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OUTPUT DYNAMICS OF THE G7 COUNTRIES - STOCHASTIC TRENDS AND CYCLICAL MOVEMENTS

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Abstract

Using a time series framework, the paper studies the interactions of the annual real per capita GDP data of the G7 countries. We find evidence of six common nonstationary processes behind the international output dynamics. In addition, there is evidence for the existence of a common business cycle among these countries. The trend and cycle components of each output series are obtained with a procedure that accounts for the presence of both the common nonstationary and cyclical factors. It is found that the relative variability and the correlation of the trend and cycle components are not similar across the G7 countries.

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I. Introduction

For both academic and policy considerations, long and short term comovements in real output data have been extensively analyzed in the literature. The issue of long-term output comovement bears significant implications for economic growth theories. Under standard assumptions, the neoclassical growth theory (Solow, 1956; Cass, 1965) predicts that the per capita output levels of countries with similar technologies and preferences converge to a common value in the steady state. The observed differences in per capita output, thus, are only a temporary phenomenon. A similar view on output convergence is shared by real business cycle models (Kydland and Prescott, 1982), which typically have productivity (technology) shocks as the main force behind economic growth. The persuasiveness of the output convergence hypothesis is, however, undermined by the advance of endogenous growth models (Romer, 1986). In this class of models, with endogenously evolving components, it is possible for economies not to converge to same per capita output levels.

The cross-section and time-series approaches are the two major methodologies used to examine the output convergence hypothesis. The relative merit of the time-series approach is advocated by Bernard and Durlauf (1996) and Durlauf and Quah (1998). Durlauf and Quah (1998) also offer a critical survey of studies on growth across countries. These authors propose that the unit root and cointegration tests are the natural time-series techniques to investigate the persistence, comovement, and convergence properties of international output data.

Bernard and Durlauf (1995) and Quah (1992) adopt the time-series approach to investigate convergence among national output data. Using the cointegration technique, Bernard and Durlauf find that there are more than one integrated process driving the output data of the 15 OECD countries. The result is considered as unfavorable to the convergence hypothesis. The existence of multiple growth factors is also reported in Lee (1998). Quah (1992) examines the unit root property of the per capita output data relative to those of the U.S. and also finds evidence against the convergence hypothesis.

The issue of cyclical output comovement is related to the transmission of business cycles across countries. In addition to common shocks, production and consumption interdependencies lead to the spillover of output fluctuations across national borders. It is widely perceived that the existence of common business cycles has important policy implications. For instance, the choice of optimal currency regime and the need for monetary integration crucially depends on business cycle comovements (Mundell 1961). Furthermore, the effectiveness of trade policies on stabilizing the local economy depends on whether there is a strong cyclical comovement across countries. A high correlation would render, for example, real exchange rate policies targeting the trade sector in the short run ineffective.

The empirical evidence on common business cycles is not unambiguous. Based on autocorrelation estimates, Campbell and Mankiw (1989) suggest the G7 countries do not share similar business cycles. Cheung (1994) uses the common feature technique and confirms Campbell and Mankiw's findings. Lumsdaine and Prasad (1997), on the other hand, adopt a time-varying weights scheme to construct the common component of national industrial production growth rates and report evidence for an international business cycle. Using a multi-country model, Canova and Marrinan (1998) find that the presence of a common shock and production interdependence play a crucial role in describing the cyclical dynamics of the de-trended output data from the U.S., Germany, and Japan. The effect of common shocks on international output comovements is also documented in Canova and Dellas (1993).

While these empirical studies offer mixed inferences on the interactions of international output dynamics, one common finding is the presence of both stochastic trends and cycles in national output data. It is useful to investigate both the long-term trends and cyclical dynamics simultaneously for at least two reasons. First, knowledge about the common long-run behavior is crucial for detecting the presence of common short-run components. Ignoring long-run interactions may lead to erroneous inference about short-run dynamics. Second, information on both long-run and short-run comovements can lead to a more efficient way to decompose the data into their trend and cycle components. One salient feature of our empirical exercise is to employ a coherent multivariate time series framework to investigate the presence of common growth factors and synchronized business cycles. This approach allows us to evaluate both the long-run and short-run international output dynamics in a consistent manner. Specifically, the cointegration technique (Engle and Granger, 1987) and the multivariate common feature test (Vahid and Engle, 1993) are used to study the output relationship. Using these techniques, we are able to decompose individual output series into their respective stochastic trend and cycle components (Vahid and Engle, 1993; Engle and Issler, 1995).

In the next section, we present the preliminary data analysis on the G7 output data. Section III reports the cointegration and common feature test results. There is evidence that the national output data tend to move together in the long run and there are multiple factors affecting long-term growth. Furthermore, a common business cycle is found among the G7 countries. The trend and cycle decomposition analysis is conducted in Section IV. The estimated U.S. cycle component is, in general, in accordance with the NBER dating of business cycles. However, the relative variability of the trend and cycle components is not the same across the G7 countries. Section V contains some concluding remarks.

II. Preliminary Analysis

The annual output data of the G7 countries; namely Canada, France, Germany, Italy, Japan, the U.K., and the U.S., from 1952 to 1997 are considered. Data on gross domestic product (GDP), consumer prices, and population were taken from the International Financial Statistics database to construct the log real GDP per capita (hereafter, output for short). As argued by Bernard and Durlauf (1996), the time series approach requires the countries under consideration are near their long-run equilibria and not dominated by the transition dynamics. Thus, our choice of a rather homogeneous group of developed countries is in accord with the maintained assumption of the time-series approach.

The output data are plotted in Figure 1. The series exhibit the upward trend commonly observed in output data. However, there are some discernible differences between these output paths. To determine the nature of the trending behavior, we formally test for the presence of unit roots (stochastic trends) in each of the seven output series. The augmented Dickey and Fuller (ADF) test allowing for both an intercept and a time trend is used. Let X_{it} be the country i's output at time t, where i = Canada, France, Germany, Italy, Japan, the U.K., and the U.S. The ADF test is based on the regression equation:

$$\Delta X_{it} = m_0 + m_1 t + aX_{it-1} + a_1 \Delta X_{it-1} + ... + a_p \Delta X_{it-p} + e_t , \qquad (1)$$

where   is the first difference operator and $_t$ is an error term. The Akaike information criterion (AIC) is used to determine p, the lag parameter.

Results of applying the ADF test to the data and their first differences are shown in Table 1. The null hypothesis of a unit root is not rejected for the data series and is rejected for the first differenced data. Thus, there is a unit root in individual output series. The unit root test result is consistent with both real business cycle and endogenous growth models. In a canonical real business cycle model, the stochastic output trend is driven by exogenous technological progresses. For an endogenous growth model, endogenous growth generating mechanism can induce I(1) nonstationarity to output data even in the absence of exogenous growth generating factors (Lau, 1999). In the subsequent analysis, we assume each output data series is difference-stationary.

The graphs of output growth rates are presented in Figure 2. There is considerable variation in the data. Nonetheless, the national output growth rates seem to display similar cyclical behavior and move in synchronization. Also, volatility appears to be lower towards the second half of the sample period. In Table 2, the numbers below the diagonal are the averages of growth differentials calculated as the average annual growth rates of the column country relative to the row country. The growth differentials indicate that there is some kind of catch-up phenomenon. Both the U.K. and U.S., which are the richer countries after World War II, have average growth rates lower than the other five countries. The sample correlation coefficients of output growth rates (numbers above the diagonal) cover a wide range from 0.09 (the U.S.-Italy pair) to 0.73 (the U.S.-Canada and France-Japan pairs). The geographic vicinity may be an explanation for the high correlation between the U.S. and Canada growth rates. Apparently, such an argument does not apply to the case of France and Japan. While Table 2 offers some insights on international output dynamics, more vigorous analyses of the interactions between these output data are given in the following sections.

III. Common Trend

Following Bernard and Durlauf (1995, 1996), we adopt the cointegration technique and apply the Johansen (1991) maximum likelihood procedure to determine the number of common stochastic trends in international output. The Johansen cointegration test is conducted as follows. Let $\mathbf{X}_t$ be the nx1 vector of national output at time t (in this exercise, n = 7). Suppose the dynamics of $\mathbf{X}_t$ can be modeled by a p-th order vector autoregression process:

$$\mathbf{X}_t = m + \sum_{i=1}^{p} g_i \mathbf{X}_{t-1} + e_t , \qquad (2)$$

where is the intercept term, and $_t$ is the vector of innovations. The Johansen test statistics are devised from the sample canonical correlations (Anderson, 1958; Marinell, 1995) between $\Delta\mathbf{X}_t$ and $\mathbf{X}_{t-p}$, adjusting for all intervening lags.

To implement the procedure, we first obtain the least squares residuals from

$$\Delta\mathbf{X}_t = m_1 + \sum_{i=1}^{p-1}\Gamma_i\Delta\mathbf{X}_{t-i} + e_{1t},$$

and

$$\mathbf{X}_{t-p} = m_2 + \sum_{i=1}^{p-1}\Gamma_i\Delta\mathbf{X}_{t-i} + e_{1t}, \qquad (3)$$

where m_1 and m_2 are constant vectors. The lag parameter, p, is determined by the AIC. Next, we compute the eigenvalues, $l_1 \geq \ldots \geq l_n$, of $\Omega_{21}\Omega_{11}^{-1}\Omega_{12}$ with respect to Ω_{22} and the associated eigenvectors, v_1, ..., v_n, where the moment matrices $\Omega_{ij} = T^{-1}\sum_t \hat{e}_{it}\hat{e}'_{jt}$ for i, j = 1, 2. l_i s are the squared canonical correlations between $\Delta\mathbf{X}_t$ and $\mathbf{X}_{t-p}$, adjusting for all intervening lags. The trace statistic,

$$t_r = -T\sum_{j=r+1}^{n}\ln(1 - l_j), \qquad 0 \leq r \leq n \qquad (4)$$

tests the hypothesis that there are no more than r cointegrating vectors. Note that the presence of r cointegrating vectors implies there are $n-r$ common stochastic trends driving the long-term dynamics. In testing the hypothesis of r against the alternative hypothesis of $r+1$ cointegrating vectors, we use the maximum eigenvalue statistic,

$$l_{r|r+1} = -T\ln(1 - l_{r+1}). \qquad (5)$$

The eigenvectors $v_1,\ldots,v_n$ are the sample estimates of the cointegrating vectors.

The trace and maximum eigenvalue statistics are reported in Table 3. Both the trace and maximum eigenvalue statistics suggest that the output data are cointegrated and there is one cointegrating relationship. The estimated cointegrating vector, with the coefficient of the Canadian output normalized to one, is reported in Table 5. The asymptotic t-statistics given in parenthesis indicate that the cointegrating coefficients are individually significant. Since countries have different output mixes and there is more than one stochastic trend (see below), it is very difficult to interpret the cointegrating vector. Nevertheless, the test result shows that all the seven output series are linked together in the long run via an empirical relationship specified by the cointegrating vector.

One crucial implication of the presence of one cointegrating vector is that, in the long run, the dynamics of the G7 output data is driven by six stochastic trend elements. The usual notion of convergence requires the existence of one and only one common stochastic trend (that is six cointegrating vectors in this case) in the system. Thus, the cointegration test result is at odds with the convergence hypothesis.

However, the presence of multiple stochastic trends may be consistent with a more general class of growth models.

The real business cycle model is widely perceived to imply output convergence at least for countries that are at a similar stage of economic and technological development. However, as observed by Durlauf (1989), if unit root persistence is generated by technology, it is likely to have different types of technological shocks affecting various sectors of an economy and, hence, its aggregate output. Further, differences in work habits, corporate cultures, and infrastructures can have persistent effects on output dynamics. Thus, it is not surprising to have more than one integrated technological shock behind output growth.

For the class of endogenous growth models, Lau (1999) offers conditions under which there is more than one common stochastic trend. Taylor (1999) develops a three-factor model to explain convergence. It appears that the presence of more than one growth factor is a theoretically viable alternative. Durlauf (1989) and Lucke (1998), in fact, document the existence of more than one sector-specific growth factor in the U.S. and German economies. King *et. al.* (1991) also cast doubt on the claim that the U.S. economy is dominated by a single permanent shock. Thus, the multitude of growth factors revealed by the cointegration test can be appropriately interpreted as an evidence of the plurality of growth factors determining national output in the long run.

IV. Common Cycle

In this section, we analyze the national output data for similar short-run cyclical movements. As short-run cyclical fluctuations are usually identified with correlation patterns, we employ the common feature test (Engle and Kozicki, 1993; Vahid and Engle, 1993) to detect the presence of common serial correlation patterns. The intuition behind the common feature analysis is as follows. Suppose the temporal dynamics of $\Delta\mathbf{X}_t$, a nx1 vector of I(0) output growth series (in this exercise, n = 7), are driven by a common stochastic process. The effect of this common stochastic component can be removed by choosing an appropriate linear combination of the elements of $\Delta\mathbf{X}_t$. Thus, the presence of a common serial correlation cycle implies the existence of a linear combination of output series that is not correlated with the past information set.

Since the national output series are cointegrated, the test for common features has to control for the long-run interactions in the data. The multivariate test procedure amounts to finding the sample canonical correlations between $\Delta\mathbf{X}_t$ and $\mathbf{W}(p) \equiv (\Delta\mathbf{X}'_{t-1}, \ldots, \Delta\mathbf{X}'_{t-p}, EC_{t-1})$, where EC_t is the error correction term given by $'\mathbf{X}_t$ and is the cointegrating vector. The inclusion of the error correction term in $\mathbf{W}(p)$ accounts for the effects of cointegration on the test (Vahid and Engle, 1993). The test statistic for the null hypothesis that there are at least s cofeature vectors (that is, the linear combinations that eliminate the common stochastic cycles) is

$$C(p, s) = -(T - p - 1)\sum_{j=1}^{s} \ln(1 - l_j), \qquad (6)$$

where l_n ³...³ l_1 are the squared canonical correlations between $\Delta\mathbf{X}_t$ and $\mathbf{W}(p)$. If s is the number of independent cofeature vectors, then the dimension of the cofeature space is *s* and the number of common cycles is given by *n – s*. Thus, the common feature test can reveal both the presence and the number of common serial correlation cycles. Under the null hypothesis, the statistic *C(p,s)* has a χ^2-distribution with *s + snp + sr – sn* degrees of freedom. The dimension (rank) of the cofeature space is equal to the number of statistically zero squared canonical correlations.

The common feature test results are reported in Table 4. The lag parameter, p, is equal to 2, which is the same as the one used in the cointegration test. The sample squared canonical correlations and the associated *C(p,s)* statistics suggest that there are six cofeature relationships in the system. The national output series respond to common transitory shocks such that some linear combinations of the growth series are unpredictable with respect to the history of the variables themselves. In other words, the short-term output variations in these countries are not independent from each other. This result is consistent with the similarity of cyclical growth behavior depicted in Figure 2. The estimated cofeature vectors and their respective t-statistics are reported in Table 5. Among 42 cofeature parameter estimates, only two are statistically insignificant. They are the Italy and UK estimates in the sixth cofeature vector. Overall, there is substantial evidence of common short-term innovations in international output.

The presence of six cofeature vectors implies the G7 countries share exactly one common serial correlation cycle. That is, there is only one common business cycle element among the G7 countries. The studies on international business cycle fluctuations usually allow for different channels for shock transmission and propagation. In addition to common shocks, the literature considers the effects of consumption and production interdependencies and country-specific disturbances (Canova and Marrinan, 1998; Glick and Rogoff, 1995; Kwark, 1999). The common feature test, however, indicates that there is only one common factor behind the cyclical behavior of the seven growth series. Even though there are different shock transmission channels, they appear to have similar implications for cyclical movements and lead to a common cycle among the G7 annual output data.

V. Trend and Cycle Decomposition

The finding of one cointegrating and six cofeature vectors constitutes an interesting special case. The number of cointegrating vectors and the number of cofeature vectors add up to the number of variables. In this case it is possible to perform a unique decomposition procedure to recover the stochastic trend and the cycle component of each output series. The rationale behind the trend-cycle decomposition can be illustrated using the common trend and common cycle representation, which is an extension of Stock and Watson (1988) common trend representation.

As the G7 output data have both common trends and cycles, it can be represented as

$$\mathbf{X}_t = \boldsymbol{dt}_t + \boldsymbol{y} c_t, \qquad (7)$$

where □$_t$ is a 6x1 vector of common I(1) trends and c_t is the common cycle. □ and *y* are coefficient matrices of appropriate orders. Let □ be the 7x1 cointegrating vector and $\tilde{b}$ be the 7x6 matrix containing the six cofeature vectors. Note that b is orthogonal to $\Box$ and $\tilde{b}$ is orthogonal to y. Define $\mathbf{B}' = (\tilde{b}\ b)$ and $\mathbf{B}^{-1} = (\tilde{b}^{-}\ b^{-})$, where the dimensions of $\tilde{b}^{-}$ and b^{-} are, respectively, 7x6 and 7x1. Hence,

$$
\begin{aligned}
\mathbf{X_t} &= \mathbf{B^{-1}B\ X_t} \\
&= \tilde{b}^{-}\,\tilde{b}'\mathbf{X_t} + b^{-}\,b'\mathbf{X_t} \\
&= \tilde{b}^{-}\,\tilde{b}'\Box\Box_t + b^{-}\,b'yc_t \qquad (8)
\end{aligned}
$$

The trend and cycle elements are given by $\tilde{b}^{-}\,\tilde{b}'\Box\Box_t$ and $b^{-}\,b'yc_t$. The decomposition is unique as **B** has a full rank. By construction the error correction term $'\mathbf{X_t}$ $(= 'yc_t)$ is the force behind the cycle components of the seven output series. The trend and cycle components are, in general, correlated (Vahid and Engle, 1993).

One unique feature of the decomposition algorithm is that it incorporates restrictions on both long-run and short-run dynamics in constructing the individual trend and cycle components. Given the existence of both cointegration and common features, it is desirable to account for these data interdependencies in extracting the components. The trend-cycle decomposition approach is in contrast with the strategy that assumes either a deterministic trend or a unit root stochastic trend to extract the individual cyclical components (Canova and Marrinan, 1998; Lumsdaine and Prasad, 1997).

The results of decomposing the national output series are summarized in Figure 3, Figure 4, and Table 6. The trend components graphed in Figure 3 appear quite different from each other. The distinctiveness of national output trends matches the result that there are six different integrated processes driving the output series. Some trend components display a higher level of volatility than the original output series. As seen in Table 6, for some countries, the correlation between the trend and cycle components are negative. Therefore, it is possible that the volatility of the trend component is higher than the output series.

For brevity, Figure 4 presents the cycle component of the U.S. data. The cycle components of the other six countries are a scaled version of the U.S. one. On the same figure, we superimpose the annual NBER chronology for recessions on the graph. The cyclical downturns derived from the decomposition procedure occur in the 1950s (three times), the early and mid-1970s, early 1980s, and early 1990s. The occurrences of these downturns are broadly consistent with the NBER dating of recessions.

The standard errors of the trend (in first differences, as the trend is I(1)) and cycle components are presented in Table 6. The result shows that the relative variability of the trend and cycle components varies across countries. Four countries (the U.S., France, Italy, and Canada) have a more volatile cyclical variation while two other countries (Germany and Japan) have a smoother cycle. The correlation between the two components is not uniform across countries. The trend and cycle are negatively correlated in Germany, Japan, the U.K., France, and Italy while they are positively correlated in the U.S. and Canada. Overall, the G7 countries exhibit different patterns of trend and cycle relationships.

VI. Conclusions

A unified time-series framework, which allows for both long-run and short-run interactions, is employed to study the relationships of the annual real per capita GDP data of the G7 countries. The cointegration test shows that international output data have more than one growth-generating factor. The result is consistent with growth models that have a multitude of driving forces behind the output dynamics. On cyclical behavior, we find evidence for the hypothesis that national business cycles are alike. While there may be different forces affecting national business cycles, the common feature test shows that the countries under consideration share one common cyclical element; a result that is supportive of the view that there are international business cycles. In assessing the relative variability of the trend and cycle components, we find some mixed results - the trend component has a higher level of variation in some countries but not in others. There are also ambiguous findings on the correlation between the two components. While the trend and cycle components in five countries are negatively correlated, they tend to move together in the other two countries.

While the empirical results reported in the previous sections offer some information on international output dynamics and economic growth models, there are still a few issues that should be addressed in future research. For instance, even if there is evidence on the presence of a multitude of growth factors and an international business cycle, little empirical evidence on the macro determinants of the growth factors and the common cycle element has been firmly established. Further, it is of interest to investigate the factors affecting the relative importance of shocks and their correlation patterns. It is recognized that the identification and the extraction of the relevant components of the macro variables can be a controversial issue. However, information on the role of macro variables and their relationships with the trend and cycle components are indispensable for a better understanding of economic growth.

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Table 1. Unit Root Test results

	Levels	First Differences
Canada	-0.94 (3)	-4.29* (1)
France	-0.86 (2)	-3.21* (2)
Germany	-1.63 (2)	-4.86* (2)
Italy	-0.39 (2)	-4.35* (3)
Japan	-1.94 (3)	-3.91* (2)
U.K.	-2.33 (3)	-3.92* (1)
U.S.A.	-2.11 (2)	-4.45* (2)

Note:
The ADF test statistics calculated from the levels and first differences of the annual real per capita GDP data are reported. The lag parameters selected by the Akaike information criterion are in parentheses next to the statistics. "*" indicates significance at the five percent level (Cheung and Lai, 1995). The unit root hypothesis is not rejected for the data series but is rejected for their first differences.

Table 2. Growth Differentials and Correlations

	USA	UK	JAP	ITA	GER	FRA	CAN
USA		0.54	0.23	0.09	0.25	0.30	0.73
UK	-0.0047		0.38	0.29	0.51	0.44	0.32
JAP	-0.0307	-0.0259		0.62	0.57	0.73	0.18
ITA	-0.0249	-0.0202	0.0057		0.62	0.68	0.22
GER	-0.0168	-0.0121	0.0138	0.0080		0.66	0.32
FRA	-0.0120	-0.0073	0.0186	0.0129	0.0048		0.27
CAN	-0.0046	-0.0007	0.0260	0.0203	0.0122	0.0074	

Note:
The numbers below the diagonal are the averages of growth differentials calculated as the average annual growth rates of the column country relative to the row country. The sample correlation coefficients of the growth rates are given above the diagonal.

Table 3. Cointegration Test Results

H(0)	Trace Statistic	Maximum Eigenvalue Statistic
r = 0	159.74*	56.32*
r = 1	103.41	39.37
r = 2	64.04	24.03
r = 3	40.00	16.43
r = 4	23.57	12.36
r = 5	11.21	9.74
r = 6	1.46	1.46

Note:
The trace and maximum eigenvalue statistics computed from the multivariate system consisting of the G7 countries real per capita GDP are reported. The lag parameter is set to two according to the Akaike information criterion. Only the null of no cointegrating relationship (r = 0) is rejected (Cheung and Lai, 1993).

Table 4. Test for Common Features

Null Hypothesis	Squared Canonical Correlation	Statistic C(p,s)	Degree of Freedom
s = 1	0.08	3.30	9
s = 2	0.18	11.11	21
s = 3	0.31	25.32	33
s = 4	0.40	44.84	58
s = 5	0.53	74.12	65
s = 6	0.62	111.56	84
s = 7	0.91	205.95*	105

Note:
The common feature test results are reported. The degree of freedom of the $C(p,s)$ is calculated with n = 7, r = 1 and p = 2. "*" indicates significance at the five percent level.

Table 5. Estimated Cointegrating and Cofeature Vectors

	USA	GER	JAP	UK	FRA	ITA	CAN
Cointegrating Vector	1.60 (1.92)	-1.12 (-9.19)	0.05 (8.20)	0.92 (1.74)	-0.20 (-2.79)	0.65 (7.13)	1 (10.00)
Cofeature Vector 1	1 (2.15)	0.25 (1.68)	-0.33 (-1.77)	0.12 (0.37)	-1.60 (-3.70)	-0.10 (-0.44)	-1.06 (2.88)
Cofeature Vector 2	-6.23 (-2.87)	1 (2.00)	2.83 (2.71)	-5.02 (-2.39)	-3.79 (-3.79)	4.16 (2.10)	1.96 (3.39)
Cofeature Vector 3	2.16 (3.45)	0.15 (2.03)	1 (3.69)	-0.86 (2.77)	-2.65 (-4.57)	1.40 (3.89)	-2.07 (-4.14)
Cofeature Vector 4	-0.25 (-4.12)	0.20 (2.56)	0.36 (4.21)	1 (3.57)	0.62 (-5.09)	-1.12 (-4.18)	-0.54 (-4.77)
Cofeature Vector 5	-0.23 (-4.87)	-0.37 (-3.22)	-0.18 (-4.83)	0.15 (4.39)	1 (5.10)	-0.01 (4.50)	-0.33 (-5.33)
Cofeature Vector 6	-2.92 (-5.35)	-1.86 (-3.88)	1.25 (5.20)	1.69 (4.61)	-0.29 (-5.53)	1 (-4.51)	-1.02 (-5.71)

Note:
The estimated cointegrating and cofeature vectors and their respective asymptotic t-statistics (in parentheses) are reported.

Table 6: Variability and Correlation of the trend and cycle components

	USA	GER	JAP	UK	FRA	ITA	CAN
Standard Error Trend (1st diff)	0.014	0.057	0.043	0.041	0.049	0.029	0.013
Cycle	0.030	0.038	0.021	0.041	0.127	0.052	0.046
Correlation	0.42	0.33	-0.28	-0.20	-0.14	-0.23	0.15

Note:
The standard errors and correlations of the trend (in first differences) and cycle components are reported.

Figure 1. Annual real per capita GDP, in Logs

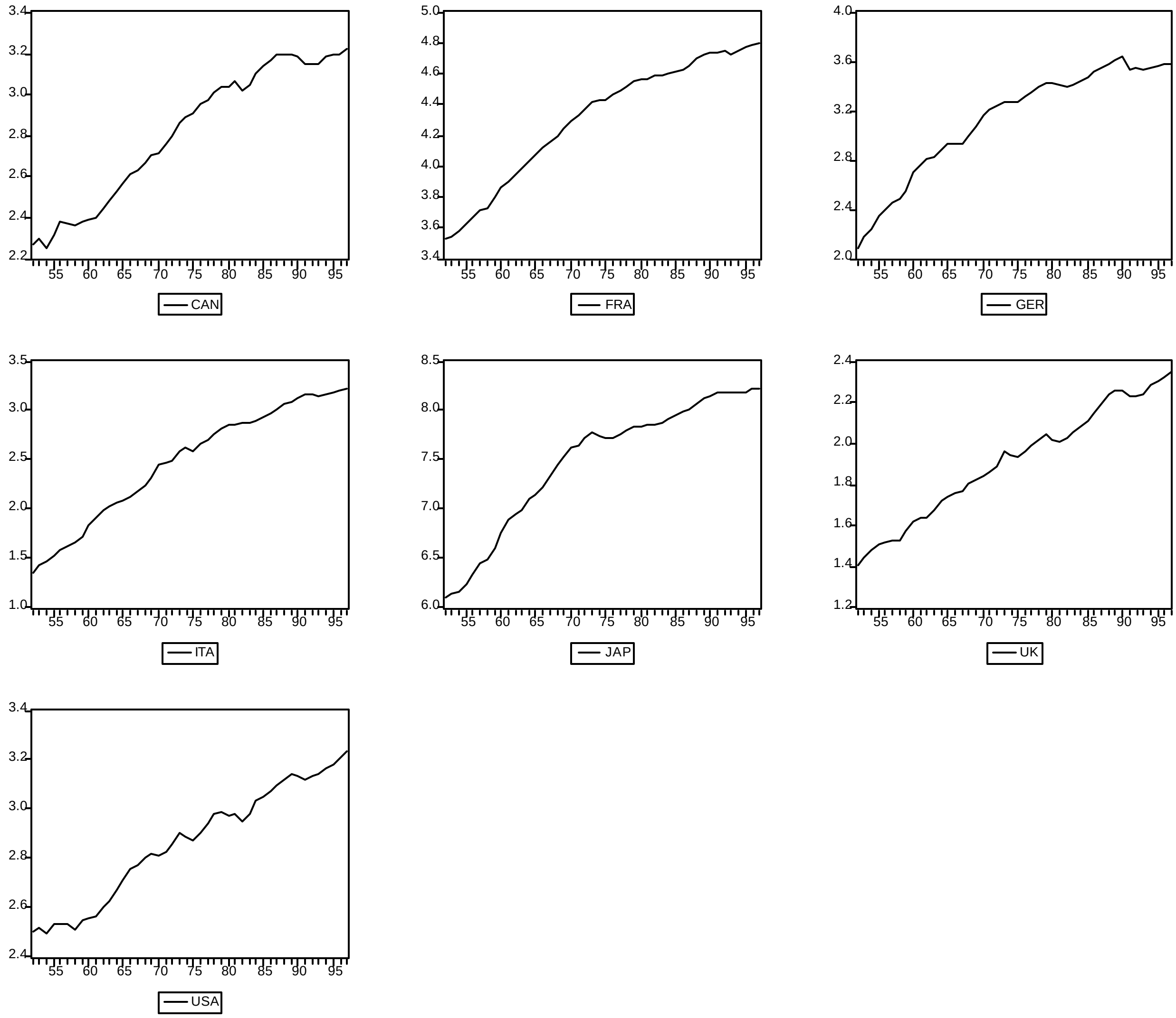


Figure 2. Annual real per capita GDP Growth

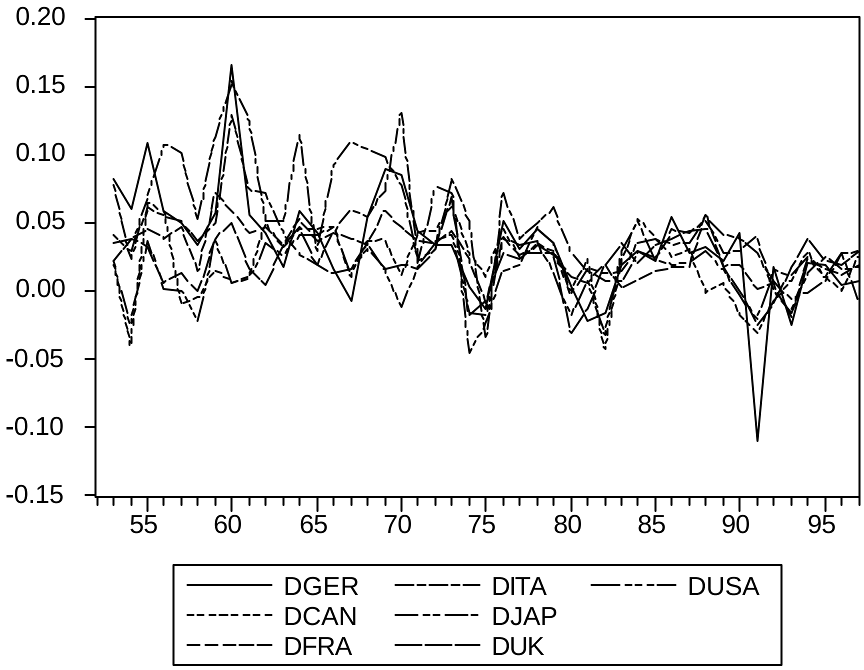


Figure 3. Output Trends of the G7 countries (normalized)

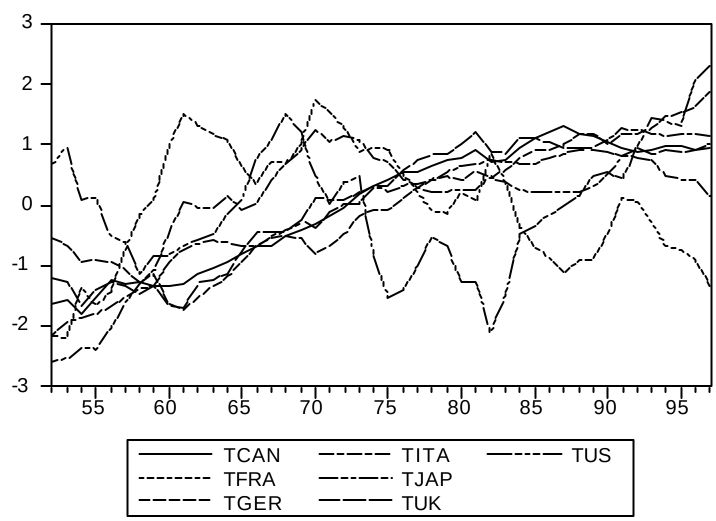
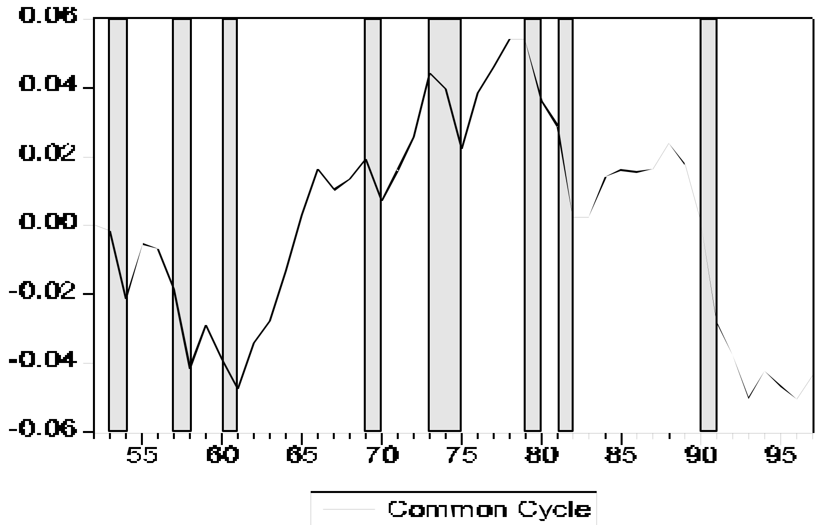


Figure 4. The Cycle Component of the U.S. Output



Note:
The solid line traces the cycle component of the U.S. output. The shaded areas denote recessions according to the NBER dating scheme (U.S. Department of Commerce, Survey of Current Business, October 1994, Table C-51).