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SAVINGS RATES AND OUTPUT VARIABILITY IN INDUSTRIAL COUNTRIES

Garry J. Schinasi and Joseph E. Gagnon

ABSTRACT

The economics literature offers competing hypotheses about the relationship between savings rates and output variability. This paper examines data for eight industrial countries to determine if there is a discernible pattern between savings rates and cyclical volatility of output. We find a striking coincidence of high gross savings rates and high output variability when real GDP gaps are estimated from a *constant* growth trend. But there is also strong evidence that this coincidence is an *artifact*. The major conclusion is that there is *not* a robust relationship between average gross savings rates and the variability of real GDP gaps (measured as deviations from trends) between 1960-Q1 and 1988-Q4. We also report a number of interesting features regarding estimated autoregressive processes for output in the major foreign industrial countries.

SAVINGS RATES AND OUTPUT VARIABILITY IN INDUSTRIAL COUNTRIES

Garry J. Schinasi and Joseph E. Gagnon[1]

1. Introduction

For many macroeconomists, the objective of macroeconomic policy is to reduce output variability around potential growth. As has been observed in other studies, output variability since 1972 has been much greater in the United States than in Japan.[2] It is also well documented that savings rates in Japan are much higher than in the United States. Although these observations are only two sample points, they nevertheless raise the question of whether there is a systematic relationship between savings rates and output variability among industrial countries. While this question is obviously of intellectual interest it also may have some relevance for macroeconomic stabilization policies. If there is a robust statistical relationship between savings rates and output variability, such a relationship might indicate the existence of underlying transmission mechanisms through which output variability might be reduced, such as government spending or tax policy.

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1. The authors are Senior Economist and Economist, respectively, in the International Finance Division of the Board of Governors of the Federal Reserve System. The authors would like to acknowledge Chairman Greenspan for posing the question addressed in this paper, without implicating him in any of the authors' observations or conclusions. We thank John Coleman, Sean Craig, Dick Freeman, David Gordon, Bill Helkie, David Howard, Karen Johnson, Eric Leeper, Ross Levine, Jaime Marquez, and Ted Truman for useful suggestions and stimulating conversations. Gwyn Adams provided excellent research assistance and Patti Teagle provided expert wordprocessing. This paper represents the views of the authors and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff.

2. See, for example, Taylor [1989].

Unfortunately, there is little definitive guidance on this question in the economics literature. Economic theory offers competing hypotheses about the relationship between savings rates and output variability. For example, multiplier-accelerator models, which assume a buffer-role for savings, generally imply a negative correlation. On the other hand, more modern representative-agent, general-equilibrium models with uncertainty imply a positive correlation. Unfortunately, rigorously testing the various new and old theories continues to pose formidable challenges.

This paper takes an atheoretic approach and examines data for eight countries to determine if there is a significant correlation between average savings rates and various measures of cyclical variability of real GDP. The analysis is thus conducted across countries rather than over time in order to avoid the necessity of specifying and estimating a dynamic model of each economy. The major conclusion is that there is <u>not</u> a robust relationship between average gross savings rates and the variability of real GDP gaps (measured as deviations from trends) between 1960-Q1 and 1988-Q4.

This conclusion deserves some amplification. There <u>is</u> a striking coincidence of high gross savings rates and high output variability when real GDP gaps are estimated from a constant growth trend. But there is also strong evidence that this coincidence is an artifact. The artifact is the consequence of inappropriately assuming a constant growth trend for a number of countries with high savings rates. For less restrictive assumptions about long-run growth trends there is no discernible pattern between savings rates and output variability.

The conclusion rests on differences across eight countries in the apparent behavior of trend growth. A constant growth rate appears to capture long-run growth trends in the United States and the United Kingdom, where savings rates are low and growth has been relatively slow and steady. In contrast, in Japan and France, where savings rates are high and where growth has slowed over the last two decades, a constant growth rate fails to capture long-run growth trends. For Japanese real GDP, for example, log-linear detrending produces a high number of large output gaps that have little relationship to cyclical variation. These illusory output gaps produce an upward "bias" to the standard deviation of Japanese output gaps. The observed coincidence, under the assumption of constant long-term growth, is the consequence of higher savings rates occurring in countries with slowing long-run growth trends.

The paper proceeds as follows. The next section selectively reviews what various theories imply about the relationship between savings rates and output variability within and across countries and then discusses the difficulties the profession has had (or will have) in testing these theories. This is followed by an analysis of gross national savings rates and various measures of output variability in major industrial countries. The next section examines estimated propagation mechanisms (autoregressive processes) and the estimated impulses (residuals) to corroborate the evidence from the raw data. A number of interesting features of the estimated autoregressive processes for the foreign industrial countries are highlighted that to our knowledge have not been reported elsewhere. A concluding section summarizes the results and offers suggestions for further research in this area.

2. Economic Theory

The economics literature contains competing hypotheses about the relationship between savings rates and output variability. At the most basic level, it is possible to distinguish between those theories that focus on the effect of output variability on savings rates and those theories that focus on the effect of savings rates on output variability.

The standard paradigm within which to analyze the effect of output variability on savings behavior is the Life Cycle or Permanent Income Hypothesis of Friedman [1957] and Ando and Modigliani [1963]. Within this paradigm, Leland [1968] demonstrated that increasing uncertainty about future income has an ambiguous effect on rates of saving. However, Leland was able to prove that uncertainty has a positive effect on savings rates if individual utility is characterized by decreasing absolute risk aversion. Many economists would agree that decreasing absolute risk aversion is a reasonable assumption to place on individual preferences. Therefore, if one takes output variability as a measure of the uncertainty of future income, one would expect to find higher savings rates in countries that have more variable output.[3]

According to the Life Cycle Hypothesis, different national rates of saving also may arise due to different demographic characteristics or to differences in the rate of subjective time preference across countries. However, the Life Cycle Hypothesis does not provide insights on the effect of different national savings rates on output variability. To answer this question one must turn to more general theories of macroeconomic behavior.

3. Differences in output stability across countries might arise due to differences in political stability or to different degrees of dependence on foreign raw materials, for example.

In the textbook Keynesian macroeconomic model, in which savings are a constant fraction of income, higher rates of savings are associated with a smaller "multiplier" of the effect of exogenous spending shocks on total output. Thus, simple Keynesian models predict that countries with high savings rates will tend to have less variable output, *ceteris paribus*. A slightly more complicated version of the Keynesian model allows for "accelerator" effects in investment spending. Accelerator effects induce some persistence in the economy's response to shocks. For stable values of the accelerator parameter, higher savings rates reduce both the magnitude and the persistence of the response of output to a shock.

Keynesian models have been criticized for their *ad hoc* assumptions about individual behavior. For example, savings need not be (and indeed, they are not) a constant fraction of income. Moreover, Keynesian models typically neglect the long-run effects of savings and capital accumulation. Countries that save more will eventually build up a larger capital stock than countries that save less. Danthine and Donaldson [1981] proved that in a simple general equilibrium growth model, countries with higher savings rates (and larger capital stocks) would tend to have more variable output in the face of random shocks to the production technology. The result is true even after scaling for differences in the average level of output. One drawback to the application of the Danthine-Donaldson analysis is that it assumes that countries are already on their equilibrium growth paths. Many researchers would argue, however, that in most countries, postwar GDP growth is better characterized as a transition to a higher long-run growth path. With the exception of the United Kingdom, the other G-7 countries and Australia appear to be growing faster than, and converging upon, the U.S. growth path. Unfortunately, the growth literature provides little if any guidance about the relationship between savings rates and output variability as countries make a transition to a new steady-state growth path.

Directly testing the above hypotheses poses a formidable challenge. To be rigorous one would have to construct a well-specified macroeconomic model that nests the various hypotheses as special cases. Such an undertaking would undoubtedly involve numerous auxiliary hypotheses that are controversial. For example, embedding the Keynesian multiplier analysis in a general equilibrium setting is an ambitious research program in itself. Also, the multiplier analysis focuses on exogenous shocks to demand, while the Danthine-Donaldson analysis focuses on exogenous shocks to supply.

In order to avoid the difficulties of specifying and identifying a complete structural model for testing the above hypotheses, this paper takes a purely statistical approach. The following sections examine the data for evidence of a significant correlation between savings rates and output variability across countries. To the extent that such a correlation is evident, it may suggest which of the above hypotheses are likely to be important. To the extent that no correlation is found, it may suggest that either none of the above hypotheses is important or that two or more effects serve to offset each other.

3. Variability of the Output Data

The first difficulty facing any analysis of output variability is the indisputable existence of long-run growth in output. To the extent that growth is the result of a fundamentally smooth accumulation of physical capital, human capital, and technological knowledge, then output variability is best measured as fluctuations around a smoothly growing trend. Because of the difficulty of measuring the fundamental growth factors, this paper considers a number of different estimates of trend growth paths in order to demonstrate the robustness of our findings.[4]

Charts la-lh present GDP data and estimated growth trends for the eight countries in the sample. The sample was determined by including every country for which at least 25 years of quarterly data were available. The countries are Australia, Canada, France, Italy, Japan, the United Kingdom, the United States, and West Germany. The sample begins in 1960-Q1 and ends in 1988-Q4. The solid line in each panel represents the natural logarithm of real GDP, the dashed line represents a linear trend (exponential in the levels of real GDP), and the dotted line represents a quadratic trend that allows for some curvature in the long-run path, if warranted. The output gap in each graph is (approximately) the percent deviation of actual real GDP from the estimated trend line.

Before turning to the Charts a comment about recessions is appropriate. Although they are related, output gaps below trend need not be associated with recessions. In the United States the National Bureau of Economic Research (NBER) provides the most widely accepted determination of when the economy is in a recession. Although the NBER's

4. Although the concept of smoothly growing trend output is standard in the literature, a recent school of thought has developed that views long-run growth as a very noisy process. According to this view, real GDP is essentially identical to trend GDP, and variability of output is best measured by the variance of the period-by-period growth rate of GDP about its mean value. See, for example, Nelson and Plosser [1982] and Campbell and Mankiw [1987].

criteria are complex, an approximate rule of thumb is that a recession consists of at least two quarters of negative real output growth. By this definition, some of the faster growing countries--such as France and Japan--have had only one or two recessions over the 29-year sample. The absence of cyclical behavior defined in this narrow way does not preclude significant fluctuations of output around its trend. For example, suppose that a country growing along its trend path experiences a 5 percentage point reduction in its growth rate for two quarters. If the country's trend growth rate is less than 5 percent, this shock will be classified as a recession, whereas if the country's trend growth rate is greater than 5 percent, the shock will not be classified as a recession. Nevertheless, the implied fluctuations in output relative to trend is equally large in both cases.

For the United States (Chart 1b) and the United Kingdom (Chart 1a), an estimated log-linear trend for real GDP appears to be a reasonable approximation to the trend in the sample. This can probably be attributed to the "maturity" of these two economies and their relatively slow and steady growth. However, for the other countries, a log-linear time trend is clearly inappropriate as an estimate of trend GDP. In these countries log real GDP exhibits a high degree of curvature relative to a linear trend. The log-linear output gaps bear little relationship to commonly accepted business cycle behavior. The overwhelming characteristic of real GDP outside of the United Kingdom and the United States appears to be that growth rates slowed over the sample period.

In order to allow for gradual changes in the growth rate of trend GDP, it is possible to estimate logarithmic trends that are polynomials in time. By successively adding terms of higher order, the estimated trend path may capture additional instances of slowdowns or accelerations in trend output.[5] However, as the order of the polynomial trend becomes large, there is a risk of including cyclical behavior in the estimated trend.

Because there is no theory indicating the appropriate order of the polynomial trend for GDP, an agnostic approach was taken and trends of order 1 (linear) through 9 were considered. Only the first and second-order (linear and quadratic) trends are plotted along with real GDP in Chart 1. The quadratic trend is clearly much better at smoothly approximating the actual path of output. Except for the case of a ninth-order trend in Japan, higher order trends were extremely close to the quadratic trends so they have not been plotted.[6]

As an alternative to the polynomial trends, a linear trend was estimated that allows for a permanent change in the growth rate of trend output beginning in 1973-Q1. This "broken" trend has a steeper slope before 1973, and a shallower slope thereafter in every country.[7] Finally, a flexible trend was estimated using a procedure developed by Hodrick and Prescott [1980]. The Hodrick-Prescott trend essentially captures fluctuations in GDP that persist for more than eight years, a

5. See Anderson [1971]. It is important to note that polynomial time trends do not represent a structural explanation of trend GDP. Rather, they are an expedient means of capturing persistent, as opposed to transitory, variations in the data.

6. The statistical significance of a ninth-order trend in Japan probably represents the inappropriate inclusion of cyclical behavior into the estimated trend, but it is conceivable that trend output growth in Japan has experienced several long-lasting transitions over the past 30 years.

7. The slowdown in output growth among industrial economies since the early 1970s is a well-documented phenomenon. See, for example, Kendrick [1984].

periodicity considerably longer than typical business cycle fluctuations of three to five years.

Table 1 presents the standard deviations of the output gaps for four estimated growth trend paths, and the standard deviation of growth rates. The countries are listed in order of ascending savings rates. Savings rates are defined as the average annual ratio of total gross savings to GDP, in current dollars, over the period 1960-87. None of our conclusions would be significantly altered if savings rates were defined as gross domestic savings, gross private savings, or total net savings rates. The conclusions of this section are the same for annual data on real GDP as well as quarterly data. Furthermore, the ranking of countries according to gross savings rates is essentially the same before and after 1973.

3a. Log-linear detrending

For the log-linear detrended output series, there is a striking, almost perfect, coincidence between higher savings rates and higher output variability, shown in the first column of Table 1 and in the scatter diagram in the upper left panel of Chart 2. The simple correlation coefficient between savings rates and output variability (shown above the scatter diagram) is .97 and is significantly different from zero at the 1 percent confidence level. Germany is the outlier. Recalling Chart 1, estimated linear trends were better approximations of trend growth paths in some countries (the United States and the United Kingdom) than in other countries (Japan and France, for example). For countries like Japan and France, which appear to have a declining growth trend, there are many observations of large deviations from a linear trend. Given the assumption of a constant growth trend, output gaps would be large even if these economies showed no variation around a curved trend growth path. Hence, the observed coincidence probably reflects a coincidence of savings rates and gaps between actual and estimated trends, resulting from slowing growth trends in countries with higher savings rates, rather than a structural link between high savings and a high degree of economic volatility.

Even in the case of the United States, where a log-linear trend appears to be reasonable, there is evidence in favor of a curved or broken trend. By comparing output gaps below trend with generally accepted business cycle troughs, it is clear that log-linear detrending is inappropriate for the United States, whereas log-quadratic or broken log-linear trends appear to capture standard business cycle behavior.[8]

3b. Less restrictive detrending

For less restrictive estimates of detrended real GDP, shown in columns 2 through 4 of Table 1, the standard deviations of GDP gaps in all countries are substantially reduced. For the log-quadratic detrended series, the reduction in the standard deviation of output gaps is larger for those countries with high standard deviations of output gaps under log-linear detrending, thereby reinforcing the qualification made in the previous paragraph. While Japan retains its position with the highest standard deviation, France moves from the second-highest to the lowest and

8. During the period 1960-1988, The National Bureau of Economic Research has identified five recessions in the U.S. economy. For the quadratic and broken linear trends, there is a one-to-one correspondence between recessions and negative output gaps of two or more quarters. The linearly detrended output series, however, does not capture the recession of 1970-71. Moreover, the linearly detrended output series does not accurately portray the relative severity of the cyclical downturns. For example, according to the output gaps from a linear trend, the U.S. recession of 1961 was several times longer and deeper than that of 1975.

the United States moves from the second-lowest to the second-highest standard deviation of output gaps.

The scatter diagrams showing the relationship between savings rates and the output gaps estimated from less restrictive detrending procedures are shown in the other panels of Chart 2. For the log-quadratic detrended series (the upper right hand panel) the simple correlation coefficient is reduced to .57 and the scatter diagram shows a less transparent relationship. This reduced transparency reduces the statistical significance of the correlation coefficient and we cannot reject the hypothesis that the correlation coefficient is indeed zero at even the 10 percent significance level. For the series detrended by a broken linear trend (shown in the lower right panel), for the Hodrick-Prescott detrended series (shown in the lower left panel), and for higher-order detrended output series (not shown), the simple correlation coefficient is reduced substantially and is not significantly different from zero at the 10 percent level. In short, unlike in the case of a constant growth trend, there appears to be no quantifiable relationship between savings rates and output variability for less restrictive detrending procedures.

Finally, the correlation coefficient between standard deviation of the growth rate of output and the gross savings rate is 0.22, which is not significantly different from zero at the 10 percent level.

4. Variability of Systematic vs. Random Components of the Output Data

The observed GDP data represent the confluence of systematic economic processes and other influences. As was discussed earlier, a statistical relationship between savings rates and output variability might arise if the rate of savings in an economy has an effect on the systematic response of the economy to outside influences. To implement this distinction between systematic and other influences it is useful to decompose the detrended real GDP data into two components: a systematic economic process and a stochastic process.[9]

4a. <u>The Estimated Propagation Mechanisms and Savings Rates</u>

One way to estimate the systematic economic process that is used extensively in the literature is to estimate simple autoregressive processes of real GDP gaps.[10] While this method appears to be arbitrary, one can often reduce the dynamic movements of output in economic models to linear difference equations involving only output. For example, the output dynamic in a simple multiplier and accelerator model can be completely characterized by a second order linear difference equation in output. The parameters of this difference equation depend on the structural parameters of a structural model. In many cases, more complicated models can also be reduced in this way.

With these thoughts in mind our objective was to estimate autoregressive processes for real GDP gaps for the countries within the sample. The criterion we used to determine the length of the process was to reduce the residuals of such regressions to what appears to be a white-noise residual (zero mean, constant variance, and uncorrelated with its own past).[11] The estimated systematic component of this regression

9. Non-economic systematic processes may be part of this stochastic component. The only requirement is that random drawings from such a process are not predictable from the systematic economic process.

10. Examples in the literature are: Blanchard [1981], Clark [1987], and Taylor [1989].

11. Unfortunately, statistical tests of the null hypothesis of white-noise have very low power (i.e., one cannot reject the null hypothesis with a high degree of confidence).

describes the systematic relationship between observed output and its own past. For all countries in the sample, a second-order autoregressive process [AR(2)] or a third-order autoregressive process [AR(3)] captured the historical relationship.

For completeness, Table 2 reports three estimated AR(3) processes for each country using log-linear, log-quadratic, and the Hodrick-Prescott detrending procedures. Three lags appeared to be sufficient to remove most if not all of the serial correlation in the estimated residuals for each regression (see the estimated "rhos"). For the log-linear detrended series the estimated processes explained at least 95 percent of the variation in the detrended output series with the exception of the United Kingdom. For the other less restrictive detrending procedures, and most notably for the Hodrick-Prescott detrending procedure, the explanatory power of the autoregressions dropped significantly, especially for Germany, France, the United Kingdom, and Australia. Another interesting feature of the estimated autoregressions involves the estimated standard errors which are estimates of the variability of the shocks each economy has experienced over the sample period. The variation of the shocks in each country is relatively small and shows little variation (between 0.9 and 1.4 percent) across countries that are otherwise quite diverse in terms of their institutional structure and their degree of openness.

Given an estimate of the systematic component of real GDP (i.e., the propagation mechanism) it can be determined how a shock alters the path of output from its trend path and how long it takes the economy to dissipate the initial impact of the shock (i.e., the persistence of shocks in the propagation mechanism). For example, an economic shock such as an oil-shortage will have an initial effect on aggregate output but may also have additional effects through time as the shortage works its way through various industries and sectors of the economy.

To further examine the dynamics of real GDP in each country, the impulse response functions associated with the estimated autoregressions are plotted in Chart 3. Compared to the impulse response function for the log-linear output gaps (the dotted lines) the impulse response is less persistent for log-quadratic output gaps in each country (the solid lines) and is even less persistent for the Hodrick-Prescott output gaps (the dashed lines). Such reductions in persistence are especially significant for the higher savings rate countries such as Japan, France, and Germany. This finding is consistent with the reduction in output variability noted earlier in moving from the assumption of a constant trend to less restrictive long-run growth trends.

Also notable is the property that for the log-linear and log-quadratic output gaps some countries do not return to trend immediately after the shock and move further away from trend and then begin to return to trend later. This "hump-backed" pattern of response has been widely perceived as a stylized fact about real output responses in the United States.[12] This feature of the response of output to shocks also appears to be present in Japan, Canada, and Italy. Under the Hodrick-Prescott detrending procedure the "humped-back" feature disappears for all countries except the United States, where the initial response away from trend still exists but is dramatically reduced.

Presented in Table 3 is a summary measure of the variability of the estimated output propagation mechanism, the area under the impulse

12. For example, see the paper by Blanchard [1981].

response function.[13] As before, the countries are ranked according to savings rate. Note how the summary measures presented in Table 3 captures the downward shifts in the impulse response functions displayed in Chart 3. This summary measure represents a measure of variability of the systematic component of real GDP in each country. No pattern emerges between savings rates and this measure of output variability.

In order to detect more clearly a pattern between savings rates and systematic output variability, if one exists, scatter diagrams and simple correlation coefficients are presented in Chart 4. As with the previous scatter diagrams, there appears to be a pattern for log-linear GDP gaps. The simple correlation coefficient is .92 and is statistically significant at the 99 percent confidence level. The pattern of savings rates and output variability is ambiguous for less restrictive detrending procedures. The simple correlation coefficients are reduced to .7 for the log-quadratic detrending procedures (which is marginally significant at the 70 percent confidence level and then only because of Japan) and the is reduced to 0.1 for the Hodrick-Prescott output gaps.

4b. <u>The Estimated Impulses and Savings Rates</u>

As stated in the previous section, the estimated output gaps may be decomposed into two components: a systematic economic process and a stochastic process. The stochastic process is the series of impulses, or economic shocks, to which the systematic process responds. Such economic shocks may be country specific, such as a bad grape harvest in France, or

13. This is equivalent to the sum of the coefficients of the "moving-average" representation of the estimated autoregressive process. The moving-average representation expresses output <u>solely</u> as a weighted average of previous shocks to output.

global, such as a sharp reduction in the world-wide production of oil, or both.

A natural estimate of the impulses affecting the economy is the series of residuals from the autoregressions of the output gaps. As noted earlier the estimated standard errors are relatively small and show little variation across countries. These measures of the variability of the output shocks are presented for each country in Table 4. Scatter diagrams between savings rates and standard deviations of the residuals are presented in Chart 5. Both Table 4 and Chart 5 indicate that there is no clear pattern between the variability of the impulses affecting the economies and average savings rates. Furthermore, the failure to find a pattern appears not to be affected by the choice of detrending.

The major conclusion to draw from the analyses in this section is that the evidence compiled by examining estimated autoregressive processes corroborates the evidence on the observed detrended data: there appears to be no robust relationship between savings rates and output variability.

5. Conclusions

While this study probably raises as many questions as it answers, there are nevertheless several conclusions. First, as with U.S. output data, the "cyclical" behavior of deviations from trend output for most of the foreign industrial countries in the sample are extremely sensitive to the choice of trend. Second, there is a striking statistical correlation between output variability under log-linear detrending and savings rates. Third, this striking correlation between output variability and savings rates disappears under a number of less restrictive detrending procedures. Fourth, as with U.S. data, an AR(2) or AR(3) process describes the foreign log-linear (and log-quadratic) detrended output data fairly well.

Nevertheless, the explanatory power of the autoregressive processes appear systematically to break down for the Hodrick-Prescott detrended series. Fifth, under log-linear (and log-quadratic) detrending a number of foreign countries (Canada, Italy, and Japan) exhibit the "humped-back" feature of output responses to shocks, a feature that has long been regarded as a "stylized fact" about output responses in the United States. Sixth, this humped-back feature disappears for all countries except the United States when the Hodrick-Prescott detrending procedure is used, and even in the United States the initial response away from trend is sharply diminished.

Overall there appears to be no robust relationship between output variability and savings rates in the highly industrialized countries examined. Furthermore, a number of interesting features that exist in the output series under log-linear detrending procedures and even log-quadratic detrending procedures appear to disappear when the Hodrick-Prescott detrending procedure is used. It is our view that this interesting feature of the Hodrick-Prescott filter bears further examination.

Chart 1a.

Quarterly Real GDP and Estimated Growth Trends
(natural logarithm of domestic currency GDP s.a.a.r.)

United Kingdom

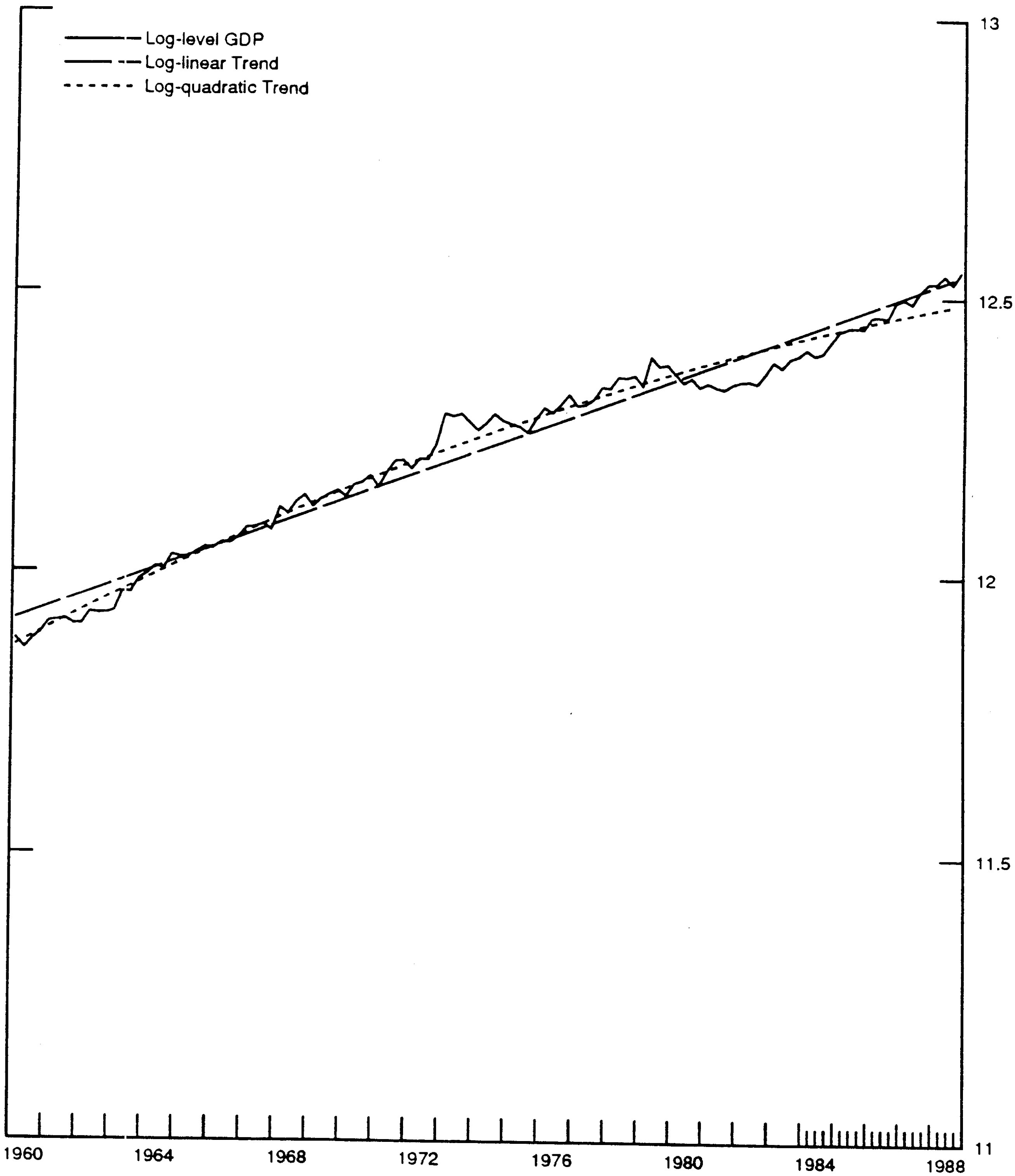


Chart 1b.

Quarterly Real-GDP and Estimated Growth Trends
(natural logarithm of domestic currency GDP s.a.a.r.)

United States

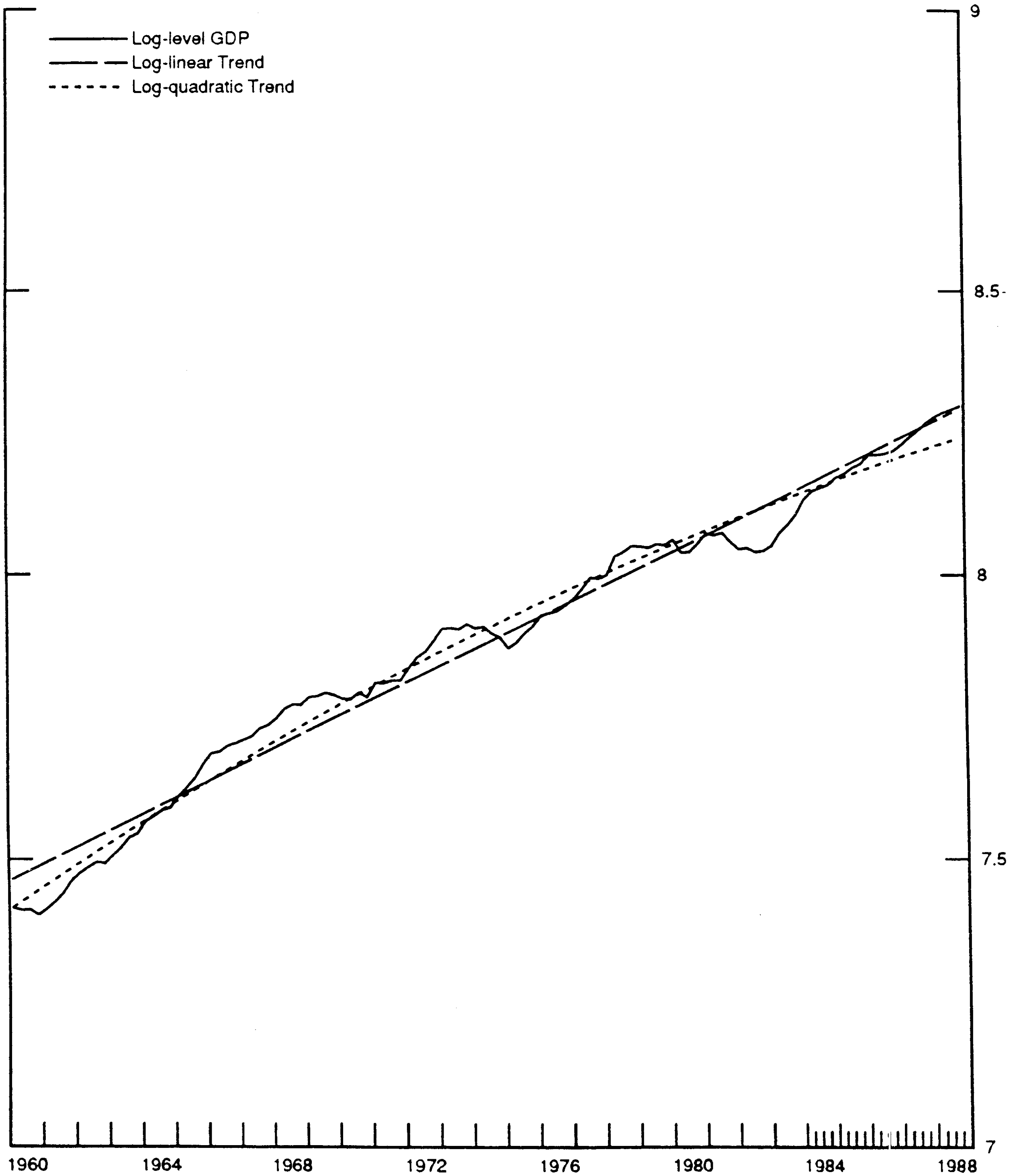


Chart 1c.

Quarterly Real GDP and Estimated Growth Trends
(natural logarithm of domestic currency GDP s.a.a.r.)

Canada

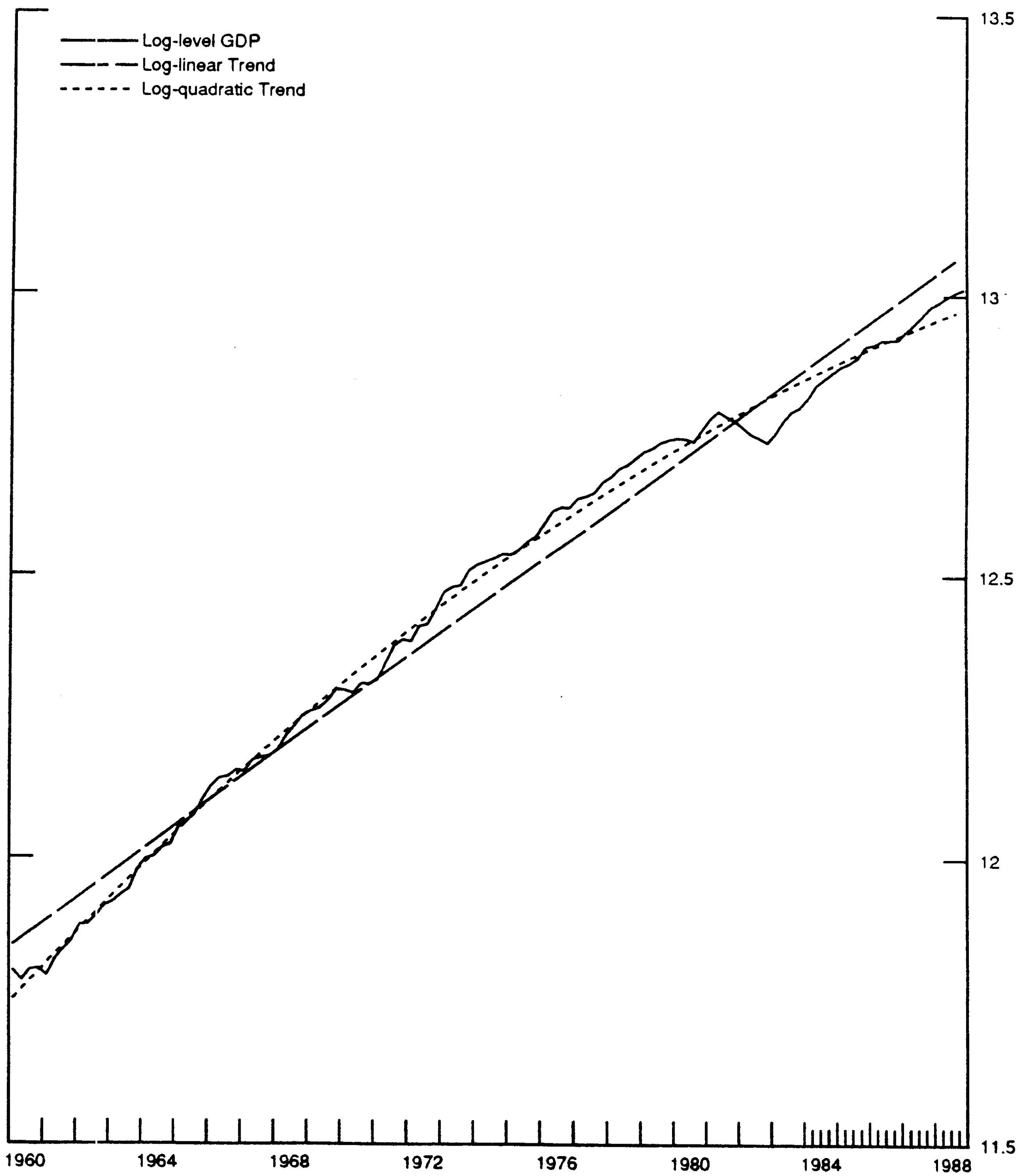


Chart 1d.

Quarterly Real GDP and Estimated Growth Trends
(natural logarithm of domestic currency GDP s.a.a.r.)

Australia

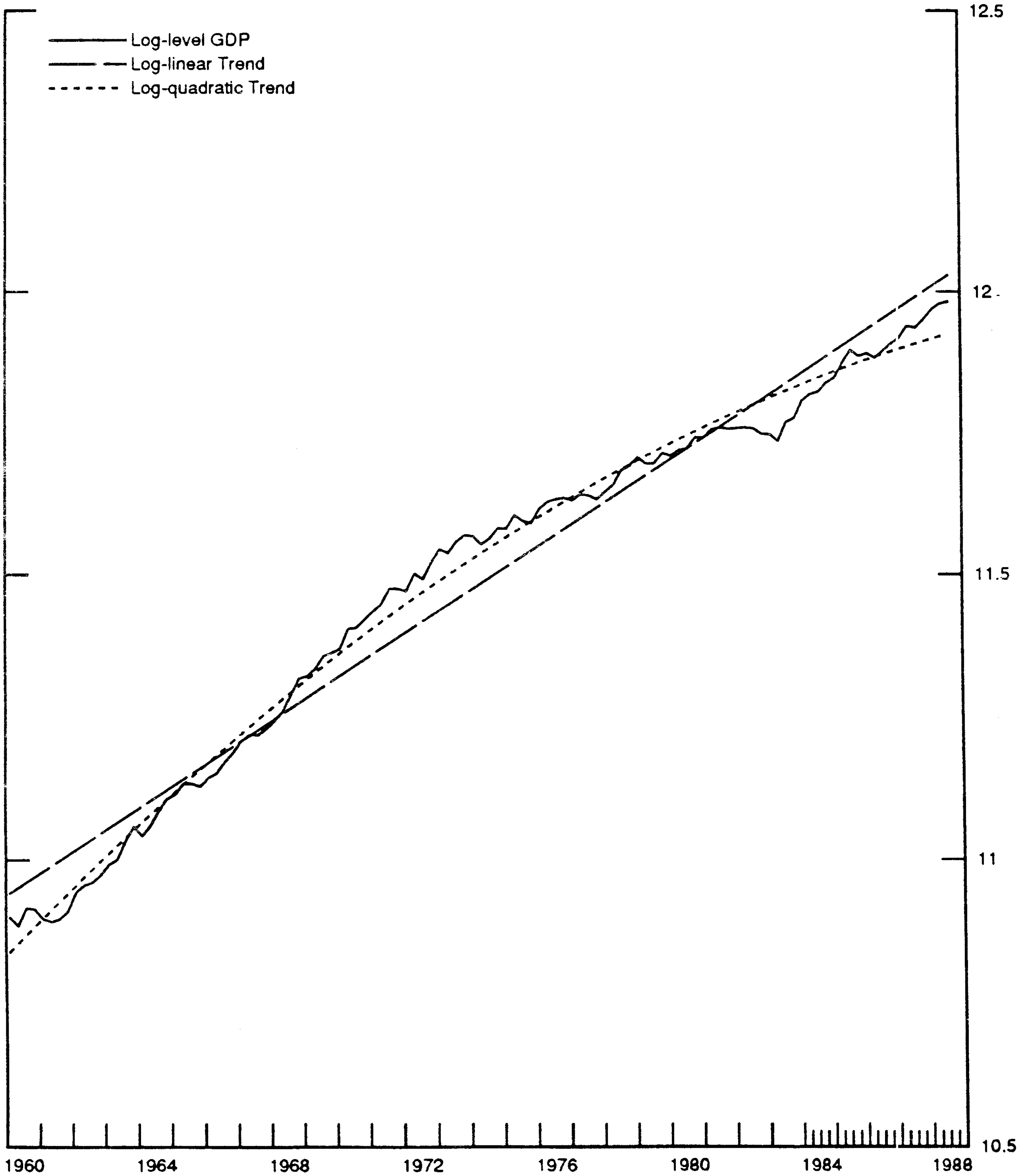


Chart 1e.

Quarterly Real GDP and Estimated Growth Trends
(natural logarithm of domestic currency GDP s.a.a.r.)

Italy

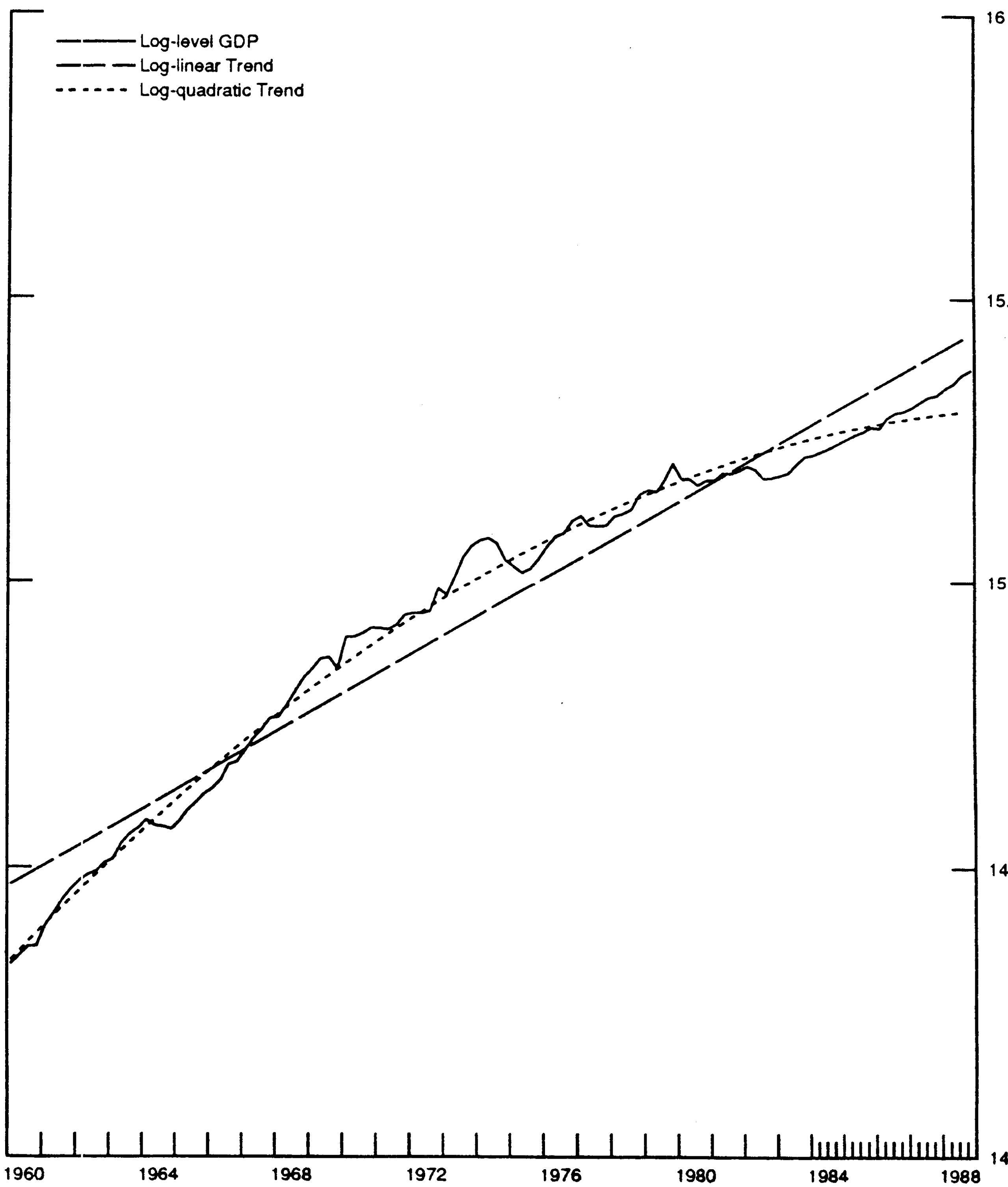


Chart 1f.

Quarterly Real GDP and Estimated Growth Trends
(natural logarithm of domestic currency GDP s.a.a.r.)

Germany

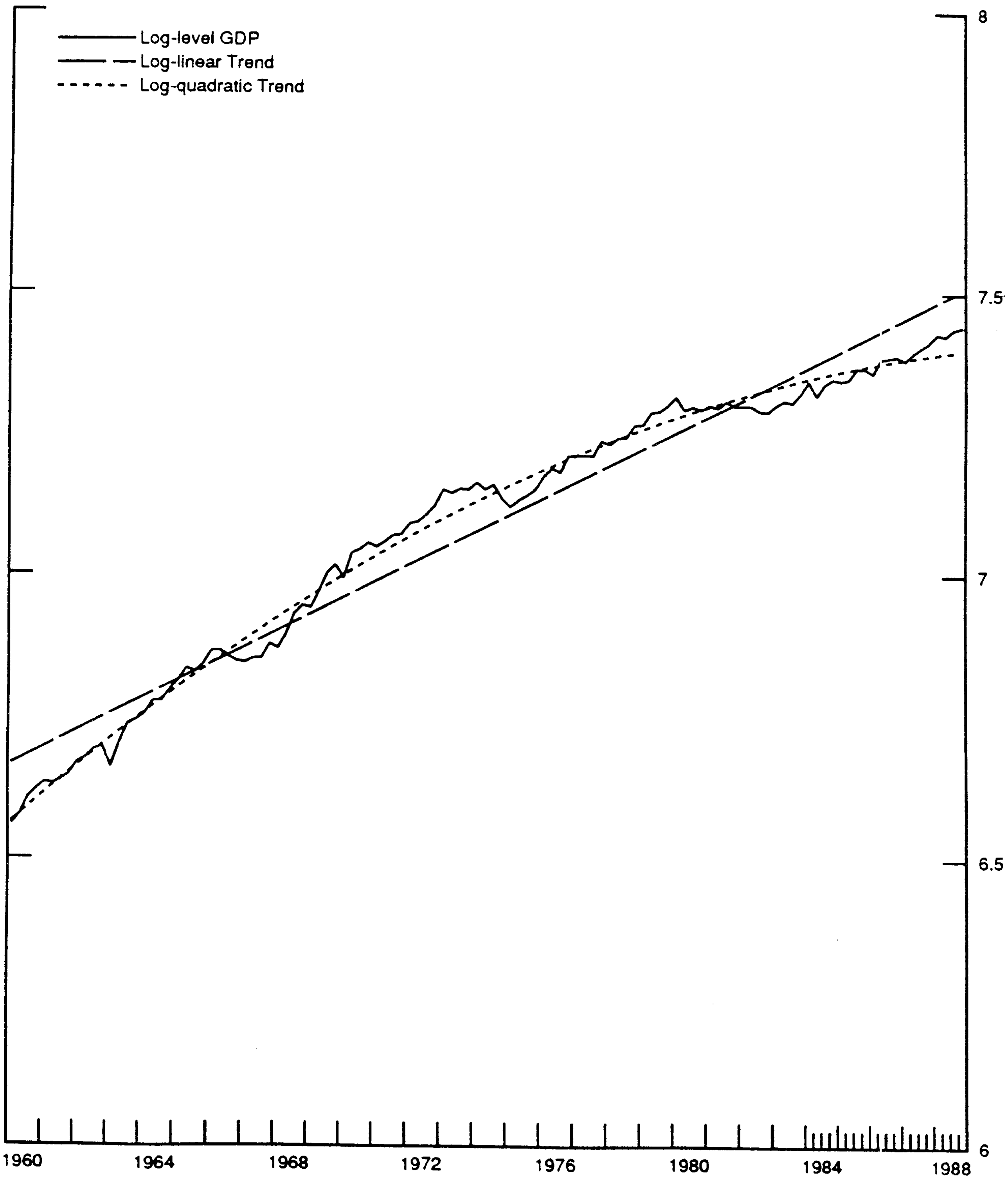


Chart 1g.

Quarterly Real GDP and Estimated Growth Trends
(natural logarithm of domestic currency GDP s.a.a.r.)

France

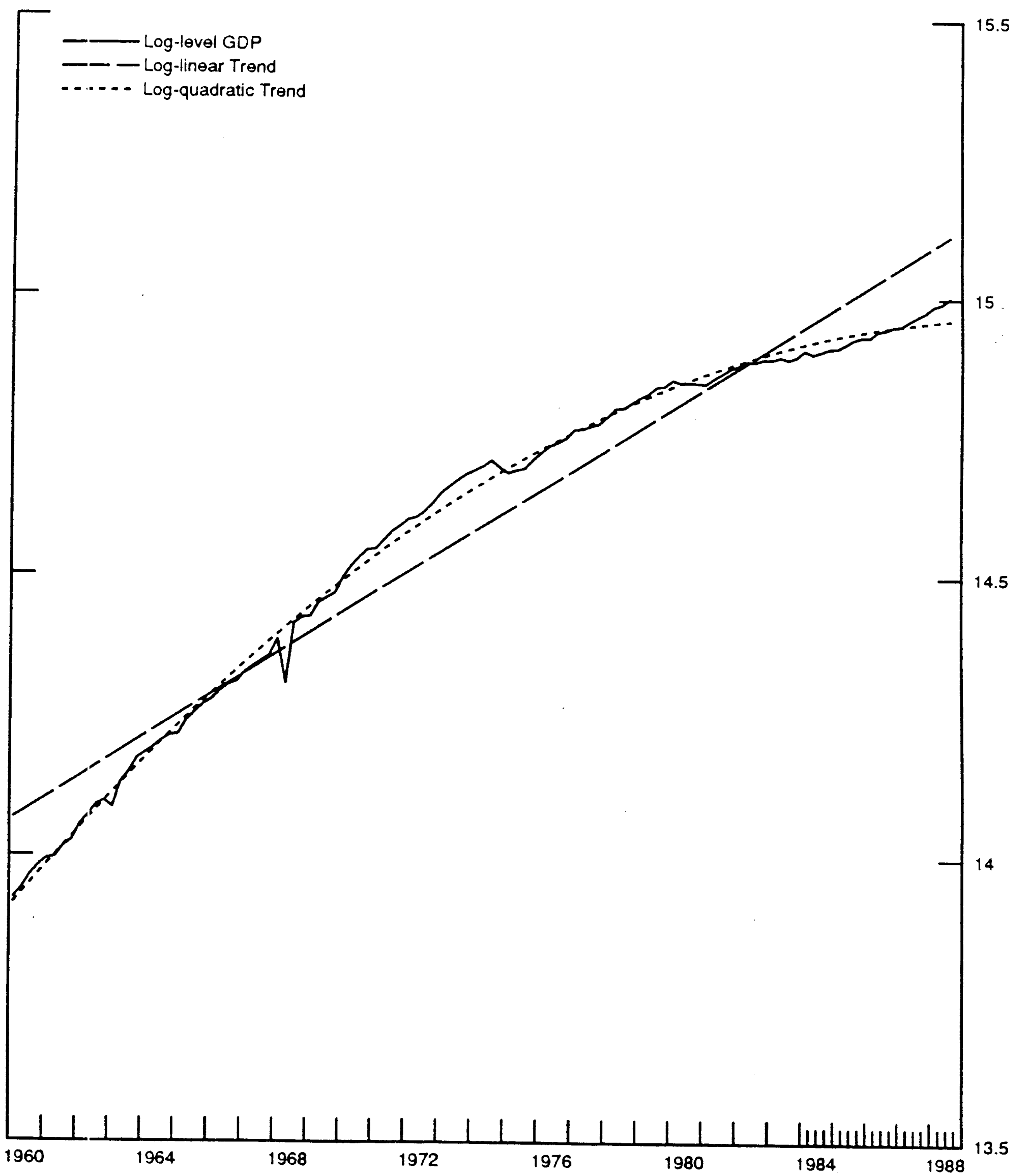


Chart 1h.

Quarterly Real GDP and Estimated Growth Trends
(natural logarithm of domestic currency GDP s.a.a.r.)

Japan

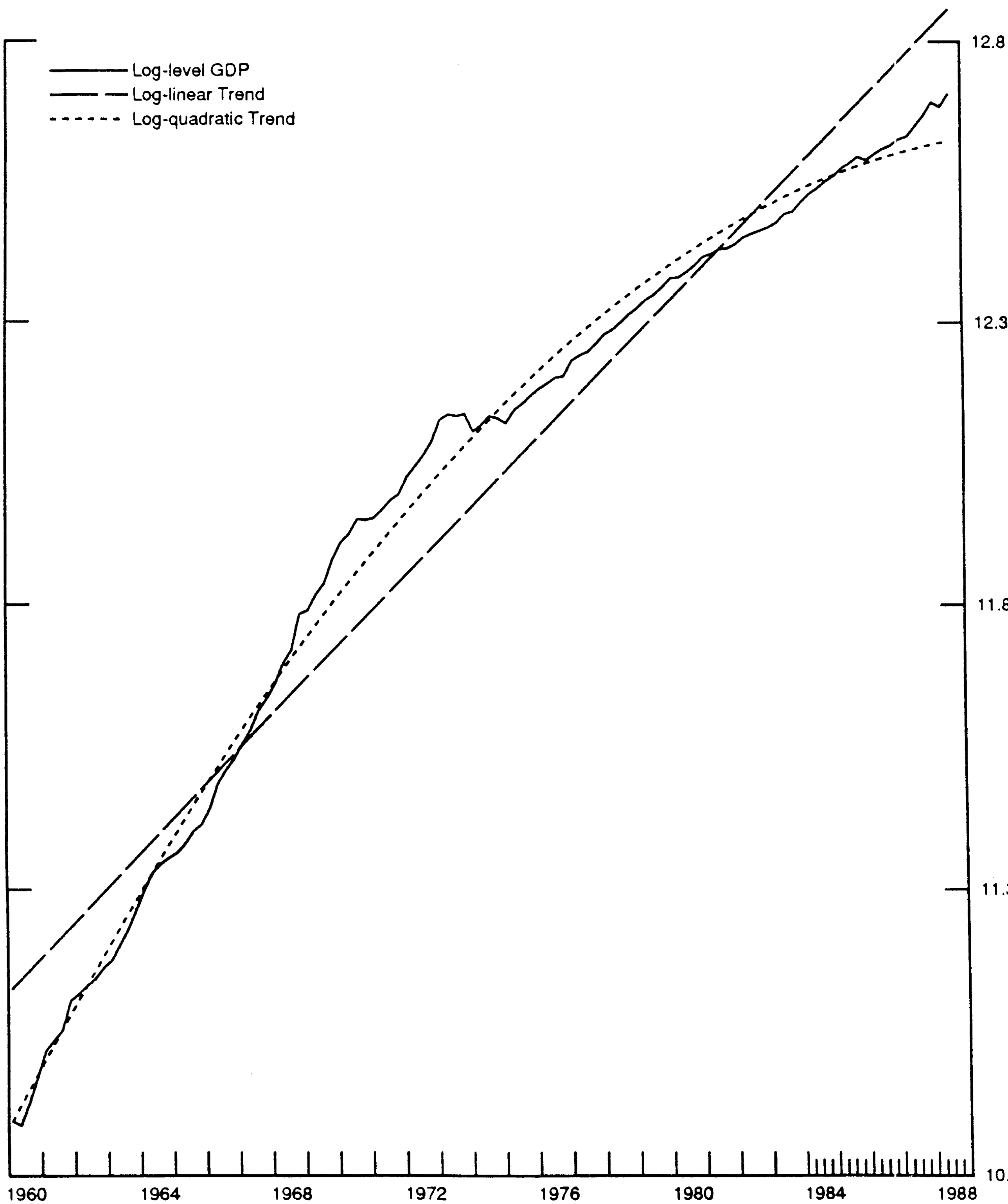


TABLE 1

MEASURES OF REAL OUTPUT VARIABILITY: 1960-1988

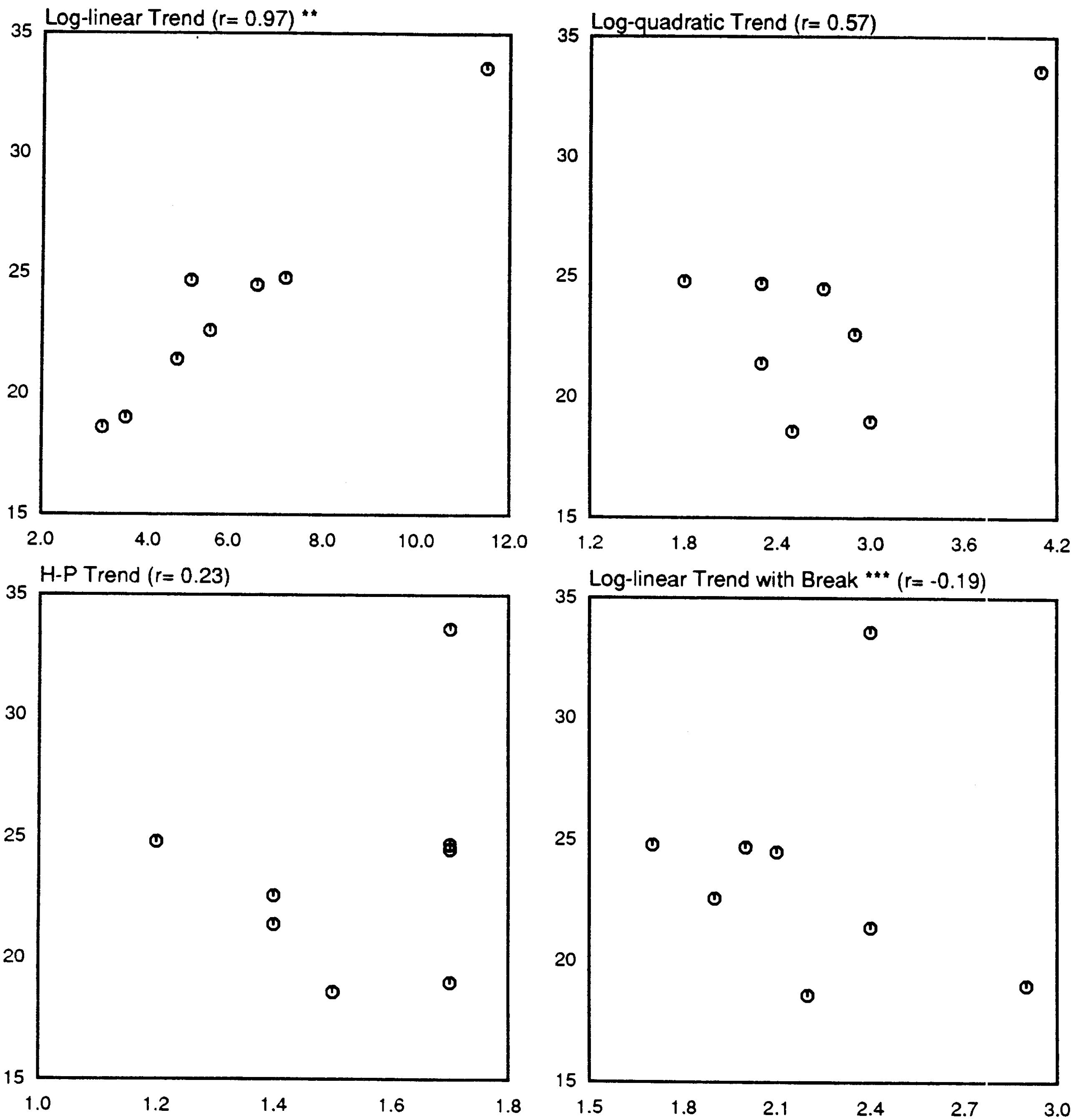
Standard Deviation of Output Gap

	log-linear trend	log-quadratic trend	log-linear broken trend	Hodrick-Prescott trend	Standard Deviation of growth rates	Memo: Gross Savings Rate
United Kingdom	.033	.025	.022	.015	.015	.186
United States	.038	.030	.029	.017	.010	.190
Canada	.049	.023	.024	.014	.010	.214
Australia	.056	.029	.019	.014	.013	.226
Italy	.066	.027	.021	.017	.013	.245
Germany	.052	.023	.020	.017	.014	.247
France	.072	.018	.017	.012	.015	.248
Japan	.115	.041	.024	.017	.013	.336

Note: Countries are ranked in order of increasing average total gross savings rates over the period 1960-87. The output gap is the percentage deviation of quarterly real GDP from various trends. The first four columns present the standard deviations of time series defined as the difference of the logarithm of real GDP from an estimated log-linear trend (column 1), an estimated log-quadratic trend (column 2), a broken log-linear trend with a change in the slope beginning in 1973-Q1 (column 3), and a trend estimated by the Hodrick-Prescott procedure (column 4). The fifth column is the standard deviation of a series defined as the first difference of the logarithm of real GDP.

Chart 2

Savings Rates and Standard Deviations of Output Gaps *
(percent)



*Savings rates are represented on the vertical axis and standard deviations of output gaps are represented on the horizontal axis.

**r is the correlation coefficient between savings rates and standard deviations of output gaps.

***The log-linear trend changes slope beginning in 1973:Q1.

Table 2a

Estimated Autoregressions for Real GDP Output Gaps
(1960-Q1 to 1988-Q4)

Dependent variable	Lagged dependent variable $y_i(-1)$	$y_i(-2)$	$y_i(-3)$	SE	R^2	ρ
	United States					
y_1	1.17 (12.56)	-0.01 (-0.10)	-0.22 (-2.40)	0.009	0.94	-0.017
y_2	1.17 (12.62)	-0.01 (-0.08)	-0.24 (-2.59)	0.009	0.91	-0.017
y_3	1.02 (11.01)	-0.01 -(0.11)	-0.26 (-2.83)	0.008	0.77	-0.017
	Japan					
y_1	1.24 (13.50)	-0.04 (-0.24)	-0.22 (-2.43)	0.012	0.99	-0.070
y_2	1.11 (11.56)	0.00 (0.03)	-0.14 (-1.54)	0.011	0.92	-0.035
y_3	0.86 (9.04)	0.00 (0.02)	-0.14 (-1.51)	0.010	0.63	-0.035
	Germany					
y_1	0.84 (8.80)	0.09 (0.70)	0.04 (0.44)	0.014	0.93	-0.004
y_2	0.75 (7.87)	0.07 (0.61)	0.02 (0.17)	0.013	0.66	-0.004
y_3	0.64 (6.69)	0.05 (0.40)	0.03 (0.29)	0.013	0.47	-0.004
	France					
y_1	0.63 (6.56)	0.34 (3.16)	0.01 (0.15)	0.014	0.96	-0.004
y_2	0.42 (4.37)	0.29 (2.93)	0.12 (1.23)	0.013	0.51	0.008
y_3	0.23 (2.41)	0.18 (1.89)	0.08 (0.81)	0.012	0.14	0.008

Note: The dependent variables y_1, y_2, and y_3 are the percentage deviations of real GDP from a log-linear, a log-quadratic, and a Hodrick-Prescott growth trend, respectively. The numbers in parenthesis are the t-ratios; SE is the standard error of the regression; and ρ is the first-order serial correlation coefficient of the estimated residuals.

Table 2b

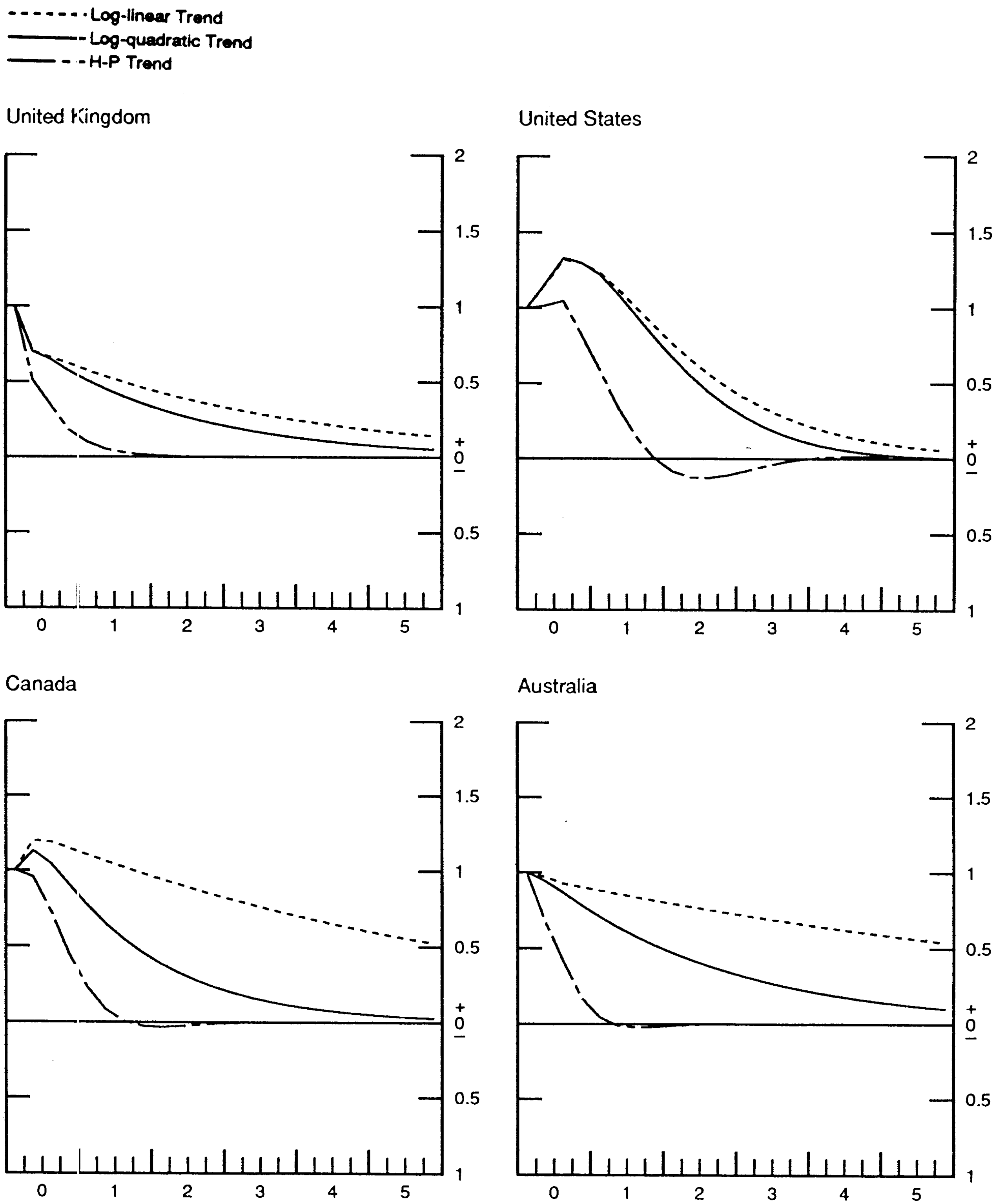
Estimated Autoregressions for Real GDP Output Gaps
(1960-Q1 to 1988-Q4)

Dependent variable	Lagged dependent variable $y_i(-1)$	$y_i(-2)$	$y_i(-3)$	SE	R^2	ρ
			United Kingdom			
y_1	0.70 (7.27)	0.16 (1.14)	0.04 (0.46)	0.014	0.81	-0.005
y_2	0.70 (7.31)	0.15 (1.30)	0.01 (0.14)	0.014	0.68	-0.002
y_3	0.51 (5.30)	0.09 (0.80)	-0.04 (-0.42)	0.013	0.30	-0.002
			Italy			
y_1	1.08 (11.40)	0.01 (0.05)	-0.13 (-1.35)	0.013	0.96	-0.014
y_2	1.01 (10.57)	0.01 (0.07)	-0.15 (-1.58)	0.012	0.79	-0.022
y_3	0.85 (9.02)	0.02 (0.13)	-0.21 (-2.21)	0.011	0.60	-0.022
			Canada			
y_1	1.19 (12.47)	-0.21 (-1.45)	-0.01 (-0.09)	0.010	0.96	0.011
y_2	1.12 (11.76)	-0.20 (-1.42)	-0.04 (-0.47)	0.010	0.83	0.004
y_3	0.96 (10.12)	-0.19 (-1.47)	-0.07 (-0.79)	0.009	0.63	-0.005
			Australia			
y_1	0.95 (10.07)	0.02 (0.15)	0.00 (0.02)	0.013	0.95	0.015
y_2	0.93 (9.80)	0.01 (0.90)	-0.04 (-0.41)	0.012	0.81	0.009
y_3	0.68 (7.30)	-0.04 (-0.39)	-0.08 (-0.90)	0.010	0.41	0.009

Note: The dependent variables y_1, y_2, and y_3 are the percentage deviations of real GDP from a log-linear, a log-quadratic, and a Hodrick-Prescott growth trend, respectively. The numbers in parenthesis are the t-ratios; SE is the standard error of the regression; and ρ is the first-order serial correlation coefficient of the estimated residuals.

Chart 3.a.

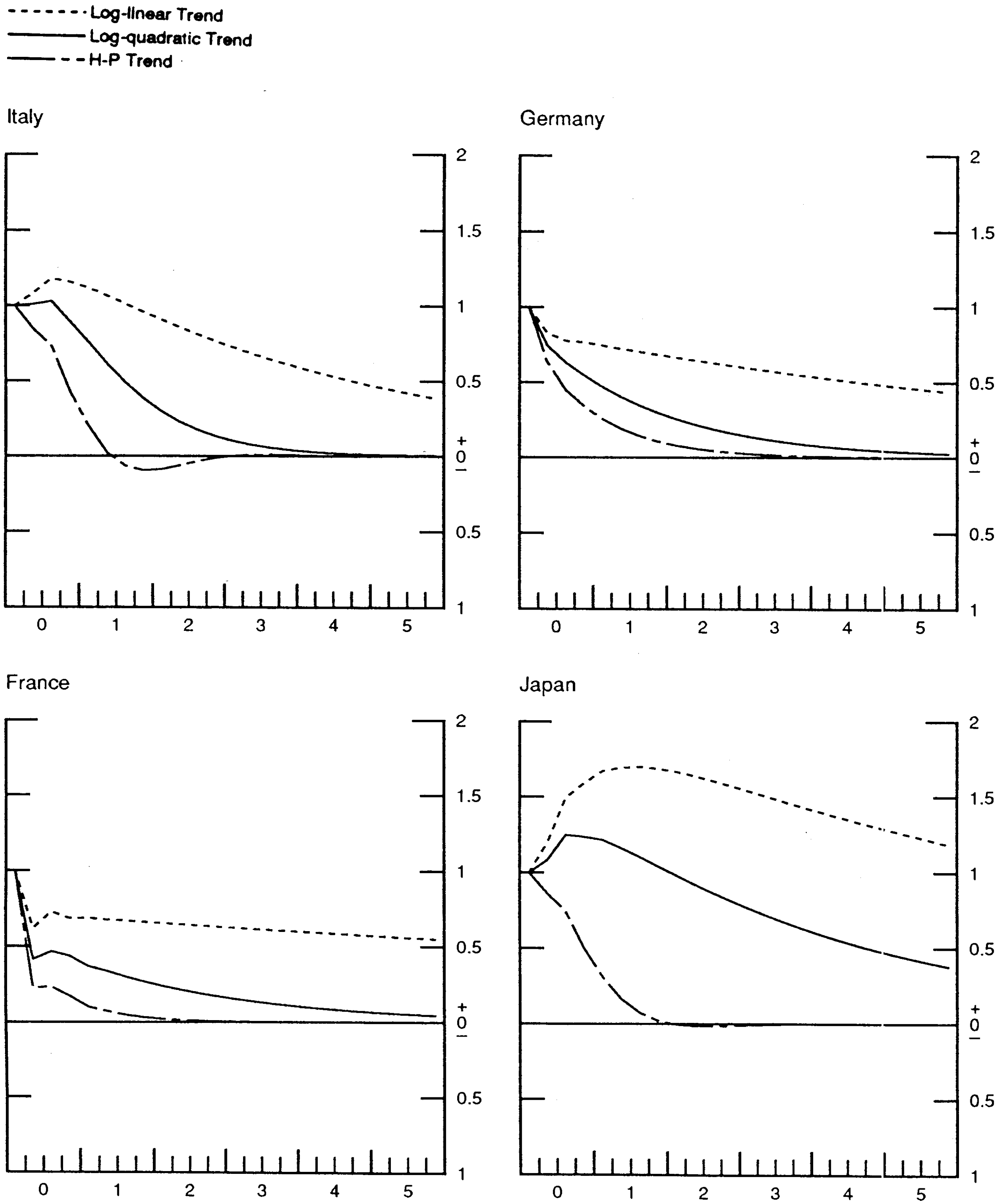
Impulse Response of Quarterly Real GDP Gaps *



*Derived from estimated AR (3) processes. The percentage deviations from trend are represented on the vertical axis, and the years after the impulse are represented on the horizontal axis. The impulse has a value of one in the initial period and zero thereafter.

Chart 3.b.

Impulse Response of Quarterly Real GDP Gaps *



*Derived from estimated AR (3) processes. The percentage deviations from trend are represented on the vertical axis, and the years after the impulse on the horizontal axis. The impulse has a value of one in the initial period and zero thereafter.

TABLE 3

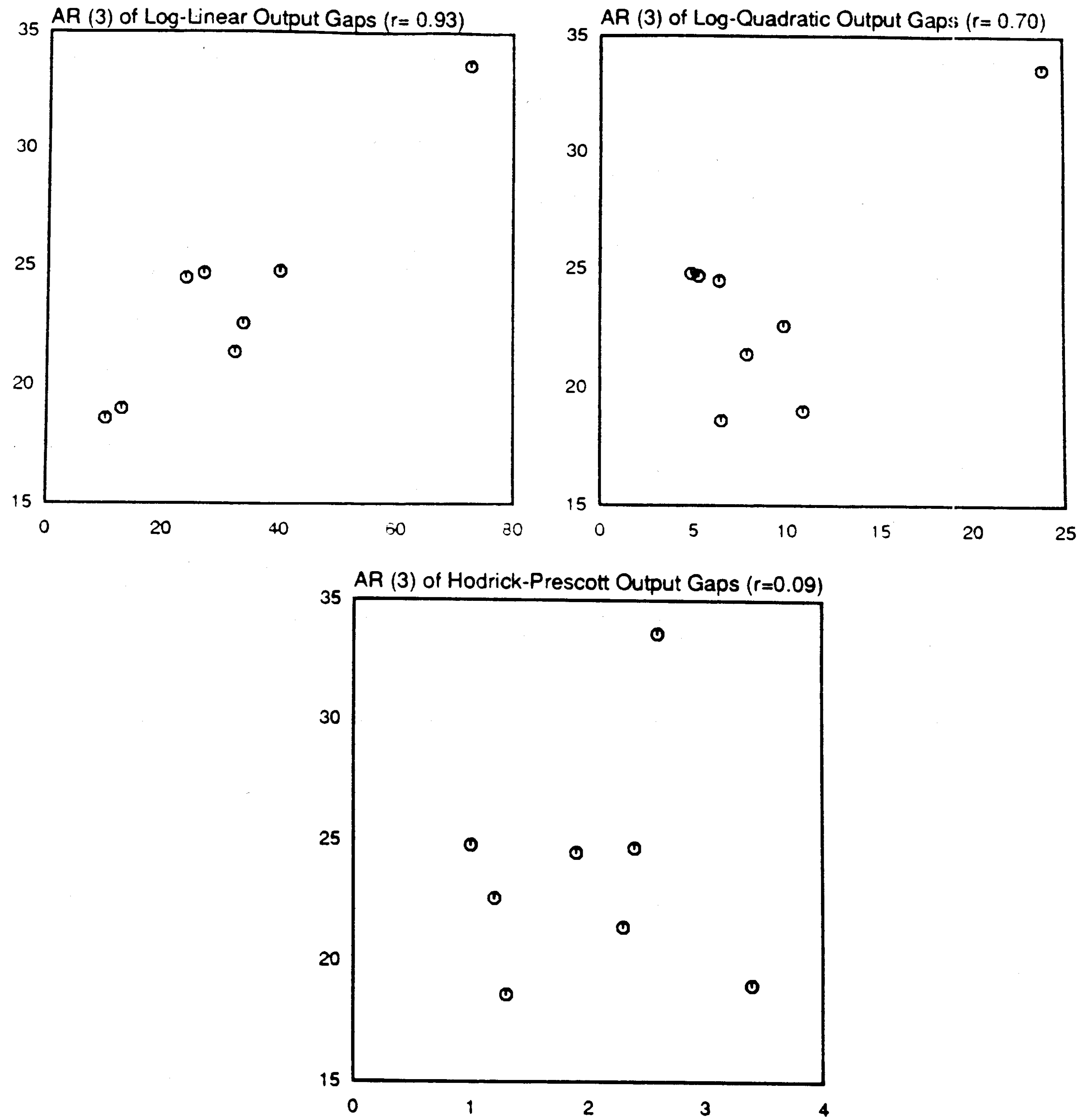
PERSISTENCE OF OUTPUT FLUCTUATIONS: 1960-1988
(Sum of moving-average coefficients
from estimated AR(3) processes)

Country	Log-linear trend	Log-quadratic trend	Hodrick-Prescott trend
United Kingdom	10.1	6.5	1.3
United States	12.9	10.9	3.4
Canada	32.4	7.9	2.3
Australia	33.8	9.9	1.2
Italy	23.9	6.4	1.9
Germany	27.0	5.3	2.4
France	40.0	4.9	1.0
Japan	72.7	23.9	2.6

Note: The persistence measures are obtained from estimated AR(3) processes of the deviations of the logarithm of real GDP from a time trend. A high sum implies a slow return to trend after a shock. The shock has a value of unity on impact after which the shock is set to zero. The moving-average representation was calculated for 90 lags.

Chart 4

Savings Rates and Persistence of Output Fluctuations *



*Savings rates are represented on the vertical axis and persistence of output fluctuations, as measured by the sum of the moving-average coefficients, are represented on the horizontal axis.

**r is the correlation coefficient between savings rates and persistence of output fluctuations.

TABLE 4

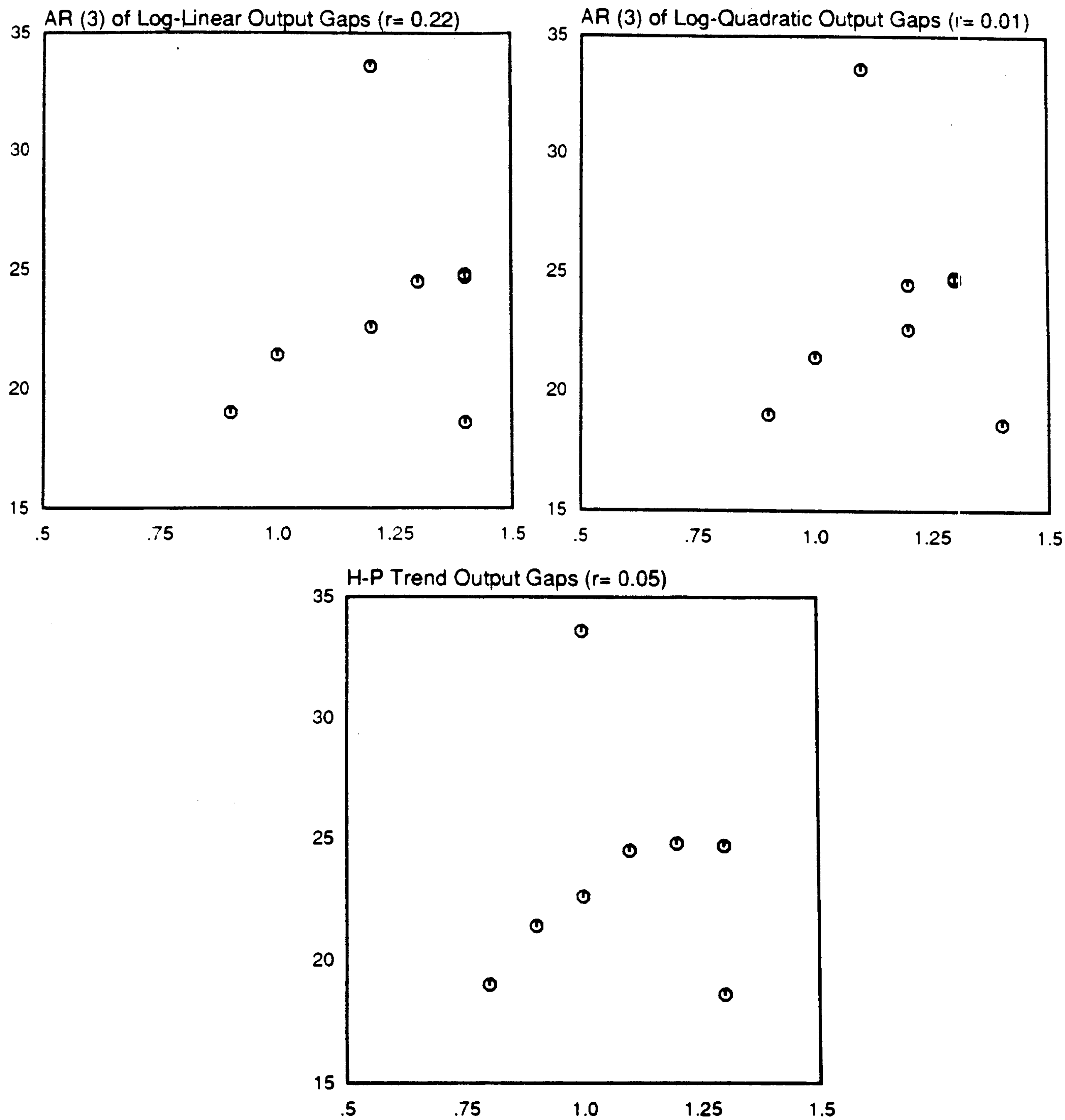
STANDARD DEVIATION OF ESTIMATED IMPULSES TO GDP
(percent of trend GDP)

Country	Log-linear trend	Log-quadratic trend	Hodrick-Prescott trend
United Kingdom	.014	.014	.013
United States	.009	.009	.008
Canada	.010	.010	.009
Australia	.012	.012	.010
Italy	.013	.012	.011
Germany	.014	.013	.013
France	.014	.013	.012
Japan	.012	.011	.010

Note: The impulses are the residuals from the estimated AR(3) processes for output gaps.

Chart 5

Savings Rates and Estimated Impulses *



*Savings rates are represented on the vertical axis and the standard deviations of the estimated impulses to GDP are represented on the horizontal axis.

** r is the correlation coefficient between savings rates and standard deviations of estimated impulses.

REFERENCES

Anderson, T.W., The Statistical Analysis of Time Series, J. Wiley and Sons, 1971.

Ando, A., and F. Modigliani, "The Life-Cycle Hypothesis of Saving," American Economic Review, March 1963.

Blanchard, O.J., "What is left of the Multiplier Accelerator?," The American Economic Review Papers and Proceedings, May 1981.

Burns, A. and W.C. Mitchell, Measuring Business Cycles, NBER, 1946.

Campbell, J.Y., and N.G. Mankiw, "Are Output Fluctuations Transitory?" The Quarterly Journal of Economics, Vol. 102, 1987, 857-80.

Clark, P.K., "Trend Reversion in Real Output and Unemployment," Journal of Econometrics, January, 1989.

Clark, P.K., "The Cyclical Component of U.S. Economic Activity," The Quarterly Journal of Economics, November 1987

Danthine, J.P. and J.B. Donaldson, "Stochastic Properties of Fast and Slow Growing Economies," Econometrica, Vol. 49, No. 4, July 1981.

DeLong, J. B. and L. H. Summers, "The Changing Cyclical Variability of Economic Activity in the United States," in The American Business Cycle, edited by Robert G. Gordon, NBER Conference Volume, University of Chicago Press, 1986.

Friedman, M., A Theory of the Consumption Function, Princeton, 1957.

Hodrick, R.J., and E.C. Prescott, "Post-War U.S. Business Cycles: An Empirical Investigation," Working Paper, Carnegie-Mellon University, November 1980.

Kendrick, J.W., ed., International Comparisons of Productivity and Causes of the Slowdown, Ballinger, 1984.

Leland, H., "Saving and Uncertainty: The Precautionary Demand for Saving," The Quarterly Journal of Economics, 1968.

Nelson, C.R., and C.I. Plosser, "Trends and Random Walks in Macroeconomic Time Series," Journal of Monetary Economics, Vol. 14, 1982, 139-62.

Samuelson, P.A., "The Interactions between the multiplier Analysis and the Principle of Acceleration," The Review of Economics and Statistics, Vol. 21, May 1939.

Taylor, J.B., "Differences in Economic Fluctuations in Japan and the United States: the Role of Nominal Rigidities," Journal of the Japanese and International Economies Vol. 3, p. 127-144, 1989.

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