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The great wars, the great crash, and steady state growth: Some new evidence about an old stylized fact

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Abstract

The 'stylized fact' that growth rates remain constant over the long run was a fundamental feature of postwar growth theory. Using recently developed tests for structural change in univariate time series, we determine whether, and when, a break in growth rates exists for 16 countries. We find that most countries exhibited fairly steady growth for a period lasting several decades, terminated by a significant, and sudden, drop in GDP levels. Following the break, per capita output in most countries continued to grow at roughly double their prebreak rates for many decades, even after their original growth path had been surpassed.

Key words: Long-term economic growth; Structural change

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1. Introduction

One of the fundamental 'stylized facts' that characterized postwar growth literature is that output grows 'at a steady trend rate', both in aggregate and per

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worker terms (Kaldor, 1961). This feature is one of the prominent characteristics of the Solow (1956) neoclassical growth model. Three decades later, the endogenous growth literature, starting with Romer (1986), has shown that growth rates need not be constant and they may actually increase over time.

Empirical research on this issue has not provided a clear choice between the endogenous and neoclassical growth models. Abramovitz (1989) uses moving average computations to smooth business fluctuations and concludes that U.S. aggregate and per capita growth rates exhibited a slowdown between 1870 and 1953. Romer (1986), on the other hand, calculates 40-year annual averages in his analysis of the United States and finds increases in the rates of growth between 1840 and 1978.[1] The analysis in this paper differs from both the Romer and Abramovitz studies in that it does not use broad averages based on arbitrary period lengths to determine the long-run behavior of growth rates. Instead, the methodology employed here utilizes each of the observations between the initial and terminal points of the data series.

Tests for structural change in univariate time series provide a natural framework for investigating the stylized fact of constant output growth. While early work on structural change imposed restrictive assumptions such as i.i.d., nontrending, and/or stationary data, many of these restrictions have since been successfully relaxed. We utilize tests for detecting shifts in the trend function of a dynamic time series developed by Vogelsang (1994), which allow for both serial correlation and trending data and are valid whether or not the series contains a unit root. This is important because tests for structural change which assume stationarity may be unable to distinguish between a stationary process with structural change from a unit root process without structural change.

In this paper, we use up to 130 years of annual aggregate and per capita GDP data for 16 countries to investigate whether output exhibits a trend break and whether economic growth is constant or changing over time. While the Vogelsang tests for structural change can be used for both stationary and unit root data, the critical values are much greater when the series contains a unit root. Therefore, the initial focus here is on a determination of whether output contains a unit root. The emphasis then shifts to the examination of the trend break question which provides the basis for the growth analysis that follows.

This study provides empirical evidence that, for nearly every one of the countries, the years that provide the strongest evidence for a trend break are associated with a sharp decline in GDP. These breaks are associated with World War II for most of the countries and either World War I or the Great Depression for the remainder. While countries do tend to exhibit relatively constant growth rates for extended periods of time, the occurrence of a major

[1] Using data from Maddison (1982), Romer (1986, 1989) also shows that rates of growth for countries that were productivity leaders have risen since 1700.

shock to the economy and the resultant drop in levels are usually followed by sustained growth that exceeds the earlier steady state growth. Thirteen of the fifteen countries for which steady state aggregate growth rates can be calculated exhibit postbreak growth rates that exceed prebreak rates. On average, aggregate postbreak steady state growth rates are 79 percent higher than the average prebreak rates. The results are even stronger for the per capita case, where all fifteen countries exhibit postbreak growth rates that exceed prebreak rates. In the per capita case, the steady state postbreak rates are 163 percent higher than the steady state prebreak rates.

The finding that postbreak growth rates exceed prebreak growth rates is not sufficient to distinguish between the neoclassical and endogenous growth models. While both frameworks would predict this outcome during the transitional phase back to the steady state path, the neoclassical model also predicts that, once the steady state is reached, growth rates should return to their prebreak steady state values. We find evidence that the faster growth usually continues even after the countries reach, and eventually surpass, their previous steady state paths, with the new, post-transition, rates of growth greatly exceeding the old steady state rates.[2]

The paper is organized as follows. Sequential trend break tests are summarized and empirical results are presented in Section 2. Implications of these results for issues involving economic growth are considered in Section 3. Conclusions are presented in Section 4.

2. Trend breaks and unit roots

The objective in this section is to test for and date trend breaks in long-term aggregate and per capita real GDP, using tests which remain valid whether or not a unit root is present in the series. Since, as will be seen below, the critical values for these tests depend on whether or not the series are stationary, we first address the different, but related question of testing for a unit root in the presence of shifts in the trend function.

2.1. Unit root tests

The question of whether macroeconomic variables, in particular real GNP, can be characterized by unit roots has been the subject of considerable

[2] The finding of increased growth rates raises the possibility, discussed by Romer (1986), that they are continuously changing. We investigate the possibility of higher-order nonstationarity by testing for unit roots in GDP growth rates. Using Augmented–Dickey–Fuller tests (without breaks), the unit root null can be rejected at the 1 percent level for both aggregate and per capita real GDP growth for all 16 countries.

investigation.[3] Nelson and Plosser (1982), in a widely cited study using long-term annual data for the United States, showed that the null hypothesis of a unit root could not be rejected for most macroeconomic variables.[4]

These results have not gone unchallenged. Perron (1989) argues that only two events, the Great Crash of 1929 and the oil price shock of 1973, have had a permanent effect on macroeconomic variables. Using the same data as Nelson and Plosser, he shows that, allowing a single change in either the intercept of the trend function after 1929 or the slope of the trend function after 1973, most macroeconomic variables, including aggregate and per capita GNP, are trend-stationary.

Perron's results have also not gone unchallenged. In Perron (1989), the date of the break is treated as known. Banerjee, Lumsdaine, and Stock (1992), Christiano (1992), and Zivot and Andrews (1992) argue that the date of the break should be treated as unknown *a priori*. Zivot and Andrews, using a sequential Dickey–Fuller test on both long-run and postwar Nelson–Plosser data, find less evidence against the unit root hypothesis than was found by Perron (1989).[5]

This study uses the Zivot and Andrews (1992) sequential trend break model to investigate the unit root hypothesis for both aggregate and per capita GDP. Two issues, both emphasized by Campbell and Perron (1991), guide our choices of data and tests. First, the power of unit root tests is largest when the span of the data is longest. Second, lengthening the span of the data increases the possibility of a major structural change. We utilize a much longer time span (130 and 120 years for most of the aggregate and per capita data, respectively) and include more countries (16) than is common in unit root studies.

The sequential Dickey–Fuller tests are run on data compiled by Maddison (1991).[6] He provides annual GDP data for 16 countries, mostly starting in 1860 for aggregate and 1870 for per capita data and ending in 1989. Indexes of annual aggregate real GDP (adjusted to exclude the impact of boundary changes) were converted into 1985 U.S. relative prices using OECD purchasing power parity units of national currency per U.S. dollar. Annual per capita GDPs were calculated by dividing the aggregate GDPs by the mid-year population levels.[7]

[3] Campbell and Perron (1991) provide extensive references.

[4] The exception was the unemployment rate.

[5] While these studies focus on the U.S., Raj (1992) and Perron (1994) use sequential trend break tests and extend the unit root analysis to additional countries.

[6] These tests are univariate. Bai, Lumsdaine, and Stock (1994) develop multivariate tests for dating breaks, but do not test for unit roots.

[7] The Maddison data were modified for consistency purposes. For example, the regions of Alsace and Lorraine were included in the French total and deducted from the German total population count. The U.K. figures were adjusted so as not to include Irish GDP or population. Also, the Italian population statistic for 1870 was augmented by Rome's population so as to accord with the subsequent Italian population data. These changes were relatively minor and did not affect the regressions in any meaningful way.

While the annual aggregate data begins in 1860 for most countries, the per capita GDP is limited by the population data which begins in 1870.

It should be pointed out that data for the war years tends to be considerably less accurate than for the nonwar years. Thus, one should not attach too much importance to a break that occurs during one war year rather than another. The emphasis here will be on the fact that the break is related to a war rather than to a precise year.

To provide a benchmark for our later results, we compute Augmented Dickey-Fuller (ADF) tests which do not incorporate breaks. For 15 of the 16 countries, the null hypothesis of a unit root cannot be rejected at the 10 percent level for either aggregate or per capita real GDP. These findings support Nelson and Plosser's (1982) inability to reject the unit root null, despite our utilization of much longer spans of data. The lone exception is the United States, where the null can be rejected at the 5 but not the 1 percent level for both variables.[8]

A plausible reason for the nonrejection of the unit root null is misspecification of the deterministic components included as regressors. With long spans of data, it becomes more likely that the series of interest is characterized by a major structural change. Failure to account for such a structural change biases the test in favor of the unit root hypothesis.

The Zivot and Andrews (1992) sequential trend break tests involve regressions of the following form:

$$\Delta y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \alpha y_{t-1} + \sum_{j=1}^{k} c_j \Delta y_{t-j} + \varepsilon_t . \qquad (1)$$

The period at which the change in the parameters of the trend function occurs will be referred to as the time of break, or T_B. The break dummy variables have the following values: $DU_t = 1$ if $t > T_B$, 0 otherwise, and $DT_t = t - T_B$ if $t > T_B$, 0 otherwise. Eq. (1) is estimated sequentially for $T_B = 2, \ldots, T - 1$, where T is the number of observations after adjusting for those 'lost' by first-differencing and lag length k.

The time of break for each series is selected by choosing the value of T_B for which the Dickey-Fuller t-statistic (the absolute value of the t-statistic for α) is maximized. The null hypothesis, that the series $\{y_t\}$ is an integrated process without an exogenous structural break, is tested against the alternative hypothesis that $\{y_t\}$ is trend-stationary with a one-time break in the trend function which occurs at an unknown time.

For each choice of T_B, the value of k is selected by the criteria advocated by Campbell and Perron (1991). Start with an upper bound on k chosen *a priori*. If the last included lag is significant, choose the upper bound. If not, reduce k by

[8] The lag length for the ADF test is chosen by the data-dependent method described below. The results are reported in Ben-David and Papell (1994).

Table 1
Sequential unit root tests

Country	First year of sample	Year of break	Dickey–Fuller t-statistic	k	Significance level (%)
Aggregate real GDP					
Australia	1860	1925	4.15	8	
Austria	1870	1944	4.86	2	10
Belgium	1860	1939	5.77	3	1
Canada	1870	1928	5.97	7	1
Denmark	1860	1939	4.21	3	
Finland	1860	1913	6.01	3	1
France	1860	1939	6.60	8	1
Germany	1860	1952	5.05	1	10
Italy	1861	1940	4.08	1	
Japan	1885	1944	6.31	8	1
Netherlands	1900	1939	4.23	7	
Norway	1865	1944	3.55	0	
Sweden	1860	1913	4.24	5	
Switzerland	1899	1944	3.71	1	
U.K.	1860	1918	6.61	5	1
U.S.A.	1869	1929	6.11	8	1
Per capita real GDP					
Australia	1870	1927	4.61	8	
Austria	1870	1944	5.99	5	1
Belgium	1870	1939	6.26	3	1
Canada	1870	1928	6.41	7	1
Denmark	1870	1939	5.84	4	1
Finland	1870	1913	4.82	4	10
France	1870	1939	6.06	8	1
Germany	1870	1946	5.05	0	10
Italy	1870	1939	4.36	1	
Japan	1885	1944	6.57	8	1
Netherlands	1900	1939	4.74	7	
Norway	1870	1939	3.62	3	
Sweden	1870	1916	5.55	4	2.5
Switzerland	1899	1944	4.41	1	
U.K.	1870	1918	5.42	8	2.5
U.S.A.	1870	1929	5.95	8	1

Critical values for the 1, 2.5, 5, and 10 percent significance levels of the Dickey–Fuller t-statistic are 5.57, 5.30, 5.08, and 4.82, respectively. Source: Zivot and Andrews (1992).

one until the last lag becomes significant. If no lags are significant, set $k = 0$. Following Perron (1989) and Zivot and Andrews (1992), we set the upper bound on k to equal 8 and the criterion for significance of the t-statistic on the last lag equal to 1.60.

Allowing for breaks produces considerable evidence against the unit root hypothesis for both aggregate and per capita real GDP. As reported in Table 1, we can reject the unit root null at the 1 percent level in 14 out of 32 cases, 7 each for aggregate and per capita. This contrasts with the failure of conventional ADF tests, which do not allow for breaks, to reject the unit root null at the 1 percent level in any of the 32 cases. At the 10 percent level, where conventional ADF tests reject the null in only 2 of the 32 cases, we reject the null in 20 cases, 9 for aggregate and 11 for per capita real GDP.[9]

2.2. Trend break tests

Having determined which countries exhibit stationarity and which do not, the emphasis now shifts to testing for structural change. The tests developed by Vogelsang (1994) for trending data involve estimating the following regressions:

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \sum_{j=1}^{k} c_j y_{t-j} + \varepsilon_t, \qquad (2)$$

where, as above, $DU_t = 1$ if $t > T_B$, 0 otherwise, and $DT_t = t - T_B$ if $t > T_B$, 0 otherwise. Eq. (2) is estimated sequentially for each break year with 1 percent trimming, i.e., for $0.01T < T_B < 0.99T$. The $SupF_t$ (or Sup Wald) statistic is the maximum, over all possible trend breaks, of two times the standard F statistic for testing $\theta = \gamma = 0$. The null hypothesis of no structural change is rejected if $SupF_t$ is greater than the critical value. The lag length k is chosen as described above.[10]

The results of the $SupF_t$ tests are reported in Table 2. In order to determine the significance of the trend breaks, we use stationary critical values if the unit root null could be rejected at the 5 percent level, and unit root critical values otherwise. We can reject the no trend break null at the 10 percent level in 20 out of 32 cases, 9 for aggregate and 11 for per capita real GDP. Fifteen of these rejections are at the 1 percent significance level.[11]

The dates of the breaks accord closely with intuition. The countries which exhibit breaks during the Second World War – Japan, Norway, and the

[9] We estimate Zivot and Andrews 'Model C', which allows a break in both the intercept and the slope of the trend function. More detailed results are reported in Ben-David and Papell (1994).

[10] These tests allow for only one break. Bai and Perron (1995) develop tests for multiple breaks, but require stationarity. Vogelsang (1994) also constructs two additional test statistics, which we do not use because they do not provide dates for the trend breaks.

[11] Under a less stringent criterion, where we use stationary critical values if the unit root null can be rejected at the 10 percent level, and unit root critical values otherwise, the no trend break null can be rejected at the 1 percent level for three additional countries. Using more stringent criteria, where stationary critical values are only used if the unit root null can be rejected at the 2.5 or 1 percent levels, makes virtually no difference to the trend break results.

Table 2
Sequential trend break tests

Country	Year of break	$SupF_t$	k	Significance level (%)
Aggregate real GDP				
Australia	1925	16.86	3	
Austria	1944	19.96	3	
Belgium	1939	32.07	4	1
Canada	1928	28.27	8	1
Denmark	1958	11.67	3	
Finland	1913	31.99	4	1
France	1939	47.90	5	1
Germany	1946	20.99	2	
Italy	1945	23.92	2	10
Japan	1944	36.21	5	1
Netherlands	1945	23.02	6	10
Norway	1944	21.86	1	
Sweden	1913	15.99	6	
Switzerland	1944	21.13	2	
U.K.	1918	43.91	6	1
U.S.A.	1929	15.99	8	5
Per capita real GDP				
Australia	1925	19.20	3	
Austria	1944	33.53	6	1
Belgium	1939	38.86	4	1
Canada	1928	34.61	8	1
Denmark	1939	30.24	5	1
Finland	1913	21.72	5	
France	1939	40.98	5	1
Germany	1946	45.35	1	1
Italy	1945	23.27	2	10
Japan	1944	40.57	5	1
Netherlands	1945	22.03	6	
Norway	1944	18.19	1	
Sweden	1916	25.24	5	1
Switzerland	1944	21.09	2	
U.K.	1918	39.74	6	1
U.S.A.	1929	16.09	8	5

Critical values for the 1, 2.5, 5, and 10 percent significance levels of the $SupF_t$ statistic are 19.90, 17.26, 15.44, and 13.62 in the stationary case and 30.44, 27.76, 25.27, and 22.60 in the unit root case, respectively. Source: Vogelsang (1994).

continental European countries (Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, and Switzerland) – are those that were most affected by the war. Breaks occur during the First World War for the United Kingdom (where the trauma of the war was followed by the loss of Ireland and the outbreak of an extremely deadly and widespread flu epidemic), Finland (which achieved independence from Russia), and Sweden.

The countries that were most removed physically and suffered the least damage during both World Wars – Australia, Canada, and the United States – exhibit breaks between 1925 and 1929. The time of break for the United States is 1929 for both aggregate and per capita real GDP, exactly what was assumed by Perron and found by Zivot and Andrews. This result, based on a span of data about twice as long as the Nelson–Plosser data, provides further evidence for the Great Crash as the cause of the U.S. break. The Great Crash, however, did not cause the break for any other country. For the vast majority of countries, 13 out of 16, the breaks were caused by wars. Even for Australia and Canada, where the breaks were associated with the onset of the Great Depression, they occur before 1929.[12]

3. Trend breaks and steady state growth

Having determined the timing of the trend breaks, the focus now shifts to their growth implications, which are important for both macroeconomic theory and policy. A one-percentage-point increase in real growth rates, from say, 2 percent to 3 percent per year, implies that real incomes double every 23 years rather than every 35 years – a nontrivial difference when viewed within the context of the 75-year average lifespans that humans enjoy. Hence even small increases in growth rates can have far-reaching welfare implications.

From a theoretical standpoint, this issue is crucial in providing a target that growth models should aim for. Should models predict Kaldor-type constant growth, or should they attempt to explain changing steady state paths and their correspondingly different steady state growth rates?

In this section, steady state growth paths are calculated for the countries using the coefficients of Eq. (2). The implications of trend breaks within the growth context are then highlighted by means of a comparison of the prebreak and postbreak steady state growth rates.

Suppose that $k = 1$ in Eq. (2), i.e., only one lag on the right-hand side. Then, omitting the intercept dummy, trend dummy, and error term (and dropping the subscript on c_1), this becomes a standard first-order difference equation with drift and trend

$$y_t = \mu + \beta t + c y_{t-1}, \tag{3}$$

[12] Most of the breaks from the trend break tests are identical to the breaks from the unit root tests, including all cases for which the unit root null can be rejected at the 5 percent level.

with $y(t)$ following the time path

$$y_t = Ac^t - \frac{\beta c - (1-c)\mu}{(1-c)^2} + \frac{\beta}{(1-c)} t,$$

where

$$A = y_0 + \frac{\beta c - (1-c)\mu}{(1-c)^2}.$$

The annual rate of growth, Δy_t (where as before y_t denotes the log of real GDP), is

$$\Delta y_t = \frac{\beta}{1-c} - (1-c)\,Ac^{t-1}.$$

If $0 < c < 1$, then the growth rate asymptotically approaches the constant value

$$\lim_{t \to \infty} \Delta y_t = \frac{\beta}{1-c}. \tag{4}$$

Rewriting Eq. (3) to include dummy variables for the intercept and trend, then

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + c y_t \tag{5}$$

and the long-run, or steady state, growth rate becomes

$$\Delta y = \frac{\beta + \gamma}{1-c} \tag{6}$$

during the period for which the trend dummy variable is relevant.

In the more general case, when $k > 0$, and the equation becomes

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \sum_{j=1}^{k} c_j y_{t-j}, \tag{7}$$

then, using the coefficients estimated from Eq. (2), it is possible to verify that the rate of growth will usually tend towards the constant value

$$\Delta y = \frac{\beta}{1 - \sum_{j=1}^{k} c_j}, \tag{8}$$

or

$$\Delta y = \frac{\beta + \gamma}{1 - \sum_{j=1}^{k} c_j}, \tag{9}$$

when the coefficient for the trend dummy variable is included.[13] This was the case for each country in each instance (i.e., for both aggregate as well as per capita output) except the Netherlands, where the coefficients did not produce results consistent with Eqs. (8) and (9). Hence, the analysis that follows will focus on the 15 remaining countries.

How then does the existence of a break in the trend function affect steady state growth? A level change (i.e., a change in the intercept of Eq. (2)) affects income levels, but it has no effect on the growth rates. On the other hand, a trend change (i.e., a change in the slope, or trend, coefficient) will have an impact on the country's steady state growth path.

Steady state growth rates were calculated for each country using the estimated coefficients for the trend ($\hat{\beta}$) and lagged GDPs ($\hat{c}_j$'s). The postbreak growth rates also incorporate the increment to $\hat{\beta}$ given by $\hat{\gamma}$, the coefficient for the trend dummy variable, DT. These steady state rates appear in Table 3. The countries are grouped according to their time of break.

The postbreak rates of growth exceed the prebreak rates in nearly every instance. In the case of aggregate GDP, the average ratio of postbreak steady state growth rates to prebreak rates is 1.79 percent. For per capita GDP, the average ratio is 2.63, indicating a sizeable increase in steady state growth breaks following the individual breaks.[14]

The differences were largest for those countries which experienced trend breaks during World War II, with the average ratio of postwar to prewar growth rates equal to 2.12 for aggregate and 2.93 for per capita GDP. The average ratios of postbreak to prebreak growth were also greater than unity for the World War I and Great Depression trend break countries. As with the World War II countries, the increase in steady state growth was greater for per capita than for aggregate GDP.

The results in Table 3 appear to confirm the Romer predictions. Each of the 15 countries analyzed here over a 120-year time span displayed higher postbreak per capita growth, with steady state growth ratios exceeding unity. While it is clear that postbreak growth exceeds the prebreak steady state rates, there remains a question of whether the postbreak results are simply driven by the rebound of the countries during their respective transition periods. In other words, these findings may be simply a reflection of the neoclassical growth model's prediction that growth should be faster during the transition back to the steady state path. What happens when the transition periods are omitted from the postbreak results? Do GDP levels and growth rates return to their prebreak paths, or do they move to a new, higher steady state growth path?

[13] This result was verified using numerical simulations.

[14] These ratios go up slightly when the countries with nonsignificant trend breaks are omitted.

Table 3
Prebreak and postbreak steady state rates of growth

	Aggregate			Per capita		
	Steady state rates of growth			Steady state rates of growth		
	Pre-break (A)	Post-break (B)	Ratio (B/A)	Pre-break (C)	Post-break (D)	Ratio (D/C)
Average						
All countries	2.30%	3.74%	1.79	1.39%	3.02%	2.63
World War II						
Austria	1.36%	4.79%	3.52	0.79%	4.37%	5.57
Belgium	1.66%	3.58%	2.15	0.84%	3.14%	3.72
Denmark	2.57%	2.05%	0.80	1.58%	2.83%	1.79
France	1.24%	4.60%	3.72	1.20%	3.80%	3.17
Germany	1.93%	3.05%	1.58	1.25%	2.66%	2.13
Italy	1.50%	2.92%	1.94	0.68%	2.33%	3.42
Japan	3.16%	7.22%	2.29	1.92%	6.12%	3.19
Norway	2.26%	3.76%	1.66	1.51%	3.14%	2.08
Switzerland	1.81%	2.51%	1.39	1.41%	1.85%	1.32
Average	1.94%	3.83%	2.12	1.24%	3.36%	2.93
World War I						
Finland	2.70%	3.88%	1.44	1.74%	3.25%	1.87
Sweden	2.14%	3.49%	1.64	1.50%	2.90%	1.94
U.K.	1.92%	2.28%	1.19	1.10%	1.89%	1.71
Average	2.25%	3.22%	1.42	1.45%	2.68%	1.84
Depression						
Australia	2.81%	4.00%	1.43	0.43%	2.13%	4.96
Canada	3.98%	4.59%	1.15	2.19%	2.77%	1.26
U.S.A.	3.53%	3.40%	0.96	1.65%	2.09%	1.27
Average	3.44%	4.00%	1.18	1.42%	2.33%	2.49

The length of each country's transition period was found by extrapolating the prebreak steady state growth path of each country from the year prior to the break. The end of the transition period is determined when the actual levels of GDP eventually equaled that of the extrapolated levels, i.e., when the country returned to its prebreak path. This left the posttransition years which could then be compared to the prebreak years.

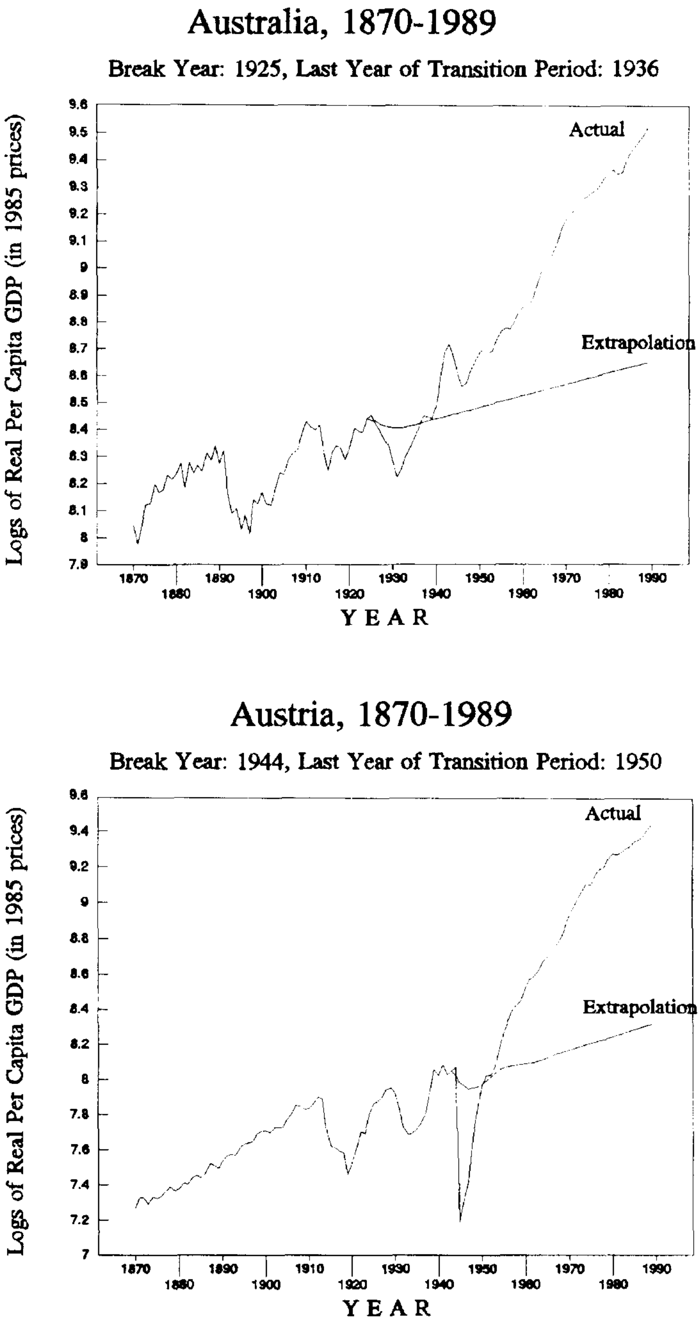
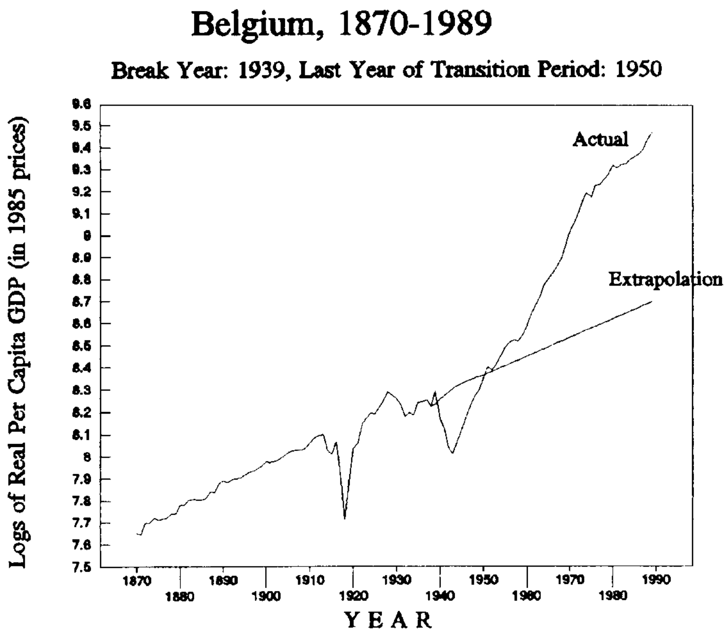
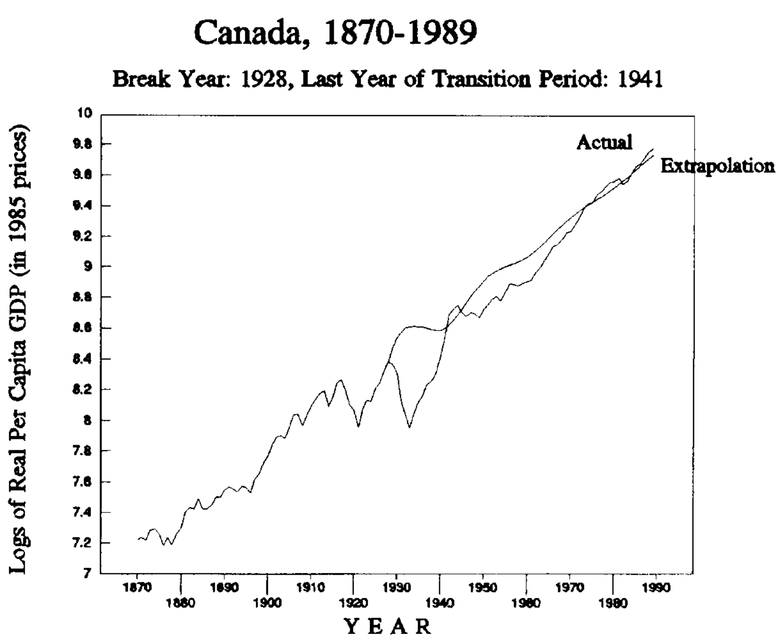


Fig. 1. Comparisons of postbreak growth with prebreak growth.





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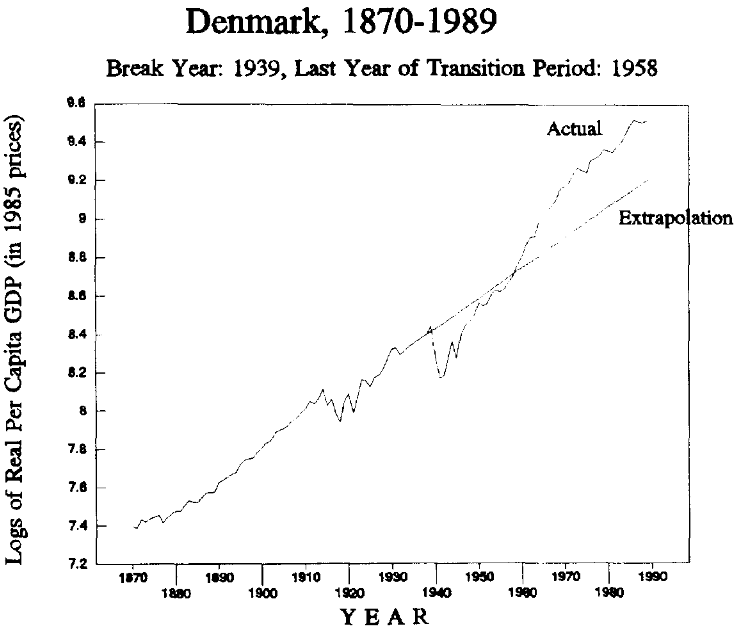


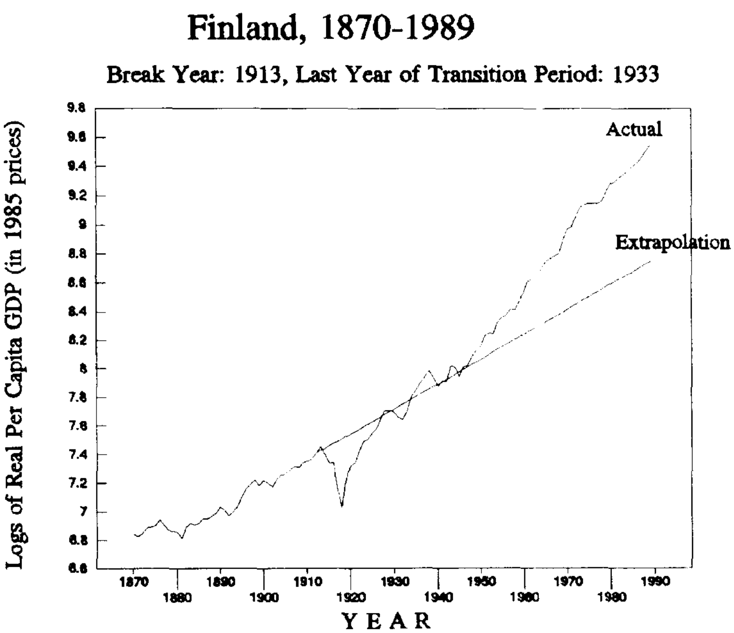
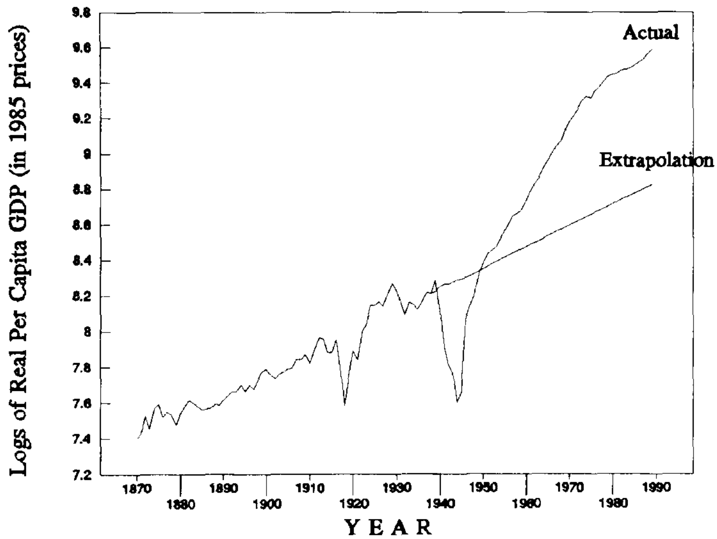


Fig. 1 (continued)

France, 1870-1989

Break Year: 1939, Last Year of Transition Period: 1949



Germany, 1870-1989

Break Year: 1946, Last Year of Transition Period: 1947

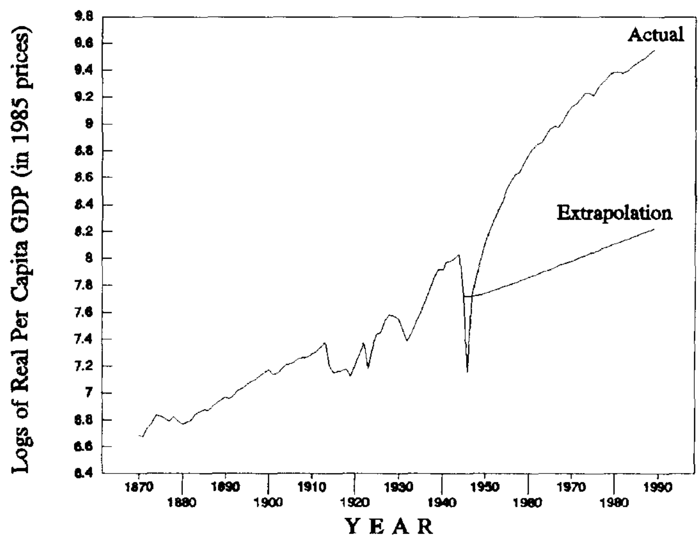
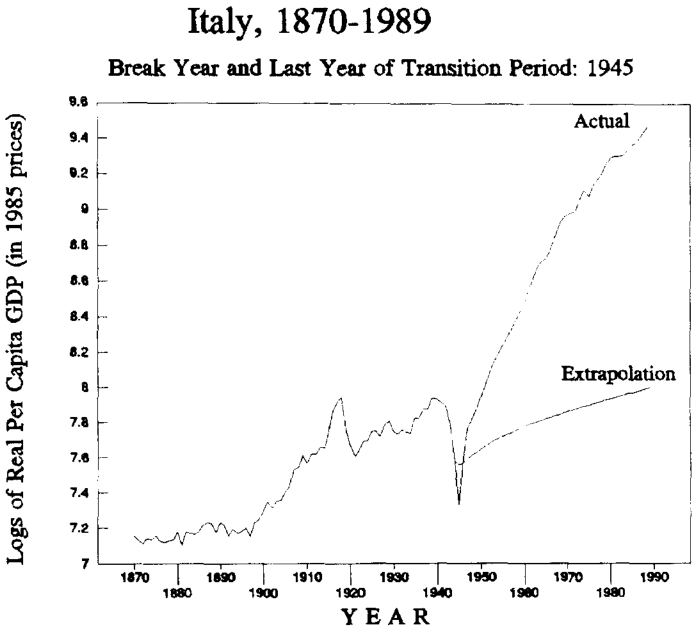


Fig. 1 (continued)



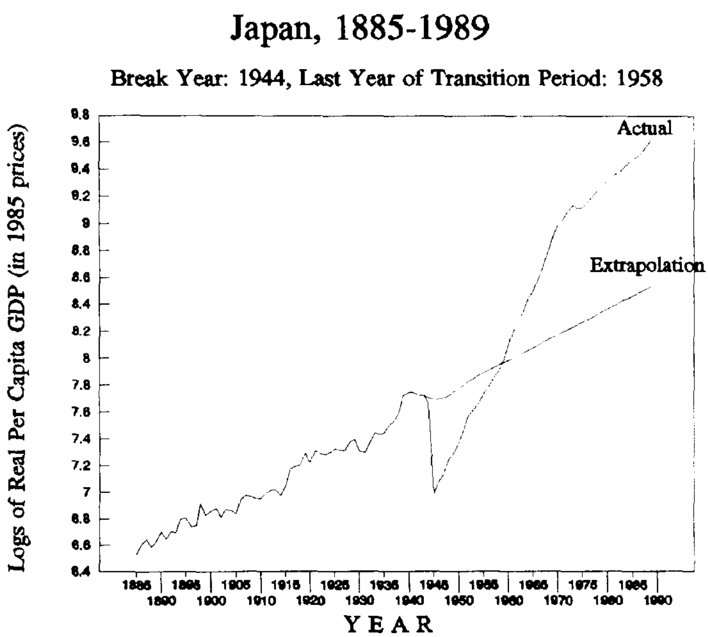
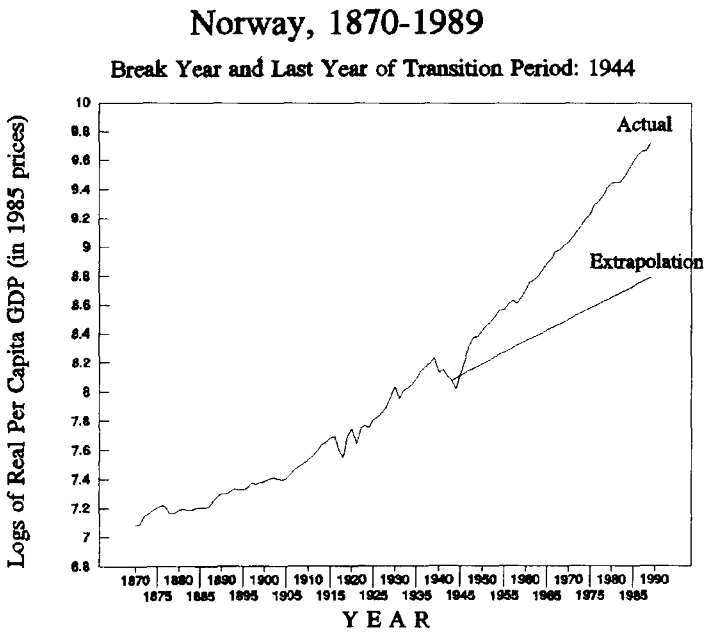


Fig. 1 (continued)



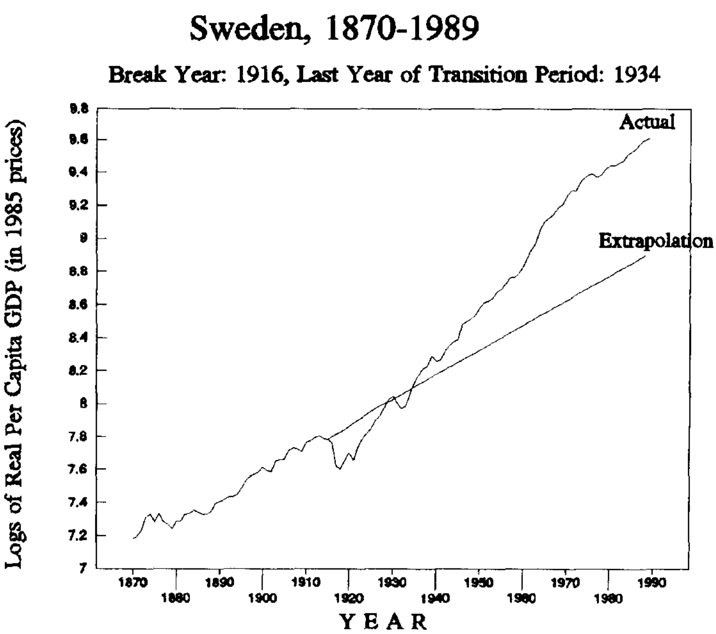
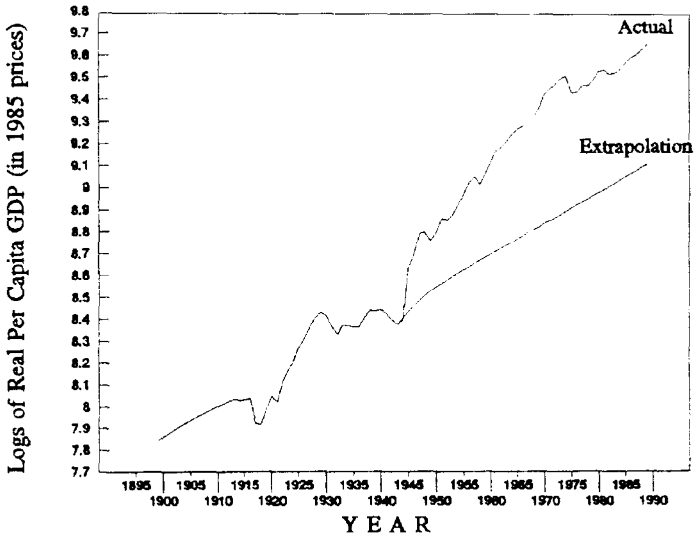


Fig. 1 (continued)

Switzerland, 1899-1989

Break Year and Last Year of Transition Period: 1944



United Kingdom, 1870-1989

Break Year: 1918, Last Year of Transition Period: 1940

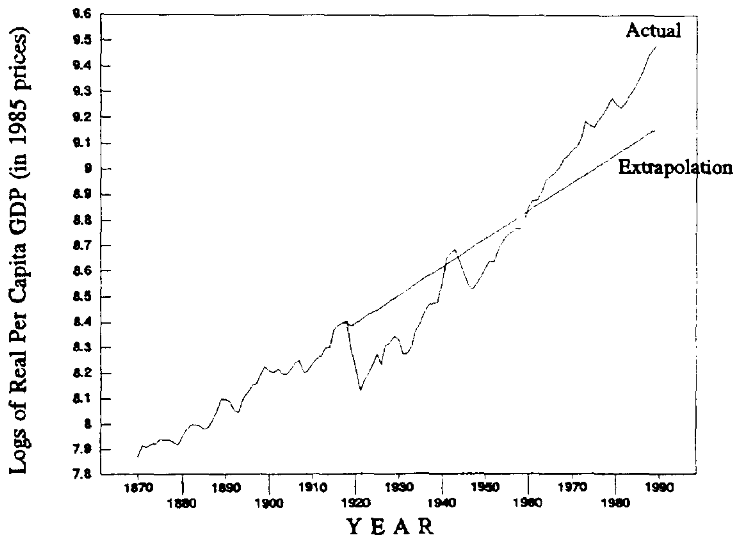


Fig. 1 (continued)

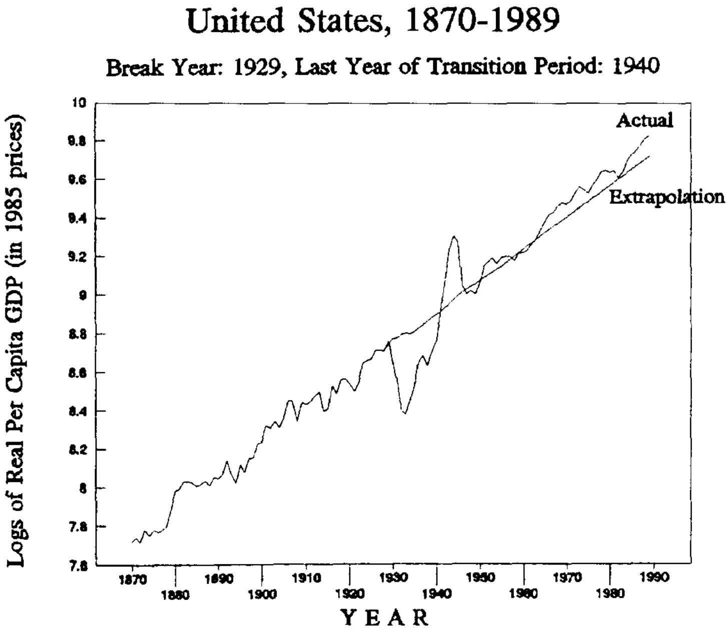


Fig. 1 (continued)

A graphical depiction of this exercise appears in the panels of Fig. 1. For completeness, the per capita GDP graphs for every one of the 15 countries are provided in these panels. In a majority of these countries, there is a noticeable transition period followed by visual evidence that the posttransition behavior of GDP is clearly different from that of the prebreak years. In each of these countries, posttransition growth exceeds prebreak growth by a substantial margin. For most of the remaining countries, a transition period is not particularly evident, and faster growth continues along a new path that rises above the old path almost immediately. The visual evidence is corroborated by a comparison of the calculated average annual growth rates in Table 4. Even after omission of the transition periods, the ratio of average posttransition growth to average prebreak growth nearly always exceeds unity. There are two exceptions, the United States and Canada. These two countries exhibit results that conform very closely to the neoclassical predictions of a return to the steady state path, both in terms of growth rates as well as levels, though in per capita terms, posttransition U.S. growth rates are still 13 percent above the prebreak growth rates.

These results suggests a possible bridge between the Romer-type increasing growth predictions and the Olson (1982) proposition that major social

Table 4
Posttransition average annual rates of growth

	Aggregate			Per capita		
	Fitted (A)	Actual (B)	Ratio (B/A)	Fitted (C)	Actual (D)	Ratio (D/C)
Average	2.41%	3.92%	1.81	1.37%	3.11%	2.60
World War II						
Austria	1.37%	3.80%	2.77	0.85%	3.80%	4.47
Belgium	1.68%	3.30%	1.97	0.85%	2.84%	3.35
Denmark	2.57%	2.98%	1.16	1.59%	2.56%	1.61
France	1.25%	3.92%	3.14	1.22%	3.14%	2.58
Germany	2.14%	4.32%	2.02	1.21%	4.19%	3.48
Italy	1.84%	4.98%	2.70	0.99%	4.46%	4.52
Japan	3.20%	6.65%	2.08	1.93%	5.64%	2.92
Norway	2.33%	4.43%	1.90	1.55%	3.69%	2.39
Switzerland	1.94%	3.31%	1.70	1.53%	2.32%	1.51
World War I						
Finland	2.73%	3.70%	1.35	1.76%	3.21%	1.83
Sweden	2.16%	3.34%	1.55	1.51%	2.79%	1.85
U.K.				1.11%	1.73%	1.57
Depression						
Australia	2.85%	4.02%	1.41	0.43%	2.07%	4.81
Canada	4.03%	3.60%	0.89	2.39%	2.34%	0.98
U.S.A.	3.62%	2.61%	0.72	1.68%	1.90%	1.13

upheavals can cause a breakup of coalitions whose removal can lead to a more efficient allocation of resources and hence, to faster subsequent growth. The increasingly free trade characterizing the postwar world may also be an important factor contributing to the faster growth. As Ben-David and Loewy (1995) show for these 16 countries, the increased liberalization of trade following the Second World War may be linked to greater trade flows and faster growth.

4. Conclusions

The findings of this study show that a majority of the OECD countries analyzed exhibited a significant trend break over the past one and a quarter centuries. The determination of trend breaks enables the calculation of asymptotic growth rates for each subperiod. These steady state rates are markedly higher following the breaks.

Real per capita output for the OECD countries grew at an average steady state rate of 1.39 percent prior to the breaks. This means that countries were advancing at a pace that doubled their real incomes every 50 years. After the trend breaks, steady state growth rates rose to an average of 3.02 percent – implying a doubling of real incomes every 23 years. While these are cross-country averages, and are therefore not indicative of each country, the magnitude of even the smallest change in per capita growth rates is not inconsequential.

For example, in the case of the United States, where postbreak growth rates exceeded prebreak rates by 27 percent (13 percent if the transition period is ommitted), the implication is a doubling of real income in 34 years (or 37 years without the transition period) rather than 42 years. In the case of France, the increase from 1.2 percent steady state growth to 3.8 percent steady state growth implies that only 19 years (22 without the transition period) are required to double real income, compared to the 58 years along the prewar growth path.[15]

This evidence that steady state growth rates appear to be growing over extended periods of time is in contradiction with the predictions of the neoclassical growth model as well as with Kaldor's (1961) stylized fact that growth rates remain steady over time. However, increasing growth is compatible with Romer-type endogenous growth models.

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[15] As a general rule of thumb, if prebreak growth rates are x percent below postbreak rates, then real income will double in x percent less years during the postbreak than during the prebreak period.

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