercise for comparison purposes.

model of exogenous growth (Lucas (1988)). The augmented model improves the fit in a further 10% reduction in the standard error; the human capital proxy is highly significant and both the size and the sign of the estimated parameters are as expected. Theoretical restrictions on the linear model are easily accepted by the data with an additional improvement in the standard error. The estimated parameters are also in the range of values reported by MRW and Durlauf and Johnson (1992) among others. The conditional convergence parameter is also higher (in absolute value) in the fully specified model than in the ones we have previously discussed. This is consistent with the idea that there is enough variation in human capital formation across OECD countries and that richer countries in 1960 have devoted more resources to invest in schooling, which in turn has contributed to increase their welfare prospects in the long run.

So far we have discussed about the signs. A more detailed analysis of the data set is needed to assess the validity of the augmented Solow model, in order to explain growth and convergence processes in the OECD countries. Rejecting convergence implies rejecting the Solow model, however accepting convergence does not necessarily implies the validity of the Solow model[15]. Equations (8), (9) and (10) contain much more information about restrictions that we can exploit in order to obtain direct estimates of the parameters of interest, and to test to what extent the data is compatible with the Solow model. We do not claim we are testing it against a well defined alternative. Rather we test whether convergence equations keep their explanatory power when we explicitly derive them from a well specified theoretical framework.

We have taken three different approaches to estimate the technological and convergence parameters. First we estimate α and γ through the joint estimation of the convergence and the steady state equations (see Holtz-Eakin (1992)) both with and without the corresponding cross equations restrictions

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15 The convergence property is also built in some endogenous growth models for particular values of the technological parameters.

in order to achieve efficiency gains. Second, we run non linear regressions of the fully restricted convergence equation; we have also estimated this equation without steady state variables (equation (14')) in order to compare the unconditional and the conditional convergence hypotheses. Finally, we have also tried the partially restricted convergence equation in which λ is directly estimated instead of calculated from (15). In some specifications, there is a non negligible difference among these two estimation procedures as far as the estimated λ is concerned.

The results of all these estimation methods are presented in Table IV.2. In column 1, the estimation imposes all parameter restrictions across equations. The model does not reject the restrictions imposed by theory although the fit of the steady state equation is rather poor[16]. The convergence equation fits better than its linear version with a moderate fall in the standard error. Similarly the cross equations restrictions are not rejected at the 5% level. The estimated parameter set has also sensible values, confirming the MRW's suggestion of a production function with a balanced share of physical capital, human capital and labour in national income ($\hat{\alpha} \approx \hat{\beta} \approx \hat{\gamma} \approx 1/3$). The convergence rate that can be drawn from these estimates is also in the range of values found in previous work (Barro and Sala-i-Martín (1991)) about 2.1%.

The joint estimation without imposing cross equations restrictions (columns 2 and 3) produces substantially the same results although revealing some interesting differences. The point estimates in the convergence equation are closer to the {1/3, 1/3, 1/3} set than those in the steady state one, with a slightly higher capital share and lower human capital share. Again the fit improves somewhat, and the implicit convergence rate is around 2%.

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16 This has two possible explanations. On the one hand, the sample average may not be a good proxy for $(Y/L)^*$. On the other hand, the steady state equation is static in nature and suffers the problems of static equations in modeling aggregate macroeconomic variables. We shall return to this later, in the pooled sample model.

This seems a promising line of research which suggests, at least, that there is weak evidence in favour of the technological restrictions implied by the Solow model. However, the fit of the steady state equation is very poor; henceforth, in what follows we abandon the joint estimation of the two equations to focus in the convergence one. We can still test the convergence hypothesis on it, although we do not claim that an 'exogenous growth' interpretation is the only one consistent with this result.

In columns 4 to 6 we present different versions of the convergence equation. In columns 4 and 6 we estimate all the parameters in (14) with and without imposing the restrictions implied in (10). In both cases the implicit labour share ($\hat{\beta}$) is about 0.33, quite similar to the values reported in MRW, Durlauf and Johnson(1992) and Holtz-Eakin (1992). Estimated α are slightly higher than expected; nevertheless, values around 0.40 are in the range of those reported for the richer countries in Durlauf and Johnson's paper, who report values between 0.34 and 0.55 for samples containing most OECD countries. On the other hand, $\hat{\gamma}$ is slightly lower than in MRW's paper, but again this result is not at odds with Durlauf and Johnson's findings who report many estimations ranging from 0.0 to 0.4. Similarly in Holtz-Eakin (1992) the estimated γ is around 0.20.

The convergence rate ($\hat{\lambda}$) is fairly robust to alternative specifications. In column 4, the parameter ϕ is estimated to be 0.03, slightly higher than the value usually imposed at 0.02. The convergence rate can be computed in two ways,

$$\hat{\lambda} = \hat{\beta}\sum_i(n_i+0.05)/24 = 0.019$$

$$\hat{\lambda} = \hat{\beta}\sum_i(n_i+\hat{\phi}+0.03)/24 = 0.022$$

both values are close to the ones obtained before and are also similar to the λ estimated in column 6 (0.023), in which parameter restrictions implied in

(10) have not been imposed. It is worth noting that the data seems to accept the restrictions in (10) fairly well. Actually, the restricted model (in columns 3 or 4) displays better standard error and $\bar{R}^2$ than the partially restricted one (column 6).

Finally, in column 5 we estimate the model in (14') without controlling for the steady state. The unconditional convergence rate is much lower than the conditional one, showing that it would take twice as much time for OECD economies to reach the same level of per capita income, than to reach each country own's steady state. There is one additional insight we can get from the explanatory power of the unconditional convergence model. In this case the fully restricted non linear version fits significantly worse than its linear counterpart[17]. The parameter restrictions implied by the augmented Solow model are rejected in the unconditional case but not in the conditional one. This suggests that controlling for the steady state is crucial in order to test the adequacy of the basic growth model. Ad hoc convergence regressions without a fully specified steady state are uninformative about the structural features of long run economic performance.

4.2 <u>Subsample estimates</u>

The results we have discussed so far seem robust to alternative econometric specifications. As we shall see throughout the paper, these results no longer hold when we look at the OECD sample at a more disaggregate level. One of these disaggregation procedures consists in analyzing to what extent the main parameter estimates hold when we take different country groups among the 24 OECD members we have been studying so far. There are three reasons for analyzing subsamples. First, the well known criticism to

17 $\sigma_{iv.1.4}$=0.118 versus $\sigma_{iv.2.4}$=0.112 in the conditional model, whereas for the unconditional model $\sigma_{iv.1.1}$=0.173 versus $\sigma_{iv.2.5}$=0.193.

convergence regressions among countries that have been observed to have converged *ex-post* (i.e. at the time T+τ (De Long (1988))). Second, the descriptive analysis in section III has revealed huge economic differences among OECD countries both in their long run and in their short run achievement. Third, several studies report sizable differences in the most relevant parameters as well as in the convergence speed across countries. To the extent that we can identify homogeneous groups among the 24 countries in our sample, it is worth testing whether convergence has taken place at the widespread accepted 2% rate inside each group.

Durlauf and Johnson (1992) put forward an explanation for these differences in terms of technological non convexities. At any point in time there are several available technologies that might be distributed across countries according to some economic or institutional features. In particular a close correlation between the type of technology used and the economic achievement may be expected. This means that we may split the OECD sample on the basis of that variable and test whether such differences do exist. According to Romer's (1986) model of learning-by-doing, the initial value A_o and the scale parameter θ, may depend on capital intensity in a non continuous fashion. In this the case, Durlauf and Johnson (1992) prove that B_2 in (14) will be higher for richer countries, and that the parameter homogeneity hypothesis could not be maintained any longer.

Given our degrees of freedom limitation we have proceed to control for differences in technological parameters in two ways. First, we have run the linear version of the model (16) for each of the 24 subsamples of 23 countries, and selected those countries whose exclusion produces a 5% change in some of the parameters $\hat{\pi}_1$, $\hat{\pi}_2$, $\hat{\pi}_3$. At the same time we have tested the significance of country dummies in the full sample regression. To our surprise this procedure revealed little changes in the relevant parameters with the exception of Turkey, Greece and, to a lesser extent Japan. For this reason we kept the subsample of the 22 OECD countries having excluded Turkey and Greece. Additionally, following Durlauf and Johnson's (1992) (see also Helliwel and Chung (1992)) suggestion we took the level of income at different points in time as an alternative splitting method. We did not try an endogenous splitting procedure but we chose groups of countries large enough as to be able to estimate the parameters of interest. Unlike Durlauf and Johnson we did not choose a single year based split, but rather we tried to identify groups of countries according to their position in 1960 and in 1990[18].

Before describing the results in Tables IV.3 and IV.4, a short comment is worth about the unreported linear estimates. Some of the most important differences among subsamples can only be seen in a non restricted setting; otherwise, restricted estimation hides some changes in relative parameters. Excluding Turkey (and to a lesser extent) Greece, the Solow model no longer holds; the parameter values are significantly different from those found for the OECD as a whole; in particular, the augmented rate of population growth $(n+\phi+\delta)$ turns out to be non significant. Turkey presents the highest rate of population growth and one of the lowest rates of per capita growth in the OECD; the negative correlation between these two variables is strong enough only because of this outlayer. Similarly, the positive correlation between growth and savings is sharply weakened when we exclude Japan. The coincidence of a high savings rate and growth rates in Japan is explaining a large proportion of what is considered evidence in favour of the Solow model.

In Tables IV.3 and IV.4 we present estimates of the model (14) and (14') for the five subsamples chosen. Excluding Turkey and Greece (column 1) generates a substantial increase in the convergence rate to 2.6, which is 30% higher than for the OECD as a whole. Notice that these two countries have been permanently at the bottom in the OECD ranking for per capita income. Hence, an alternative way of looking at this issue is to split the sample in

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18 Actually, none of these procedures can be formally justified. An alternative method based in more solid grounds is tried in Andrés and Boscá (1993). At this stage we are merely interested in excluding from the sample the countries in each of the tails of the distribution at different points in time.

the way we do in columns 2 and 3. We first exclude[19] from the sample the seven richest countries[20] in 1960 (column 2) and then the seven poorest[21] (column 3). A careful look at the estimates reveals some striking differences.

First, the parameter estimates are rather different, in particular B_2, γ and, to a lesser extent, ϕ. Differences in B_2 and γ are consistent with the technological non convexity argument discussed earlier. In particular the sharp difference in the constant term B_2 among the poorest and the richest countries is largely consistent with the notion that the latter have enjoyed a higher level of efficiency per worker (A_o) as well as a more efficient technology (θ) at a given point in time[22]:

$$B_2^P = (\beta^P)^{-1}\ln\theta^P + \ln A_o^P < B_2^R = (\beta^R)^{-1}\ln\theta^R + \ln A_o^R$$

This is even more evident if we consider that the estimated β is smaller for the poorest countries sample, and so is the convergence rate λ. This rate is 50% higher among the richest countries; this gap is much larger if we compute λ taking in account the estimated rate of labour augmenting technical progress (ϕ) that turns out to be non significant for the poorest countries; in such case the rate of convergence of the former group is twice as large as that for the latter. Finally, the overall fit of the convergence equation is consistently better for the group of more advanced countries; this is a common feature we shall find in alternative specifications and which we shall

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19 The results are rather robust to the cut-off income level. We chose this split in order to avoid a sharp fall in the degrees of freedom, and also to allow for different countries in each group when we rank them according to their position in 1990.

20 USA, Switzerland, New Zealand, Luxembourg, Sweden, Australia and the United Kingdom.

21 Turkey, Greece, Portugal, Spain, Japan, Ireland and Iceland.

22 Helliwell and Chung (1992) also report sizable differences in the constant term once their full sample is divided according to per capita income levels. These differences present the expected sign, the constant term being lower for low income than for rich income groups of countries.

discuss latter.

Most of these results carry over to the split based in the 1990 relative wealth[23]. Again, the parameters, as well as the overall fit, are very different across subsamples. The high rate of convergence among the rich countries is not surprising and may be criticized on the basis of sample selection. Nevertheless, in this case, the convergence rate is higher than the average in both subsamples as might be expected when we split the sample in more homogeneous groups. If homogeneity is measured as the final achievement (per capita income in 1990) we find faster intragroup convergence, whereas if homogeneity is measured at the starting point this is no longer the case. The split based on initial per capita income is not free of criticism. Similar per capita incomes in 1960 may be consistent with very different growth prospects, so they can hardly be taken as similar technologies. In this sense, the alternative split, based upon 1990 wealth, may reflect much better these technological differences.

The good fit for the last subsample (column 5) is somehow surprising if we consider the rather implausible parameter values we obtain in the context of Solow technology. To analyze this puzzle we have run unconditional convergence regressions for the five subsamples. The unconditional model fits much worse than the conditional one among poor countries and generates a very low convergence speed. The unconditional rate is about a half of the conditional one; this holds regardless of whether we define the poorest countries in 1960 (0.6 versus 1.3) or in 1990 (1.0 versus 2.3). The correlation among the initial conditions and the steady state is strong and positive among poor countries; the lower the initial conditions the lower the steady state

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23 In this case the seven richest countries are: USA, Switzerland, Luxembourg, Canada, Germany, Japan and Denmark. On the other hand, the seven poorest are: Turkey, Greece, Portugal, Ireland, Spain, New Zealand and Italy.

In the rich countries subsamples (columns 3 and 5) things look different. When we choose the countries on the basis of their position in 1960, the unconditional model fits slightly worse, but produces a higher rate of convergence than the *conditional* one (4.7 *versus* 2.7). Unlike the other subsamples, in this case the correlation among initial conditions and the steady state is negative. Finally, when we choose the richest countries in 1990, the steady state variables become irrelevant. The absolute and relative rates of convergence are similar, and the fit does not improve substantially. This result, together with the implausible parameter values for this subsample, casts some doubts on the adequacy of the augmented Solow model at this disaggregate level. Information about technological constraints add nothing to the simple unconstrained unconditional model.

4.3 Growth and medium term macroeconomic performance

The relation between medium term macroeconomic policy and performance and long run growth is a recurrent topic in macroeconomics. In fact, the theoretical gap between these two approaches still remains to be filled, although the empirical analysis of growth is increasingly interested in the incidence of some variables such as inflation, public spending and others upon the longer run prospects of the economy. In the next pages we discuss the effect of some of these variables upon both the growth rate and the rate of convergence in our OECD sample.

The expected impact of each variable on growth relies in some arguments put forward in the literature in a more or less formal manner. Their impact on convergence can be better understood using an omitted variables argument; to the extent that the true steady state is influenced by medium term macroeconomic stance, its omission from the model may introduce a bias in the parameters of interest, in particular in λ. The sign of this bias depends on the correlation between each omitted variable and the steady state.

Starting with Kormendi and Meguire's (1985) seminal work, a series of recent papers have run convergence like regressions allowing for macroeconomic indicators. The main argument in a nutshell is as follows. To the extent that some variables affect the accumulation of capital they should not appear in the convergence regression. However if they influence the rate of return of investment they may be significant (Fischer (1991)). The variables to be considered are related to the public sector size, trade and nominal variables such as inflation and the like.

Public spending (coefficient A_G in Table IV.5) affects growth in many ways. In the theoretical growth literature different components of public spending enhance or harm growth depending on whether they are cooperants with other factors in the production function or not (Barro (1989)). If they are so, as in the case of infrastructure, justice, etc., they increase both the social and the private returns of other factors; otherwise, they might work in the opposite direction introducing tax based price distortions affecting the supply of some factors by reducing after tax rates of return (Singh (1992)). Public investment has already been considered in our total investment variable, with positive influence on growth; as in many other studies (Grier and Tullock (1989)) we have only homogeneous information about public consumption[24] which may harm growth in the long run. Demand led growth arguments can hardly be expected to hold over such a long period.

Nominal variables can affect growth in a variety of ways. We have tried several of these variables: inflation (coefficient A_P), inflation growth (A_A), standard deviation of inflation (A_{VT}), standard deviation of inflation growth (A_{VA}), money supply growth (A_M), unanticipated money (A_{AM}), standard

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[24] A more disaggregate information about transfers, infrastructures, etc. has proved difficult to assembly for the time being. We have also been unable, for the time being, to construct a good data base for other fiscal variables such as public deficit and debt.

deviation of money growth (A_{VTM}) and standard error of unanticipated money (A_{VAM}). The expected sign of all these coefficients is negative with the exception A_M and A_{AM}. According to standard keynesian or accelerationist versions of the Phillips curve mechanism, inflation might be positively correlated with growth (Grimes (1991)). Nevertheless these influences are better captured by the exogenous anticipated and specially unanticipated money growth, as it became popular in the imperfect information based business cycle models. Hence, if monetary variables are allowed in, the expected sign of price variables is negative to account for the distortionary effects on relative prices and on intertemporal allocation of resources in particular. Finally, the way in which monetary policy is conducted may have also long lasting implications[25]. Henceforth, the effect of all standard deviation measures is expected to be negative as they capture the increased uncertainty that the wrong management of short term shocks may introduce in the economy.

Finally we tried several open economy indicators. The relationship between the degree of openness and growth has been vastly discussed in the development literature. An important outcome of the long lasting debate about inward versus outward oriented policies is the widespread consensus about the better growth performance of countries more actively involved a in international trade. On the one hand, presence in international markets gives a country the opportunity to have access to the more advanced production techniques via imports; on the other hand, competition in export markets enhances productivity and incentives each country to look for its own place in the international division of labour in order to gain competitiveness.

A number of authors (see Balassa (1978) or Michaely (1977) among

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25 In a recent paper De Long and Summers (1992) have studied the relationship among Central Bank independence and productivity growth. They find that Central Bank independence is negatively correlated with inflation and positively correlated with growth (once the effect of initial conditions has been discounted)

others) highlighted in the late seventies several beneficial aspects of exports, such as higher capacity utilization, incentives for technological improvements and efficient management due to competitive pressures abroad, training of higher quality labour or the existence of economies of scale. Feder (1982) analyzed, in the context of a two sector neoclassical growth model, the existence substantial differences between marginal factor productivities in the export and non-export sectors. He found statistical evidence of such productivity differentials as well as of positive externalities from the export to the non-export sector in a sample of semi-industrialized countries. Nevertheless, productivity differentials could not be found in a sample of developed countries.

More recently, and in the context of the new growth theory, Grossman and Helpman (1991) have further studied the relationship between trade, technological change and growth. Their main contribution is to show that a country's comparative advantage depends on its factors endowment, and in particular that countries better endowed with human capital tend to specialize in those activities with higher productivity. Because the rate of growth is an average of the growth rates of the R&D sector, the production of high technology goods sector and the production of traditionally competitive goods sector, those countries specialized in the human capital intensive activities display higher growth rates. In this context countries that export more, mainly in intraindustry trade goods will grow faster.

Finally, Levine and Renelt (1992) show that the openness indicators show a highly significant positive correlation with growth that remains robust no matter which other variables are included in the regression. In this paper, though we don't find that all the trade indicators are significant; the finding that the rate of growth of exports weighted by their share in GDP is not significant is in accordance with Feder's finding that for developed countries there is no productivity differential.

The specification search has proceeded by analyzing the effect of each variable in the non linear model and trying all possible combinations among them. The chosen specification in terms of goodness of fit was the following augmented convergence equation

$$\ln y^{i}_{T+\tau}-\ln y^{i}_{T}=\phi\tau+\left(1-e^{-\lambda\tau}\right)\left[B_2+\phi T-\ln y^{i}_{T}+\ln y^{i}_{T+t}{}^{*}+\sum_j A_j X_j\right]+\sum_k A_k X_k+\eta_i \tag{17}$$

where k indexed variables are those related to trade and j indexed ones are nominal variables and the ratio of public spending to GDP.

The main results are summarized in Table IV.5. Unlike some previous studies, we find that the public sector size is not strongly correlated with growth in the OECD sample. The ratio of public consumption to GDP (GY) appears negatively signed in most specifications but with a low t ratio, which is only slightly above 1 in the model including other macroeconomic indicators (column 6). The strongest evidence in favour of this effect is found by Grier and Tullock (1989) for the OECD countries; however their specification is different to ours[26], in particular their model does not include the investment rate. Similarly, Barro (1989) finds strong negative correlation among public consumption and growth for the Summers and Heston data set, whereas Levine and Renelt (1992) in a comprehensive study, find that this correlation[27] is non robust to the inclusion of other macroeconomic indicators. As can be seen comparing columns 1, 4 and 6, public consumption adds very little to the overall significance of the Solow model, and is non robust to the enlarged regressors set. Furthermore, the implied λ is not affected by the exclusion of the ratio GY.

Only the acceleration of prices appears, out of the several nominal

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26 In fact they obtain this result in a pooling model; as we shall see later this weak correlation among growth and public spending carries over to our pooled sample model.

27 And in general among any other public sector size indicator and growth.

variables tried, negative and significant regardless of the set of regressors in the equation. The inflation rate is only weakly significant, whereas the monetary variables and the corresponding standard deviations are not significant at all. Our results are consistent with Kormendi and Meguire's (1985); on the other hand, Fischer (1991) finds a strong negative effect of inflation on growth in both cross section and pooling models using the Summers and Heston data set, and so does Grimes (1991) who also reports a negative influence of inflation growth. It is interesting to realize that this variable contributes to a 20% fall in the standard error as well as to a substantial increase in the convergence rate. This result suggests that price acceleration has not only harmed growth but that has done so unevenly across countries; convergence would have been faster if some countries would not have suffered higher inflation growth than others. Price acceleration has the effect of reducing the steady state per capita income which a particular country points to; this has been more important for poorer countries in 1960, narrowing the gap between their initial income level and their effective steady state, making convergence to look faster.

Finally, as was pointed out in other works, there is a strong correlation among openness and growth. We have tried alternative measures of competitiveness and openness, such as trade balance, real and nominal exports plus imports, etc.. Among those, only the rate of growth of exports (and to a lesser extent this rate weighted by the share of exports in GDP) is robust to alternative specifications. As can be seen in columns 3, 5 and 6, growth is associated with exports growth regardless of the set of macroeconomic variables we take in account. This result is stronger than those reported in other studies such as Kormendi and Meguire's (1985) and Levine and Renelt's (1992) who found this positive correlation to be non robust to alternative specifications. On the other hand, the inclusion of exports does not significantly affect the implied convergence rate λ.

The comprehensive work carried out by Levine and Renelt (1992) shows how fragile are the findings about partial correlations among growth and most macroeconomic indicators. Macroeconomic performance varies also very much across our sample countries; most of the differences in published work have also very much to do with the set of countries considered in each case. A natural test on the robustness of the results in Table IV.5 is to check to what extent they hold for different subsamples. Again the search has proceeded excluding one country at a time and controlling with country dummies. The results are pretty sensitive to the composition of the sample. Nevertheless, these results must be taken cautiously because the corresponding dummies were never highly significant[28], which means that no country was found off the confidence interval of the fitted model.

As can be seen in Table IV.6 the public spending to GDP ratio is non robust to particular subsamples. Excluding Spain, New Zealand, Greece and the UK, the ratio GY becomes significant. The same happens, excluding either of those. On the other hand, two countries present abnormally high inflation rates: Iceland and Turkey. The exclusion of Iceland and Turkey for the sample generates a dramatic change in the effect of macroeconomic variables. Given that these countries suffer from a very high inflation rate but stills grow at a higher than average rate, once we include them in the sample the (negative) correlation among inflation and growth vanishes. However, once we drop Iceland and Turkey from the sample the inflation rate appears as the main medium term macroeconomic impediment to growth.

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28 The highest t value was that of Iceland around 1.70.

V. Pooling.

Cross section results, as the ones presented in the previous section are, illustrative in many ways of the long run behaviour of the OECD economies; nevertheless, there is an alternative use of our information that covers a large time span from 1960 to 1990. There are several advantages in exploiting the time series dimension of our data set. First, the way in which long term growth and shorter term fluctuations are isolated is somewhat arbitrary; it is true that the time span needed for growth forces to become effective is long and it is advisable not to draw conclusions from annual data. A popular intermediate approach consists of taking shorter period averages as representatives of the long run path of the economy; this cancels some uninteresting cyclical movements but still leaves some room for time varying shocks to affect the growth process. We have chosen a five year period split with the break points at 1960, 1965, 1970, 1975, 1980 and 1985. This amounts to reformulate the model to,

$$\ln y^{i}_{T+t}{}^{*} = B_1+\phi T+\beta^{-1}\left[\alpha \ln(s^{i*}_{kT})+\gamma \ln(s^{i*}_{hT})-(\alpha+\gamma)\ln(n^{i*}_{T}+\phi+\delta)\right]+v_{iT} \tag{18}$$

$$\ln y^{i}_{T+\tau} - \ln y^{i}_{T} = \phi\tau + \left(1-e^{-\lambda\tau}\right)\left[B_2+\phi T-\ln y^{i}_{T}+\ln y^{i}_{T+t}{}^{*}\right]+\eta_{iT} \tag{19}$$

or in linear format,

$$\ln y^{i}_{T+\tau}-\ln y^{i}_{T}=\pi_0+\pi_1 \ln y^{i}_{T}+\pi_2 \ln(s^{i*}_{kT})+\pi_3 \ln(s^{i*}_{hT})+\pi_4 \ln(n^{i*}_{T}+\phi+\delta)+\varepsilon_{iT} \tag{20}$$

where

$i = 1, 2, ...,24$

$T = 1960, 1965, ..., 1985.$

$\tau = 5$

The second advantage of the model in (18), (19), (20) is to enable us to improve our understanding of the relationship among growth and medium term macroeconomic performance. By its very nature, long run averages of macroeconomic indicators are not much informative about their impact on growth. Consider two economies experiencing a 2% average inflation over 30 years. Economy A has suffered sharp changes in inflation, whereas in economy B inflation has been stable along the period. The incidence of inflation on growth is likely to be very different in these economies; hence, we may obtain much more precise estimates of correlation among these two variables using shorter term averages.

A third advantage of the pooled sample is the possibility to carry out some tests of structural stability on the convergence model. Growth rates have been far from homogeneous along the sample period in the OECD. Many countries grew very fast until 1973 and entered in a deep recession since then up to 1986. This raises two related issues as far as the Solow model is concerned. The first one is to what extent it is legitimate to expect the Solow model (or in general any model based in labour market equilibrium) to hold during periods of high unemployment. Moreover we can also investigate whether the rate of convergence remains stable regardless of average growth. In other words, the question is whether OECD economies converge at the same speed during recessions or rather weather richer countries fare better than poor ones in bad times, so that the distance among them is widened.

Finally, there are two ways in which the econometric specification can be improved, one of which we shall exploit here. So far we have relied on OLS estimates in the cross section. The reasons to do that were twofold; first because of the difficulty of finding well suited instruments, and second for comparison purposes, given that most of the work done in this area has followed this approach. In fact the size of the simultaneity bias is expected to be small in the cross section, given that only the last element in the full period average of each variable is simultaneously determined with the final year per capita income[29]. However, in the pooled sample, the potential bias is larger, because now is one out of five (rather than one out of thirty) elements in the average which is simultaneously determined with the left hand variable. In general we have estimated the models by non linear instrumental variables. Instruments are first lags of endogenous variables as well as some current and lagged macroeconomic variables.

The model in (18), (19), (20) could also be estimated allowing for time invariant individual country effects[30]. In fact the null of the same constant term across countries has been imposed rather than tested at this stage. Henceforth, we shall proceed assuming that these effects do not exist or at least that they are uncorrelated with the right hand side variables to ensure consistency in the estimates in our pooling model.

5.1 Results for the whole sample.

The linear regression estimates in Table V.1 partially confirm the results found in the cross section model. The coefficient of initial income, $\hat{\pi}_1$, is negative and highly significant. Including the steady state variables improves the fit with a 10% fall in the standard error. In this case the conditional model also yields a much higher convergence rate, with a 40% increase in $\hat{\pi}_1$, which again suggests a positive correlation among the initial conditions and the steady state. The parameter restrictions implied by the linearized Solow model are easily accepted by the data, as can be seen in the unchanged standard error. Unlike the cross section case, in the pooled data set the human capital proxy is positive but not always significant, with a *t*

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29 Although this is not true for the steady state equation.

30 The contrast of country specific parameters is now in the research agenda; given the heavy non linearity involved in (18) and (19) this is not a trivial task in particular if this individual effect affects the parameter ϕ.

statistic below 1.5. As we shall see this result is heavily dependent on the specification chosen, so that the estimated elasticity of human capital must be carefully interpreted[31].

Non linear instrumental variables regressions are summarized in Table V.2. In Table V.2a we present the results of the joint estimation of both the steady state and the convergence equations with (columns 1 and 4) and without (columns 2, 3, 5 and 6) imposing all cross equations restrictions. The difference among columns 1 to 3 and columns 4 to 6 relies on the treatment of technical progress. In the first block the model in (18), (19) is estimated under the assumption of a constant rate of technical progress to be estimated (ϕ). In the models indexed with D a more general specification for technical progress considers a constant average rate ϕ set to 0.02, allowing to different rates in each period, substituting the linear trend by time dummies.

The fully restricted model (column 1) fits rather worse than the unrestricted linear one. The estimated parameter set yields plausible values ($\hat{\alpha}$, $\hat{\gamma}$, $\hat{\phi}$) with $\hat{\alpha}$ slightly lower than expected (0.24). The restriction imposed on ϕ is easily accepted; free estimation yields a point estimate around 0.01. Unlike the linear case, once we impose the cross equations restrictions human capital appears well signed and significant. The convergence rate is between 1.9 and 2.3, in the range of values obtained in the cross section model. However, the fit of the convergence regression worsens significantly as compared with the linear case. Similarly, the steady state equation presents a poor fit with a low DW[32]. Moreover, the rejection of theoretical

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[31] By its own nature the impact of s_h upon growth only works over the long run. If this was the case, shorter period correlations among human capital accumulation and growth may not be very strong. The fact that the model with time dummies γ appears significant reinforces this interpretation.

[32] Residual autocorrelation is common to most estimations of the production function, and the steady state equation is a rather straightforward

restrictions is overwhelming; the point estimates of α, γ and ϕ differ very much across equations and point to very different technological parameters, as can be also seen in the corresponding χ^2 statistics significantly higher than their critical value.

The joint estimation of both equations without imposing the cross equations restrictions in columns 2 and 3 also reveals other explanations for the poor performance of the fully restricted model. Imposing cross equations restrictions produces parameter values close to the ones obtained in the (poorly specified) steady state equation. When these restrictions are relaxed the fit of the convergence equation improves sharply as to reach the same statistics as the unrestricted linear model ($\hat{\sigma}$=0.076). We obtain an illustrative picture comparing the estimates in Tables IV.2 and V.2a. These statistics ($\hat{\alpha}_{ss}$, $\hat{\gamma}_{ss}$, $\hat{\sigma}_{ss}$) are very similar for the steady state equations in both cases; however, this coincidence does not carry over to the convergence equation. Unlike the cross section case, here the convergence equation fits rather worse in the fully restricted model and the parameter estimates are far from the values obtained there (1/3, 1/3, 1/3). Despite the labour share is still around 0.37, in the pooled sample the share of human capital is not significantly different from zero. Finally, in the cross section fully restricted model, point estimates lie somewhere in the middle of those found for each equation taken separately, while in the pooling model joint estimation parameter values have nothing to do with those found in the convergence equation. All these discrepancies are summarized in the estimated convergence rate which is in this case extremely different depending on whether we evaluate it at the steady state point estimates (1.5% annual rate) or at the convergence equation ones (2.7% annual rate).

How could we account for this discrepancy?. Our guess is that the convergence model specification is incomplete if we do not allow for the

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transformation of the production function, evaluated in a poorly measured steady state capital/labour ratio.

changing performance of OECD economies along the sample period. In columns 4 to 6 we present a similar exercise but including time dummies to account for the huge differences across subperiods. As we have seen the, six periods in which we have split our sample display extraordinary variations in terms of growth and macroeconomic performance. Including dummies improves the overall fit of the model, in particular in the case of the convergence equation (with a 20% fall in the standard error). The parameter values are closer to the (1/3, 1/3, 1/3) set that we found in the cross section. In particular γ is now positive and unambiguously significant in both equations. Cross equation restrictions are still rejected but not at 1% level of significance, although the pairs $\{\hat{\alpha}_{ss}, \hat{\gamma}_{ss}\}$ and $\{\hat{\alpha}_{ce}, \hat{\gamma}_{ce}\}$ are still pretty different. Nevertheless the estimated labour share and convergence rates are fairly similar and much closer to the values found in the cross section model (between 2.1% and 2.3%). It is interesting to note that time dummies turn out to be significant in the convergence equation but not so much in the steady state one. As in the cross section model the poor fit of this equation as well as the conceptual difficulty of using average $(Y/L)_{T,T+\tau}$ as the steady state proxy makes it advisable to focus in the convergence model.

In Table V.2b four versions of the convergence equation confirm most of these results. In columns 1 and 2 technical progress is specified as a linear trend and γ is set to zero as it turned out to be non significant. When the estimation yields implausible parameter values of ϕ we choose to set it to 0.02. The fit is similar in both cases and the same happens with the relevant parameters α, ϕ and λ. The direct estimation of λ turns out to be rather precise. When time dummies are considered and ϕ set to 0.02 (columns 3 and 4), γ becomes significant and the overall fit improves significantly, yielding a value of λ between 2.1 (if calculated from estimated parameters) and 2.6 (if directly estimated[33]). In column 5 the specification of technical

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33 This value falls somewhat off the range of values obtained so far; nevertheless we keep it for comparison purposes with similar specifications by subsamples.

progress combines the linear trend and the time dummies; the statistics do not change very much but the estimated ϕ is much higher than the value obtained in other specifications and generates an abnormally high convergence equation (3.0%).

The overall conclusion we can draw from these estimations is a value of λ which is slightly higher than that found in the cross section analysis, in the context of a convergence equation which bears many similitudes with the one estimated in the previous section. The share of capital ($\alpha+\gamma$) is about 2/3, although in the pooling model the relative share of human capital appears smaller, and is even non significant if we do not control for different average growth rates across periods. In fact when these differences are controlled for, the pooling model becomes very similar to the cross section one.

5.2 Subsample estimates.

In order to facilitate comparisons with the results in section IV, we have kept the same split among countries as in the cross section model. As in that case, we have proceeded to estimate the model with and without steady state variables to establish differences among conditional and unconditional convergence. In all cases we have chosen the linear trend specification for technical progress in order to be able to estimate ϕ. In the time dummies model this estimated showed implausible values and we are interested in testing whether there are significant differences in technology among country subsamples.

Let us consider the conditional model first (Table V.3). The exclusion of Turkey and Greece from the sample increases the rate of conditional convergence by more than a 50% (from 2.2% to 3.4%), and improves the fit with a substantial fall in the standard error. As in the cross section, the convergence model displays a much better fit as we exclude poor countries from the sample. The differences in estimated parameters among poor and rich countries according to their position in 1960 (columns 2 and 3 respectively) are striking. The relative size in $\hat{B}_2$ goes in the direction suggested by theory ($\hat{B}_2^P < \hat{B}_2^R$) pointing towards huge differences in efficiency in the use of productive factors in favour of most advanced countries. These differences also arise in the estimated rate of labour augmenting technical progress ($\hat{\phi}$), which is higher for rich countries than for poor countries[34] (3% versus 2%). The discrepancy in the capital share is even larger; the point estimate of $\hat{\alpha}$ for poor countries is almost three times as large as that for the rich ones. It is noteworthy that the dramatic change in this parameter, once we exclude the seven poorest countries from the sample, casts some doubts about the validity of the Solow model at this disaggregate level. The differences in implied conditional convergence rates are large; evaluated at average ϕ (0.02) convergence has proceeded twice as fast among initially rich countries than among the poorest ones. When we computed λ using the point estimate $\hat{\phi}$, the differences are much larger; faster technological progress among richer countries has made convergence to advance at a 5% annual rate versus 1.4% for the poor countries group.

These results are largely confirmed if we take the alternative splitting criteria (per capita income in 1990). Again, the initial conditions and the scale effect (summarized in $\hat{B}_2$) are significantly better for rich countries and so is the rate of technological progress ϕ. The estimated labour share is also much larger among richer countries, generating a conditional convergence rate of 5% against 2.1% among the poor ones. Calculated at $\hat{\phi}$, this difference gets wider, the former being three times the latter. Nevertheless, again the estimated capital share is rather implausible for the rich countries sample; the point estimate is less than one fifth of the value obtained for the OECD as a whole and is not even significantly different from zero.

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34 For this group $\hat{\phi}$ is not even significantly different from zero.

Unconditional convergence models in Table V.4 confirm these differences and the caveats about the textbook Solow model interpretation of convergence. Given that the unconditional model is in general badly specified, we should not trust very much the point estimates. Nevertheless, the differences in $\hat{B}_2$, $\hat{\alpha}$ and $\hat{\phi}$ in columns 2 and 3 versus columns 4 and 5 go in the direction suggested by the technological non convexities argument put forward earlier.

The two more relevant conclusions we can draw from these results are the following. First, the unconditional model fits as well as the conditional one for the rich countries group, whereas this is not the case in the poor country group. Second, unconditional convergence is slower than conditional convergence among less advanced countries regardless of the splitting time (0.9% to 1.4% versus 2.1%). As discussed earlier, this is a sign of both that the steady state has variation enough among these countries and that poorer countries move towards lower per capita incomes in the long run. Similarly, unconditional convergence is faster than conditional convergence among the richer countries (5.4% to 7.4% versus 4.3% to 6.8%). On the basis of this result we may conclude that the steady state is uncorrelated with initial conditions in these samples (in particular among the richest countries in 19960), or that this correlation is negative (among the richest countries in 1990). The rather implausible values of the main parameters in columns 3 and 5, as much as the unimportance of the steady state suggests that the strong convergence bias among the richest countries in the OECD is not fully accounted for by the mechanism built in the Solow model.

5.3 Growth and medium term macroeconomic performance

One of the main advantages of using pooled rather than cross section information is the way in which the impact of medium term macroeconomic variables can be treated. The relationship among medium term variables and growth is not the same across the different stages of economic development. Consider the case of the public sector size. At the early stages of development, a sustained level of public spending may be growth promoting, both through its supply side effects and also introducing the necessary demand impulses to help economic activity. Nevertheless, when the economy has reached its equilibrium growth path and moves close to its potential output, the demand impulse vanishes and public consumption might be harmful for growth if induced distortions on productive factors supply predominate over and above the beneficial effects of public consumption in education, law, and social stability (transfers, etc.)[35]. Similarly, fast growing economies in their take-off process may devote most resources to the domestic market, while advanced economies need to sell abroad to achieve high growth rates.

On the other hand, the correlation among public spending, inflation and the openness of the economy with the rate of growth is unlikely to remain stable over the cycle. Inflation, for instance, may be an undesired consequence of demand impulses to growth, or rather the result of negative supply shocks leading to an economic slowdown. It is difficult to attach a particular interpretation to the relation among short run macroeconomic indicators and long run growth if we average over long time periods. This procedure hides the different stages of development achieved by OECD economies from 1960 to 1990 and also cancels out the large variations in the average rate of growth along the sample period.

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35 In many studies of this kind, political stability indicators, as well as those related with the extent to which property rights can be enforced, show an unambiguous positive correlation with growth (Perotti (1992).

Finally, the variables taken to measure the short run macroeconomic performance are to a large extent endogenous to the growth process. This is more evident for the case of the rate of inflation and the ratio of public spending to GDP, and less so for first differences and second moments of nominal variables. The simultaneity among growth and exports is also less clear cut and we shall take the rate of growth of exports as exogenous[36]. This raises the convenience of instrumenting at least some macroeconomic indicators, and we can do so using current exogenous and lagged endogenous variables.

The best specifications of the augmented convergence equation are presented in Table V.5. In all these models the parameter ϕ is exogenously restricted and the trend is excluded. Free estimation of ϕ in equations with trend gave a value slightly above 0.01, with a low t statistic (in all cases below 1.2). However, the main parameters of interest are fairly robust and remain unaffected by the consideration of technical progress, so we chose to set the rate of growth of labour augmenting technical progress to 0.02. The alternative way of accounting for technical progress (i.e. time dummies) may interact in a complicated manner with the impact of medium term macroeconomic indicators. These dummies may explain changes in average growth for reasons other than variations in the rate of technical growth and may be highly collinear with some of the variables we consider here. To avoid this we have proceeded to search for the best specifications in equations without time dummies; after that, in columns 5 and 6, we test to what extent these preferred models are robust in presence of time dummies.

A common feature of all specifications we tried is the absence of correlation among the rate of growth of per capita income and the public

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36 As the economy grows, the presence of economies of scale may increase competitiveness and exports. However, to the extent that this effect takes time we can safely keep exports growth as exogenous in the convergence equation.

sector size. This is so regardless of the time period, and the inclusion of other regressors. The estimated coefficient A_G turned out to be positive in some specifications and negative in others but with a t statistic always below 0.5. This result contradicts somehow those obtained in the cross section model. Although there we found weak negative correlation among the size of the public sector and the rate of growth, we trust more the absence of correlation once the time variation has been considered.

Unlike the cross section model, the impact of nominal variables we have examined comes up strong and well signed in the pooling model. The impact of inflation is negative, as expected, in any specification we tried, which is in accordance with the results reported by Fischer (1991), Kormendi and Meguire (1985), and Grimes (1991) among others. Contrary to Levine and Renelt's (1992) results, the significance of A_p is robust to alternative choices among the macroeconomic policy indicators; only in the case in which money growth is not included the rate of inflation becomes non significant. Notice that, as long as we include money supply growth in our equations, there should not be much ambiguity in the interpretation of this negative coefficient. Phillips curve type effects should be captured by money growth and hence, the negative impact of price inflation represents the genuine price distortion and uncertainty effects that may induce misallocations of resources.

Money growth, on the other hand, enhances growth. This effect has also been reported in the literature (Kormendi and Meguire (1985)), and as in the case of inflation, A_M keeps its significant positive value regardless of the set of regressors included, with the exception of inflation. When inflation is not included, again money growth contributes very little to growth. Two non mutually exclusive explanations can be put forward to this joint behaviour of money growth and inflation. First, there must be some collinearity in the data; nevertheless, inflation is instrumented by its first lags, whereas money growth is taken as exogenous, which must help to reduce collinearity. Second, as we discussed above, the two opposite effects of nominal growth upon real growth may cancel out if we only consider one of these variables on its own.

We should bear in mind that this positive influence of money upon growth cannot be understood as implying non-neutrality of money in the long run. It depends on how nominal GDP impulses are split among inflation and real GDP changes over the long run, and this depends largely on institutional and distributional matters. Notice that inflation and money supply growth enter in all specifications with roughly the same coefficient and opposite signs (the same happens in the 'base' coefficients reported by Levine and Renelt (1992)[37]). To the extent that inflation has a unit elasticity with respect to changes in the money supply, nominal shocks have no effect whatsoever upon real per capita growth. We cannot say at this stage if long run neutrality holds[38], what we can claim is that results in Table V.5 do not rule out such possibility.

We have also tried the acceleration of money supply as a proxy of unanticipated money[39]. As can be seen in columns 3 and 4, there is weak evidence of a positive effect of unanticipated money over and above the effect of total changes in money supply. We can conclude then that even in the medium term, the effect of money is lower if anticipated; nevertheless, as we shall see shortly, this result is not robust to changes in the specification of the augmented model.

Three second moments of nominal variables appear significant in the

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37 See Table 11 in their paper.

38 In fact real growth models of this kind are not well suited to test this hypothesis.

39 This is a commonly used assumption if money growth follows a random walk,

$$\Delta M_T = \Delta M_T + \xi_T$$

where ξ_T is white noise, then,

$$M_T - E(M_T) = \xi_T = \Delta^2 M_T$$

convergence equation. The (log of) variance of inflation, money growth and unanticipated money enter significantly in the equation with the expected negative sign. The variance of inflation appears strongly significant (as in Grier and Tullock (1989)) in equations not including other nominal variables, mainly inflation and money supply growth; however, when these variables are brought in the *t* ratio falls near the level of non significance (close to 1.55). Unlike the results reported by Levine and Renelt (1992), the variance of the truly exogenous nominal shocks, whether represented by total money or unanticipated money growth, stands strongly significant regardless of the set of regressors. As expected, given the time series behaviour of money supply, these two components are pretty similar and their statistical effect is indistinguishable. The rationale of this effect can be found in the endogenous nature of price variability, which is the result of the exogenous shocks and the way the monetary policy faces them. Perhaps the variance in money supply is a better proxy for the erratic nature of monetary policy and for the increased uncertainty which harms long run growth through relative price distortions.

The strong positive correlation among growth and exports that we found in the cross section model carries over the pooled sample. As in the cross section, only the rate of growth of exports, out of the several proxies of competitiveness tried, proved to be robust to alternative specifications. This variable is not only strongly significant but also extraordinarily robust to the inclusion of other regressors and to the estimation method.

The statistical contribution of these macroeconomic indicators is non negligible. When introduced, the standard error falls in about a 20%, close to the improvement caused by the introduction of time dummies. A sizable proportion of the changes in the average rates of growth across periods can be accounted for by the cyclical behaviour of OECD economies. Similarly, once we augment the convergence model, the estimation of the human capital share is more precise and we get a *t* statistic close to the level of significance (between 1.5 and 1.6).

The estimated λ also changes to some extent. The inclusion of these variables, in particular of inflation related variables, increases the convergence speed up to 2.5% (about a 20%). This finding, that was also detected in the cross section analysis, is of some interest, for it implies that inflation has reduced the prospects of growth of the OECD as a whole, but not homogeneously across countries. When inflation and the variance of prices is not taken into account, the implied convergence rate is around 2.%, whereas once it is included it jumps to 2.6%. This may imply that convergence has happened at a faster rate than previous results show. Some of the low growth countries have high inflation rates: if this is not taken into account, convergence seems slower than actually is.

In the case of exports, the ability to sell abroad seems to have affected positively the rate of growth of OECD countries; nevertheless, this does not affect significantly to the estimated λ. This may imply that exports growth is uncorrelated with the savings rate and with the initial per capita income. The omission of this variable is irrelevant for the convergence proposition but not for growth as such.

Equations in columns 5 and 6 deserve some additional comments, for they qualify some of the effects we have discussed so far. After choosing the best specifications, we have analyzed to what extent these results simply capture the major shifts in the macroeconomic performance of OECD economies across the six five year periods in the sample. To do this, we have reestimated these models including the time dummies in B_2 and found that the weaker effect of inflation variance is no longer significant; similarly, the effect of money growth is the same whether anticipated or not (A_{AM} is non significant either). Apart from that, many correlations found before still hold, and become more significant than in the constant B_2 models. This is the case in particular with the coefficients A_P, A_M and A_X which increase by a 50%, and with the ratio A_P/A_M which keeps its value at -1.

Bringing the dummies in causes an additional fall in the standard error in about a 10% and, as in the model without macroeconomic variables, produces a substantial alteration in the estimated technological parameters. The share of physical capital falls towards 1/3 and that of human capital is now significant and close to that value. Notice that the implied production function is now very much like the one drawn from the cross section estimates. Similarly, the implied convergence rate is close to the usual value 2.1%. It is important to note that the pooling model becomes closer and closer to the cross section one once we augment it to account for the shifts in the short run macroeconomic performance across OECD countries. This may lead us to two alternative conclusions. On the one hand one might think that all we can learn about the convergence process among the OECD countries is incorporated into the very long run averages and that taking shorter periods somehow hides the long run tendencies built in the data. As long as pooling with 30 years averages is not a real possibility for the time being, we should better keep on the cross section analysis. On the other hand, the pooling model shows how that long run averages cancel out many interesting bits of information in the data, some of which are correlated with observable macroeconomic indicators whereas others are not. The explanation of these observed correlations and the search for an economic interpretation of the statistical contribution of the dummies can improve our knowledge of the growth and convergence processes.

5.4 Convergence and non convergence across the sample period.

Pooling data permits yet another way of analyzing the data that sheds additional insights on the structural stability of the growth process we are looking at. Perhaps the main advantage of the time series dimension in our sample is that it may be used to uncover possible structural breaks in the relevant parameters of the Solow model. 1960-1990 is a very long period for technological parameters to remain unchanged; however it is not the time span of the data what we are interested in here. The issue we want to address is whether or not the speed of convergence itself bears any particular relationship with the average rate of growth.

Most studies of the relationship among growth and medium term macroeconomic performance proceed by including specific variables in the convergence equation, as we have just done. This amounts to search for stable correlations among long run features of the economy and variables with higher short run variation than the former. A more general approach to this issue is to study the convergence and growth processes across different episodes of the business cycle. Our sample period can be split into two subperiods with very different performances of OECD economies, as was discussed in section III. These periods capture better than a set of variables the changing performances of OECD economies in the postwar era: sustained and balanced growth until 1974 and a long lasting recession thereafter until 1985. Since then, OECD economies have grown rather fast again, although they have experienced major macroeconomic shocks.

In what follows we carry out the study of growth and convergence by splitting the sample into two periods. Period I covers the fifteen first years of the sample, from 1960 until 1975, plus the latest period 1985-1990; similarly, period II refers to 1975 to 1985. Given that our interest is mainly to analyze the relation among growth and convergence, we chose this splitting in order to isolate fast growth and low growth periods. Furthermore we have proceeded to estimate the equation (19) for the six subperiods by simple OLS and found very different parameter estimates that lead to high convergence rates from 1965 to 1975, and more moderate ones in 1960-1965 and 1985-1990. Conversely, estimated factor shares for periods 1975-1980 and 1980-1985 are rather different from the other estimates, leading to very low convergence rates and suggesting a genuine change in structural parameters.

As usual, some of the most remarkable differences among subsamples are somehow hidden in the linear fully restricted model and can be better shown in the context of the linear unrestricted version (20). In Table V.6 we display some of the most interesting results. The comparison of simple linear models (column 1 vs column 4), reveals three important differences across periods. The fit of the unrestricted linear model in period I is much better than in period II. The standard error is 10% higher and the R^2 is less than one fourth in period II as compared with period I. In fact, the abnormally high DW casts some doubts on the adequacy of the Solow model for the low growth period. Turning to the estimated parameter values we see how $\hat{\pi}_1$ is also much lower and less precisely estimated in the second subperiod. The sum of coefficients $\hat{\pi}_2$ and $\hat{\pi}_4$ is also much higher in period II, this suggests a much lower convergence rate in this period.

The change in the regression results in response to the inclusion of time dummies is also revealing the remarkable differences between the two subsamples. Time dummies add very little explanatory power to the model in period I, whereas they contribute to a substantial improvement in the fit for the second period (leading also the DW to more plausible values). The differences among $\hat{\pi}_1$ are now far larger; falling to 0.09 versus 0.14 for the first one. When human capital is not considered the model even predicts non convergence at all. The human capital proxy is crucial in the second period; if we exclude it, the Solow model collapses, and $\hat{\pi}_1$ and $\hat{\pi}_3$ become non significant.

In Table V.7 we proceed to estimate the non linear model (19). Again the model displays a very poor fit for the second period when time dummies are not included (col 1 vs 4). Although the overall fit in both cases is similar to the linear version in Table V.6, the imposition of parameter restrictions makes the estimation of γ much more precise in period I, whereas the gain in the standard error of γ is much more modest in period II. The difference in the estimated rate of growth of labour augmenting technical progress is also remarkable. The point estimate of ϕ coincides in 0.04 but it is non significantly different from zero in the low growth period. Even in this case, a dramatic difference in the implicit rate of convergence can be detected. Implicit λ (evaluated at average ϕ = 0.02) is now 2.8 during the first period (30% higher than for the whole sample period) and 1.4 during the recession (30% lover than for the full sample). The rate of convergence in fast growth periods is twice as large than during the period of stagnation. If we compute λ taking into account the much lower rate of technical progress in period II, the differences get much larger, reaching a value of 3.4 in fast growth years versus 0.9 in the stagnation period. The differences in estimated B_2 are also fairly substantial and point to what theory suggests: the estimated value is much smaller in the period of low growth and slow convergence. This cannot be interpreted, as in the splitting across countries, as a 'threshold level effect' because we are taking observations at different points in time. An alternative interpretation may rely on the negative impact of short term macroeconomic shocks upon the choice among alternative technologies, as in the literature of multiple equilibria (see Durlauf (1991) among others).

Bringing time dummies in (columns 2, 3, 4 and 6) improves the fit in both periods, but again much more clearly in the second one. The standard error falls by 20%, and the DW gets close to 2. This new specification also widens the differences among $\hat{B}_2$ across subsamples. This better fit gives more relevance to human capital in the recession period. Again the estimated α, β and γ differ markedly across periods. The share of physical capital maintains its value, but the labour's share declines sharply in the recession period (from 0.44 to 0.24) whereas the share of human capital increases. This casts some doubts on the interpretation of α and γ estimates during deep recession periods, unless one is prepared to accept that capital is used more efficiently in slumps[40]. λ values are again significantly different across periods, regardless of whether they are estimated directly (3.2 and 1.8 vs a 2.6 average) or calculated from estimated parameters (2.6 and 1.4 vs a 2.3 average). In the low growth period, we find that λ is not only smaller, but also much less significant with a drop in the *t* statistic towards the limit of non rejection of the null of non convergence.

The changing impact that time dummies have across subperiods, suggests that the correlation among growth and macroeconomic indicators may not be stable along the cycle. We want also to check to what extent this changing interaction influences the value of λ across periods. This is the reason why we have carried out this exercise keeping the same sample split we have used so far. A genuine investigation of these effects should consider also an alternative split to take account of the peculiarity of the last period (1986-1990) in which growth rates have recovered despite high inflation and unemployment. Although in terms of growth and convergence, the latest years belong to what we have called period I, their medium term macroeconomic features (such as inflation, unemployment, public deficits, interest rates, etc) resemble much more those which took place in the slump. Actually, what has been specific of the last recovery since 1986 is that it has happened despite the enormous waste of resources that unemployment rates at their historical levels seem to indicate.

Upon estimation of the augmented convergence equation for the first subperiod we find that much of the features we found in the full sample still hold (Table V.8). However, several results deserve further comments. First, macroeconomic variables add very little explanatory power to the model with and without time dummies in Table 7. The parameter B_2 remains also largely

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40 An alternative explanations in terms of omitted variable bias can be stated as follows: when unemployment is high and rapidly changing, the model in terms of per capita incomes is not properly specified. As unemployment rates are not included as regressors, the parameters may be biased.

unchanged with a moderate increase, which points to slightly better initial technological conditions. On the other hand, although slightly less significant, the set of variables in these equations are very similar to those found for the sample as a whole. Nevertheless only exports and the variance of nominal variables appear clearly significant. The non significance of A_G is one of the most robust findings, and also holds for these high growth years.

It is interesting to look at the correlation among real and nominal variables along the period of sustained and balanced growth. If any, we find that the negative impact of inflation is accounted for by the variance terms. Inflation is no longer significant and money growth is only weakly significant. As was discussed previously, inflation should be negatively correlated with growth after negative supply shocks. To the extent that fast growth was fueled by a rapidly expanding demand, inflationary pressures could be the undesirable effect of growth rather than an impediment to it. However, even in these years, a wrongly managed monetary policy leading to excessive nominal variability could have lowered the growth prospects of these economies.

The estimated λ value is slightly higher than in the model without macroeconomic indicators. We may attach the usual interpretation to this result. Medium term macroeconomic performance mattered during the fast growth period but it affected all countries in a rather homogeneous way, not having much effect upon the relative speed with which each country approached its steady state. As we saw in the model with dummies, the Solow convergence equation explains fairly well the long run behaviour of the OECD economies in the period of balanced growth, with no need of additional information. Shorter term macroeconomic variables or time dummies may be significant but in no way alter the main features of the estimated basic model (overall fit, parameter values, convergence rate, etc.).

Things look very different when we introduce these macroeconomic indicators in the convergence equation for period II. As can be seen in Table

V.9, this modification does change the estimated model in a non negligible manner. The fit improves dramatically with a 20 to 30% fall in the standard error. What is more interesting indeed is that now the model fits even better than the corresponding model with time dummies. The overall specification also improves with a DW close to 2.0[41]. The estimated constant term B_2 also falls significantly getting twice as large in absolute value. This reveals that the sharp differences in the available technology after a series of negative shocks are even larger than the ones estimated in the basic model. Whereas the point estimate of B_2^I was three times larger than B_2^{II} in the basic model, in the model with macroeconomic indicator this the estimated B_2^I is over nine times B_2^{II}.

There is weak evidence of a negative impact of inflation on growth. At the same time, the variance terms lose significance. Is interesting to realize the different correlation among growth and inflation that was pointed out earlier. The inflation rate that wasn't harmful for growth along the period covered by the first subsample, appears as one of the major difficulties for growth during the recession. In fact, the kind of supply shocks that lowered growth rates in industrialized countries were also responsible for rising inflation[42].

Exports growth accounts for most of the explanatory power of macroeconomic variables. This variable explains almost as much as all growth related variables included, and more than any of these taken separately. This reinforces the previous impression that the Solow model no longer fits the

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41 The basic model in the fourth column of Table V.7, suffered from severe specification problems with a DW close to 2.8.

42 Again we must not give to this correlation any causal interpretation, that depends on the way monetary authorities faced the recession particularly at its earlier stages. Institutional aspects related with the autonomy of Central Banks (as pointed out by De Long and Summers (1992)), or with openness (Romer (1991)) lie behind the association among supply shocks and inflation responses.

data properly during the recession period. Once we augment the model, the estimated value of λ is now far lower than in the basic growth model. Unlike the first period, now the inclusion of macroeconomic indicators reduces the rate of convergence speed. In fact this rate is now 0.8, almost one fourth than the value obtained for the first period once these variables are included (3.0); moreover, this convergence rate is not significantly different from zero in some specifications. If we take this result seriously we should consider that the low growth period was not only a one of slow convergence but that the historical process of narrowing the gap among the OECD economies was interrupted by the recession. Although growth forces no longer generated convergence, the ability to gain external competitiveness allowed some less advanced countries to keep growing as to keep pace with the most advanced ones.

VI. Conclusions.

In this paper we have estimated the augmented Solow model (including human capital) for the OECD countries during the period 1960-1990. We have proceeded to homogenize the country series, using the 1990 PPP series published by the OECD, for each component of GDP.

Unlike most previous studies, we have chosen to estimate the model taking full account of the theoretical parameter restrictions. Linear estimation gives some interesting hints, but non linear models are well suited to discuss other implications of the Solow model. Exploiting the technological parameter restrictions we can get direct point estimates and t statistics for the basic parameters of interest and assess whether these restrictions are rejected by the data. The basic convergence equation has also been estimated jointly with the steady state equation imposing the cross equation restrictions.

In the cross section model, parameter estimates fall in the range suggested in previous work; the production function has similar factor shares {1/3, 1/3, 1/3}, and the rate of labour augmenting technical progress grows at the commonly accepted rate of 2%.. In this setting the data seem to accept fairly well the cross equations restrictions so that convergence features are consistent with the implications of the Solow model. When pooled data are used, cross equations restrictions are overwhelmingly rejected and we must control for the sizable differences in average growth rates across shorter periods; otherwise the pooling model presents remarkable differences with cross section one. Estimation by non linear instrumental variables and controlling with time dummies, yields plausible point estimates, although the share of physical capital is higher than expected (around 0.45) and that of human capital slightly lower (0.2).

The rate of convergence is very robust to alternative estimation procedures and takes a value between 2.0 and 2.3, very much in the range of what previous studies have found. However this value is not fully stable.

When different splits are taken in the sample, the estimated rate of convergence changes substantially. In particular, the rate of convergence seems to be higher among the richer countries (defined according their per capita income at different points in time). The ratio between the rate of unconditional convergence and that of conditional convergence also changes across subsamples; for the poorer countries this ratio is below one, whilst it is above one when only richer countries are considered. Subsample estimates also reveal remarkable differences with respect to goodness of fit and the adequacy of the Solow model. Estimated parameters are very different across subsamples, in a way suggesting the presence of technological non convexities. Moreover, for the group of richer countries the rate of convergence is very high despite the implausible values of the technological parameters.

The estimated convergence rate is not stable either in the time dimension. In periods of fast growth (1960-1975, 1986-1990) this rate is twice as large as in recession times (1975-1985). In these latter years, the rate of convergence is not even significantly different from zero in some specifications. Low growth has been also caused by a fall in the rate of increase of labour augmenting technical progress and for other negative technological shocks, reflected in a significant drop in the constant term. Furthermore, the Solow model is not well suited to fit the growth patterns of OECD countries during the 1975-1985 decade. In this period, a rather *ad hoc* specification including indicators of short and medium term macroeconomic performance seems to do much better.

Macroeconomic variables seem to influence growth (and to some extent the speed of convergence itself) in the way suggested by a series of more or less *ad hoc* arguments. Nevertheless, in this case the difference between the results in the cross section and in the pooling model are remarkable. In the cross section model, there is weak evidence of a negative impact of public consumption on growth, whereas exports growth is unambiguously positively correlated with it. Among the nominal variables, only the rate of growth of inflation shows the expected negative influence upon growth. The findings of the pooling model deserve a more detailed discussion. Public spending is not significant in any specification we tried. The effect of growth exports is enhanced, once the time dimension of the data set is taken into account. The set of significant nominal variables is far richer than in the cross section model. Inflation, and inflation and money supply variability harm growth, whereas money growth (specially if unanticipated) displays a positive effect upon growth rates. The impact of macroeconomic variables changes along the cycle.

The overall picture that can be drawn from this exercise can be summarized as follows. The human capital augmented Solow model explains reasonably well growth and convergence among the OECD economies over the 1960-1990 period; however, a closer look reveals many features that remain to be explained. Convergence occurs at different speeds among different groups of countries, depending on the income split chosen. Convergence seems a feature of fast growth times. During recessions, convergence is much slower or non-existing. The model does not fit very well in shorter time periods of great macroeconomic turbulence. Variables related to medium term macroeconomic performance affect the rate of growth and convergence; however, their effect is not stable along the sample period and even outperform growth related variables in periods of low growth.

These issues deserve further research. The main lines open for the near future are the following. First there is the construction of alternative PPP indexes. Although we have not pursued this line of research here, in some preliminary work we have found that some of the results reported in the literature are not robust to alternative homogenization procedures. Second, we want to try alternative estimation methods in order to evaluate to what extent either the initial conditions or the steady state contain unobservable country specific effects. Third, the subsample split deserves further analysis in order to test the stability of the convergence result, combining the split across countries and across time periods. Fourth, a sensitivity analysis of the macroeconomic variables could bring about interesting results. Finally, on the theoretical side, the relationship among medium term performance and long run growth, specially during the episodes of high and increasing unemployment, seems to be one of the most promising areas of research to account for the growth prospects of the OECD countries.

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Tables and Figures

TABLE III.1
1960-1990 AVERAGES

COUNTRY	RATES OF GROWTH (AVERAGES IN %)					INFLATION	GDP/L (USA=100)		REAL	REAL	NOMINAL		HUMAN
	GDP/L	Inflation	MONEY	EXPORTS	L	Acceleration	1960	1990	G/GDP	I/GDP	I/GDP	(X+M)/GD	CAPITAL (Kyriacou)
Australia	2.07	7.26	8.94	6.92	1.62	0.08	71.87	74.14	18.61	24.47	24.67	30.10	7.82
Austria	3.03	4.68	7.29	9.32	0.30	-0.09	56.01	77.14	22.98	23.26	25.58	53.90	7.61
Belgium	2.91	4.99	5.94	8.55	0.29	0.05	57.12	75.80	18.90	17.78	20.23	108.87	8.48
Canada	2.89	5.50	8.74	10.91	1.33	0.10	66.37	87.53	21.72	20.78	22.32	42.34	9.17
Switzerland	2.05	4.58	5.70	8.52	0.80	0.05	92.97	96.41	12.93	24.10	25.78	68.74	6.24
Germany	2.72	3.98	7.97	8.72	0.44	-0.06	67.52	84.97	21.43	20.77	22.49	45.89	9.36
Denmark	2.42	7.30	11.39	7.20	0.39	-0.09	69.60	80.10	28.88	19.72	21.37	64.77	7.41
Spain	3.76	10.38	15.41	11.28	0.81	0.16	32.48	54.71	16.94	18.69	23.44	20.54	6.87
Finland	3.41	8.23	12.28	7.70	0.40	-0.01	51.18	78.11	23.37	28.87	26.14	52.30	7.77
France	2.74	6.91	9.56	8.12	0.73	-0.02	62.91	79.67	20.08	19.97	22.65	34.61	9.40
United Kingdom	2.11	8.19	10.32	5.63	0.31	0.14	71.55	75.58	30.23	13.48	18.25	38.56	7.71
Greece	3.77	11.76	17.27	9.87	0.66	0.62	20.65	34.74	19.93	16.99	21.50	30.57	7.52
Ireland	3.16	8.80	10.06	9.64	0.71	-0.16	35.53	50.73	22.43	17.72	21.94	78.45	7.79
Iceland	4.10	28.15	32.64	7.07	1.24	-1.23	44.82	79.84	19.91	24.43	25.07	89.79	7.56
Italy	3.33	10.01	15.73	9.44	0.46	0.18	48.92	73.24	19.39	20.13	23.26	28.62	7.92
Japan	5.04	4.98	12.04	10.86	0.94	-0.20	33.62	81.81	13.90	25.74	31.31	19.48	8.32
Luxembourg	2.45	5.19	13.44	6.90	0.64	0.23	80.10	89.32	16.16	22.26	25.16	160.02	6.10
Netherlands	2.42	5.03	8.17	7.84	0.88	-0.10	64.78	74.57	19.11	19.91	22.95	84.97	8.41
Norway	3.12	6.51	12.81	7.17	0.56	0.07	55.90	78.28	21.39	28.79	28.31	94.23	8.82
New Zealand	1.13	8.94	9.98	5.50	1.18	0.25	81.15	63.59	21.54	15.85	22.82	41.00	8.46
Portugal	4.04	12.44	14.55	10.58	0.57	0.38	22.80	40.93	21.07	18.69	25.33	31.79	6.20
Sweden	2.17	7.23	9.04	6.79	0.45	0.22	73.28	78.49	28.88	19.05	21.03	64.88	8.09
Turkey	3.14	29.04	32.18	9.86	2.40	1.89	15.27	21.28	21.43	19.64	18.73	11.14	4.43
United States	1.93	5.05	6.12	6.46	1.09	0.12	100.00	100.00	18.99	18.73	18.71	15.01	11.26

Sources: OCDE and FMI (several publications), Kyriacou (1991) and own calculations

TABLE III.2
1960-1975 and 1985-1990 AVERAGES

COUNTRY	RATES OF GROWTH (AVERAGES IN %) GDP/L	Inflation	MONEY	EXPORTS	L	Money growth Acceleration	INFLATION Acceleration	GDP/L 1960 (log. I$)	REAL G/GDP	REAL I/GDP	NOMINAL I/GDP	(X+M)/GD	HUMAN CAPITAL (Kyriacou)
Australia	2.66	6.60	9.29	9.93	1.88	1.62	0.67	7.42	18.10	24.99	24.93	30.16	7.67
Austria	3.63	4.75	8.97	12.73	0.49	0.43	0.04	5.78	22.92	23.65	26.15	52.96	7.47
Belgium	3.83	4.91	7.17	12.47	0.43	0.31	0.42	5.90	18.41	18.47	20.87	106.85	8.33
Canada	3.25	4.91	8.25	11.88	1.56	-1.34	0.56	6.85	21.96	20.88	22.37	41.76	9.01
Switzerland	2.49	5.44	6.72	11.68	1.15	-0.55	0.31	9.60	12.79	25.15	27.42	66.87	6.45
Germany	3.26	4.36	9.26	12.50	0.77	0.04	0.02	6.97	21.25	21.59	23.29	44.76	9.48
Denmark	2.68	7.18	11.51	10.38	0.55	0.09	0.30	7.18	27.33	20.79	22.54	64.35	6.89
Spain	5.53	8.56	17.50	14.80	0.85	0.77	0.71	3.35	16.57	19.47	24.33	20.22	6.25
Finland	4.11	8.16	13.50	9.87	0.42	1.15	0.50	5.28	22.65	29.79	26.46	51.45	7.41
France	3.48	5.77	9.79	11.63	0.89	-0.37	0.37	6.49	19.95	20.47	23.22	33.46	9.07
United Kingdom	2.23	7.20	9.66	6.97	0.45	0.49	1.42	7.39	30.11	14.01	18.69	38.39	7.76
Greece	4.70	9.14	17.25	14.12	0.55	-0.78	0.73	2.13	19.40	17.68	21.47	30.76	7.31
Ireland	3.77	7.14	9.34	11.23	0.55	0.98	0.58	3.67	21.24	16.77	20.47	78.06	7.44
Iceland	4.43	20.94	24.14	8.29	1.43	0.22	-1.65	4.63	19.38	25.02	25.50	94.56	7.41
Italy	3.73	7.47	16.03	12.92	0.57	-0.41	0.69	5.05	19.60	20.98	23.43	26.95	7.70
Japan	6.24	5.91	15.82	13.50	1.07	-0.52	0.00	3.47	13.95	25.93	32.17	17.39	8.13
Luxembourg	2.91	4.77	18.05	10.15	0.89	1.05	0.16	8.27	15.91	23.74	26.21	164.13	5.50
Netherlands	3.22	5.43	9.70	11.45	1.09	0.54	0.31	6.69	19.28	21.16	24.20	82.60	8.29
Norway	2.74	5.81	13.49	9.19	0.70	0.03	0.39	5.77	21.15	29.00	28.19	94.78	8.75
New Zealand	1.45	7.06	10.99	6.97	1.56	0.72	0.42	8.38	20.86	16.16	22.47	40.90	8.39
Portugal	5.45	8.33	14.47	13.69	0.34	1.38	0.31	2.35	20.07	19.24	24.55	34.31	5.23
Sweden	2.94	6.48	9.24	10.10	0.61	1.01	0.79	7.56	27.69	19.80	21.93	64.14	7.86
Turkey	4.05	22.03	29.38	8.67	2.57	2.30	1.57	1.58	21.13	19.46	18.46	10.96	4.03
United States	2.00	4.43	5.46	8.48	1.18	-0.41	0.54	10.32	19.62	19.05	18.33	14.56	10.77

Sources: OCDE and FMI (various publications), Kyriacou (1991) and own calculations

TABLE III.3

1975-1985 AVERAGES

COUNTRY	RATES OF GROWTH (AVERAGES IN %)					Money growth	INFLATION	GDP/L	REAL	REAL	NOMINAL		HUMAN
	GDP/L	Inflation	MONEY	EXPORTS	L	Acceleration	Acceleration	1975 (log. I$)	G/GDP	I/GDP	I/GDP	(X+M)/GD	CAPITAL (Kyriacou)
Australia	0.89	9.24	9.17	1.89	1.29	-1.92	-0.98	12.08	19.91	23.50	24.15	30.35	8.04
Austria	1.82	5.04	4.83	3.79	-0.03	-1.12	-0.33	10.30	22.84	22.74	24.50	58.29	7.83
Belgium	1.06	5.64	4.22	1.94	0.06	-1.25	-0.60	10.41	20.09	16.42	19.03	117.66	8.71
Canada	2.17	7.17	10.55	10.17	1.03	1.24	-0.72	11.90	21.30	20.69	22.19	44.58	9.42
Switzerland	1.18	3.42	4.33	3.38	0.20	-0.69	-0.41	13.67	13.38	22.17	22.60	75.63	5.94
Germany	1.64	3.66	6.33	2.40	-0.13	-0.76	-0.38	11.12	21.88	18.85	20.72	50.24	9.18
Denmark	1.90	8.26	12.30	1.89	0.11	-0.45	-0.80	11.17	32.54	17.71	19.01	67.54	8.18
Spain	0.20	14.86	12.98	5.73	0.81	-0.40	-0.81	7.63	17.47	17.50	21.96	22.49	7.79
Finland	2.00	9.18	11.20	4.35	0.40	-2.35	-0.91	10.12	25.09	26.67	25.27	55.46	8.32
France	1.25	9.78	10.08	2.27	0.48	-0.48	-0.74	11.21	20.18	19.24	21.68	38.28	9.90
United Kingdom	1.87	10.89	12.61	3.65	0.07	-0.06	-2.16	9.98	30.35	12.57	17.55	39.66	7.64
Greece	1.93	17.93	19.03	2.77	0.94	0.14	0.48	5.29	21.00	15.62	21.81	31.23	7.83
Ireland	1.96	12.81	12.45	7.59	1.09	-1.80	-1.52	6.13	24.98	20.28	25.63	82.55	8.31
Iceland	3.43	44.68	52.06	5.48	1.01	-0.62	-0.58	9.50	20.91	22.75	23.75	78.47	7.78
Italy	2.52	15.83	16.75	3.75	0.30	-0.14	-0.73	8.92	18.74	18.14	22.64	33.36	8.25
Japan	2.63	3.71	6.06	6.94	0.80	-0.81	-0.59	9.41	13.32	26.19	29.82	24.60	8.61
Luxembourg	1.52	6.50	6.04	1.43	0.22	-3.28	0.39	11.70	16.68	19.30	23.49	155.63	6.98
Netherlands	0.81	4.77	6.10	1.75	0.59	-1.29	-0.83	11.13	18.38	17.35	20.25	92.94	8.59
Norway	3.87	8.50	12.80	4.05	0.36	0.37	-0.51	9.92	22.23	28.53	28.50	95.31	8.92
New Zealand	0.51	13.39	9.07	3.25	0.58	-0.01	-0.03	10.49	23.05	15.37	23.69	41.73	8.55
Portugal	1.22	21.51	16.16	5.75	1.05	0.30	0.55	5.18	23.80	17.56	27.11	27.89	7.65
Sweden	0.62	9.36	9.57	1.18	0.19	-1.21	-0.80	12.32	31.72	17.56	19.12	68.48	8.45
Turkey	1.32	45.26	40.70	13.10	2.30	0.83	2.65	2.75	22.37	20.22	19.53	11.37	5.04
United States	1.80	6.74	7.97	3.26	1.03	0.75	-0.60	14.08	17.62	18.10	19.52	16.42	11.99

Sources: OCDE and FMI (various publications), Kyriacou (1991) and own calculations

Table III.4

Dependent Variable: $\log (y_i^{ppp}/y_{USA}^{ppp})$

Estimation method: OLS

Explanatory variables	Coefficient	*t*-statistic
1. Year dummy	0.176	5.57
2. $\log (y_i^{\$}/y_{USA}^{\$})$	0.760	10.26
3. $[\log (y_i^{\$}/y_{USA}^{\$})]^2$	0.099	2.85
4. $\log ((X+M)_i/GDP_i)/((X+M)_{USA}/GDP_{USA})$	-0.136	-1.83
5. $[\log ((X+M)_i/GDP_i)/((X+M)_{USA}/GDP_{USA})]^2$	0.056	1.86
6. $\log (C_i/GDP_i)/(C_{USA}/GDP_{USA})$	0.908	3.69
7. $[\log (\Delta GDP\ deflator_i)/(\Delta GDP\ deflator_{USA})]^2$	-0.061	-2.01

Usable Observations = 44
Degrees of Freedom = 37
R^2= 0.949 $\bar{R}^2$= 0.941
Mean of Dependent Variable. =-0.410
Std Error of Dependent Vble.= 0.324
Standard Error of Estimate = 0.079

Sample: OECD countries 1985 and 1990, excluding Iceland and Switzerland in 1985, Turkey (1990) and Ireland (1990, because argument of log in variable 7 is negative).

FIGURE 1: CONVERGENCE AMONG OECD COUNTRIES 1960-1990

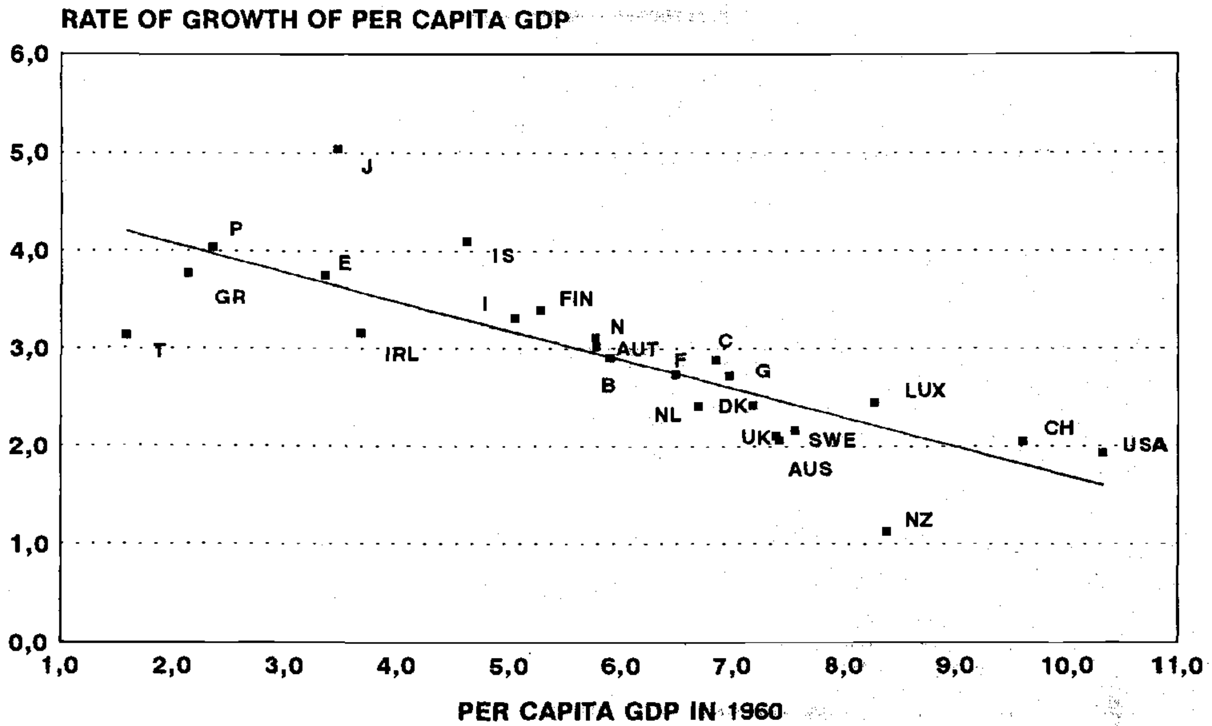


FIGURE 2 (a): CONVERGENCE AMONG OECD COUNTRIES 1960-1975 AND 1986-1990

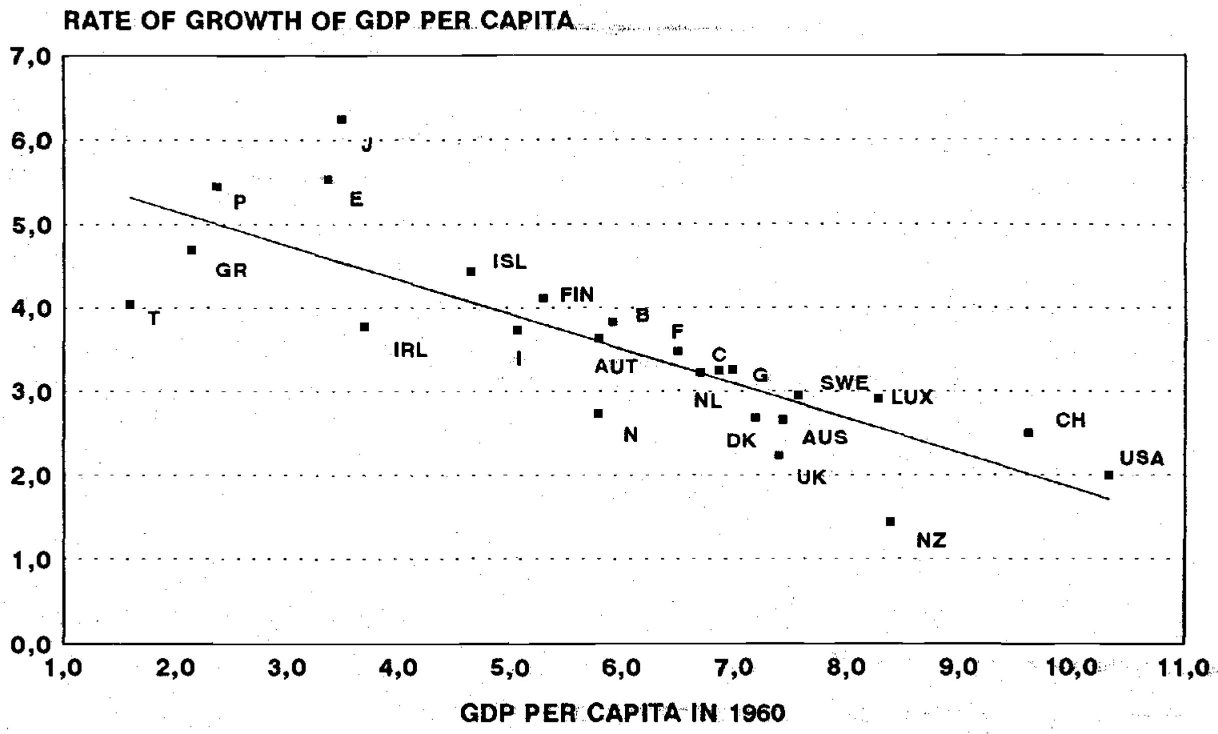


FIGURE 2 (b): CONVERGENCE AMONG OECD COUNTRIES 1976-1985

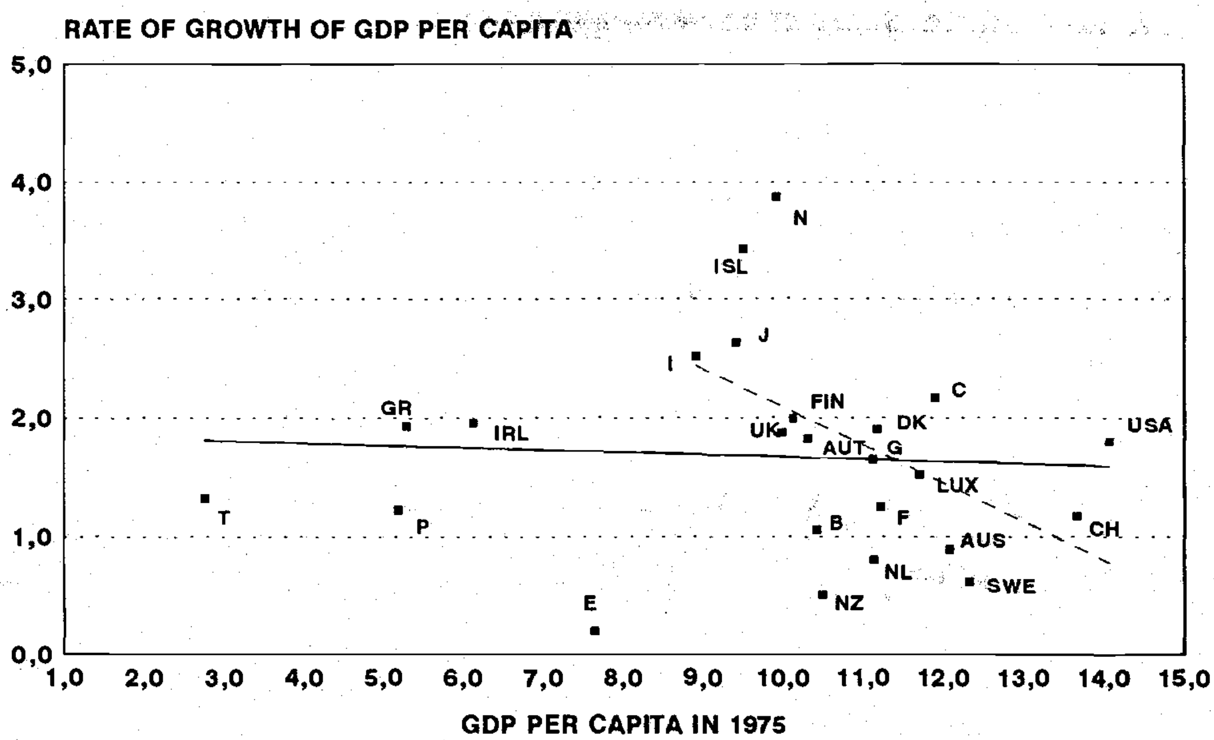
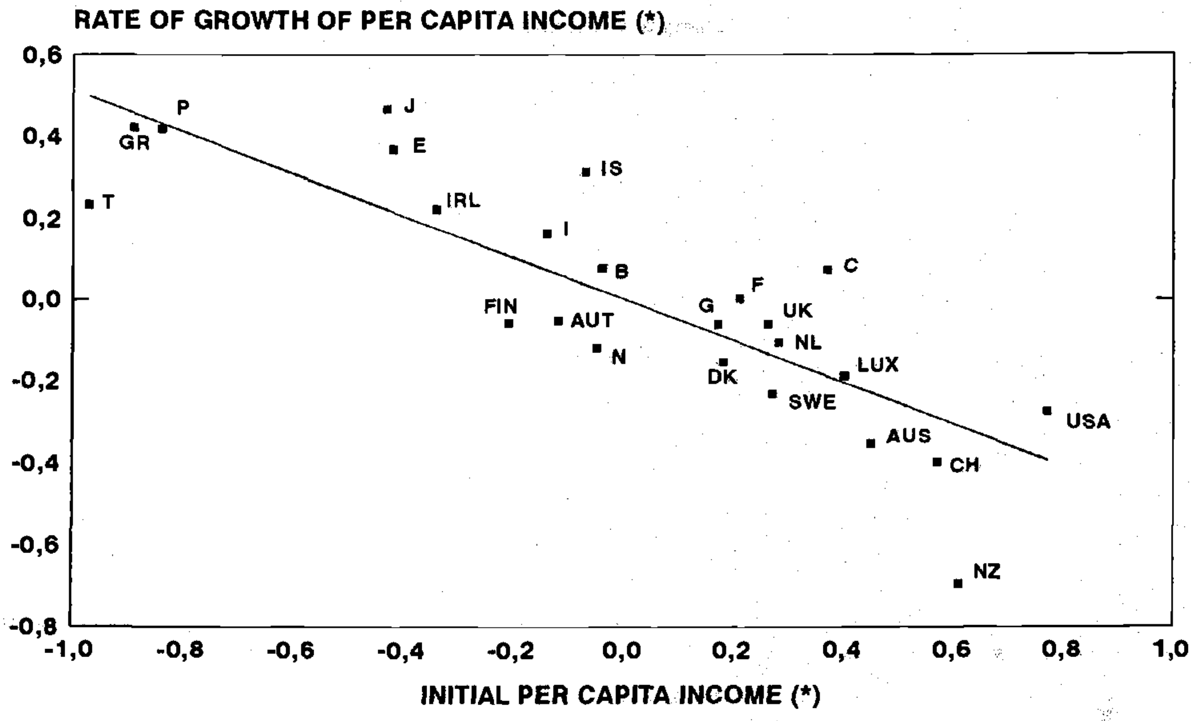
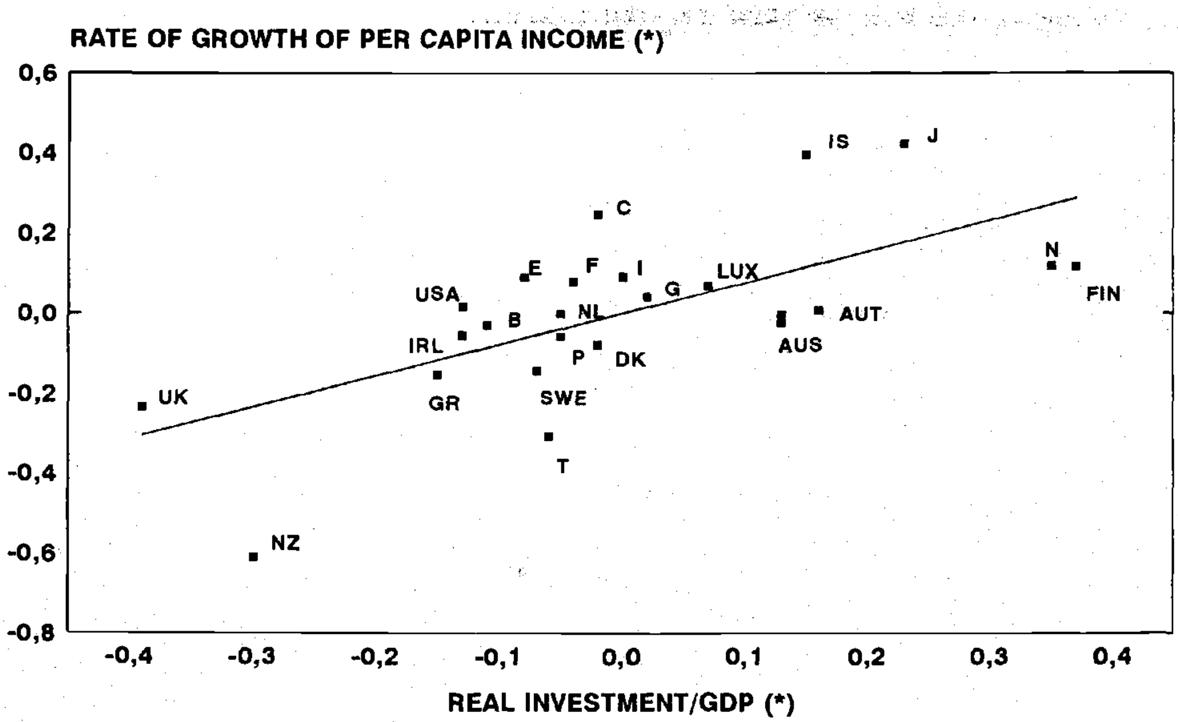


FIGURE 3: CONVERGENCE AMONG OECD COUNTRIES 1960-1990
PARTITIONED REGRESSION ANALYSIS



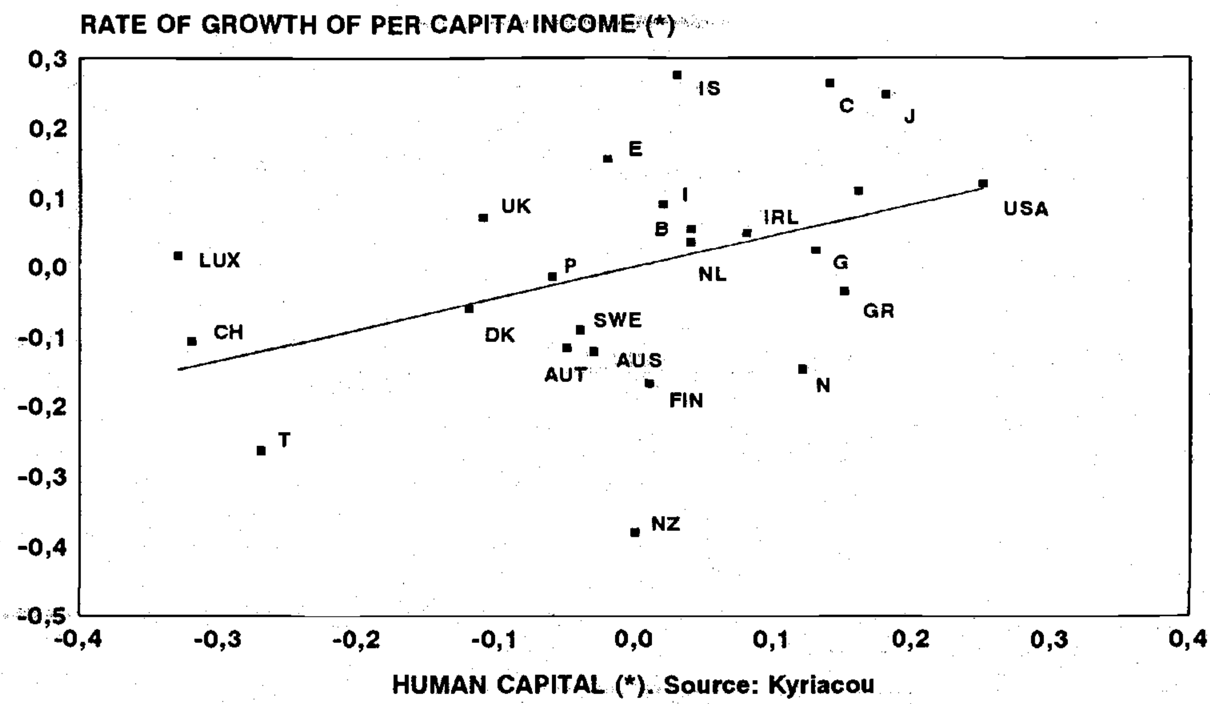
(*) OLS residuals in logs. Regressors are I/Y and population growth.

FIGURE 4: REAL INVESTMENT SHARE IN GDP AND GROWTH OECD: 1960-1990



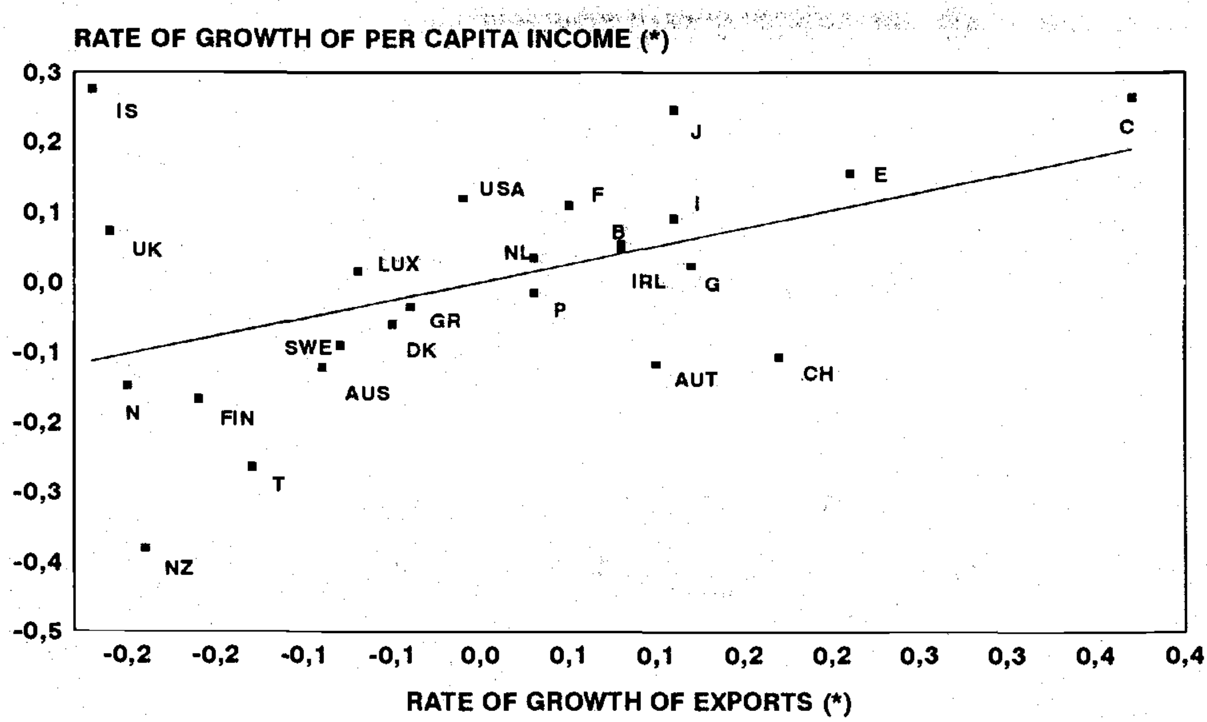
(*) OLS residuals in logs. Regressors are initial income and population growth.

FIGURE 5: HUMAN CAPITAL AND GROWTH OECD: 1960-1990



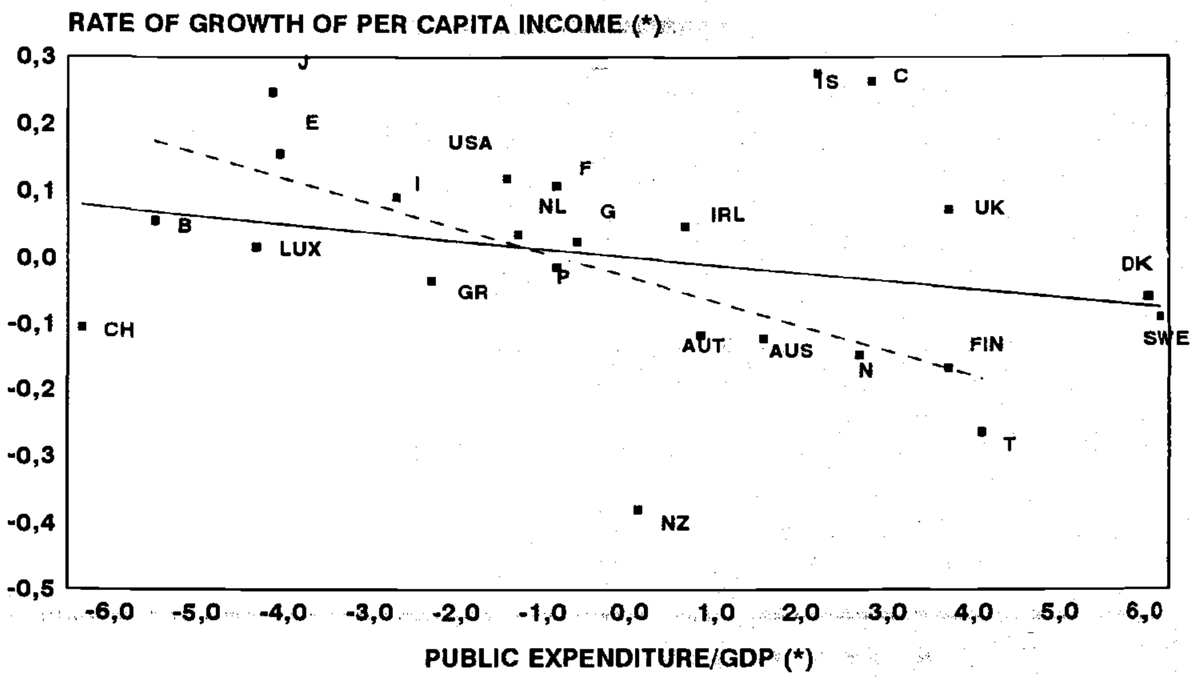
(*) OLS residuals in logs. Regressors are I/Y, initial income and population growth.

FIGURE 6: EXPORTS AND GROWTH OECD: 1960-1990



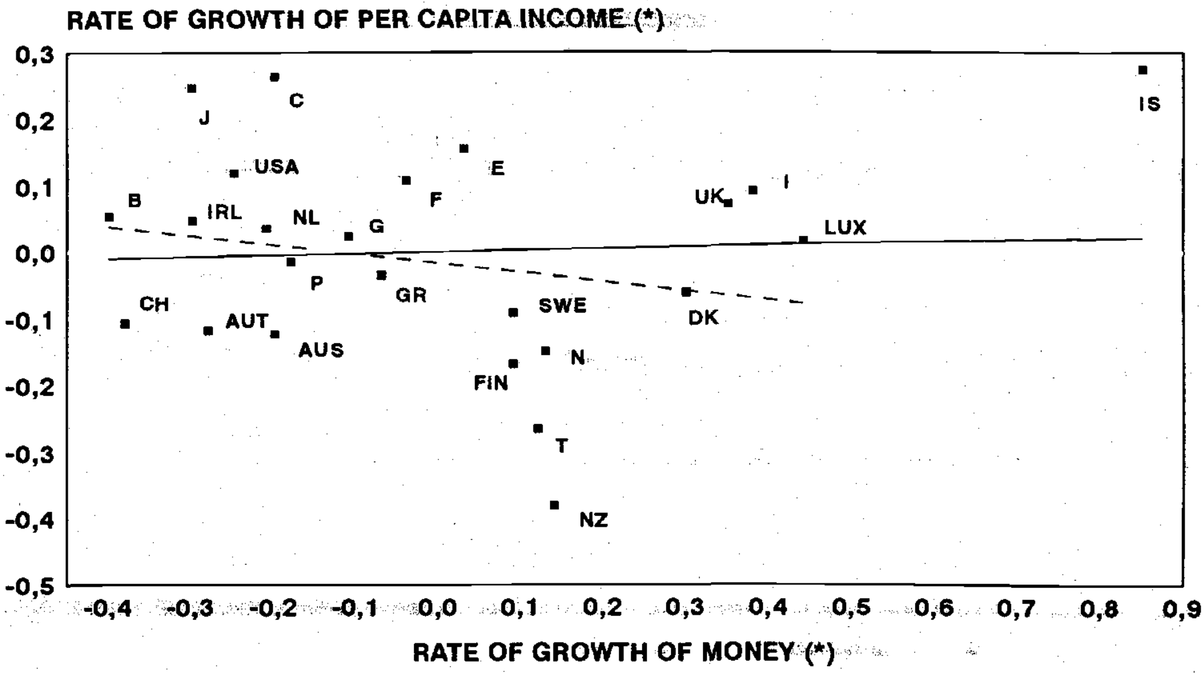
(*) OLS residuals in logs. Regressors are I/Y, initial income and population growth.

FIGURE 7: PUBLIC EXPENDITURE
OECD: 1960-1990



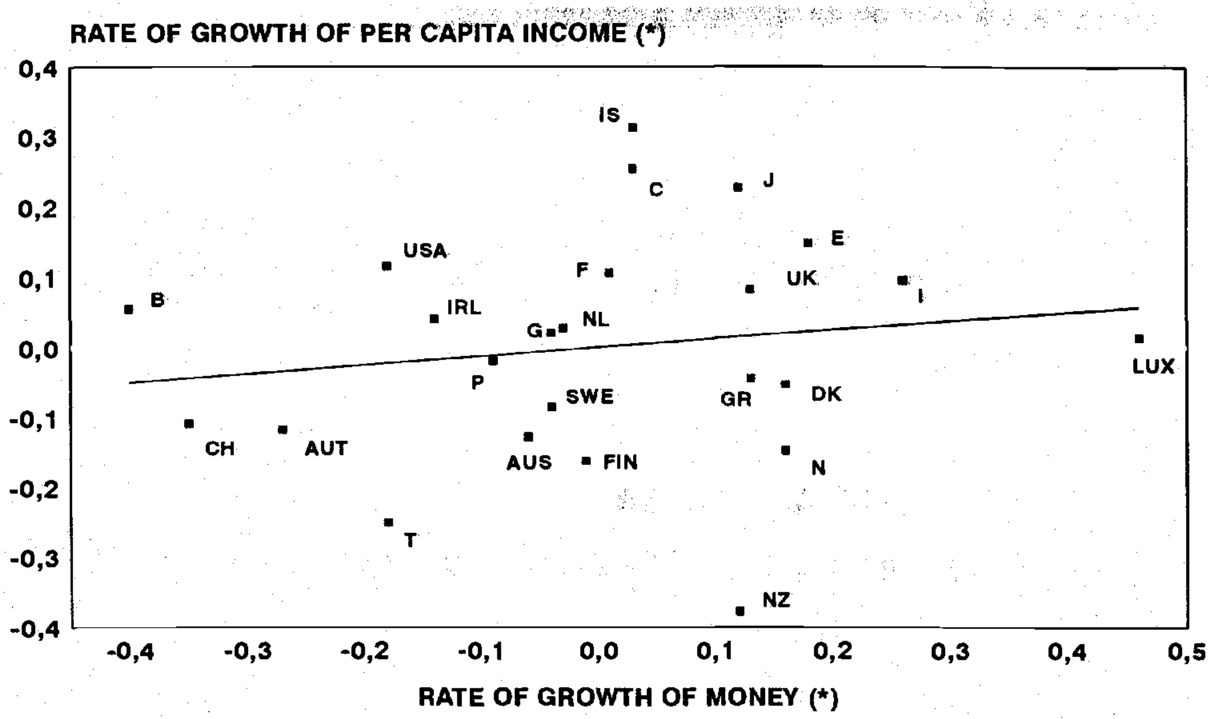
(*) OLS residuals in logs. Regressors are I/Y, initial income and population growth.
Dashed regression line excludes: CH, NZ, SWE, DK, UK, C and IS

FIGURE 8 (a): MONEY AND GROWTH
OECD: 1960-1990



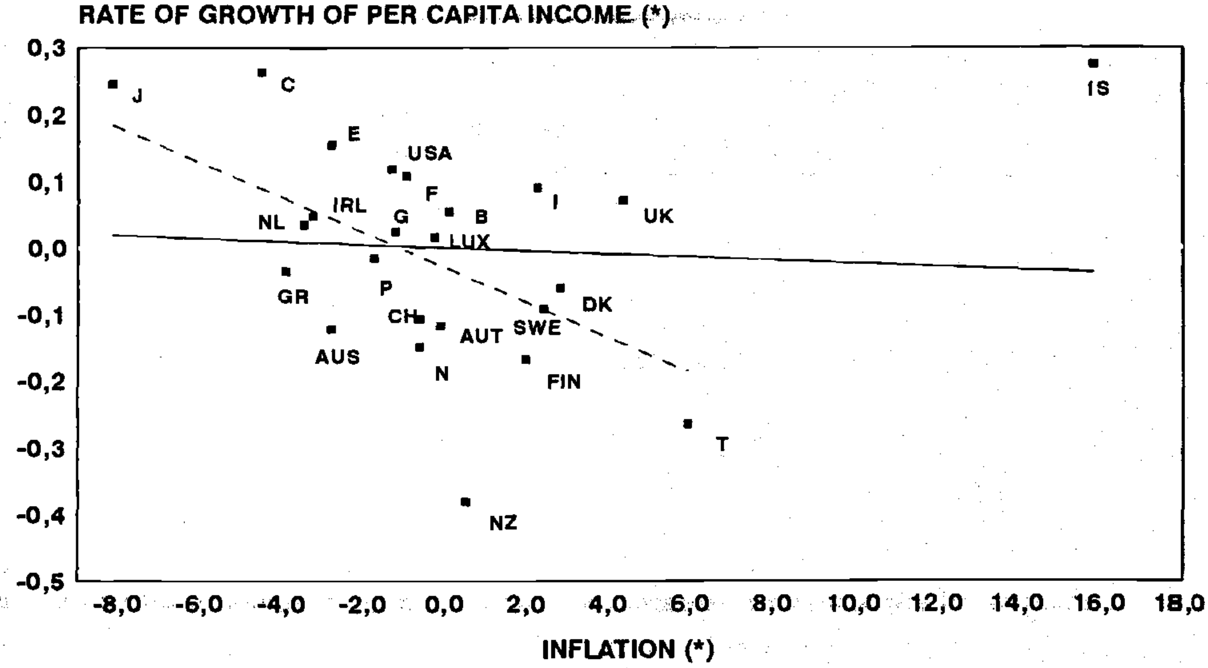
(*) OLS residuals in logs. Regressors are I/Y, initial income and population growth.
Dashed regression line excludes Iceland

FIGURE 8 (b): MONEY AND GROWTH
OECD: 1960-1990



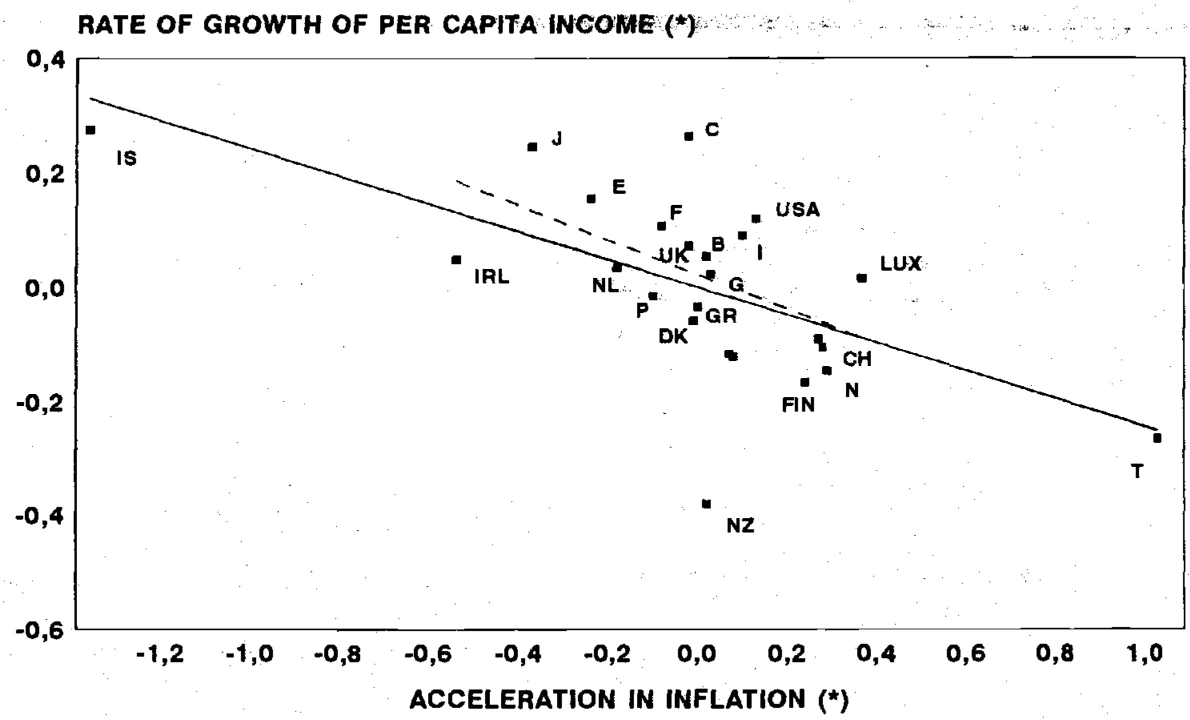
(*) OLS residuals in logs. Regressors are I/Y, initial income, inflation and population growth.

FIGURE 9: INFLATION AND GROWTH
OECD: 1960-1990



(*) OLS residuals in logs. Regressors are I/Y, initial income and population growth.
Dashed regression line excludes Iceland

FIGURE 10: ACCELERATION OF INFLATION
OECD:1960-1990



(*) OLS residuals in logs. Regressors are I/Y, initial income and population growth.

Table IV.1

Dependent variable $\log(Y^i_{90}/Y^i_{60})$. Sample i: 1,.., 24.

Estimation method: OLS

	1	2	3	4	5
ctte.	1.45	-2.85	-2.03	-3.14	-3.33
	(11.1)	(2.52)	(2.41)	(3.06)	(4.39)
$\log(Y^i_{60})$	-0.36	-0.42	-0.40	-0.49	-0.49
	(4.81)	(7.07)	(6.98)	(7.96)	(8.16)
$\log(I/Y)^i$	--	0.55	0.60	0.57	0.55
		(3.63)	(4.16)	(4.13)	(4.23)
$\log(n+\phi+\delta)^i$	--	-0.96	-0.60*	-0.80	-0.90*
		(2.69)		(2.47)	
$\log(s^i_h)$	--	--	--	0.39	0.36
				(2.39)	(2.71)
$\bar{R}^2$	0.490	0.710	0.710	0.765	0.775
σ	0.173	0.131	0.131	0.118	0.115

NOTES: *: restricted parameter.

Table IV.2

Dependent variable $\log(Y^i_{90}/Y^i_{60})$. Sample i: 1,.., 24.

Estimation method: non linear least squares

	1^j	2^{ss}	3	4	$5^†$	6
B_2	-6.84		-7.92	-9.06	2.73	-7.82
	(5.81)		(5.21)	(5.29)	(9.40)	(4.53)
B_1	-7.54	-6.19				
	(6.18)	(3.28)				
α	0.30	0.18	0.39	0.40		0.39
	(4.86)	(1.77)	(5.21)	(5.48)		(5.09)
γ	0.33	0.42	0.26	0.27		0.26
	(6.13)	(5.04)	(4.18)	(4.30)		(3.51)
λ						0.022
						(5.72)
$(\alpha+\gamma)$					0.77	
					(11.4)	
ϕ	0.02*	0.02*	0.02*	0.03	0.02*	0.02*
				(2.70)		
$\bar{R}^2$	0.801		0.814	0.788	0.379	0.775
$\bar{R}^2_{ss}$	0.498	0.531				
σ	0.109		0.105	0.112	0.192	0.115
σ_{ss}	0.273	0.264				
β_{imp}	0.37	0.40	0.35	0.33	0.23	0.35
λ_{imp}	0.021	0.023	0.020	0.019	0.013	--
$\lambda_{imp}(\hat{\phi})$				0.022		

NOTES: *: restricted parameter.

j: joint estimation, full restrictions: $\chi_1(\alpha)$= 3.14; $\chi_1(\gamma)$= 2.62; $\chi_2(\alpha,\gamma)$= 3.17.

cols. 2, 3: joint estimation without cross equation restrictions.

ss: steady state equation.

†: this equation does not include steady state variables.

Table IV.3

Dependent variable $\log(Y^{i}_{90}/Y^{i}_{60})$. Sample i: 1,.., 24.

Estimation method: non linear least squares

	1	2	3	4	5
B_2	-4.34	-8.52	-4.33	-8.20	1.38
	(2.11)	(3.68)	(1.43)	(5.00)	(1.33)
α	0.38	0.36	0.33	0.33	0.14
	(4.48)	(2.65)	(4.01)	(3.74)	(1.11)
γ	0.16	0.31	0.22	0.32	--
	(1.75)	(2.72)	(2.26)	(4.10)	
ϕ	0.02	0.02	0.02	0.03	0.016
	(1.97)	(1.34)	(2.26)	(2.25)	(1.85)
$\bar{R}^2$	0.836	0.550	0.796	0.779	0.892
σ	0.100	0.126	0.077	0.105	0.075
β_{imp}	0.46	0.33	0.47	0.35	0.86
λ_{imp}	0.026	0.019	0.027	0.020	0.049
$\lambda_{imp}(\hat{\phi})$	0.026	0.013	0.027	0.024	0.041

NOTES: *: restricted parameter.
Col. 1: excluding Turkey and Greece.
Col. 2: excluding the seven richest countries in 1960
Col. 3: excluding the seven poorest countries in 1960
Col. 4: excluding the seven richest countries in 1990
Col. 5: excluding the seven poorest countries in 1990

Table IV.4

Dependent variable $\log(Y^i_{90}/Y^i_{60})$. Sample i: 1,.., 24.

Estimation method: non linear least squares

Steady state variables not included

	1	2	3	4	5
B_2	2.53	4.37	2.26	2.84	2.27
	(25.4)	(2.46)	(38.1)	(5.86)	(55.1)
$(\alpha+\gamma)$	0.51	0.90	0.18	0.82	0.02
	(4.64)	(14.0)	(0.64)	(11.0)	(0.10)
ϕ	0.02*	0.02*	0.02*	0.02*	0.02*
$\bar{R}^2$	0.710	0.097	0.666	0.267	0.891
σ	0.134	0.179	0.098	0.191	0.075
β_{imp}	0.49	0.10	0.82	0.18	0.98
λ_{imp}	0.029	0.006	0.047	0.010	0.057

NOTES: *: restricted parameter.
Col. 1: excluding Turkey and Greece.
Col. 2: excluding the seven richest countries in 1960
Col. 3: excluding the seven poorest countries in 1960
Col. 4: excluding the seven richest countries in 1990
Col. 5: excluding the seven poorest countries in 1990

Table IV.5

Dependent variable $\log(Y^i_{90}/Y^i_{60})$. Sample i: 1,.., 24.
Estimation method: non linear least squares

	1	2	3	4	5	6
B_2	-7.62	-5.16	-10.3	-4.77	-6.60	-6.11
	(4.66)	(4.08)	(5.43)	(3.93)	(4.53)	(4.16)
A_g	-0.02	--	--	-0.01	--	-0.01
	(1.67)			(1.63)		(1.15)
A_a	--	-0.31	--	-0.29	-0.29	-0.28
		(4.13)		(4.00)	(3.93)	(3.84)
A_x	--	--	0.03	--	0.02	0.02
			(2.44)		(2.26)	(1.86)
α	0.36	0.37	0.41	0.33	0.37	0.35
	(4.45)	(5.31)	(5.87)	(4.74)	(6.12)	(5.41)
γ	0.30	0.21	0.28	0.25	0.24	0.25
	(4.37)	(3.60)	(4.70)	(4.09)	(4.43)	(4.59)
ϕ	0.02^*	0.02^*	0.02^*	0.02^*	0.02^*	0.02^*
$\bar{R}^2$	0.805	0.865	0.829	0.876	0.888	0.890
σ	0.107	0.089	0.101	0.086	0.081	0.081
β_{imp}	0.34	0.42	0.31	0.42	0.39	0.40
λ_{imp}	0.020	0.024	0.018	0.024	0.023	0.023

NOTES: *: restricted parameter.

Table IV.6

Dependent variable $\log(Y^i_{90}/Y^i_{60})$: Sample i: 1,.., 24.

Estimation method: non linear least squares

	1	2
B_2	-4.80	-5.93
	(1.68)	(4.01)
A_p	-0.04	--
	(1.94)	
A_a	--	-0.28
		(4.08)
A_g	--	-0.02
		(1.86)
A_x	0.03	0.03
	(1.83)	(2.04)
α	0.35	0.37
	(4.61)	(4.30)
γ	0.21	0.23
	(2.17)	(3.05)
ϕ	0.02^*	0.02^*
$\bar{R}^2$	0.886	0.889
σ	0.082	0.071

NOTES: *: restricted parameter.

Col. 1: excluding Iceland and Turkey.

Col. 2: excluding Spain, New Zealand, Greece and United Kingdom.

Table V.1

Dependent variable $\log(Y^i_{T+5}/Y^i_T)$.Sample,i:1,.,24; T:1960,65,.,85.

Estimation method: OLS

	1	2	3	4
ctte.	0.34	-0.85	-0.95	-0.82
	(8.87)	(2.70)	(2.88)	(2.92)
$\log(Y^i_T)$	-0.10	-0.13	-0.14	-0.14
	(5.53)	(6.77)	(5.75)	(5.76)
$\log\left(I/Y\right)^i_{\bar{T}}$	--	0.15	0.16	0.17
		(3.90)	(4.03)	(4.40)
$\log\left(n+\phi+\delta\right)^i_{\bar{T}}$	--	-0.28	-0.28	-0.22*
		(2.75)	(2.82)	
$\log(s_h)^i_{\bar{T}}$	--	--	0.04	0.05
			(1.00)	(1.42)
$\bar{R}^2$	0.207	0.328	0.329	0.332
σ	0.081	0.075	0.075	0.075
DW	1.90	2.08	2.07	2.10

NOTES: *: restricted parameter.

Table V.2a

Dependent variable $\log(Y^i_{T+5}/Y^i_T)$. Sample, i: 1,..,24; T: 1960,65,..,85.

Estimation method: non linear instrumental variables

	1^j	2^{ss}	3	$4^{j,d}$	$5^{ss,d}$	6^d
B_2	-5.35		-9.02	-5.60		-6.96
	(5.49)		(2.42)	(7.38)		(4.00)
B_1	-5.83	-8.59		-5.92	-5.76	
	(7.31)	(7.01)		(7.73)	(6.64)	
α	0.24	0.20	0.65	0.24	0.21	0.42
	(5.74)	(4.40)	(3.92)	(6.06)	(4.67)	(4.58)
γ	0.36	0.40	-0.03	0.37	0.40	0.21
	(12.2)	(11.5)	(0.16)	(11.4)*	(11.3)*	(2.84)*
ϕ	0.01	0.006	0.04	0.02	0.02	0.02
	(1.67)	(3.26)	(2.61)			
$\bar{R}^2$	0.218		0.277	0.499		0.524
$\bar{R}^2_{ss}$	0.565	0.563		0.578	0.581	
σ	0.081		0.076	0.065		0.063
σ_{ss}	0.273	0.272		0.269	0.268	
DW	2.00		1.94	2.11		2.20
DW_{ss}	0.74	0.77		0.68	0.68	
β_{imp}	0.40	0.40	0.35	0.39	0.39	0.37
λ_{imp}	0.023	0.023	0.020	0.023	0.023	0.021
$\lambda_{imp}(\hat{\phi})$	0.019	0.015	0.027			

NOTES: *: restricted parameter.

j: joint estimation imposing full restrictions: $\chi_1(\alpha) = 6.74$; $\chi_1(\gamma) = 9.22$; $\chi_2(\alpha,\gamma) = 13.71$; $\chi^d_1(\alpha) = 4.47$; $\chi^d_1(\gamma) = 5.18$; $\chi^d_2(\alpha,\gamma) = 5.22$.

d: equation including time dummies.

ss: steady state equation.

Cols. 2,3 and 5,6: joint estimation without cross equation restrictions

Instruments: constant, $\log(Y^i_T)$, $\Delta\log(Y^i_{T-1})$, $\log\left(I/Y\right)^i_{T-1}$, $\log(Y^i)_{T-1}$, $\log(s_h)^i_T$, $\log\left(n+\phi+\delta\right)^i_{T-1}$, $\left(n+\phi+\delta\right)^i_{T-1}$, $(G/Y)^i_{T-1}$, π^i_{T-1}, ΔX^i_{T-1}, trend or dummies.

Table V.2b

Dependent variable $\log(Y^i_{T+5}/Y^i_T)$. Sample, i:1,..,24; T:1960,65,..,85.

Estimation method: non linear instrumental variables

	1	2	3^d	4^d	5^d
B_2	-6.63	-5.18	-7.21	-7.39	-9.00
	(3.21)	(2.58)	(3.90)	(4.37)	(5.30)
α	0.61	0.56	0.43	0.41	0.40
	(11.6)	(8.68)	(4.54)	(5.59)	(5.81)
γ	--	--	0.21	0.23	0.26
			(2.74)	(3.40)	(4.39)
ϕ	0.02	0.02*	0.02*	0.02*	0.05
	(1.72)				(3.10)
λ	--	0.024	--	0.026	--
		(6.55)		(5.44)	
$\bar{R}^2$	0.298	0.338	0.495	0.510	0.414
σ	0.076	0.074	0.065	0.064	0.070
DW	2.08	2.11	2.21	2.13	2.25
β_{imp}	0.39	0.47	0.36	0.36	0.34
λ_{imp}	0.023	--	0.021	--	0.020
$\lambda_{imp}(\hat{\phi})$	0.023				0.030

NOTES: *: restricted parameter.

d: equation including time dummies.

Instruments: as in Table V.2a (in cols. with γ set to 0, $\log(s_h)^i_{\bar{T}}$ is not included as an instrument).

Table V.3

Dependent variable $\log(Y^i_{T+5}/Y^i_T)$.Sample,i:1,..,24; T:1960,65,..,85.

Estimation method: non linear instrumental variables

	1	2	3	4	5
B_2	-1.84	-7.53	0.20	-7.76	1.15
	(1.18)	(2.82)	(0.22)	(3.23)	(1.33)
α	0.41	0.63	0.25	0.63	0.12
	(4.84)	(10.4)	(2.78)	(11.6)	(1.13)
ϕ	0.02	0.02	0.03	0.02	0.04
	(2.18)	(1.24)	(2.63)	(1.76)	(2.94)
$\bar{R}^2$	0.357	0.247	0.419	0.322	0.443
σ	0.072	0.085	0.055	0.077	0.064
DW	2.17	2.25	2.14	2.15	2.23
β_{imp}	0.59	0.37	0.75	0.37	0.88
λ_{imp}	0.034	0.021	0.043	0.021	0.050
$\lambda_{imp}(\hat{\phi})$	0.034	0.014	0.050	0.021	0.068

NOTES: *: restricted parameter.
Col. 1: excluding Turkey and Greece.
Col. 2: excluding the seven richest countries in 1960
Col. 3: excluding the seven poorest countries in 1960
Col. 4: excluding the seven richest countries in 1990
Col. 5: excluding the seven poorest countries in 1990
Instruments: as in Table v.2b.

Table V.4

Dependent variable $\log(Y^i_{T+5}/Y^i_T)$.Sample,i:1,.,24; T:1960,65,.,85.

Estimation method: non linear instrumental variables

Steady state variables not included

	1	2	3	4	5
B_2	2.41	1.57	2.29	1.18	2.00
	(4.12)	(0.63)	(6.67)	(0.57)	(6.04)
β	0.64	0.23	0.94	0.24	0.96
	(3.41)	(2.78)	(4.61)	(2.87)	(5.42)
ϕ	0.02	0.03	0.02	0.04	0.04
	(1.11)	(0.89)	(1.63)	(1.07)	(2.22)
$\bar{R}^2$	0.261	0.101	0.364	0.149	0.432
σ	0.077	0.093	0.058	0.086	0.064
DW	1.96	2.01	2.03	1.85	2.19
λ_{imp}	0.037	0.013	0.054	0.014	0.055
$\lambda_{imp}(\hat{\phi})$	0.024	0.009	0.054	0.009	0.074

NOTES: *: restricted parameter.
Col. 1: excluding Turkey and Greece.
Col. 2: excluding the seven richest countries in 1960
Col. 3: excluding the seven poorest countries in 1960
Col. 4: excluding the seven richest countries in 1990
Col. 5: excluding the seven poorest countries in 1990
Instruments: as in Table v.2b.

Table V.5

Dependent variable $\log(Y^1_{T+5}/Y^1_T)$.Sample,i:1,.,24; T:1960,65,.,85.

Estimation method: non-linear instrumental variables

	1	2	3	4	5^d	6^d
B_2	-5.51	-5.42	-4.67	-4.85	-7.80	-7.51
	(3.58)	(3.57)	(3.06)	(3.04)	(3.42)	(3.39)
A_p	-0.04	-0.04	-0.05	-0.06	-0.08	-0-08
	(2.71)	(2.69)	(3.32)	(3.36)	(4.36)	(4.23)
A_m	0.04	0.04	0.05	0.05	0.08	0.08
	(2.86)	(2.87)	(3.41)	(3.47)	(4.40)	(4.31)
A_{am}	--	--	0.03	0.03	--	--
			(1.43)	(1.37)		
A_{vt}	-0.07	-0.08	-0.07	-0.08	--	--
	(1.50)	(1.66)	(1.51)	(1.56)	--	-0.12
A_{vtm}	-0.10	--	-0.09	--		(2.42)
	(2.19)		(2.04)			
A_{vam}	--	-0.10	--	-0.10	-0.11	--
		(2.37)		(2.31)	(2.30)	
A_x	0.004	0.004	0.004	0.004	0.006	0.006
	(4.41)	(4.43)	(4.23)	(4.25)	(4.41)	(4.39)
α	0.57	0.57	0.44	0.42	0.34	0.32
	(12.0)	(12.1)	(4.20)	(4.12)	(3.46)	(3.30)
γ	--	--	0.11	0.13	0.29	0.30
			(1.49)	(1.69)	(3.78)	(3.99)
ϕ	0.02*	0.02*	0.02*	0.02*	0.02*	0.02*
$\bar{R}^2$	0.531	0.532	0.524	0.526	0.599	0.596
σ	0.062	0.062	0.063	0.063	0.058	0.058
DW	2.03	2.03	2.09	2.09	2.23	2.26
β_{imp}	0.43	0.43	0.45	0.45	0.37	0.38
λ_{imp}	0.025	0.025	0.026	0.026	0.021	0.022

NOTES: *: restricted parameter. d: equation including time dummies.
Inst.: ctt., dum., $\log(Y^1_T)$, $\Delta\log(Y^1_{T-1})$, $\log(I/Y)^i_{T-1}$, $\log(Y^i)_{T-1}$, $\log(s_h)^i_T$, $\log(n+\phi+\delta)^i_{T-1}$, $(n+\phi+\delta)^i_{T-1}$, $(G/Y)^i_{T-1}$, Δm^i_T, Δm^i_{T-1}, $\Delta^2 m^i_T$, $\Delta^2 m^i_{T-1}$, π^i_{T-1}, ΔX^i_T, ΔX^i_{T-1}, $\Delta\pi^i_{T-1}$, var(π^i_T), var(π^i_{T-1}), var($\Delta\pi^i_T$), var($\Delta\pi^i_{T-1}$), var(Δm^i_T), var(Δm^i_{T-1}), var($\Delta^2 m^i_T$), var($\Delta^2 m^i_{T-1}$).

Table V.6

Dependent variable $\log(Y^i_{T+5}/Y^i_T)$.Sample,i:1,.,24.

Estimation method: Instrumental Variables

	1	2^d	3^d	4	5^d	6^d
ctte.	-0.88	-0.86	-0.80	-1.60	-1.28	-0.75
	(2.51)	(2.46)	(2.32)	(2.47)	(2.41)	(1.61)
$\log(Y^i_T)$	-0.15	-0.14	-0.13	-0.13	-0.09	-0.04
	(5.82)	(5.46)	(6.31)	(2.38)	(2.02)	(1.05)
$\log\left(I/Y\right)^i_{\bar{T}}$	0.12	0.12	0.11	0.20	0.14	0.12
	(2.48)	(2.49)	(2.33)	(3.15)	(2.73)	(2.28)
$\log\left(n+\phi+\delta\right)^i_{\bar{T}}$	-0.32	-0.31	-0.32	-0.39	-0.28	-0.18
	(2.91)	(2.78)	(2.87)	(1.91)	(1.73)	(1.15)
$\log(s_h)^i_{\bar{T}}$	0.04	0.04	--	0.13	0.13	--
	(0.98)	(1.02)		(1.59)	(1.98)	
$\bar{R}^2$	0.412	0.432	0.428	0.116	0.421	0.402
σ	0.067	0.065	0.067	0.073	0.059	0.060
DW	2.03	2.02	2.03	2.59	2.09	2.07

NOTES: d: equation including time dummies.
Cols. 1, 2 and 3, T: 1960, 1965, 1970, 1985.
Cols 4, 5, and 6 T: 1975, 1980.
Instruments: as in Table V.2.

Table V.7

Dependent variable $\log(Y^i_{T+5}/Y^i_T)$.Sample,i:1,.,24.

Estimation method: non linear instrumental variables

	1	2^d	3^d	4	5^d	6^d
B_2	-5.07	-4.55	-5.03	-14.9	-16.1	-15.7
	(2.92)	(2.64)	(2.84)	(2.79)	(2.72)	(3.06)
α	0.40	0.39	0.39	0.50	0.43	0.39
	(4.08)	(3.14)	(4.23)	(3.11)	(3.08)	(3.53)
γ	0.17	0.17	0.19	0.25	0.33	0.37
	(2.37)	(1.80)	(2.29)	(1.78)	(2.71)	(3.78)
ϕ	0.04	0.02^*	0.02^*	0.04	0.02^*	0.02^*
	(2.37)			(1.13)		
λ	--	--	0.032	--	--	0.018
			(5.45)			(2.14)
$\bar{R}^2$	0.396	0.415	0.448	0.129	0.431	0.438
σ	0.068	0.067	0.065	0.073	0.059	0.058
DW	2.21	2.23	2.12	2.80	2.17	2.08
β_{imp}	0.43	0.44	0.42	0.25	0.24	0.24
λ_{imp}	0.026	0.026	--	0.014	0.014	--
$\lambda_{imp}(\hat{\phi})$	0.034			0.009		

NOTES: *: restricted parameter.
d: equation including time dummies.
Cols. 1, 2 and 3, T: 1960, 1965, 1970, 1985.
Cols 4, 5, 6 and T: 1975, 1980.
Instruments: as in Table V.2a.

Table V.8

Dependent variable $\log(Y^{i}_{T+5}/Y^{i}_{T})$.Sample,i:1,.,24.

Estimation method: non linear instrumental variables

	1	2	3	4
B_2	-4.30	-4.32	-4.21	-3.36
	(2.77)	(2.74)	(2.74)	(2.67)
A_m	0.02	0.01	0.01	--
	(1.36)	(1.28)	(1.19)	
A_{am}	0.03	0.03	--	
	(1.16)	(1.07)		
A_{vt}	-0.14	-0.14	-0.13	-0.11
	(2.65)	(2.62)	(2.44)	(3.37)
A_{vtm}	--	-0.09	--	
		(1.70)		
A_{vam}	-0.10	--	-0.09	
	(1.94)		(1.80)	
A_x	0.003	0.003	0.003	0.003
	(2.07)	(1.97)	(1.85)	(2.13)
α	0.54	0.54	0.54	0.50
	(9.30)	(9.13)	(9.22)	(8.97)
ϕ	0.02^*	0.02^*	0.02^*	0.02^*
$\bar{R}^2$	0.486	0.478	0.482	0.467
σ	0.062	0.062	0.062	0.063
DW	2.15	2.09	2.22	2.30
β_{imp}	0.46	0.46	0.46	0.50
λ_{imp}	0.027	0.027	0.027	0.029

NOTES: *: restricted parameter.
T: 1960, 1965, 1970, 1985.
Instruments: as in Table V.7

Table V.9

Dependent variable $\log(Y^i_{T+5}/Y^i_T)$. Sample, i: 1,..,24.

Estimation method: non linear instrumental variables

	1	2	3	4
B_2	-19.6	-21.8	-31.5	-29.0
	(1.61)	(1.57)	(2.10)	(2.32)
A_p	-0.08	-0.07	--	--
	(1.78)	(1.60)		
A_m	0.08	0.08	--	--
	(1.87)	(1.87)		
A_{vtm}	--	-0.30	--	--
		(1.42)		
A_{vam}	-0.23	--	--	--
	(1.35)			
A_x	0.008	0.008	0.007	0.009
	(5.40)	(5.65)	(5.02)	(6.40)
α	0.79	0.80	0.85	0.46
	(8.54)	(8.83)	(14.7)	(3.79)
γ	--			0.39
				(3.64)
ϕ	0.02^*	0.02^*	0.02^*	0.02^*
$\bar{R}^2$	0.460	0.480	0.437	0.547
σ	0.057	0.056	0.059	0.052
DW	1.94	2.01	1.74	1.99
β_{imp}	0.21	0.20	0.15	0.15
λ_{imp}	0.012	0.011	0.008	0.008

NOTES: *: restricted parameter.
T: 1975, 1980.
Instruments: as in Table V.7