Do Interest Groups Really Matter in Economic Growth? Evidence from the U.S. States, 1980-97♣

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Abstract

A striking feature of the U.S. data for the 1980-97 period is that there exists a positive relation between the average growth rate of interest groups and the average rate of economic growth. This paper asks if the number of interest groups really help to close the gap between the poorer and the richer economies across the United States. I find that it can. I estimate a non-linear version of the traditional neoclassical model of economic growth and the Generalized Method of Moments (GMM) in order to assess the effects of this political variable over the convergence rate of economic growth.

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1. Introduction

Understanding the effects of the interest groups over the rate of economic growth is important for many questions not only in economics but also in political science. It bears directly on issues as wide ranging as government spending and public policy. During the last decade many studies have been conducted in order to find the relationship between these variables. Most existing work on this field has focused on studying the degree at which the interest groups promote economic growth for a short period of time. Relatively little attention has been paid to investigate if the formation of interest groups accelerates the growth rate of income per capita across the U.S. states (i.e. Convergence Rate of Economic Growth) in the long-run horizon.[1] This is unfortunate.

This paper focus on how the interest groups contribute to accelerate the economic growth of the states with the lower initial level of income per capita and to maintain the idea of conditional convergence across the 50 U.S. states in the 1980-97 period. Following the standard neoclassical model of economic growth we are able to investigate this concept by using a non-linear least squares cross-sectional regression. The Generalized Method of Moments estimation (GMM) is also obtained in order to control for unobserved characteristics, which may account for cross sectional differences in steady state, and to get more consistent estimations of the convergence rate of economic growth. The average annual growth of real income per capita per state is used as a dependent variable, the independents variables are the logarithm of the initial per capita product by state, a second set of control variables represented by the average growth rate of interest groups per state is used to capture the differences in steady state across the entities

[1] The idea behind this concept is that the economies with lower initial levels of income per capita will tend to grow faster than those with higher initial levels. Therefore, the poorer economies will catch up with the richer economies.

2. Literature Review in Economic Growth and Interest Groups

2.1 Political Variables from the Economist's Perspective

The neoclassical model of economic growth proposed by Solow (1956) is considered as the seminal literature in Economic Growth. The importance of the neoclassical theory relies on its capacity to clarify the adjusting mechanisms that guarantee the convergence of the per capita income to its steady state level.[2]

In a series of influential papers, Barro (1991), Barro and Sala i Martin (1991, 1992a, b) and Mankiw, Romer and Weil (1992) have argued that there is sufficient empirical evidence consistent with the hypothesis that the economies with low initial income per capita tend to grow faster than those with higher initial income (i.e. of *beta convergence*). Starting from a standard neoclassical model of growth, these authors derive and estimate a convergence equation by using different national and regional samples. The finding of convergence in these studies is generally taken to be consistent with a prediction of the neoclassical model, although at a very slow rate (around 2% per year).

Many studies have been conducted in order to estimate the convergence across the regions of some countries. Barro and Sala i Martin (1991, 1992, 1995) found convergence evidence across the U.S. states. Using variables that include revolutions, coups and political assassinations, Barro (1991) shows that there is a negative relation between the growth rates and the measures of political instability for a fairly large number of countries. Levine and Renelt (1992) find robustly negative correlation between the political instability variables and the investment share of gross domestic product. However the importance of these empirical works, they have been cast using many economic indicators giving relatively little importance to the political variables. Moreover, it is fair to say that they fail to incorporate a credible measure of political instability and no effort was made to show that political variables matter when analyzing state level economies.

2.2 The Political Science's Perspective

Olson (1982), Dean (1983), Gray and Lowery (1988) and Brace (1989), using U.S. state data, developed an interesting theoretical approach of how interest groups affect the rate of economic growth over time during the period of the late 1970s and early 1980s. The importance of these works relies in its capacity to define and to incorporate the political variables into the economic growth analysis. While much of the empirical evidence for the U.S. states supports these models, they are failing to incorporate the economic growth determinants and they are not making any effort in order to show how the interest groups contribute to close the gap between the rate of economic growth across the U.S. states.[3]

2.2.1 The Olson's Hypothesis

In *The Rise and Decline of Nations* Mancur Olson (1982) developed a powerful theory, which he claimed that could explain, among other things, differences in the growth rates of the states. This proposed model of economic growth has attracted great attention as a theoretical account of how interest groups influence the rate of economic growth over time.

In an earlier work, Olson forcefully argued that there were biases in the ability of groups to form.[4] Some groups, either small groups or those with access to selective incentives, would form while potential large groups faced important impediments and would not succeed to do so. Using relevant data on interest groups in the states, Olson suggests that over time, the number and influence of interest groups interested in retarding economic growth accumulate and are incrementally successful in having antigrowth policies adopted and implemented. The long-term consequence of this adoption is a decline in economic growth rates as nations move further from the periods of invasion or domestic upheaval that serve to upset patterns of interest-group organization and influence. Hence the political success of certain interests can undermine the economic health of a state or nation.

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[2] This is, the point where the growth rate of income per capita is constant.

[3] The convergence coefficient gives the necessary time for the economies to have the same rate of economic growth.

[4] Mancur Olson, The Logic of Collective Action (Cambridge, Mass.: Harvard University Press, 1965).

2.2.2 Dean's Hypothesis

James W. Dean (1983) criticized Olson for failing to recognize the political importance of business groups. According to Dean, Olson focused on "antigrowth" groups such as farm organizations, professional associations, and labor unions ignoring the importance of the "progrowth" business groups in the economic growth process. Dean argued that these groups cannot be ignored because their political power is sufficient to block the reducing activities of antigrowth groups. If so, Olson is wrong, because then the net effect of the interest groups on economic growth would not longer be negative.

Another important argument is that the balance of power between progrowth business groups and antigrowth groups plays an important role in the rate of economic growth. In his hypothesis, Dean states that the greater the power of business groups relative to that of antigrowth groups the higher the economic growth rate is. [5]

2.2.3 The Gray-Lowery Test

Virginia Gray and David Lowery (1988) developed and tested, using U.S. state data, a more complete specification of the Olson model (1982) for the period of the late 1970s and early 1980s. In the study, Gray and Lowery identify five characteristics of interest groups. These characteristics are: the number of groups, the encompassingness of groups, the power of interest groups relative to the government and to each other and the size of the group.

They argue that the Olson's construct should be tested using more discrete time periods. Therefore, the growth-rate variables are measured taking the period which ranges from 1977-82, while the interest-group variables are measured taking the period 1975-80.[6]

[5] This hypothesis is completely antithetical to Olson's argument.
[6] Complete data were not available for all states for all variables. Data on one or more of the variables is missing for Alabama, Alaska, Hawaii, Iowa, Nebraska, Nevada, Rhode Island, Utah, and West Virginia.

As a result of the specification model, the results obtained by Gray and Lowery (1988) provide little support to Olson's construct. First, they were unable to replicate the strong results reported by Olson on the relationship between time since statehood or the Civil War and total growth rates. There also appears to be little or no relation between time since statehood or the Civil War and various measures of interest-group influence, and finally the absolute power of interest groups was found to be positively related to the several measures of economic growth rates.

2.2.4 Critical Analysis of the Existing Literature

Although its importance, the Olson's hypotheses can be criticized in three different ways. First, it fails to specify the complete set of relationships that lie between the initial observation of time since invasion and changes in the rate of economic growth. Second, the specification of the precise manner in which interest group power is influenced by the passage of time and, in turn, influences policies affecting growth rates is ignored in Olson's tests. And third, the Olson's model is failing to recognize the political importance of business groups.

There is no doubt that the Gray and Lowery's test is an exceptional contribution to the study of economic growth and interest groups but it fails to consider important exogenous determinants of state growth. The performance of the national economy, as well as the international economic situation, can have a substantial impact on the growth of states.[7] Moreover, this study fails to recognize that the economic growth is a long-run phenomenon and, as a consequence, it is imperative to extend the period of study as long as the data permits.

Both studies are only finding relations between the rate of economic growth and the interest groups. The fact that there is relation between these two variables can be exploited in order to obtain more explanatory concepts of economic growth. One of these concepts is the convergence rate of economic growth. The convergence coefficient measures the time that will take the poorer states to catch up with the richer states. To

[7] It follows that we must control for these exogenous variables to asses the effect of special interest groups on state economic growth accurately.

the best of my knowledge, no one has been able to find evidence that shows that the political variables matter in the convergence coefficient.[8]

Using the fact that there has been shown to be an important relationship between the rate of economic growth and the interest groups, in the next two sections of this paper, I will extend the analysis in order to get an estimation of the convergence rate for the 50 U.S. states during the 1980-97 period.

3. Evidence on the Determinants of Growth

During the last decade, growth theory has experimented a revolution. The traditional neoclassical paradigm has been replaced by new "endogenous growth" theories that correct the old model's failure to predict sustained growth without reliance on exogenous technological change (See Appendix I).

Together with the surge of activity in the theoretical front, an enormous body of literature has emerged studying the factors that explain economic growth in a large sample of countries and states.[9] This empirical literature has not abandoned the spirit of the neoclassical growth model. The most important reason is that the basic model still generates growth in the transition to the steady state. Transitional growth is important because it would still show up in the relative short-time horizons used in most empirical analyses given estimates of a slow speed of convergence in conventional neoclassical models. Moreover, the fact that the steady state can vary across economies adds enough richness to the neoclassical model to make it empirically relevant. The large number of contribution to the empiric growth has been possible by the development of large data sets.

After reviewing a large number of studies explaining cross-country variations in growth, it is possible to reach a fair judgment on the most important determinants in

[8] This is probably due to a wrong specification of the political variables.

[9] A thorough exposition of these areas is beyond the scope of this paper. The reader is referred to the volume by Barro and Sala-i-Martin (1995) for an analysis and discussion of growth theory and regional empirical studies on economic growth.

growth regressions.[10] The most significant state variable included in these regressions is the initial level of GDP per capita which is intended to capture the initial capital stock $k(0)$. As the neoclassical model predicts, this variable is systematically estimated to have a negative influence on the growth rate after controlling for other X and Z variables. This result is evidence in favor of the conditional convergence hypothesis: that is, the notion that poor economies grow faster than rich economies once care is taken to condition on steady state determinants.

Other state variables commonly used are some indicators of initial human capital, such as educational attainment, schooling enrolments or life expectancy at birth. Although results vary depending on the specific variable used these variables often appear to have a positive impact on the growth rate. This result can be, at first, counterintuitive because standard neoclassical models would predict, as in the case of physical capital, a negative coefficient arising from the convergence effect. However, in some endogenous growth models where accumulation of human capital is “harder” than the accumulation of physical capital, the initial ratio of human to physical capital is important. Thus, once the initial stock of physical capital is controlled for, it is possible to have a positive effect on growth from the initial stock of human capital.

Regarding policy and environment variables, many studies include the rate of investment as a regressor. These variable is, however, in principle endogenous so serious questions of reverse causality emerge in interpreting these results. The causation from growth to investment is confirmed by the fact that many of the other regressors are also often found to affect investment. The consumption expenditure by the government frequently appears with a negative sign. This variable is not capturing the positive influence that government provided infrastructure or other services may have on productivity. Instead, it reveals the negative influence of a large public sector and its concomitant the tax burden on factor accumulation and productivity.

Many researchers have also included indicators of political freedom (democracy, civil liberties, etc.), political stability (revolutions and coups, assassinations, etc.) and the rule of law (corruption, expropriation, bureaucracy, etc.) as explanatory variables in

[10] Levine and Renelt (1992) and Sala-i-Martin (1997) investigate the robustness of many of the commonly used regressors in the empiricl growth literature.

growth regressions. Their importance is usually explained on the effect that the quality of political institutions has on the proper appropriation of economic benefits, say through the security of property rights, and the provision of the right incentives to investment and production. The particular results vary from variable to variable, but in general it appears that political stability is beneficial to economic growth. The influence of political freedom variables is less straightforward, with some authors finding non-linear effect of democracy on growth (Barro, 1997).

4. Econometric model, estimation and data set

4.1 Cross Sectional Estimation

The empirical estimation of the speed of convergence across countries and states has been estimated, in most of the cases following equation

$$\ln\left(y_{i,t}\right) - \ln\left(y_{i,t-\tau}\right) = \beta \cdot \ln\left(y_{i,t-\tau}\right) + W_{i,t-\tau}\delta + \eta_i + \xi_t + u_{i,t}\,, \qquad (1)$$

where $y_{i,t}$ is per capita income in region i in period t, $W_{i,t}$ is a row of vectors determinants of economic growth, η_i, is a country specific effect, ξ_t is a period specific constant, and $u_{i,t}$ is a n error term.[11]

The 'usual' assumption s about this model are that: the $u_{i,t}$'s are serially uncorrelated, have zero mean, scalar variance σ^2, and are uncorrelated with the individual effects η_i an the starting values $y_{i,0}$; the η_i's have zero mean and variance σ^2, and the exogenous variables are non-stochastic and uncorrelated with either the $u_{i,t}$'s or the η_i's.[12]

The coefficient on lagged income per capita gives the interpretation of equation (1). A significantly negative coefficient is consistent with the prediction of the neoclassical growth model, that regions relatively close to their steady-state output level will experience a slowdown in growth (conditional convergence). In this case the

[11] Appendix II contains the flaws of the cross-sectional estimation.
[12] For a more detailed explanation, see Lee, Longmire, Matyas and Harris (1998).

variables in $W_{i,t}$ and the individual effect η_i are proxies for this long-run level the region is converging to.[13]

4.2 Generalized Method of Moments (GMM)

Caselli, Esquivel and Lefort (1996) proposed the use of the generalized method of moments (GMM) technique as the best alternative in order to get consistent estimations of the convergence parameter.[14] From their point of view, the GMM estimator optimally exploits all the linear-moment restrictions implied by a dynamic panel-data model.

From now on, the variables will be taken as deviations from period mean so that there will be no necessity to include the time-specific constants.[15] The proposed equation that allows us to get the parameters of interest without relying on any statement concerning the state effect, to be estimated is

$$y_{i,t} - y_{i,t-\tau} = \tilde{\tilde{\beta}}\left(y_{i,t-\tau} - y_{i,t-2\tau}\right) + \left(W_{i,t-\tau} + W_{i,t-2\tau}\right)\delta + \left(u_{i,t} - u_{i,t-\tau}\right) \qquad (2)$$

It is important to notice that equation (2) cannot be estimated by least squares because we will require the use of instrumental variables since there is still endogeneity of the variables $W_{i,t-\tau}$ and $W_{i,t-2\tau}$ and correlation between the lagged dependent variable and the composed-error term in period $t-\tau$. The authors make the following identifying assumptions. First, there is no τ-order serial correlation (that is, $E\left(u_{i,t}u_{i,t-\tau}\right) = 0$). Second, the 'stock' variables in vector $W_{i,t-\tau}$ are predetermined. Third, the 'flow' variables $W_{i,t-\tau}$ are not predetermined for $u_{i,t}$, but they are predetermined for $u_{i,t+\tau}$. These identifying assumptions mean for example, that $y_{i,0}$ and the stock variables

[13] The choice of the list of regressors to include in $W_{i,t}$ depends on the particular variant of the neoclassical growth model one wishes to examine. Measures of investment (in stocks of) physical and human capital, indicators of the quality and size of government are but some of the many covariates that have been used in determinants-of-growth regressions. The country-specific effect η_i captures the existence of other determinants of a country's steady state that are not already controlled by $W_{i,t}$.

[14] Their study is based on Holtz-Eakin, Newey, and Rosen (1988), and Arellano and Bond (1991).

[15] Doing this, the term $\varepsilon_{i,t}$ is dropped out from equation (10).

in $W_{i,0}$ are valid instruments for the equation in which $y_{i,2\tau} - y_{i,\tau}$ is estimated as a function of $y_{i,\tau} - y_{i,0}$ and $W_{i,\tau} - W_{i,0}$. Moving up one period, $y_{i,0}$, $W_{i,0}$, $y_{i,\tau}$ and $W_{i,\tau}$ can be used in the regression for $y_{i,3\tau} - y_{i,2\tau}$, and so on.

The GMM framework deals consistently (and efficiently) with the estimation problems presented by the cross-sectional regressions and the panel data approach described above.

5. Estimating Convergence

5.1 Do the interest groups matter in the convergence rate of economic growth?

The Bureau of Economic Analysis provides estimates of the gross domestic product for the 50 U.S. sates covering the 1990-97 period. Using these data, I will construct series of state incomes (income per capita in logarithms) and real per capita GDP growth rates. I will use them to estimate various specifications of a standard growth equation in order to find evidence of convergence across the U.S. states. I apply the estimator described in section 4 of this paper which is consistent with the literature in this field, and following the standard practice I regress the rate of growth of real per capita GDP on two sets of variables. First, I consider beginning-of-period levels of state variables, which account for the economy's initial position. Second, using the data on the number of interest groups by state presented by Gray and Lowery (1999), I include a set of control variables that capture differences in steady state across the entities. This specification is consistent with the growth neoclassical models that accept as a solution a log-linearization around the steady state of the form

$$\ln(y_t) - \ln(y_0) = -(1 - e^{-\lambda t})\ln(y_0) + (1 - e^{-\lambda t})\ln(y^*) \qquad (3)$$

where y_t is the per capita real GDP al time t, y^* is the steady state value, and λ is the convergence rate.

This analysis considers a panel including a seventeen-year period from 1980 to 1997 for the 50 U.S. states. The initial level of per capita GDP measured at the beginning of the seventeen-year period, denoted as IGSP, is used as the explanatory variable. The set of control variables include the average annual percentage change in state lobby registrations by organized interests during the same period of study is denoted by the variable INTGRP.

Table 1. USA. Convergence Estimations: 1980-97[a]

Variable	Panel OLS (1)	GMM[b] (2)
IGSP	-0.0117*	-0.0391
	(0.0014)	(0.0063)
INTGRP	0.0337*	0.0724*
	(0.0151)	(0.0222)
Implied λ	0.0207	0.0495
States	50	50
Hausman		85.3221

[a] Dependent variable is $\ln(y_{i,t}) - \ln(y_{i,t-\tau})/\tau$. τ is 17 in all columns.

[b] The instrument variables for the GMM approach are IGSP and INTGRP.

• indicate that the coefficient is significantly different from 0 at the 5% significance level.

Standard errors are in parenthesis.

Table 1 shows the results. To make a comparison, estimates of an ordinary pooled least-squares regression are presented in column one. The implied convergence coefficient is 2.07% per year, which is similar with the standard coefficient of 2% proposed by Barro and Sala i Martin (1990) and the variable INTGRP has a positive relation with the average rate of GSP growth.[16] The independent variables appear to be statistically significative at a confidence level of 5%. These results are interesting because the positive sign on the Variable INTGRP suggests that, in fact, the interest groups not only have a positive effect on the economic growth of the states but they also act as a source of convergence across the U.S. entities. In economic terms, this means that the creation of interest groups in states with lower initial levels of GSP promote growth more than in those states with higher initial levels of GSP.

Column 2 presents the estimation of the convergence rate of economic growth using the Generalized Method of Moments (GMM). The major result, as stated by Caselli, Esquivel and Lefort (1996), is that the convergence coefficient is substantially higher than the one obtained by OLS. It jumps from two to almost five percent. The results suggest that there exists a positive relation between the interest groups and the rate of convergence. The explanatory variables conserve the expected effects over the explanatory variable and the statistical significance. The Hausman test performed to each exercise strongly rejects the strict exogeneity of each set of explanatory variables.

The results obtained when using the generalized method of moments mean that the average time an economy spends to cover half of the distance between its initial position and its steady state is about 6 years instead of the thirty eight implied by the convergence rate obtained by OLS. Then, as a consequence, most of the U.S. states will be very near to their steady states, and the important differences in per capita income levels will be mainly explained by their steady-state values.

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[16] The implied λ is obtained by taking logarithms in the formula $\lambda = -(1 - e^{-\beta t}) / \tau$.

6. Conclusions

After briefly reviewing the literature on economic growth and interest groups, in this paper I have used data on the 50 U.S. states to obtain the estimates of the convergence rate of economic growth via the panel OLS and the Generalized Method of Moments (GMM) using the logarithm of the initial level of GSP and the percentage change in the number of interest groups as explanatory variables.

The results are interesting in various ways. First, I can support the idea of conditional convergence across the U.S. states including the political variable in the regression. The NLS regression gives estimates of a convergence rate around the two percent per year, which is similar to previous studies. The difference is that in those studies gave no importance to the role of the political variables in the rate of convergence across economies.

Second, there is evidence that the application of the GMM approach to the American case gives the possibility to estimate a more efficient and consistent estimation of the convergence rate since it allows to eliminate some of the problems presented by the cross–sectional and panel techniques. The use of this method opens a new line of research that can be used to light the importance of the political variables in the policy-making process.

Third, since this analysis has been rather informal and restricted to some of the multiple variables that can explain the differences across the steady-state values of the U.S. regions, it would be dangerous to try to draw the conclusion that only these variables affect the convergence rate. However, trying to perform a bigger analysis could be troublesome since there is difficult to find accurate definitions and data of the interest groups for a long period of time.

7. References

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Appendix I

In the Solow (1956) model the differences in the initial levels of income were caused by differences in the ratio capital-labor. Barro and Sala i Martin (1995) argued that given an initial level of the saving rate, the less is the ratio (K / L) the higher will be the (K / L) proportional increase on the equilibrium path.

To derive the analytical form of the model neoclassical model, we assume a Cobb-Douglas production function of the form

$$y_t = Ak_t^{\alpha}, \qquad (1)$$

where Y is the production, k_t is the capital intensity and A is any Harrod-neutral technology that affects the production function. It is also assumed that the production function presents constant returns to scale,[17] is homogeneous of degree one and satisfies the Inada Conditions.[18]

The dynamics of this model is captured by the equation[19]

$$\dot{k}(t) = sAk^{\alpha} - (n + x + \delta)k(t), \qquad (2)$$

In the steady state $\dot{k} = 0$ which in turn implies $sAk^{\alpha} = (n + x + \delta)k(t)$. The implications of equation (2) are very important for the analysis of this model because they show how the capital will tend to accumulate faster in economies with lower initial stock of capital and tend thereby to catch up or converge to those with higher capital/labor ratios.

The per capita growth rate of capital will be

$$\gamma_k = \frac{\dot{k}}{k} = \frac{sk^{\alpha}}{k} - (n + x + \delta) = 0, \qquad (3)$$

Since at the steady state the growth rate of capita is zero we can find the optimal level for k^* substituing for k in equation (3)

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[17] This is: $F(cK, cAL) = cF(K, AL)$.

[18] The Inada Conditions imply: $\lim f_{k \to \infty} f'(k) = 0$, $\lim f_{k \to 0} = \infty$.

$$k^* = \left[\frac{As}{n+x+\delta}\right]^{\frac{1}{1-\alpha}}, \qquad (4)$$

From (4), we can see that there is an inverse relation between the investment rate and the capital stock at the steady state.[20] The per capita growth rate of output is also zero at the steady-state and equal to

$$\gamma_y = \frac{\dot{y}}{y} = sAk^{\alpha} - (n+x+\delta)Sh(k) = 0, \quad (5)$$

Then, substituing (4) on (1) we will find that the output[21] in the steady state is of the form

$$y^* = \left[\frac{As}{n+x+\delta}\right]^{\frac{\alpha}{1-\alpha}}, \quad (6)$$

The speed of convergence β can be obtained applying log-linearization around the steady state to equations (3) and (6), then the solution for $\log[\hat{y}(t)]$ is[22]

$$\ln\left[\hat{y}(t)\right] = \ln\left[\hat{y}(0)\cdot e^{-\beta t} + \ln\left(\hat{y}^*\right)\cdot\left(1 - e^{-\beta t}\right)\right], \qquad (7)$$

where β which is the parameter that dictates the adjustment speed is equal to[23]

$$2\beta = \left\{\psi^2 + 4\left(\frac{1-\alpha}{\theta}\right)\left(\rho + \partial + \theta x\right) * \left[\frac{\rho + \partial + \theta x}{\alpha} - \left(n + \partial + x\right)\right]\right\}^{\frac{1}{2}} - \psi, \quad (8)$$

with $\psi = \rho - n - (1-\theta)x > 0$.

Equation (7) implies that the average growth rate of per capita output, y, over an interval from an initial time 0 to any future time $T \geq 0$ is given by

$$\frac{1}{T}\cdot\ln\left[\frac{y(T)}{y(0)}\right] = x + \frac{1 - e^{-\beta t}}{T}\cdot\ln\left[\frac{\hat{y}^*}{\hat{y}(0)}\right], \quad (9)$$

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[19] This equation is obtained when the capital accumulation is derived with respect to time.

[20] Notice that, at every point in time, the growth rate of the variable will be equal to its per capita growth rate plus the population growth rate (n) and the technological progress (x). Thus, $\gamma_K = \gamma_k + n + x$.

[21] In equilibrium, the investment rate must be equal to the saving rate s

[22] For example, the variance across the levels of per capita income.

[23] For a more detailed explanation of this procedure see Barro and Sal i Martin (1995).

From (9), we can conclude that with higher values of β, the growth rate between the per capita income levels ($\log\left(\hat{y}^*\right)$ and $\log\left[\hat{y}(0)\right]$) will be higher, this is, the speed of convergence will increase.

Appendix II

There is a vast literature studying growth regressions based on equation (10) and using cross sectional studies of a large sample of developed or developing countries (i.e. Baumol (1986), De Long (1988), Barro (1991), Mankiw, Romer and Weil (1992), Barro and Sala i Martin (1992).

The main problem estimating equation (10) by cross sectional regressions is that the cross sectional estimator will be consistent as long as the lagged dependent variable $y_{i,t-1}$ and the individual specific effects η_i are uncorrelated. However, it is easy to see that this assumption is easily violated by the growth regression, since

$$E\left[\eta_i y_{i,t-\tau}\right] = E\left[\eta \left(\hat{\beta} y_{i,t-2\tau} + W_{i,t-2\tau} + \eta_i + u_{i,t-\tau}\right)\right] \neq 0 \qquad (11)^{24}$$

This means that the usual estimates of the coefficient $\hat{\beta}$ will be biased and inconsistent. Intuitively, regions with high individual effects will have high levels of steady-state income and as a result of this it is not necessarily true that a region with high income are closer to its steady-state level than a region with low income.

Another problem associated with the cross sectional estimation is the endogeneity because in most specifications of the model at least a subset of the elements in the vector $W_{i,t}$ is endogenous.[25]

[24] Note that the last inequality follows from the fact that at least $E\left(\eta_i^{\,2}\right) \neq 0.$

[25] For example, it is reasonable to think that the rate of investment in physical capital is determined simultaneously with the rate of growth.