to be applied in Puerto Rico, with several exceptions for determined industries. By 1981 almost all Puerto Rican economy was subject to the federal minimum wage.

Despite this disproportionate minimum wage there is no evidence that this legislation has had any effect on unemployment. Unemployment rates have always been high in Puerto Rico ranging from a low 10.3 percent in 1970 to a high 23.4 in 1983. The average unemployment rate for the postwar period has been 16 percent. This unemployment rate is particularly high if one considers that the participation rate in Puerto Rico has been less than 45 percent since 1980, that unemployed Puerto Ricans have the choice to move to the mainland, and that the government of Puerto Rico has been employing more than 20 percent of total employment since 1980.

In spite of all the problems that the Puerto Rican way to development might have had, one thing has been surely accomplished. Puerto Rico has been able to move closer, in terms of per-capita output, to richer and more developed economies. In particular, the Puerto Rican economy has narrowed at some extent the income gap with the U.S.. This catch-up effect has often been described as a consequence of the beneficial effects achieved by the cooperation between a developed and an underdeveloped economy.
Baumol and Wolf (1994) first elaborated on the catch-up effect experienced by Puerto Rico during the post-war era. They show that labor productivity in Puerto Rico grew from less than 25 percent of the U.S. level in 1950 to 75 percent in 1990. A similar pattern is observed for per-capita GDP, although it is less pronounced. They also pointed out that several social and economic indicators for Puerto Rico demonstrate that the Puerto Rican economy has experienced development in many areas that is comparable to that of richer economies. They conclude that Puerto Rico’s postwar history demonstrates how much can be accomplished when a rich, developed economy cooperates and interacts with one that is initially far less developed. Using a growth accounting analysis, they found that the existence of an educated labor force was the primary reason for Puerto Rico’s rapid economic growth during the postwar period, explaining over a third of the increase in per-capita GDP. The catch-up effect explains between 16 and 38 percent of the growth, Puerto Rico’s investment rate another 16-21 percent, and its trade openness and scientific manpower accounts for much of the remainder.

An interpretation of their findings in terms of neoclassical growth theory could be that by substantially increasing the ability of Puerto Rico to accumulate physical and human capital, the development strategy initiated after the War, might have moved the economy’s long-run expected income towards that of the United States, initiating a process of convergence that provides significant explanations for the high rate of growth that the Puerto Rican economy experienced for a relatively long period of time. In the following sections of this paper I will investigate the extent and duration of this process of convergence.

3 A Quick Look at the Convergence Hypothesis

This section offers a quick review of the main implications of the neoclassical theory of growth in terms of convergence, and summarizes the empirical literature in this subject.

A large number of growth models developed following the pioneering work of Solow (1956) and Swan (1956) are built on a neoclassical production function exhibiting diminishing returns to capital. As a consequence of the diminishing returns to capital, each economy approaches a unique long-run equilibrium or steady state. During the transition towards this steady state, other things being equal, the rate
of return in the economy and hence the rate of capital accumulation is inversely related to the initial per-capita stock of capital.\textsuperscript{6} Because of the diminishing returns to capital, the rate of per-capita accumulation of capital decreases as the stock of capital increases approaching the steady-state value. As a consequence, the further away an economy is from its own steady state in terms of per-capita income, the higher is the rate of growth predicted by the theory for this economy. This prediction is the basis of the concept of convergence.

In the simplest neoclassical growth model, the steady-state level of per-capita income is determined by the technology available, the rate of population growth, the depreciation rate and the savings rate. Therefore, only if a group of countries share the same technology, preferences and other relevant parameters, will their economies be expected to have the same long-run level of per-capita income or steady-state. In general, the level of technology can be affected by government policies and regulations that distort the markets and by the degree of integration with other economies with superior technology. The savings rate can be considered to be exogenous, or can be endogenously determined by the underlying preference parameters.\textsuperscript{7} After completing its transitional dynamics, an economy reaches its long-run level of per-capita income when the different per-capita variables start growing at the same constant rate of growth given by the rate of exogenous technological progress. At that point, the economy is said to be in its steady state, and its level of per-capita income is known to be the steady state level.\textsuperscript{8}

Consider a group of economics that because of cultural, political or physical proximity share the same steady-state value of per-capita income. The neoclassical model of growth predicts that the countries with lower initial levels of per-capita income will have higher rates of per-capita income growth. This is known as the absolute convergence hypothesis. Poorer economies will tend to converge or catch up to richer ones, in per-capita terms, if their economies differ only because of initial

\textsuperscript{6}See Sala-i-Martin (1994) for a discussion. For a more formal analysis of the concepts covered in this section, see Barro and Sala-i-Martin (1994).

\textsuperscript{7}The first case corresponds to the Solow-Swan model, while the second and more general is the Ramsey-Cass-Koopmans model.

\textsuperscript{8}In the simplest case, if the rate of exogenous technological progress is zero, the steady-state rate of growth of per-capita income is zero. In a more general case, the per-capita income keeps growing at the exogenous rate, and the rate of growth of per-effective worker income is zero.
conditions.

However, even the simplest of the neoclassical growth models, the Solow-Swan model, requires a restatement of this implication if all economies do not share the same steady state. In particular, if different countries have different saving rates, population growth rates, or different technologies, the theory only predicts that the rate of growth of per-capita income of a specific economy will be negatively related to the distance from its own steady-state.\(^9\) Different economies will close the gap between their actual state, measured as the level of GDP per capita, and their long-run steady-state at a rate that is proportional to the size of this gap. Notwithstanding, after controlling for differences in steady-states, it can be shown that economies with low initial levels of per-capita income will grow at a higher rate in per capita terms, than those with high initial levels. This concept is called conditional convergence after the revisions of the convergence hypothesis by Barro and Sala-i-Martin (1992), and Mankiw, Romer and Weil (1992).

The speed of convergence is an important parameter to be assessed, not only as a theoretical curiosity, but also because of its economic implications. A low speed of convergence implies that countries spend much of the time far away from their steady-states. A speed of convergence of 2.5 percent suggests that the average time that an economy spends to cover half of the distance to its steady-state is around 30 years. Therefore, medium-term growth rates will be dominated by the transitional dynamics, being only marginally affected by changes in the steady-state positions. In contrast, high speeds of convergence imply that economies spend much of the time in the vicinity of their steady-state. Therefore, short-run rates of growth are strongly affected by shocks to steady-states and by the long-term steady-state growth rate.

There have been many attempts to estimate the speed at which economies approach their steady-states in the empirical growth literature. Since Romer (1986) there is consensus on the absence of evidence in favor of the absolute convergence hypothesis at a global level. Regressions using large samples of countries show that rates of growth of per-capita income are usually positively correlated, with initial levels. There have been two approaches used to deal with the differences among steady-states across countries. The first one involves restricting the sample of economies to a group that, presumably, is homogeneous enough to share a common steady-state.

\(^9\)In models with endogenous determination of saving rates, different economies may differ in their preference parameters and discount rates.
In this case, we are measuring local absolute convergence. The second approach has been to deal with a cross section of heterogeneous countries, and control the estimation of the speed of convergence using a set of variables that proxy for the difference in the steady-state positions across countries. This is called the global conditional convergence.

Figure 6: Convergence Across the United States
(per-capita income growth: 1900-1980)

Following the local absolute convergence approach, Barro and Sala-i-Martin (1992), in their analysis for the contiguous 48 U.S. states, found a speed of convergence of around 2 percent per year. Figure 6 reproduces well-known graphical evidence from that paper of the convergence experienced by the continental U.S. states during this century. The figure shows that the poorest states at the beginning of the century, the Carolinas, Mississippi, Georgia and Alabama, have been growing on average twice as fast as richer states. Consequently, the dispersion of per-capita incomes across states has been dramatically reduced pair wise and absolutely. For example, while South Carolina, the poorest state, had 22.4 percent of the per-capita income of New York in 1929, by 1990 this ratio had become 71.8 percent. Mississippi was the poorest state in 1940. It had 22 percent of the per-capita income of Delaware, the richest state of America then. By 1990, Mississippi, still the poorest state, already had 50 percent of
the income of the richest state, now Connecticut. In 50 years, Mississippi has been able to reduce by half the distance that separates it from the richest states. Given the degree of cultural and economic integration among the different U.S. states, the convergence effect must be the main reason that Mississippi grew at a rate twice as high, on average, as that of the much richer Northeastern states during the last 50 years. Figure 6 is also useful illustration of the so-called convergence frontier. The imaginary line connecting North Carolina in the upper left of the figure and California in the lower right corner gives an approximate idea of the position that economies sharing the same convergence rate and steady-state level must have. Therefore, the fact that most states are aligned over this frontier gives an idea of the high degree of homogeneity displayed by the continental U.S. states.

Under the global conditional convergence approach, differences in steady-states across countries are controlled including, among others, the investment ratio to GDP, measures of distortions like government consumption and black market premium, measures of political instability, and measures of the quality and quantity of human capital. In a series of regressions using cross-sectional and pooled-panel approaches, the estimates obtained for the speed of convergence have fluctuated between 2.5 and 3 percent per year.\textsuperscript{10} A rate of convergence that fluctuates between 5 and 9 percent has been found in studies that apply econometric techniques that correct for unobservable differences across countries (i.e. individual effects) arising from differences in the technology available.\textsuperscript{11} The main finding of the cross-country empirical growth literature seems to be that there exists a global conditional speed of convergence ranging from the 2 or 3 percent per-year of the Barro estimates to the almost 10 percent recently obtained using dynamic panel techniques. The literature also suggests the existence of local absolute convergence of approximately the same magnitude in several regions.

The implication of these findings is that the speed of convergence has an

\textsuperscript{10}See Barro and Sala-i-Martin (1992), and Mankiw, Romer and Weil (1992) for cross-sectional studies, and Barro and Sala-i-Martin (1994), and Barro and Lee (1994a) for pooled-panel data approach.

\textsuperscript{11}Using the II-matrix approach Knight et al (1994) and Islam (1994) reported 5 percent for this parameter. In a recent study Caselli, Esquivel and Lefort (1994) apply a general method of moments estimator that takes care of individual effects and predetermined explanatory variables, obtaining a convergence rate of 9 percent. Evans (1994) also obtains 9 percent using a slightly different method.
important impact on the medium-term process of economic growth. Countries or states relatively homogeneous in their determinants of the steady-state, but differing in their initial conditions, converge towards each other thereby reducing their initial differences in per-capita income. The higher the speed of convergence, the faster this process will be. In a recent paper, Sachs and Warner (1995) point out that a sufficient condition for higher than average growth of poorer countries is that poorer economies follow reasonably efficient economic policies. They find strong evidence of convergence among those countries following open trade policies and with clear property rights.

In addition, for a given speed of convergence, increases in the steady state level of per-capita income at which an economy is converging will raise the per-capita income growth rate during the transition since this economy will have to cover a longer distance in the same time. For that reason, an economy that is able to increase its long-run steady-state per-capita income by improving the technology available, increasing the confidence of the public in its institutions, reducing market distortions, augmenting the quality of its labor force or opening its economy to a more developed region, will enjoy an increase in its average rate of growth due to the convergence effect.

4 Evaluating the Performance of Puerto Rico

In this section, I look at the data to evaluate the performance of the Puerto Rican economy when compared to the U.S. states, and to a sample of Latin American and Caribbean countries. In particular, I am interested in determining whether Puerto Rico is effectively closing the income gap with the U.S..

First I will provide some casual evidence in terms of relative measures of output between Puerto Rico, the U.S. and some Latin American and Caribbean nations. Secondly, I will present some more rigorous evidence in the form of growth regressions. Extending the work of Barro and Sala-i-Martin (1992), I will perform panel data regressions with a sample consisting of the 48 mainland U.S. states plus Puerto Rico and Hawaii for the period 1940 to 1990. The empirical evidence provided by these regressions shows that during this period, Puerto Rico clearly performed below the predicted growth rate implied by its initial level of per-capita income, even after controlling for with a standard set of control variables. Puerto Rico is the
only economy in the sample showing such a serious under performance. Interpreting these results in light of the neoclassical theory of growth, it is possible to argue that even though Puerto Rico narrowed in part the income gap with the U.S., it is not converging towards the per-capita income of the States. I will show some evidence that the political status of the island could be one of the reasons for this under performance. Finally, I will explain the economic growth displayed by the Puerto Rican economy in comparison to Latin American and Caribbean economies using a panel of countries.

4.1 Casual Evidence

A first exercise in order to evaluate the performance of Puerto Rico relative to other economies is to make pairwise comparisons of measures of output per-capita of different economies. I use GDP and GNP per capita measured at current international prices for Puerto Rico, the U.S.A. and a set of Latin American and Caribbean economies, obtained from the Penn World Tables version 5.6.

Figure 7 shows Puerto Rican current per-capita GDP and GNP as a percentage of the same measures for the U.S.. The figure clearly indicates that the Puerto Rican economy grew faster relatively to the American economy until 1972. Between 1955 and 1972, Puerto Rican per-capita GDP moved from 22 percent to 45 percent of American per-capita GDP. Per-capita GNP follows a similar pattern although less pronounced, increasing from 19 percent to 30 percent. The figure also shows that after 1973, the catch-up force has been practically inexisten when comparing GDP's, and it has been clearly reversed in terms of per-capita GNP. There is no clear signal that Puerto Rico is going to further reduce the output gap.

Is this the normal behavior of other economies in Latin America and the Caribbean basin? Figures 8 plot relative measures of current output per-capita for some Latin American and Caribbean countries relative to the U.S. and Puerto Rico. A quick look at figures 8, shows that most economies in the region have under performed both Puerto Rico and the U.S.. The exceptions are Dominican Republic and Chile from 1974 on. The case of Dominican Republic is especially interesting. In 1955, per-capita GDP in Dominican Republic was almost 50 percent of Puerto Rico's. From then on this ratio steadily decreased reaching less than 30 percent in 1973, as Dominicans became poorer relative to Puerto Ricans. However, from 1973 on a different picture emerges. Per-capita GDP has been growing slightly faster, in
average, in Dominican Republic. Dominican Republic per-capita GNP was around 27 percent of Puerto Rico’s in 1970 reaching 40 percent in 1990. The Dominican Republic has been clearly outperforming Puerto Rico since 1973. Interestingly enough, all along the postwar period, the Dominican Republic has been slowly increasing its per-capita GDP relative to the U.S..

When compared to other Latin American and Caribbean economies, the performance of the Puerto Rican economy is good in general. All the economies in the sample became poorer compared to Puerto Rico between 1955 and 1973. All of them show a quick recovery relative to Puerto Rico after the oil shock, indicating that the Puerto Rican economy was hit particularly hard by the oil shock. After the oil shock Puerto Rico reassumes the over performance relative to most economies in the sample although less aggressively.

In summary, Puerto Rico showed an outstanding catch-up effect in the early post-war compared to the U.S., over performing all other Caribbean and Latin American economies. However, since 1973 its rate of growth or per-capita output has decreased relative to other economies in the region, and there is no clear indication that it is being able of closing the income gap with the U.S. at the same speed it used to.