Taxes and Growth in Europe: 1885-1987

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1. Introduction

The total tax rate, calculated as the ratio of total tax revenue to Gross Domestic Product (GDP), has increased almost steadily over the last one hundred years in virtually all European countries, more than quadrupling or quintupling for some of them. During the same time, the growth rate of real GDP has been very volatile, following a complex pattern which can be divided in a number of phases (see for example Maddison, 1991). What has been the effect of the changes in the tax rate on real growth? Have higher taxes resulted in slower growth, a lower level of GDP, or both? These are the questions addressed in this paper.

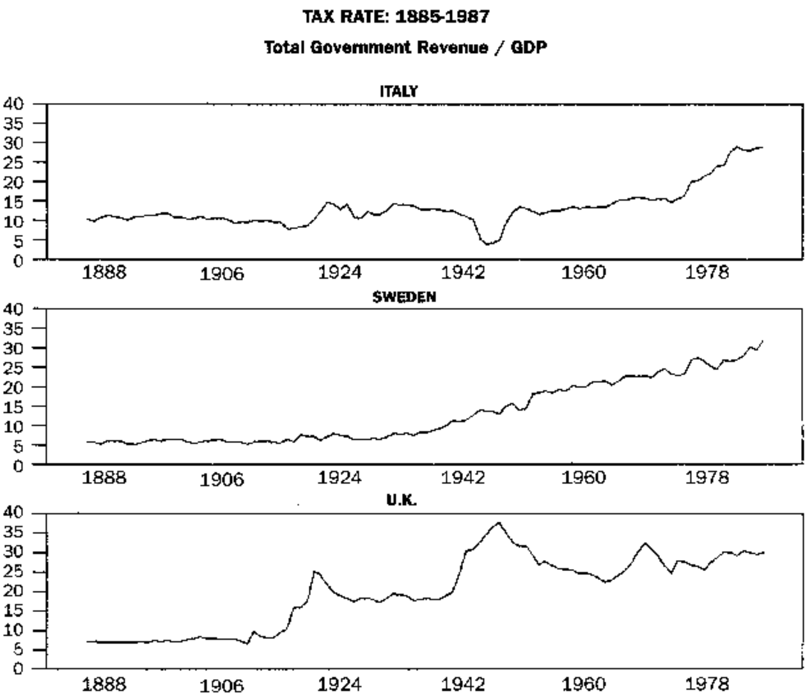
Theoretically, the answer to these questions depends on whether one accepts the neoclassical or the endogenous growth paradigm. In particular, the neoclassical growth model developed by Ramsey (1928), Solow (1956), and Cass (1965) predicts that permanent changes in the tax rate, while permanently changing the steady-state level of output per capita, will alter its growth only temporarily, having no permanent effect on the economy's steady-state growth rate. On the contrary, endogenous growth models, such as those proposed by Romer (1986, 1990), Lucas (1988), Rebelo (1991), and others, predict that tax-rate changes will permanently change the growth rate of per capita output.[1] The issue, therefore, has to be resolved empirically.

This is the goal of the present paper which investigates the effects of the tax rate on economic growth using data from the 1885-1987 period for a panel of three European countries: Italy, Sweden, and the United Kingdom. Real growth rates and tax rates have varied significantly across these countries and over time.[2] Over the entire 1885-1987 period the average annual growth rate of real GDP was 2.80% in Italy, 3.25% in Sweden, and 1.92% in the U.K., while the average total tax rate was 13.2% in Italy, 13.3% in Sweden, and 20.1% in the U.K. These average numbers, however, mask substantial variability over time which is indicated in Figures 1 and 2. Note that for all three countries total taxes as a fraction of GDP have increased almost steadily. In Italy, for example, the tax rate increased from about 10% in 1885 to almost 30% in 1987; in Sweden from less than 6% in 1885 to 32% in 1987; and in the U.K. from about 7% in 1885 to 30% in 1987. The evolution of the tax rate is clearly related to the two world wars in the U.K. where the rate jumps from 8% in 1913 to 25% in 1929, and from 19% in 1939 to 38% (its maximum value) in 1947. The effect of the second world war was somewhat different in Italy where tax revenue as a fraction of GDP fell from about 12% in 1939 and 1940 to 4% in 1945 and 1946. Still, as recently as 1974 the tax rate in Italy was only 15%, but then it almost doubled in a decade. Sweden has had a smoother experience than either Italy or the U.K., but we can still distinguish two major phases: (i) from 1885 to the late 1930s, when there was an almost constant single-digit tax rate, and (ii) from the late 1930s to 1987, when the tax

[1] The Appendix illustrates these different results for two simple versions of the neoclassical and endogenous growth models.

[2] Output is measured by GDP in constant prices, while the total tax rate is constructed by dividing total government revenue by GDP (both in current prices). The GDP data come from Liesner (1989) and the data on total government revenue from Mitchell (1980) and Mitchell(1992). Both the choice of countries and the sample period were dictated by data availability.

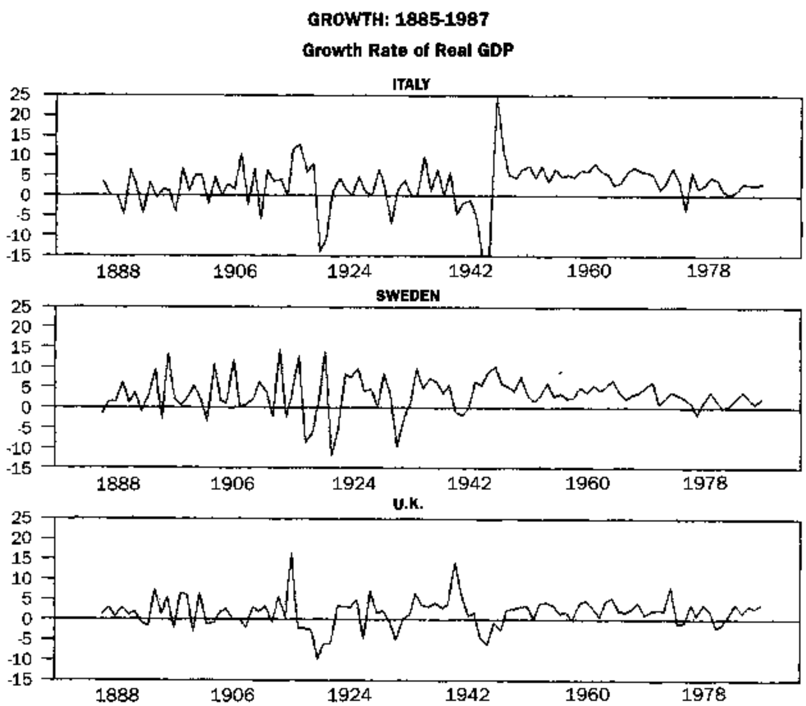
FIGURE 1 - Total Tax Rate, in percent: 1885-1987



rate was double-digit with a considerably steeper rate of growth. This marked variability of the tax rate both across the three economies and over time should facilitate an empirical identification of its role for real economic growth which, as shown in Figure 2, has also been quite volatile during the 1885-1987 period.

The rest of the paper is organized as follows. Section 2 investigates the time-series properties of the tax rate and the real growth rate in the three countries. It is shown that, consistent with Barro's "tax smoothing" hypothesis, tax rates have exhibited significant persistent changes. At the same time, output growth rates have not. This is inconsistent with the endogenous class of growth models. Section 3 uses a dynamic time-series model in order to

FIGURE 2 - Growth Rate of Real GDP, in percent: 1885-1987



estimate directly the permanent growth effect of an increase in the tax rate. The hypothesis that this effect is zero cannot be rejected for any of the countries. In addition, the effects of an increase in the tax rate on real growth are shown to be short-lived. This suggests that a change in the tax rate permanently alters the level of output but has no permanent effects on the output growth rate. This is consistent with the predictions of the neoclassical model but inconsistent with those of an endogenous growth model. Section 4 concludes.

2. Time Series Properties of Growth and the Tax Rate

Table 1 reports a number of unit-root tests for the real GDP growth rate and the total tax rate in each of the three countries.

TABLE 1 - Time-Series Properties of Real Growth and Tax Rates: *By Country*

A. Real GDP Growth Rates

		Trend				No Trend	
Country	**DF/PP**	**ADF**	**APP**	**δ**		**ADF**	**APP**
1. Italy	-9.36**	-6.36**	-9.34**	-0.05		-6.20**	-9.24**
2. Sweden	-10.40**	-5.95**	-10.46**	-0.03		-5.98**	-10.52**
3. U.K.	-8.52**	-5.03**	-8.58**	-0.08		-5.00**	-8.58**

B. Total Tax Rates

		Trend				No Trend	
Country	**DF/PP**	**ADF**	**APP**	**δ**		**ADF**	**APP**
1. Italy	-0.45	-1.54	-0.96	0.01		-0.20	0.30
2. Sweden	-1.62	-1.23	-1.37	0.20		2.17	1.87
3. U.K.	-1.74	-2.47	-2.14	0.08		-1.42	-1.27

Notes: The estimated model is $xt = \alpha + \delta t + \rho x_{t-1} + B(L)\Delta x_{t-1} + e_t$, where xal growth rate (g) in panel A, and the total tax rate (τ) in panel B. DF and PP are the standard Dickey-Fuller and Phillips-Perron tests for the null hypotesis $\rho = 1$; ADF and APP are the augmented versions with the lag length of B (L) set to two. The critical values for the model with the trend are -4.04 for the 1% level, -3.45 for the 5% level, and -3.15 for the 10% level; without trend ($\delta = 0$) the critical values are -3.51, -2.89, and -2.58, respectively. The "δ" column reports the estimated coefficient of the trend from the augmented model. Significance is denoted by ** (1% level), * (5% level).

Panel A of the table looks at the growth rates of real GDP. The first three columns contain the Dickey-Fuller (DF), augmented Dickey-Fuller (ADF), and augmented Phillips-Perron (APP) tests from models which include a linear trend, while the fourth column reports the estimated coefficient of the trend from the augmented version with two lags. For all three countries, the null hypothesis of a unit root in the real growth rate can be rejected at the 1% significance level. (Note that the estimated linear trends are negative but statistically insignificant.) In addition, this finding is robust to all specifications. Thus, the results from panel A of Table 1 suggest that the growth rates of real GDP in the three countries are stationary which means that changes in the growth rates are transitory.

Panel B of Table 1 repeats the same exercise for the total tax rate. What is striking now is the complete failure to reject the null of a unit root in any specification or test at the 1% or 5% levels. (Also note that the estimated deterministic trends are now all positive but again statistically insignificant). The results of Panel B strongly suggest, therefore, that the total tax rates in the eleven countries are non-stationary. Theoretically there is good reason to expect this result. Barro's (1979) well known "tax smoothing" hypothesis says that, if the marginal cost of raising tax revenue is increasing in the tax rate, the optimal tax rate (defined as the rate that minimizes the present value of the distortions due to the tax) is a random walk. Intuitively, just as the smoothing motive of consumers makes consumption a random walk (Hall, 1978), the smoothing of tax rates by the government makes the tax rate a random walk. Consistent with the prediction of the tax-smoothing hypothesis, panel B of Table 1 suggests that changes in the tax rates have been permanent.

Recall that endogenous growth models predict that permanent changes in the tax rate produce permanent changes in the real growth rate, so that a unit root in the tax rate should result in a unit root in real growth. We have shown, however, that, while the tax rates contain unit roots, the growth rates of real GDP are better characterized as stationary series. In other words, even though permanent changes in tax rates were shown to be prevalent, no such permanent changes were found in the growth rates of real GDP. Unless the timing of tax changes perfectly and always coincides with a permanent change in another variable that completely cancels out its effect on growth, this finding rules out endogenous growth mechanisms. It is consistent with the neoclassical model, however, which predicts that the effects of tax changes on growth are transitory, so that unit roots in tax rates do not introduce non-stationarity in the growth rates.

3. Long-Run and Short-Run Effects of Tax Rates on Growth

As Jones (1995) points out, an alternative way of testing whether changes in the tax rate permanently affect growth is by estimating a dynamic time-series model. We start with the specification

$$g_{j,t} = \mu_j + \delta_j t + A_j(L)g_{j,t-1} + B_j(L)\tau_{j,t} + u_{j,t},$$

where g is the growth rate of real GDP, τ is the tax rate, μ and δ are parameters, A(L) and B(L) are p^{th}-order polynomials in the lag operator L with roots outside the unit circle, and j and t index over countries and time, respectively. This specification can be rewritten as

$$g_{j,t} = \mu_j + \delta_j t + A_j(L)g_{j,t-1} + B_j(1)\tau_{j,t} + C_j(L)\Delta\tau_{j,t} + u_{j,t}, \quad (1)$$

where B(1) is a parameter equal to the sum of the coefficients of the polynomial B(L), and C(L) is a $(p-1)^{th}$-order polynomial whose coefficients are related to those of B(L) according to $c_k=-\Sigma^{p}_{s=k+1}b_s$. It follows that estimating B(1) in model (1) can be used to construct a test of the neoclassical versus the endogenous growth models. A finding of B(1)<0 implies that higher tax rates permanently reduce growth as suggested by the endogenous growth theories; on the other hand, B(1)=0 would imply that the tax rate has no permanent effect on growth, supporting the neoclassical model.

The results from the estimation of two versions of (1) for each of the three countries are reported in Table 2.[3] The first version ("Model 1" in the Table) imposes $\delta_i=0$, whereas the second version ("Model 2") includes the deterministic trend. While the point estimates of the B(1)s have generally the expected negative sign (the only exception being "Model 1" for Sweden), none of them is statistically significantly different from zero for any of the three countries. Thus, the hypothesis that B(1)=0 cannot be rejected. This is consistent with the neoclassical model's predictions and inconsistent with those of an endogenous growth model.

So far it has been determined that changes in the tax rate do not permanently alter the real GDP growth rate. This means that the

[3] All specifications of Table 4 are estimated for p=3 (polynomials of the 3rd order). The results are robust to different lag lengths.

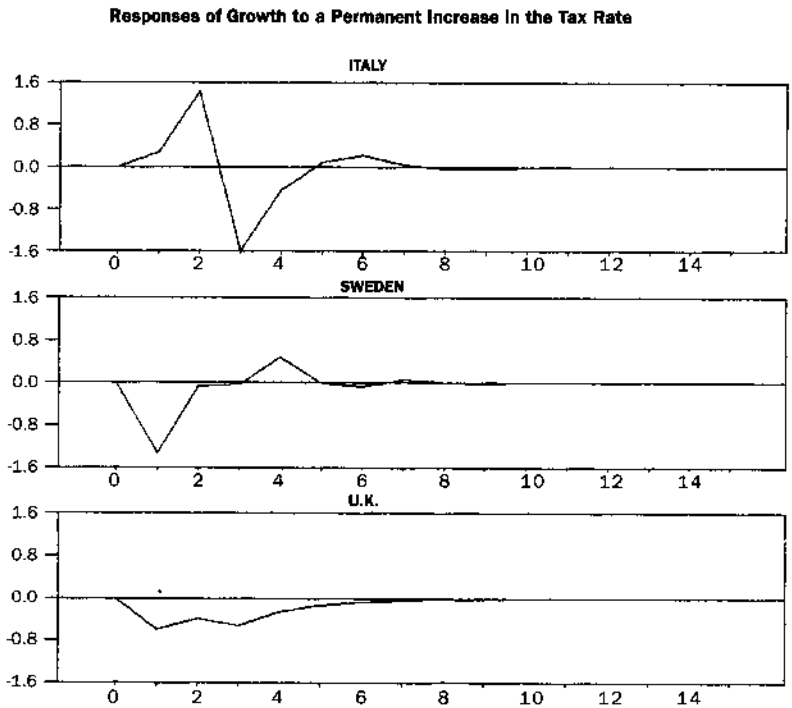
TABLE 2 - Long-Run Effect of the Total Tax Rate (τ) on Growth (g)

j		Model 1	Model 2
Italy	μ_j	3.347	3.811
		(2.380)	(2.360)
	δ_j		0.067
			(0.036)
	$B_j(1)$	-0.012	-0.309
		(0.175)	(0.233)
Sweden	μ_j	3.728**	3.578**
		(1.092)	(1.150)
	δ_j		0.020
			(0.048)
	$B_j(1)$	0.003	-0.066
		(0.065)	(0.172)
U.K.	μ_j	1.861*	2.176*
		(0.924)	(0.934)
	δ_j		0.047
			(0.028)
	$B_j(1)$	-0.014	-0.149
		(0.039)	(0.089)

Notes. Model 1: $g_{j,t} = \mu_j + A_j(L)g_{j,t-1} + B_j(1)\tau_{j,t} + C_j(L)\Delta\tau_{j,t} + u_{j,t}$.
Model 2: $g_{j,t} = \mu_j + \delta_j t + A_j(L)g_{j,t-1} + B_j(1)t_{j,t} + C_j(L)\Delta\tau_{j,t} + u_{j,t}$.
Estimated standard errors in parentheses below δ and B(1); Significance is denoted by ** (1% level), * (5% level).

effects of tax-rate changes on growth are transitory. In order to examine the magnitude and duration of these transitory effects, we estimate model (1) subject to the restriction B(1)=0 for each country, and simulate the response of the real growth rate to a permanent increase in the total tax rate by one percentage point. Figure 3 plots these responses for the three countries. The response patterns for Sweden and the U.K. are perfectly consistent with the theoretical predictions. In particular, a permanent increase in taxes by one percent of GDP reduces the real growth rate (by about 1.3% in Sweden and 0.6% in the U.K.) initially, and continues to keep growth below trend for the next few years, after which growth returns to trend. In the case of Italy the interpretation is more problematic: an increase in the tax rate is followed by an initial increase in the growth rate which does not begin to decline until

FIGURE 3 - Responses of Real GDP Growth Rate (in percent) to a Permanent Increase in the Tax Rate by one percent of GDP



three years later.[4] Nevertheless, it is readily seen from Figure 3 that the effects of the increase in the tax rate on growth are not just transitory, they are also short-lived.

Thus, the first implication of these simulated responses is that the effects of the tax rate on growth are exhausted very quickly: not only are there no permanent effects, but also the transitory ones are practically over in five or six years. The second implication, which can only be conclusively drawn for Sweden and the U.K., is that the

[4] This pattern for Italy suggests that the dynamic tax-growth model for this country may not have been identified properly. It may be interesting, however, to note that this results does not change when the investment rate is included in the model (see below).

cumulative effect of an increase in the tax rate on growth is negative. This suggests that, while a higher tax rate has no permanent effect on the real *growth rate,* it has a permanent negative effect on the *level* of real GDP. We note once more that this is exactly the response pattern predicted by the neoclassical model.

To investigate the robustness of these results, the dynamic model was generalized to include investment:[5]

$$g_{j,t} = \mu_j + \delta_j t + A_j(L)g_{j,t-1} + B_j(L)\tau_{j,t} + D_j(L)i_{j,t} + u_{j,t},$$

where i is the investment rate (calculated as the ratio of real gross fixed capital formation to GDP), and D(L) is a p^{th}-order polynomial in the lag operator L with roots outside the unit circle. This was estimated as

$$g_{j,t} = \mu_j + \delta_j t + A_j(L)g_{j,t-1} + B_j(1)\tau_{j,t} + C_j(L)\Delta\tau_{j,t} + D_j(1)i_{j,t} + E_j(L)\Delta i_{j,t} + u_{j,t}, \quad (2)$$

where D(1) is a parameter equal to the sum of the coefficients of the polynomial D(L), and E(L) is a $(p-1)^{th}$-order polynomial whose coefficients are related to those of D(L) according to $e_k=-\Sigma^{p}_{j=k+1}d_j$. The results are completely unaffected. In fact, not only are all the estimated B(1)s statistically insignificant as before, but so are the estimated D(1)s as well.[6] Consistent with our earlier results, this means that permanent changes in either the tax rate or the investment rate have no permanent effects on the growth rate, reinforcing our conclusion in favour of the neoclassical growth model.

5. Conclusions

This paper investigated the effects of the tax rate on economic growth in three European countries (Italy, Sweden, and the United Kingdom) since 1885. Theoretically, a permanent increase in the

[5] The investment data are obtained from Liesner (1989).

[6] The results with investment are not reported here to preserve space. All results are available on request.

tax rate will permanently reduce the real growth rate in an endogenous growth model, but not in a neoclassical model where growth will be affected only temporarily, the only permanent effect being a decrease in the steady-state level of output per capita. A number of different empirical specifications were shown to be consistent with the theoretical predictions of the neoclassical growth model and inconsistent with those of endogenous models.

Specifically, the paper's empirical results support the following conclusions. First, consistent with the tax-smoothing hypothesis, tax rates have exhibited significant persistent changes in the three countries, while output growth rates have not. This is inconsistent with endogenous mechanisms of growth. Second, for Sweden and the United Kingdom it was shown that a higher tax rate permanently reduces the level of output but has no permanent effects on the output growth rate. For the case of Italy, the permanent effect on growth was also zero, but the impact on the level of output was ambiguous. Overall, these findings suggest that the relationship between output and the tax rate is best described by the neoclassical growth model.[7]

The practical implications of such a conclusion cannot be underestimated. In terms of tax policy, the findings of this paper imply that a change in the tax rate will permanently alter the level of output per capita, but only temporarily affect its growth rate, while a tax cut will have symmetric effects. A corollary is that tax policies may be quite costly in terms of Gross Domestic Product but they cannot be blamed for any permanent "productivity slowdowns."

[7] This is consistent with the findings of Karras (1997) for a panel of 11 OECD economies during the 1960-1992 period. A similar consensus on the debate between neoclassical and endogenous models seems to be forming in another part of the literature which has relied on the implications of the two classes of models for convergence. For example, Mankiw, Romer, and Weil (1992) and Evans and Karras (1996), using different empirical methodologies, conclude that the evidence on the convergence of GDP per capita across economies is more consistent with the predictions of the neoclassical model. Evans and Karras (1996) also survey this literature.

Appendix

This appendix outlines a standard growth model which nests the neoclassical and endogenous classes of models in order to compare and contrast the theoretical relationships between the tax rate and the steady-state growth rate of output.[8] Suppose the representative household is infinitely-lived and has a CRRA utility function

$$\int_0^\infty [c_t^{1-\sigma}/(1-\sigma)]\, e^{-\rho t}\, dt, \qquad \text{(A1)}$$

where c is per-capita consumption, s the inverse of the elasticity of intertemporal substitution ($\sigma>0$), and r the rate of time preference ($\rho>0$). The goal is to maximize (A1) subject to the economy-wide constraint (in per capita terms)

$$\dot{k}_t = (1-\tau)y_t - c_t - (n+\delta)k_t, \qquad \text{(A2)}$$

where k is capital stock per capita, τ is the tax rate, y is output per capita, n is the population growth rate, δ the depreciation rate, and a dot over a variable denotes differentiation with respect to time.

Neoclassical models are based on the assumption that the production function is *neoclassical,* such as the Cobb-Douglas

$$y_t = A_t k_t^{\beta}, \qquad \text{(A3)}$$

where A_t is multifactor productivity, and $0<\beta<1$.[9] Letting g denote the constant steady-state growth rate of y and k (and c), the problem's first order condition requires

[8] It is emphasized that the model is presented for illustration purposes without pretensions of theoretical innovation. For more complex theoretical treatments see Blanchard and Fischer (1989) and Barro and Sala-i-Martin (1995).

[9] A *neoclassical* F has positive and diminishing marginal products, and exhibits constant returns to scale. See Barro and Sala-i-Martin (1994, section 1.2.1) for the full definition.

$$\beta(1-\tau)A_t k_t^{\beta-1} = \rho+n+\sigma g. \qquad \text{(A4)}$$

Taking logarithms and differentiating with respect to time, the steady-state growth rate is given by

$$g = \alpha/(1-\beta), \qquad \text{(A5)}$$

where $\alpha \equiv \dot{A}_t/A_t$ denotes the exogenous growth rate of multifactor productivity. It is clear from (A4) that an increase in τ will reduce the steady-state capital stock per capita, and thus output per capita. At the same time, (A5) implies that a higher τ will have no effect on the steady-state growth rate: the steady-state output path shifts downward, but in a parallel fashion preserving its slope.

The simplest way to generate an endogenous model is to write the production function as

$$y_t = Ak_t, \qquad \text{(A6)}$$

where A is a constant.[10] The first order condition now gives $(1-\tau)A=\rho+n+\sigma g$, or

$$g = [(1-\tau)A-\rho-n]/\sigma. \qquad \text{(A7)}$$

This implies that an increase in t will not just reduce the steady-state capital stock and output per capita, but will also reduce their steady-state growth rates. A higher t makes the steady-state output path flatter.

[10] This is the so called "AK" model. See Rebelo (1991).

REFERENCES

BARRO ROBERT J., "On the Determination of the Public Debt." *Journal of Political Economy*, 87, (1979), pp. 940-971.

BARRO ROBERT J. and XAVIER SALA-I-MARTIN, *Economic Growth*. (McGraw-Hill, New York 1995).

BLANCHARD OLIVIER J. and STANLEY FISCHER, *Lectures on Macroeconomics*, (MIT Press, Cambridge 1989).

CASS DAVID, "Optimum Growth in an Aggregative Model of Capital Accumulation." *Review of Economic Studies*, 32, (1965), pp. 233-240.

DICKEY D.A. and W.A.FULLER, "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root." *Econometrica*, 49, (1981), pp. 1057-1072.

EVANS PAUL and GEORGIOS KARRAS, "Convergence Revisited." *Journal of Monetary Economics*, 37, (1996), pp. 249-265.

JONES CHARLES I., "Time Series Tests of Endogenous Growth Models." *Quarterly Journal of Economics*, 110, (1995), pp. 495-525.

KARRAS GEORGIOS, "Taxes and Growth: Testing the Neoclassical and Endogenous Growth Models." *Contemporary Economic Policy*, forthcoming, 1999.

LIESNER THELMA, *One Hundred Years of Economic Statistics*, (The Economist Publications, 1989).

LUCAS ROBERT E. JR., "On the Mechanics of Economic Development." *Journal of Monetary Economics*, 22, (1988), pp. 3-42.

MADDISON ANGUS, *Dynamic Forces in Capitalist Development*. (Oxford University Press, 1991).

MANKIW N. GREGORY, DAVID ROMER and DAVID N. WEIL, "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics*, 107, (1992), pp. 407-438.

MITCHELL B.R., *European Historical Statistics: 1750-1975*, (2nd revised edition, Facts on File 1980).

MITCHELL B.R., *International Historical Statistics. Europe: 17501-1988*, (3rd edition, Stockton Press 1992).

PHILLIPS PETER C.B. and PIERRE PERRON, "Testing for a Unit Root in Time Series Regression." *Biometrika*, 75, (1988), pp. 335-346.

RAMSEY FRANK, "A Mathematical Theory of Saving." *Economic Journal*, 38, (1928), pp. 543-559.

REBELO SERGIO, "Long-Run Policy Analysis and Long-Run Growth." *Journal of Political Economy*, 99, (1991), pp. 500-521.

ROMER PAUL M., "Increasing Returns and Long-Run Growth." *Journal of Political Economy*, 94, (1986), pp. 1002-1037.

ROMER PAUL M., "Endogenous Technological Change." *Journal of Political Economy*, 98, (1990), pp. S71-S102.

SOLOW ROBERT M., "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics*, 70, (1956), pp. 65-94.