Can government policies increase national long-run growth rates?

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Abstract

We obtain time series estimates of the long run growth rates of 17 OECD countries, and test the hypothesis that these are the same across countries. We find that we cannot reject this hypothesis for the first and last three decades of the 20th century. We conclude that: (i) there are few, if any, feasible policies available that have a significant effect on long run growth rates, and; (ii) any policies that can raise national growth rates must be international in scope. The results therefore have bleak implications for the ability of countries to affect their long run growth rates.

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1 Introduction

Following the growth models of Romer (1986) and Lucas (1988), there is a substantial amount of theoretical evidence to suggest long run national growth rates respond to a range of economic variables. These theories contrast sharply with the neo-classical view, in which long run growth rates are largely independent of economic policies (Mankiw, Romer and Weil (1992) and Parente and Prescott (2000) and Hall and Jones (1999)).

Both views enjoy some support from empirical studies where a broad array of potential explanatory variables are considered across 100 or more countries. Many of the variables in these studies, however, are not especially relevant to policy makers in developed market economies.[1] Thus a recent, but rapidly growing literature has emerged, that focuses on the sources of differences in growth rates among the set of relatively developed economies, such as the G7 and OECD.[2] Indeed, since much of the theoretical endogenous growth literature is explicitly concerned with policies such as R&D subsidies, patent protection and taxation, and is calibrated using G7 or US data, it is appropriate that these theories also be tested in sub-samples of developed market economies.[3]

Following this recent literature, therefore, we ask whether the differences in economic policies that exist among the set of developed market economies, have any observable impact on their relative long run growth rates? Moreover we propose a particularly parsimonious approach to obtaining an answer. Using Maddison's (1995) long run data,

[1] For example, Barro and Lee (1994) include measures of political instability and life expectancy among their explanatory variables. While these are interesting from an economic development perspective, they are not part of the usual portfolio of policy options facing policy makers of developed market economies.

[2] For example Bassanini and Scarpetta (2002) find evidence that human capital has a significant impact on growth rates in OECD economies, and Guellec and de la Potterie (2001), find similar evidence for R&D policies. Other recent OECD studies that tend to support these results include Bassanini, Scarpetta and Hemmings (2001), Scarpetta, Bassanini, Pilat and Schreyer (2000) and Bassanini, Scarpetta and Visco (2000). Similarly Kneller, Bleany and Gemmell (1999) provide evidence that financial policies can affect long run growth rates in OECD countries. A much more cautionary survey of the relationship between human capital and growth, in these countries, consistent with the findings herein, is Temple (2001).

[3] For example see Caballero and Jaffe (1993), Pecorino (1993), Stokey and Rebelo (1995) and Howitt (1999).

we estimate the mean growths rates for each country and then use the estimated error variance to test whether the differences in growth rates are significant. If the alternative policy mixes employed across countries have had significant effects on long run growth rates, we should be able to reject the hypothesis that mean growth rates are the same across countries.

From a policy perspective our results are stark. We find that for the first and last three decades of the 20th century, we cannot, at any reasonable level of confidence, reject the hypothesis that all the countries were on identical balanced growth paths. Thus, except for the decades around WWII, we find no evidence of country specific effects on long run growth rates. This implies that the policies chosen, among the range of feasible policy alternatives, had no consequences for each countries long run growth rates. The only exception to this is if the impact of the policies is international in scope, for example via large and ubiquitous technology spill-overs. In either case the results suggest that that the growth rate is primarily determined by international factors, and that the range of feasible policies for increasing the long run growth rate, is very limited.

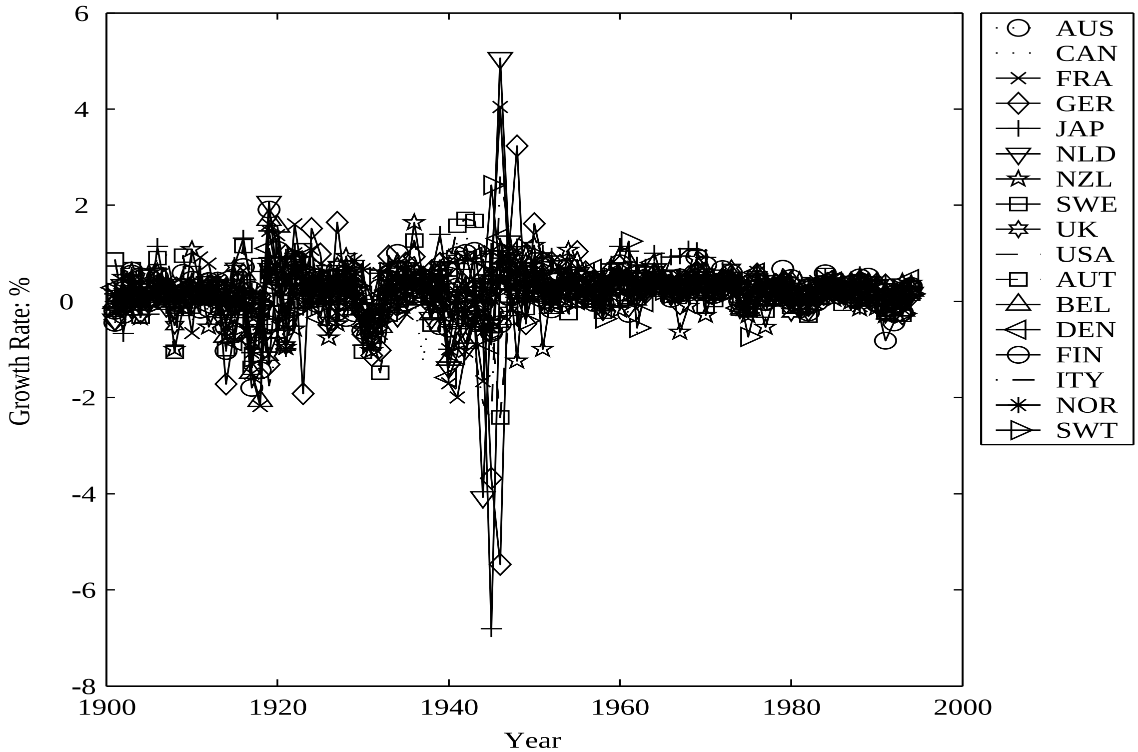
2 The Data

By way of previewing our main results, it is instructive to consider a visual inspection of the data.[4] The data, denoted y_{it}, used is annual real GDP per capita for the period 1900 until 1994, for 17 OECD countries. Figure 1 shows the first differences of this data in logarithms, $\Delta \ln y_{it}$.

It can be seen that each series has a non-zero mean for each country in our sample, and hence the data is either trend or difference stationary. For each country, we therefore use an augmented Dickey-Fuller (ADF) test to determine whether the non-stationarity

[4] The data is from (Maddison 1995) and is measured in 1990 Geary-Khamis dollars. Table 1 gives a list of countries in the sample.

Figure 1: Growth Rate of Real GDP:1901-1994



present in the data is due to the presence of a unit root or a time trend. The results of these tests, given in Table 1, show that for all countries, a unit root for $\ln y_{it}$ cannot be rejected.

It is, however, not easy to compare the mean growth rates directly from the time series plots of $\Delta \ln y_{it}$ in Figure 1. To compare the means and distributions across countries therefore, we report statistical boxplots of the data. These compare the distributions of annual growth rates for each country over the sample time period, 1900-1994[5]. Because there were large disparities in the growth rates in the middle of the century, we break the sample up into two periods: Period I which includes the years 1901-1939 and 1960-1994, and Period II which includes the years 1949-1960. The resulting boxplots are given in Figures 2 and 3. The country indexes are reported in Table 1.

[5]The boxplots report the interquartile range (IQR), the sample median and the minimum and maximum value. If any observation is less than $2 * IQR$ below the first quartile or more than $2 * IQR$ from above the third quartile it is regarded as an outlier and depicted with a '+'.

Table 1: Summary of Augmented Dickey-Fuller Results

Index	Country	t-stat	Lag Length
1	Australia (AUS)	-1.97	1
2	Canada (CAN)	-0.12	1
3	France (FRA)	-1.78	2
4	Germany (GER)	-2.33	4
5	Japan (JAP)	-1.51	2
6	Netherlands (NLD)	-2.20	2
7	New Zealand (NZL)	-2.09	1
8	Sweden (SWE)	-1.90	1
9	United Kingdom (UK)	-2.08	3
10	USA (USA)	-2.80	1
11	Austria (AUT)	-2.04	1
12	Belgium (BEL)	-1.83	1
13	Denmark (DEN)	-2.02	2
14	Finland (FIN)	-2.43	1
15	Italy (ITY)	-1.91	1
16	Norway (NOR)	-1.88	1
17	Switzerland (SWT)	-1.91	1

It can be seen from Figure 3 that the in the first and last part of the 20th Century, there is substantial overlap of of the interquartile range (IQR) of the growth rates for each country. There is substantially less overlap, however, for the middle part of the century, 1949-1960. Thus, while it is not at all clear that the distribution of growth rates are the same across countries, the data show that aside from the period around WWII, the hypothesis is plausible and deserves further investigation. This leads us to formally testing for equality of growth rates, and in particular, equality of mean growth rates across the countries in our sample.

In the reminder of the paper we first describe how we proceed to obtain a more formal test for equality of mean growth rates for the countries in our sample. In particular, we control for serial correlation in the data using a simple autoregressive structure and control for cross-country heteroscedasticity using a seemingly unrelated regressions framework. We then offer a discussion of the results and relate out findings to the existing literature.

Figure 2: Distribution of Growth Rates by Country: 1901-1994

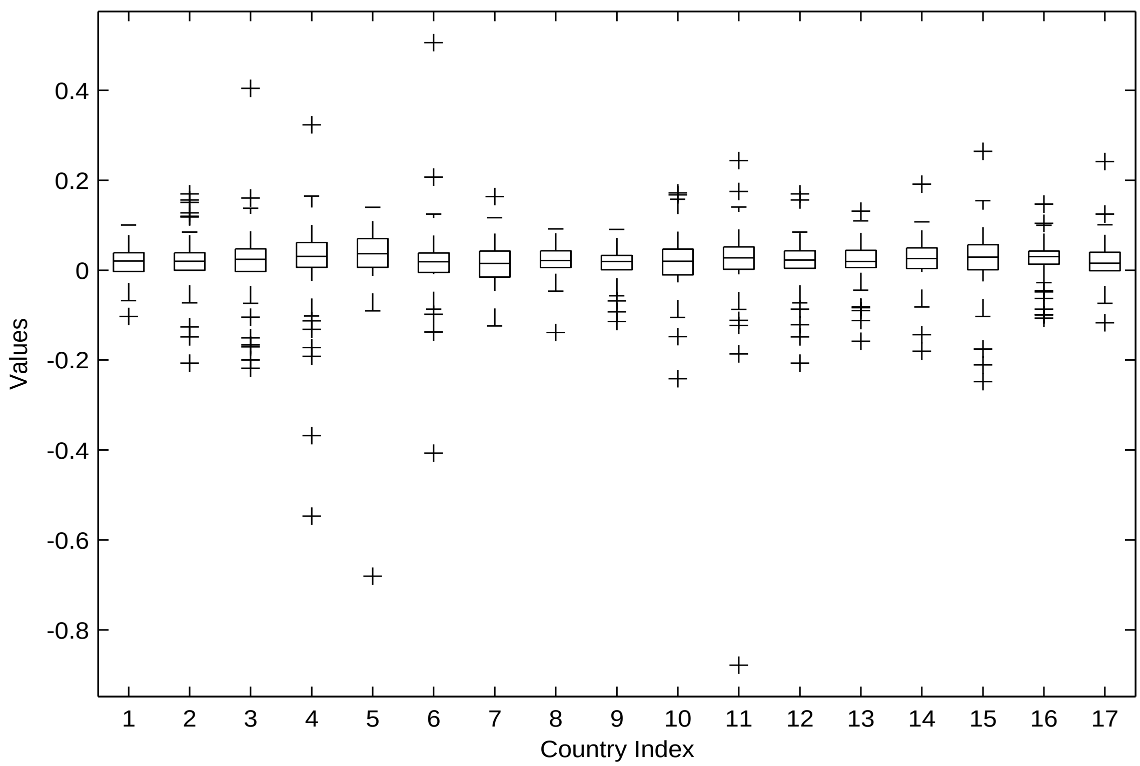
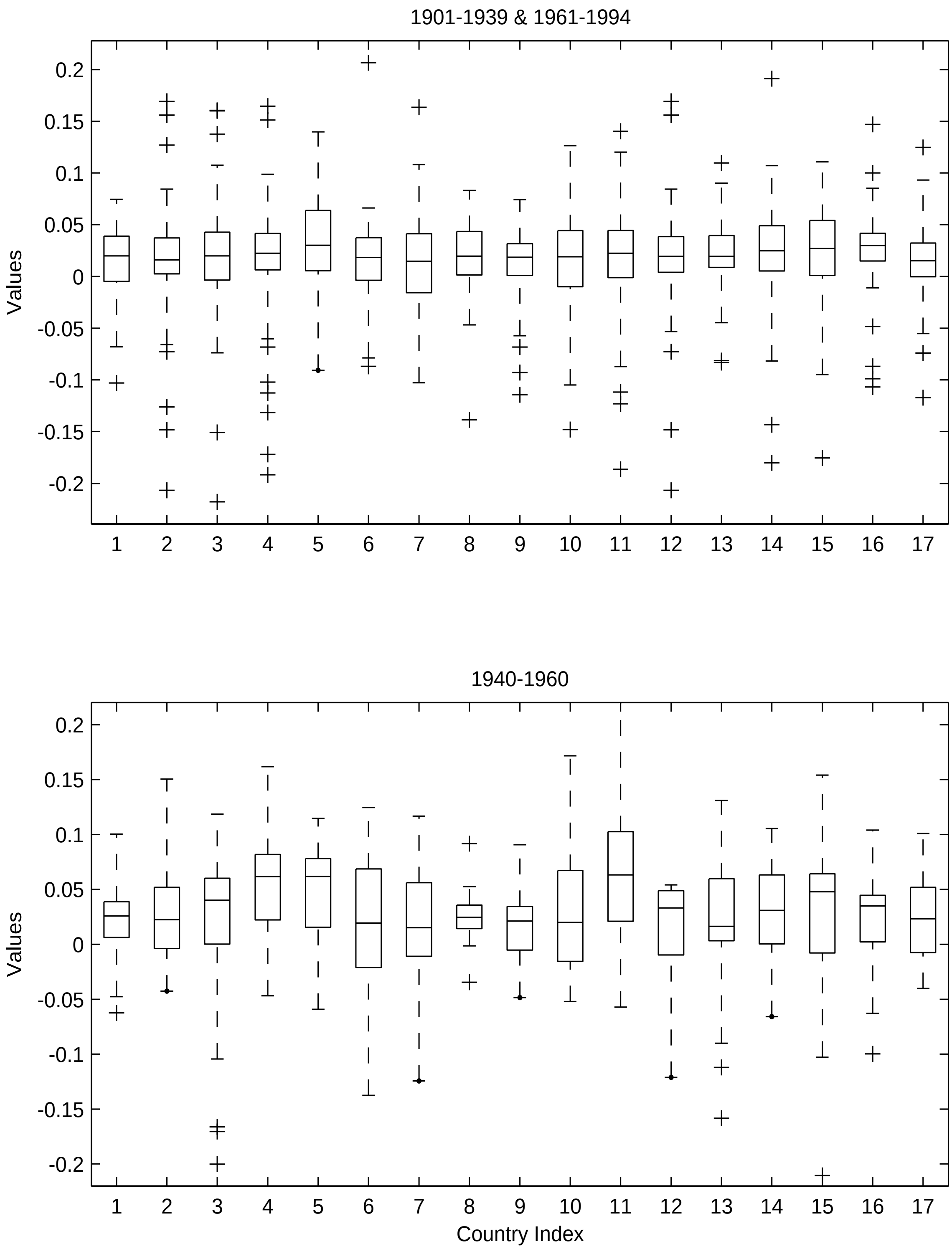


Figure 3: Distribution of Growth Rates by Country: Subsamples



3 Estimating the Trend Growth Rate

3.1 Serial Correlation and Persistence

An important limitation of the preceding visual inspection of the data is that we have not allowed for serial correlation that is present in the data. In practice we expect the time path of $\ln y_{it}$ to exhibit some persistence in response to economic shocks. In particular Mankiw et al. (1992) estimate the rate of convergence to the balanced growth path (hereafter the rate of β convergence) to be approximately 3% per year.[6] This implies that the half life of a deviation from trend is 24 years. Such strong persistence will make it difficult to obtain accurate estimates of the balanced path growth rate from observations of GDP per worker over time.

Nevertheless, recent panel data studies by Knight and Villaneuva (1993), Islam (1995), Caselli, Esquivel and Lefort (1996), and Lee, Pesaran and Smith (1997) find much faster rates of β convergence. These estimates range from 10-30% per year, implying half lives between 2 and 7 years. Similarly, using time series data, Jones (1995) finds that GDP in OECD countries exhibits very little persistence. [7]

Further, fast convergence rates are predicted by open economy growth models, such as Foley and Sidrauski (1970). For example, Barro and Sala-i Martin (1995) show that these models generate convergence rates of 10% and higher, when they are calibrated so that the the shadow price of capital equals observed ratios of firms market value to capital stock.[8] Since the countries in our sample are best characterized as open economies, we expect *a priori* that deviations of GDP per capita from its balanced growth path, exhibit

[6] This finding is also predicted by closed economy neo-classical growth models, where the capital share is interpreted broadly to include human capital.

[7] Also see Cook (2002) who obtains estimates of convergence rates of 0.4-0.6%.

[8] The key parameters in these models is the adjustment costs elasticities of capital and investment. See Brainard and Tobin (1968) for a discussion of the interpretation of the shadow price of capital and Tobin's q. Similarly, Landon-Lane and Robertson (2001) show that fast convergence rates are predicted for these models for wide ranges of values of these parameters and for broad values of the capital share.

little persistence.

One approach to thinking about the persistence of deviations of growth rates from their long-run trend is via an error correction model. The error correction model can be represented as an infinite order autoregressive model whose coefficients, due to the stationary nature of the growth rate data, converge to zero as lag length grows. The infinite order autoregressive model will be approximated by a finite order autoregressive model of the following form:

$$\Delta \ln y_{it} = \varphi_{i,0} + \sum_{j=1}^{P_i} \varphi_{i,j} \, \Delta \ln y_{i,t-j} + \epsilon_{it}, \tag{1}$$

where P_i is the finite lag length, and Δ represents the first difference operator.[9] If convergence rates are fast, the magnitude of the autoregressive parameters, will quickly converge to zero. Hence (1) will be a good approximation to the an infinite autoregressive process, even for small values of P_i. Equation (1) can therefore be regarded as describing the growth rate of a range of endogenous and exogenous growth models that exhibit a trend with some persistence in deviations from the trend. Assuming that $\Delta \ln y$ is stationary, the unconditional mean growth rate is

$$\mu_i = \frac{\varphi_{i,0}}{1 - \sum_{j=1}^{P_i} \varphi_{i,j}}. \tag{2}$$

If there has been no change in the parameters that determine the balanced growth path, then μ_i will simply equal the balanced path growth rate. In particular, using the neoclassical growth model, we can interpret μ_i as the rate of labour augmenting technological progress.

[9] A note containing a formal derivation of (1) from a general error correction growth model is available from the authors upon request.

3.2 Trend Breaks

A second issue to consider is the possibility of breaks in the trend growth rate. It is apparent that the balanced paths of the countries in our sample will not have been constant over the entire 20th Century. In particular previous studies, such as Ben David and Papell (1995), have found evidence of trend breaks in the growth rate for a similar sample of countries.[10] In view of this we begin by estimating the growth rate for relatively small periods of 15 years each. We then test whether consecutive 15 year periods can be aggregated into longer periods.

Thus, in order to obtain estimates of μ for particular subsamples, (1) is modified to include dummy variables for each subsample. That is, for country i, if there are N subsamples, (1) becomes

$$\Delta \ln y_{it} = \sum_{k=1}^{N} \delta_{ik} D_{kt} + \sum_{j=1}^{P_i} \varphi_{i,j} \, \Delta \ln y_{i(t-j)} + \epsilon_{it} \tag{3}$$

and the growth rate for subsample k is

$$\mu_i^k = \frac{\delta_{ik}}{1 - \sum_{j=1}^{P_i} \varphi_{i,j}}. \tag{4}$$

Note that this assumes that only the trend growth rate changes between the different subsamples so that the persistence properties remain unchanged over the whole sample.

3.3 Testing for the equality of μ across countries

In estimating (1) or (3) we also need to account for any cross-sectional heteroscedasticity and contemporaneous correlation. We therefore use the seemingly unrelated regression

[10] These center on WWI and WWII for war affected countries, and in the late 1920's for non war affected countries.

(SUR) estimator of Zellner (1962).[11] The system is estimated using iterated feasible generalized least squares (IFGLS), and value of the lag length P_i is chosen to minimize Akaike's Information Criterion.

We then consider whether the trend growth rates, μ_i, are equal across countries. For a given time period the null and alternative hypotheses are

$$H_0 : \mu_1 = \mu_2 = \ldots = \mu_{17} \quad v. \quad H_A : \; \mu_i \neq \mu_j \text{ for some } i \neq j. \tag{5}$$

The null hypothesis is then tested using a non-linear Wald test.

4 Results

As anticipated, the test for equality of growth rates between the countries in our sample was rejected for the whole period, 1904-94. The Wald statistic, reported in Table 2, was 29.46 with a p-value of 0.021, and hence the null can be rejected the 5% level. Next we allow for trend breaks. We therefore divide the sample into six periods of approximately 15 years each, and estimate (3) for each period. If H_0 cannot be rejected for two consecutive periods, we then test whether the value of μ is constant across the adjacent time periods. We then aggregate these adjacent periods where when we cannot reject the hypothesis that μ is the same across time.[12] This leads us to consider whether the hypothesis of a common μ across countries can be rejected for two periods of approximately three decades each, 1904-30 and 1961-94. The definitions of the final sub-periods used and the results from the non-linear Wald tests can be found in Table 2 below.

It can be seen that for these thirty year periods, where the trend growth rate appears

[11] The hypothesis of a diagonal covariance matrix is rejected. The Breusch-Pagan LM test statistic for a diagonal covariance matrix is 1186.1 and is distributed as χ^2 with 136 degrees of freedom.

[12] The results for these 15 years periods are given in Appendix A, Table A.1.

Table 2: Results from Wald Tests for equality of growth rates

Period	Years	Wald Statistic	Degrees of Freedom	p-value
Test for Whole Sample				
	1904-1994	29.46	16	0.021
Tests within sub-periods				
I	1904-1930	15.27	16	0.504
II	1931-1945	45.18	16	0.000
III	1946-1960	33.71	16	0.006
IV	1961-1994	15.76	16	0.470
Tests between sub-periods				
	I and II	60.59	33	0.002
	II and III	85.73	33	0.000
	III and IV	49.65	33	0.032
	I and IV	39.18	33	0.212

to be constant for each country, we cannot reject the hypothesis that μ is the same across countries. For both periods the probability of falsely rejecting the null hypothesis is approximately 50%. Hence for these periods, 1904-1930 and 1961-1994, we find no significant difference in the trend growth rates of these 17 countries.

Finally we note that there is strong evidence that the sub-samples cannot be aggregated further, since the tests for equality of growth rates between the adjacent periods are all rejected at the 5% level.[13] Thus these intervening years mark a clear break from the parallel growth paths at the start and end of the century. Interestingly, the third panel of Table 2 also shows that we cannot reject the hypothesis that the common value of

[13] Jones (1995) and Ben David and Papell (1995) conduct tests for differences in mean growth rates on a country by country basis. Jones (1995) finds no evidence for a shift in the mean growth rate for the USA, but does find evidence of a mean shift in other OECD countries. Ben David and Papell (1995) similarly find evidence of a shift in the mean growth rate for their sample, including the USA.

μ across countries for period IV (1961-1994) was the same as the common value across countries for period I (1904-1930). Thus we cannot exclude the possibility that each country has returned to the same balanced growth path that they began on at the start of the century. Certainly we find little evidence that the trend rate increased or decreased over the century.

5 Interpretation and Discussion

In contrast to much of the existing empirical growth literature, we have not attempted to determine the significance of any particular explanatory variables. Rather, we have asked a more fundamental question - are the measured differences in growth rates are statistically significant? Our finding is that they are not significant for most of the last century, excluding only the WWII and post war recovery periods. This leads us to question whether any relevant policy alternatives can place a country on a higher growth path than other countries at similar levels of development.

To see this consider the broad alternative policy implications of countries having the same long run growth rates. The possible explanations are that either: (i) there are no politically feasible policies that can increase the national long run growth rate; (ii) some feasible long run growth policies exist, but they were not implemented by any of the countries in our sample; (iii) some feasible national long run growth policies exist, but these were all implemented by all countries, or; (iv) that any feasible national long run growth policies, have equivalent effects on international growth rates, through, for example, knowledge spill-overs and externalities from internationally traded capital goods.

Of these possibilities, (ii) seems the least plausible. It is likely that if any politically feasible growth strategies existed, they would have been undertaken by some government.

The alternative, given in (iii), is that all the countries in our sample adopted the same long run growth policies. If we rule out coincidence, this implies that there were no politically feasible alternatives to these decisions. For example, radical tax reform might potentially increase growth, but this is not on the political agenda of the countries in our sample.[14] Thus (i), and (iii) lead to the conclusion that there were no feasible alternative policies that would have increased national growth rates.

The qualification to this conclusion is given by (iv). If some of the different policy packages employed across countries did affect domestic growth rates, the results imply that these must have had similar impacts on other countries in the sample. For example, policies that affect the rate of scientific research and the creation of new knowledge, might also generate substantial international knowledge and productivity spill-overs. The range of domestic factors that have such a strong international consequences, must be limited however. For example, this may be a plausible description of the effects of the level of subsidies to basic science in in large countries, such as the USA. For small economies such, as Australia, New Zealand or Switzerland however, it is less plausible.

A second implication of our results relates to the convergence and catch-up hypotheses. The results do not contradict previous studies that find that "catch-up" in income levels occurred over last century, for many of these countries, (Baumol 1986). Specifically we reject the hypothesis that the trend growth rate was the same for each country, from 1904-1994. Our results show, however, that catch-up was not steady, but was centered on the middle of the century around WWII. This is consistent with Ben David and Papell ((1995) and (2000)), who estimate trend breaks for OECD countries individually.[15] Since catch-up appears to be a result of a trend break however, it is likely that exogenous political and social changes, rather than economic policy, may have been important factors in determining the timing and extent of catch-up.

[14] Similarly, consider radical but inegalitarian education reforms.

[15] Time series tests of convergence, such as Bernard and Durlauf (1995) find evidence of convergence among some pairs of countries only. See Durlauf and Quah (1999) for a survey of these results.

Finally we consider the relationship between these findings and other empirical growth literature. Our results indicate that each countries balanced path growth rate primarily determined by international, rather than domestic factors. They therefore provide compelling empirical support for recent models that emphasize the importance of international links in determining productivity growth, such as Eaton and Kortum (1996), Parente and Prescott (2000) and Acemoglu and Ventura (2001). They are also consistent with Jones (2002), who shows that the USA growth rate has been approximately constant over the post war era, despite a very large expansion of research sectors in the USA and the G5 countries.[16]

The results do not necessarily contradict models in which domestic policy choices can explain the cross sectional variation in growth rates. As emphasized in the introduction, they suggest that among developed market economies, the differences in education attainment and R&D spending are not large enough to have a significant effect on their relative growth rates. Hence these models appear to be less relevant to developed market economies and more relevant to issues facing developing economies.

6 Conclusion

Many growth theories suggest that domestic policy choices are an important determinant of national long run growth rates. Empirical support for these theories is mixed however. We have considered an alternative empirical test that sets a minimum standard for any theory of growth relating domestic policy to national long run growth rates. By estimating the trend growth rates of 17 OECD countries, we found that for the first three

[16]The finding of parallel growth paths also complements Evans (1998), who finds that GDP from 1900-1994 among these countries is co-integrated. In contrast to Evans (1998), however, our results do not reject the long run convergence hypothesis across the entire sample of countries in Maddison's data. Moreover, our findings can be viewed as support for the premise of the Solow (1956) and Swan (1956) model. They also provide additional evidence against the existence of scale effects as a determinant of the long run growth rate, at the national level. See also Jones (1999).

and last three decades of the century, the hypothesis that the trend growth rates are the same across countries, cannot be rejected at any reasonable level of confidence. Thus, except for the decades around WWII, there is no evidence of country specific effects on long run growth rates.

The results therefore have stark implications for the ability of most countries to determine their own long run growth rates. The many policy packages used across these countries, including differences in tax, research, education and investment, did not have significant long run effects on relative growth rates. We conclude therefore that long run growth rates are determined by international factors, and are insensitive to national policies, especially for small countries. This implies severe restrictions of the ability of most governments to increase national long run growth rates. Nevertheless our results provide empirical support for a number of recent growth models that have emphasized the importance of international links in determining national productivity growth.

A Test Results for 15 year samples

Table A.1: Wald Tests for equality of μ: 15 Year Periods

Period	Years	Wald-statistic	Degrees of Freedom	p-value
Tests within sub-periods				
1	1904-1915	11.46	16	0.781
2	1916-1930	16.31	16	0.432
3	1931-1945	46.09	16	0.000
4	1946-1960	33.55	16	0.006
5	1961-1975	12.29	16	0.717
6	1976-1994	11.73	16	0.762
Tests between sub-periods				
	1 & 2	27.93	33	0.718
	3 & 4	85.90	33	0.000
	5 & 6	26.17	33	0.794

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