WP/00/210

IMF Working Paper

The U.K. Business Cycle, Monetary Policy, and EMU Entry

Zenon G. Kontolemis and Hossein Samiei

INTERNATIONAL MONETARY FUND

 WP/00/210

IMF Working Paper

European I Department

The U.K. Business Cycle, Monetary Policy, and EMU Entry

Prepared by Zenon G. Kontolemis and Hossein Samiei [1]

Authorized for distribution by Juha Kähkönen and Alessandro Zanello

December 2000

Abstract

In the context of the U.K. government's EMU entry condition of cyclical convergence, this paper (i) provides further evidence suggesting that historically the U.K.'s business cycle has been more volatile than, and relatively independent of, the cycles in the euro-area countries; and (ii) identifies, using a small VAR model, a relatively significant role for monetary policy in explaining these differences. A simulation exercise suggests that if the U.K. interest rates had been more closely aligned with those in the euro area in the 1990s (as they would be if the United Kingdom were to join EMU), output growth might have been less volatile and more correlated with that in the euro area, but inflationary pressures might have persisted.

JEL Classification Numbers: E32, E37, E50, F02

Keywords: business cycles, EMU, monetary policy

Author's E-Mail Address: ZKontolemis@imf.org, SSamiei@imf.org

---

[1] European I Department, International Monetary Fund, 700 19th Street, NW, Washington DC 20431. This paper was presented at the *Money, Macro, and Finance Conference*, London, September 2000. The authors are grateful to the conference participants, as well as Michael Artis, Sharmini Coorey, Michael Deppler, Julio Escolano, Bob Ford, Bob Hagemann, Alessandro Leipold, Ramana Ramaswamy, and Alessandro Zanello for helpful discussions; and to Lina Annab and Sergei Antoshin for research assistance.

Contents | Page

I. Introduction

In 1997, the U.K. government announced five economic tests that would need to be met before entry into the Economic and Monetary Union (EMU) (H.M. Treasury, 1997). These tests require sustainable convergence between the United Kingdom and the EMU countries so that a unified interest rate policy would make economic sense; sufficient flexibility in the United Kingdom to cope with economic change; and grounds to believe that EMU will have favorable effects on investment, the financial services industry, and employment.

Of these five tests, the first—the compatibility of business cycles—has been accorded prominence by both the authorities and outside commentators: it appears to be sufficiently well defined and it is the only one that clearly depends on the relative cyclical position of the U.K. economy. The other tests, by contrast, are more structural in nature and unlikely to be influenced by policy in the short term. It is also harder to decide if they have been met.[2] The significance of the convergence test is heightened by the contention that historically U.K. business cycles have been more volatile than, and not particularly synchronized with, those of the EMU members (Figure 1).[3] The implication is that cyclical convergence may not occur naturally by the time that the United Kingdom may seriously contemplate joining. A stated aim of the government elected in May 1997 has been to give a higher priority to policies that enhance macroeconomic stability, which may help in terms of eventually achieving sustainable cyclical convergence.

This paper examines the properties of the U.K. business cycle in order to put the convergence criterion in the relevant context, and assesses the role of monetary conditions in the shaping of the cycle and influencing the likelihood of cyclical convergence.[4] The paper provides further evidence suggesting that the business cycle in the United Kingdom is more correlated with those in North America than in Europe, although shocks to output are not synchronized with those in either region. The results also demonstrate that the U.K. business cycles have not only been out of line vis-à-vis those in major European countries, but they have also been, on average, deeper and more volatile than elsewhere (see also H.M. Treasury, 1998).

Cycles in the U.K. may differ from those on the continent for principally three reasons: different policies or exogenous variables, different transmission mechanisms, and different idiosyncratic shocks. In algebraic terms, suppose that output reacts to policy (and exogenous) variables in the

---

[2] Indeed, it has been suggested by commentators that all five criteria are too broad and vague to have any real operational content, see Buiter (1999).

[3] See, for example, Engle and Kozicki (1993); Christodoulakis, Dimelis, and Kollintzas (1995); Artis, Kontolemis, and Osborn (1997); Artis and Zhang (1995); and Artis (1999).

[4] The paper does not present a cost benefit analysis of the U.K.'s EMU membership. Some contributions to that end include Currie (1997), Artis (1999), Artis and Ehrmann (2000), and Escolano (2000).

following fashion: $y_{i,t} = A_i Z_{i,t} + \eta_{i,t} + e_t$ where the subscript i refers to country, Z_t is a vector of the explanatory variables, $\eta_{i,t}$ an idiosyncratic or country specific shock, and e_t is a common shock. In this framework differences in policies, in transmission mechanisms, and in country-specific shocks are, respectively, reflected in differences in Z_t, A_i, and $\eta_{i,t}$. This paper examines only the role of monetary policy and exogenous variables in this regard. Clearly, different transmission mechanisms and/or idiosyncratic shocks could also play important roles.[5]

Estimation results from a co-integrating VAR model of the U.K. economy are presented to provide evidence that monetary conditions have significantly contributed to GDP fluctuations. For example, the downturn during 1990-92 is largely explained by movements in the interest rate and the exchange rate. These results emphasize the need, recognized by the authorities, for actively pursuing policies that strengthen the medium-term focus of monetary and fiscal policies.[6]

The paper uses the estimated model to analyze, using a simulation exercise, the implications of alternative monetary policy rules in output fluctuations. In particular, the paper attempts a counterfactual exercise to assess the view that "if national monetary shocks are an important contributor to cyclical divergence, it could be expected that the formation of a monetary union itself could create a tendency for greater business cycle symmetry to emerge" (Buiter, 2000). More specifically, the exercise assesses the implications of the U.K. interest rates being more closely aligned with those in the euro area—as they would be under EMU—during the sample period. The results suggest that output could have been less volatile and more correlated with the euro-area business cycle, but inflationary pressures would have persisted. Indeed, since interest rates have been generally higher in the United Kingdom than in the euro area, this result could be interpreted as suggesting that higher output volatility and lower synchronization have in part resulted from efforts to contain relatively more persistent inflationary pressures in the United Kingdom, especially prior to 1992.

The paper does not address in depth the appropriateness of cyclical convergence as a criterion for EMU entry. While, there could even be advantages in requiring the opposite—countries with different cyclical positions may benefit from the resulting counteracting influences—the case in favor of the criterion is clearly strong: cyclical convergence, in particular to the extent that it implies convergence in policies, would indicate suitability for currency unification; it would also help ensure a smooth transition by diminishing the likelihood of exchange rate misalignment caused by cyclical differences. Note also that the paper does not attempt to examine the full

[5] See Christodoulakis, Dimelis and Kollintzas (1995) for evidence on idiosyncratic shocks in European countries, Britton and Whitely (1997) and Ramaswamy and Sloek (1997), and references therein, on the transmission mechanism.

[6] See H.M. Treasury (1997), which suggests that macroeconomic policy has historically had a destabilizing impact on the U.K. economy.

Figure 1. GDP (Constant Prices)

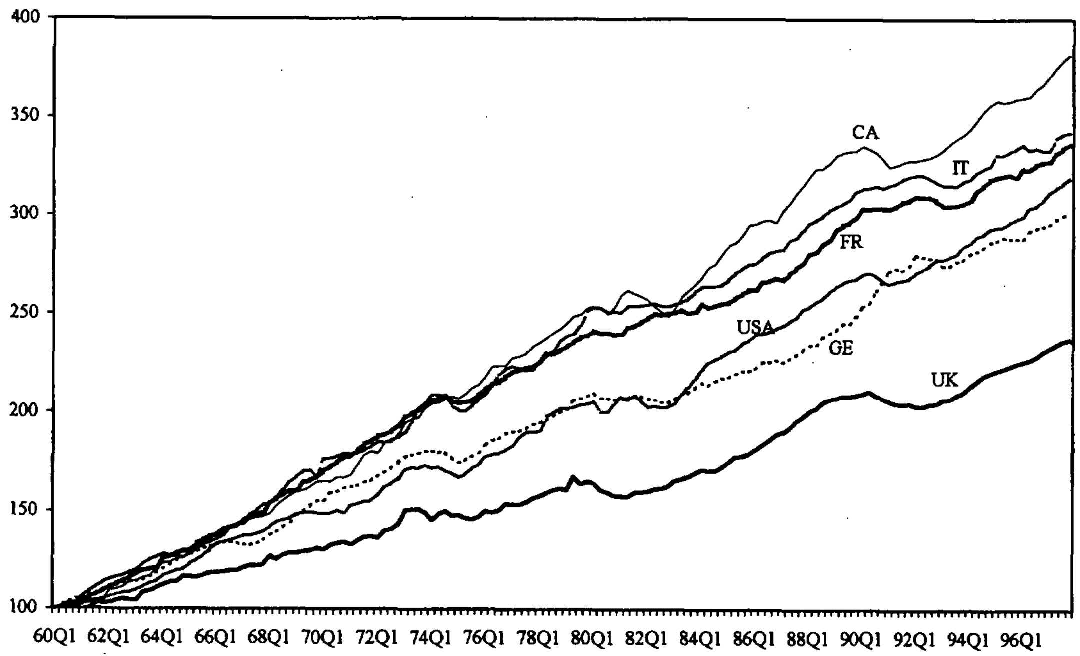
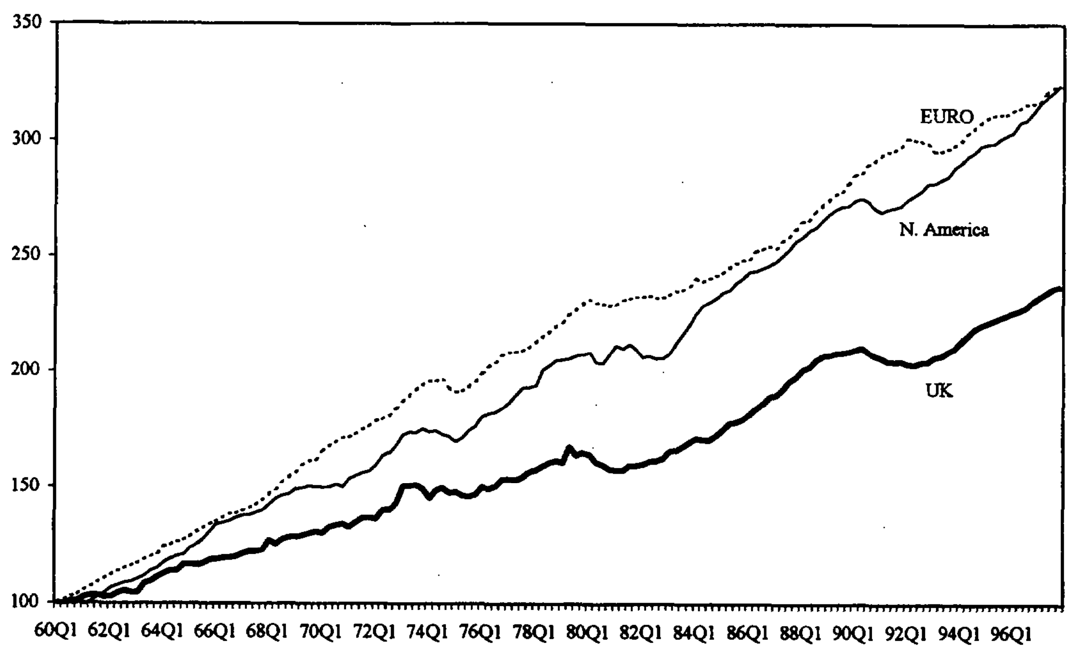


Figure 2. Aggregate GDP (Constant Prices)



implications of EMU membership but rather focuses on policies during the 1980s and 1990s.[7]

The paper is organized as follows. Section II discusses the properties of the U.K. business cycle.Section III estimates a VAR model of the U.K. economy. Section IV discusses the role of monetary conditions in the cycle and presents some simulation results. Section V concludes.

II. Properties of the U.K. Business Cycle

According to conventional wisdom, the U.K. business cycle is more correlated with those in the United States and Canada than with any of the core euro-area countries' cycles (Artis and Zhang, 1995, Bayoumi and Eichengreen, 1992, and Artis, 1999, and references therein). In this section we provide further support for this hypothesis in the case of GDP growth cycles (output gaps, growth rates, or business cycle turning points), but find that shocks to output are relatively independent of those in both regions. We also show that U.K. business cycles are more volatile and have a longer duration than cycles in most other European countries or in North America.

Synchronization between cycles

Decomposing GDP into cycles and other components is inevitably hampered by definitional uncertainties. In general terms a time series may comprise three types of components: trends, cycles—both of which may include stochastic terms—and shocks. There are no generally acceptable methods to separate these components and different methods often yield apparently different results. While one may set criteria that help in choosing from among the various methods, depending on the particular features of the cycle that one is interested in, there is clearly a great degree of arbitrariness.[8]

To enhance the reliability of the results, we use two different approaches. The first uses the Hodrick-Prescott (HP) filter to define "growth cycles" as deviations from the trend. This concept of the cycle is closely related to the output gap. An HP filter (with a parameter of 1600) is applied to quarterly GDP at constant prices for the United Kingdom, United States, Canada, Germany, France, and Italy for the period 1960:1-1997:4.[9] The second method identifies and compares business cycle turning points using a simple two-consecutive change rule. The method allows a separate examination of the characteristics of expansions and contractions while avoiding the de-trending component of methods such as the HP filter, which may, under certain conditions, induce spurious cycles (see King and Rebello, 1993, and Osborn, 1995, for example). A binary time series variable is defined for each country, denoting periods of expansion with

---

[7] See also Barrell and Dury (2000) who, using a large macro model (NiGEM), find that under EMU membership output volatility could in fact *increase* as a result of the loss of the interest rate and exchange rate as shock absorbers.

[8] See Canova (1998), for a critical discussion of the arbitrariness inherent in using various de-trending methods; and Burnside (1998) for a defense of the conventional methodology.

[9] The data, which are from the IMF database, are available on request.

ones and contraction with zeros.[10] These binary variables are then used to obtain an alternative correlation measure—based on Pearson's contingency coefficient—that compares downturns and upturns directly across countries (see Artis, Kontolemis and Osborn, 1997, for details).

The results from using these two methods, reported in Table 1, appear to be in conformity. They demonstrate that GDP (growth) cycles in the United Kingdom are more closely correlated with those in the United States and Canada than with those in Germany, France, or Italy. Similar results hold for correlations between the United Kingdom and aggregates for North America (United States and Canada) and the euro area (France, Germany, and Italy).[11]

An alternative approach to comparing cycles is to examine shocks to GDP. While correlation between business cycles is an indicator of the degree of integration between different economies, the appropriateness of a currency union also depends on the extent to which shocks to GDP are symmetric. A simple way to examine this question is to extract business cycle shocks from the residuals of autoregressive models for GDP. The results, reported in Table 1 (in parentheses), suggest that correlation between shocks is generally low among industrial countries, although shocks to the U.K. GDP appear to be marginally more correlated with those in the euro area than with those in North America. While the analysis does not attempt to identify the various sources of shocks to GDP, differences in policies are likely to have contributed significantly to these symmetries.[12]

Volatility of cycle

The U.K. business cycles have not only been out of line vis-à-vis those in major European countries, they have also been, on average, deeper and more volatile than elsewhere. Detailed results presented in Tables A1 and A2 of the Appendix suggest that the variance of the U.K.'s GDP growth (over the period 1960-97) is significantly higher than those in France, Germany, and Italy (Figure 2). For example, it is twice as high as that in France. In addition, as a result of the higher frequency and severity of recessions, the cumulative decline during all downturns (defined as two consecutive absolute declines) has been higher in the United Kingdom, and GDP has increased by a smaller degree over the period (83 percent, compared with 115 percent in the United States, 130 percent in Canada, and 115 percent in France).[13] Furthermore, comparing the

---

[10] Turning points are obtained if any two or more consecutive observations are above the mean growth (upswing) or below the mean (downswings). The classification into binary zero-one variables makes similarities and differences appear more pronounced.

[11] Aggregation is carried out using PPP weights from the WEO database.

[12] See Bayoumi and Eigengreen (1992) and Artis (1999), who identify supply and demand shocks using bivariate VAR models of output and prices for a number of European countries, and provide some evidence suggesting that supply shocks are more correlated within Europe than between Europe and the United Kingdom.

[13] For example, the ratio of the cumulative decline of GDP in the United Kingdom, during all recessions to total growth, was 19.1 compared with 3.1 for France.

Table 1. GDP Growth Cycles and Shock (in parentheses) Correlation Coefficients

	UK	US	CA	FR	GE	IT	Euro	N. Am.
	Correlation Coefficients of GDP Growth Cycles and Shocks (in parentheses) 1/							
UK	1							
US	0.58	1						
	(0.19)							
CA	0.54	0.74	1					
	(0.19)	(0.31)						
FR	0.47	0.31	0.28	1				
	(0.26)	(0.13)	(0.07)					
GE	0.26	0.33	0.19	0.48	1			
	(0.33)	(0.24)	(0.06)	(0.35)				
IT	0.24	0.22	0.26	0.55	0.29	1		
	(-0.01)	(0.04)	(0.06)	(0.38)	(0.02)			
Euro	0.38	-	-	-	-	-	1	
N.America	0.58	-	-	-	-	-	-	1
	Contingency correlation coefficients of business cycles regimes 2/							
UK	1	0.63	0.43	0.22	0.17	0.14	0.60	0.18
GE	0.17	0.36	0.41	0.73	1	0.51	-	-

1/ Growth cycles are defined in terms of deviations of GDP from trend (extracted by the HP filter); Shocks extracted from GDP series by fitting an AR(2) process.

2/Correlations of business cycle regimes (downturns/upturns) identified using a "2-consecutive-change(quarter)" rule (see Table A1 for details).

three "common" cycles for the major industrial countries over this period (with downturns during 1973-75, 1980-82, and 1990-93) reveals the longer duration of the downturns in the United Kingdom in comparison with the other countries. For example the 1990-93 recession lasted eight quarters in the United Kingdom compared with three in the United States, four in Germany, and five in Italy.

III. MONETARY CONDITIONS AND THE CYCLE: A STRUCTURAL VAR ANALYSIS

This section estimates a system of cointegrating structural VAR in order to assess the contributions of monetary policy and the exchange rate to the business cycle in the United Kingdom (for examples of alternative VAR models for the U.K. economy see Henry and Pesaran, 1993; Garratt et al, 1997; Doornik and Hendry, 1994; Lane and van den Heuvel,1998).[14] We use a relatively simple model of the macroeconomy involving six variables: money, GDP, domestic nominal interest rates, foreign nominal interest rate, real effective exchange rate, and inflation. Three long-run relationships are identified and estimated: in the money market the exogenous stock of money is in the long run equal to money demand, which is expressed as a function of income and the interest rate; perfect capital mobility requires that domestic and foreign interest rates are equalized; and finally in the goods market, deviation of actual output from potential is determined by the interest rate and the real effective exchange rate with three long-run relationships.

The above relationships are assumed to hold in a cointegrating sense in the long run and stationary short-run deviations are permitted. The second stage of the modeling exercise involves the specification and estimation of these short-run dynamic relationships. Inflation could not be satisfactorily incorporated in the long-run analysis as an I(1) variable, and is introduced in the short-run relationships as an I(0) variable.[15] Under this assumption, excluding it from the cointegration analysis would not be a problem even if, in principle, it could influence both the demand for money and output long-run equations—although, our results did not appear to suggest that this was the case. While ADF tests may suggest that inflation is an I(1) variable, this is not be reasonable from a theoretical point of view.[16] Mean reversion is also an essential property if the monetary authority is to have any control over the inflation rate.

---

[14] Clearly, any exercise of this kind would by nature be tentative because of the large degree of arbitrariness that exists in choosing from among competing VAR specifications. In particular, the need for identifying restrictions inhibit a thorough cross comparison of alternative VARs.

[15] A number of different specifications with the inflation rate were explored but none provided a reasonable long-run structure. Moreover, including the real interest rate (as opposed to the nominal rate) was not supported by the data either and the over-identifying restrictions were strongly rejected.

[16] While, one could make the same argument about the nominal interest rate, which we treat as I(1), our tests suggested that this variable has an autocorrelation coefficient closer to unity than inflation.

The model estimated in this section is used in Section IV to compare different hypothetical scenarios arising from alternative monetary policy rules that may be relevant in assessing business cycle synchronization and the likely impact of EMU membership.

A. The Long-Run Model

The Johansen cointegrating methodology is employed to estimate the five-variable VAR system (see, for example, Johansen, 1988a,b and 1995; Hendry, 1995; Doornik and Hendry, 1997, and references therein). Denoting by z_t the vector that includes all the variables of interest, the vector autoregressive (VAR) system takes the form:

$$z_t = \sum_{i=1}^{m} \pi_i z_{t-i} + cD_t + v_t$$

where D_t is a vector of deterministic terms. This can be written in the error correction form as:

$$\Delta z_t = c_1 + \sum_{i=1}^{m-1} \pi_i^* z_{t-i} + \alpha(\beta' z_{t-1} + \gamma' t) + v_t$$

if $\alpha(\beta' z_{t-1} + \gamma' t)$ is I(0), that is, if there exists at least one cointegrating vector between the variables in z_t. The term in parentheses represents the error correction term, with β being the cointegrating vector and α measuring the response to long-run disequilibrium.

We present results for a model with $z = [m, y, i, i^*, e]$ corresponding to, respectively, real money, real GDP, three-month domestic interest rate, three-month foreign interest rate (trade-weighted average of interest rates from France, Germany, Italy, Japan, the Netherlands, and the United States), and the real effective exchange rate defined as the price of domestic currency times relative prices. All variables are in logarithms, except for the interest rates:

$$m - y = -\beta_{11} i + \beta_{12} t + c_1,$$
$$i = i^* + c_2,$$
$$(y - \beta_{31} t) = -\beta_{32} i - \beta_{33} e + c_3,$$

where t is a time trend and c_1, c_2, and c_3 are stationary error terms. Income homogeneity is imposed in the money demand equation; interest rate arbitrage is assumed to hold in the long run;[17] and potential output is assumed to grow at a constant rate in the long run. The cointegrating system includes intercepts and restricted time trends,[18]

[17] The uncovered interest parity condition implies a relationship between the interest rate spread and expected depreciation of the exchange rate. But the latter variable is stationary and it may be removed from the interest rate parity equation in the long run to avoid complications.

[18] The trend is restricted in order to avoid inducing a quadratic trend in the levels of these variables while still allowing for a drift in the equations in first differences.

Table 2. Model Diagnostics and Cointegration Tests

	m	v	i	e	i*	VAR
			Residual Correlations			
M	1					
Y	0.23	1				
I	-0.05	-0.05	1			
E	-0.15	-0.14	-0.25	1		
i*	-0.12	0.05	0.29	-0.13	1	
			Diagnostic Tests			
Standard error-σ	0.019	0.006	0.005	0.085	0.002	
$F_{ar}(5,96)$	0.60	1.93	0.41	1.51	3.70**	
$\chi^2(2)_{norm}$	0.12	3.59	2.53	1.14	1.32	
$F_{het}(62,38)$	0.71	0.68	0.56	0.63	1.06	
$F_{ar}(125,359)$						*1.13*
F_{het} (930,425)						0.54
$\chi^2(10)_{norm}$						9.89
			Cointegration Tests			
r	*0*	*1*	*2*	*3*	*4*	
μ		0.27	0.21	0.19	0.0	
Max	43.9**	33.3*	29.1*	7.8	4.4	
Tr	118.8**	74.8**	41.4	12.2	4.4	

Table 3: Long-Run Relationships

	Endogenous i*	Exogenous i*
	Money Demand	
m	1.00	1.00
y	-1.00	-1.00
i	7.04	7.00
e		
i*		
t	0.006	0.007
DM4	0.275	0.266
	Interest Rate Arbitrage	
i	1.00	1.00
i*	-1.00	-1.00
	Excess Demand	
y	1.00	1.000
t	-0.005	-0.006
i	0.91	1.000
e	0.23	0.250
Over-identifying Restrictions	12.3 [0.05]	24.60[0.064]

Table 4: The Error-Correction Model

	Δm	Δy	Δi	Δe	Δp
Δm_{t-1}	0.420	0.136			-0.136
Δm_{t-2}		0.113	0.100	-0.226	0.150
Δm_{t-3}	0.212				-0.060
Δm_{t-4}	-0.131			0.300	0.092
Δm_{t-5}	0.226	0.089			-0.066
Δy_{t-1}	-0.079			0.289	0.118
Δy_{t-2}	0.127	-0.091		-0.653	
Δy_{t-3}		0.121	0.163	-0.432	0.069
Δy_{t-4}		-0.127	-0.124		0.074
Δy_{t-5}	0.124			-0.358	-0.143
Δi_{t-1}	-0.375		0.279	0.486	0.310
Δi_{t-2}		-0.192	-0.110		
Δi_{t-3}	-0.163	0.073			0.219
Δi_{t-4}	0.373		-0.087	-0.494	-0.234
Δi_{t-5}			0.120		0.191
Δe_{t-1}	-0.070	0.055			0.019
Δe_{t-2}		0.024		-0.092	-0.030
Δe_{t-3}	-0.030	0.042	0.048		0.044
Δe_{t-4}					-0.027
Δe_{t-5}		0.034	0.042	-0.121	
Δi^*_{t}		0.135	0.537	-1.038	-0.125
Δi^*_{t-1}	0.292	0.249		1.068	-0.302
Δi^*_{t-2}	-0.262	-0.192	-0.287		0.164
Δi^*_{t-3}		0.172	0.114		
Δi^*_{t-4}		-0.251		0.597	
Δi^*_{t-5}		-0.096	-0.340	1.722	
Δp_{t-1}	0.370	0.190	0.112	0.613	0.344
Δp_{t-2}	-0.697		0.118	-0.438	0.192
Δp_{t-3}	0.451			-0.320	-0.151
Δp_{t-4}		-0.160	-0.207	0.590	0.714
Δp_{t-5}				-0.455	-0.318
		Error Correction Terms			
$CI_{1,t-1}$	-0.056	0.027	-0.008	-0.106	0.009
$CI_{2,t-1}$	0.075	0.104	-0.149	1.221	-0.085
$CI_{3,t-1}$	0.146	-0.242	0.044	0.000	0.007
		Dummies			
Doil	-0.019	-0.016	0.005	0.0388	0.0143
Dout		0.023			
Dm4	0.054				
Di	-0.022	0.010	0.034	-0.050	0.0152
De			-0.007	-0.080	
Constant	-1.102	1.542	-0.298	-0.466	
T	0.000	0.000			
		Equation Diagnostics (p-values)			
s.e.	0.011	0.007	0.007	0.027	0.008
AR	2.28	2.17	2.30	2.19	1.73
Norm	0.79	5.92	2.76	0.54	3.97
ARCH	1.63	1.28	0.97	1.03	4.59*
		System Diagnostics (p-values)			
AR 1-5			0.690		
Normal			0.197		

as well as five dummy variables essential to provide normally distributed error terms.[19]

Table 2 shows the cross-correlations among the residuals from the VAR equations and the standard diagnostic tests. These suggest that the system is well specified: the residual correlations are all low, and the tests for serial correlation, normality, and heteroskedasticity, and the analogous system tests do not indicate any major statistical problem.[20] Standard and recursive Chow tests, moreover, show that the estimated parameters are stable throughout the sample. The test for cointegration using the Johansen procedure produces three relatively large eigenvalues—μ in the tabulation below—and suggests two, possibly three, cointegrating vectors. Based on the theoretical framework discussed earlier, we chose three rather than two cointegrating vectors. A visual examination of the residuals from these three equations does not indicate obvious signs of nonstationarity.

The detailed results for the cointegration exercise are shown in column 1 of Table 3. The table includes estimates for the cointegration coefficients (β-matrix) with the normalizations and restrictions that will identify unique cointegrating relationships. The results are broadly in line with expectations. In the money demand equation, the interest rate coefficient is equal to -7, similar to that estimated in Hendry and Doornik (1995) and Ericsson, Hendry and Mizon (1998); and in the output gap equation the interest rate and exchange rate coefficients are around –1 and –¼, respectively. Note, however, that these coefficients cannot be interpreted as elasticities because of the cointegration property.[21] The parameters of the estimated moving average impact matrix, however, which provides the long-run effects on the variable of interest resulting from a unit shock, could be more easily interpreted as estimates of the long-run elasticities. These are about –1¾ and –½, respectively, for the interest rate and the exchange rate in the output gap equation.[22]

[19] Two of these dummy variables (Dout and Doil), introduced in Hendry and Mizon (1993), Engle and Hendry (1993) and Hendry and Doornik (1994), represent proxies for the "Heath-Barber" boom and the initial effects of the Thatcher government, and the two oil shocks. Dout is zero except for 1972:4, 1973:1 and 1979:2. Doil is zero except in 1973:3, 1974:4, and 1979:3. Two dummies to account for abrupt exchange rate (De) and interest rate (Di) changes–including the ERM crisis in 1992–were included as well as a dummy variable for a break in the M4 series in 1997 (Dm4). These dummy variables were introduced unrestricted in the VAR.

[20] The only exception is the equation for i*, which shows some signs of residual autocorrelation. This is not unexpected given that this variable should more appropriately be treated as exogenous—see below.

[21] This implies that a change in one variable will, by definition, be followed by a change in the other variables in the cointegration space.

[22] With regard to other elasticities, note that, given the assumed income homogeneity in the money demand relationship and the long-run interest rate parity, the model implies that money and income move closely together while in the long run domestic interest rates are independent of other domestic variables.

For the purpose of the remainder of the analysis, we re-estimate a simpler version of the model treating foreign interest rates as exogenous. In estimating this model, we also impose the restrictions (based on the original model) that the coefficients on the interest rate and exchange rate are 1 and ¼ respectively (not rejected at the 5 percent level). The cointegrating relationships obtained from this model are reported under column 2 of Table 3. We define the monetary conditions index as MCI = $i + \frac{1}{4} e$ and separate this term in order to highlight the role of monetary conditions in the U.K. business cycle in the next section.[23]

B. Dynamic Error Correction Model and the Interest Rate Rule

In this section, using the cointegrating relationships reported under column 2 of Table 3, we estimate a dynamic error correction model which, in addition to real money, GDP, interest rate, and the real effective exchange rate, includes an equation for inflation. Since the cointegration property is invariant to the specification of the short-run model and inflation could not be included in the analysis as an I(1) variable such a modeling strategy is justifiable. The estimated model reported in Table 4 is derived after eliminating insignificant variables from each equation while ensuring the absence of serial correlation in the estimated system. The diagnostic tests show that the model is well specified and reject the presence of autocorrelation or heteroskedasticity in the residuals. The recursive analysis and Chow tests show further that the model is stable throughout the sample. The results suggest, in particular, that a rise in output growth or in the output gap (actual minus potential, adjusted for monetary conditions, as represented by the third error-correction term) would raise inflation and lower output growth in future periods. The latter result implies that, other things being equal, output tends to revert to trend over time.

A significant result of the short-run estimation is the interest rate equation. This can be treated as an interest rate rule for the U.K. economy, obtained as a natural byproduct of the cointegrating VAR estimation of the model. According to this rule, the interest rate responds to the three error-correction terms, which can be interpreted, respectively, as disequilibrium in the money market, interest rate differential with abroad, and the output gap relative to what is justified by monetary conditions (the interest rate and the exchange rate):

$$\Delta i_t = -0.008(m_s - m_d)_{t-1} - 0.149(i - i^*)_{t-1} + 0.044(ygap - MCI)_{t-1} + Other\ \ terms$$

where MCI (monetary conditions index) = ¼ e + i. Thus the interest rate rises (falls) if money demand exceeds (falls short of) supply, or if the interest rate is below (above) foreign interest rates, or if the output gap is larger (smaller) than justified by monetary conditions. This can be considered as a variation on the Taylor-type rule, where the interest rate adjusts procyclically to

[23] This is in line with the weights used to construct monetary conditions indices for the United Kingdom (see *World Economic Outlook*, May 1998, for example), although the nominal interest rate is used here.

the output gap for given inflation. This interest rate rule will be used in the next section to examine alternative monetary policy scenarios.

IV. Monetary Conditions and EMU Entry: A Simulation Exercise

The model estimated in the previous section reveals that monetary conditions have been crucial in determining the U.K. business cycle (see also Figure 3 below). To throw light on the possible implications of EMU entry for the business cycle, this section simulates the effects of alternative monetary policy rules on output and inflation. The question of interest is: How would the U.K. business cycle have been different, if the U.K. authorities had followed an interest rate policy more in line with that in Europe? [24]

With more integration, the U.K. monetary authorities would follow more closely monetary policy in the euro area. In terms of the interest rate rule described above, this would require that the impact of the interest rate spread on the U.K. interest rate would be stronger. We conduct dynamic simulation exercises under three different sets of parameters: the baseline scenario using the estimated coefficient for the interest rate spread of 0.15; the partial accommodation scenario with the feedback coefficient equal to 0.4; and the (almost) full accommodation scenario where the feedback coefficient is set equal to 0.99.

The simulated values are obtained by computing dynamic forecasts using initial values for the first quarter of 1970:

$$\Delta z^s_{T+h} = \hat{c}_1 + \sum_{i=1}^{m-1} \hat{\pi}^*_i z^s_{T+h-i} + \hat{\alpha}(\hat{\beta}' z^s_{T+h-1} + \hat{\gamma}' t) + \sum_{j=1}^{n} \hat{\theta}_j x_{T+h-j},$$

for T=1970:1, ...,1998:4, where x_t is the set of exogenous variables, the superscript s denotes the simulated values of an endogenous variable, and m and n respectively denote the orders of lags of the endogenous and exogenous variables (see Doornik and Hendry, 1997. p. 205).

[24] Since the foreign interest rate variable used in the analysis includes those in the U.S. and Japan, the analysis does not simulate precisely the effects of closer ties to the euro area. However, rather than complicating the analysis by separating the European components, we note that the i* used in the analysis and the "euro interest rate" have been highly correlated during the sample period.

Figure 3. Simulations: GDP Growth and the Role of Monetary Conditions

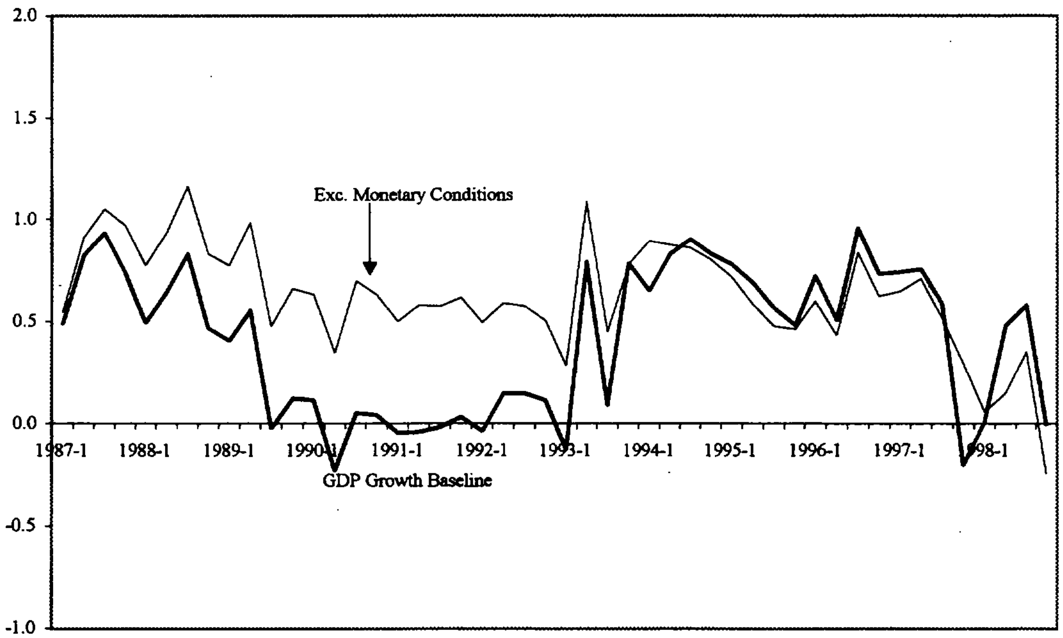
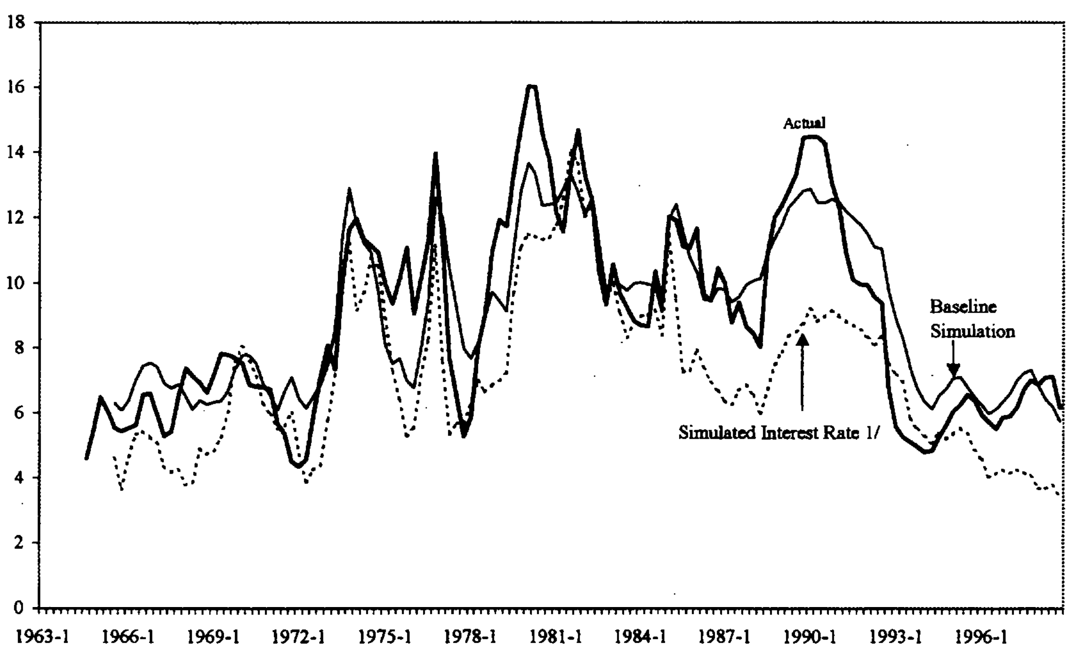
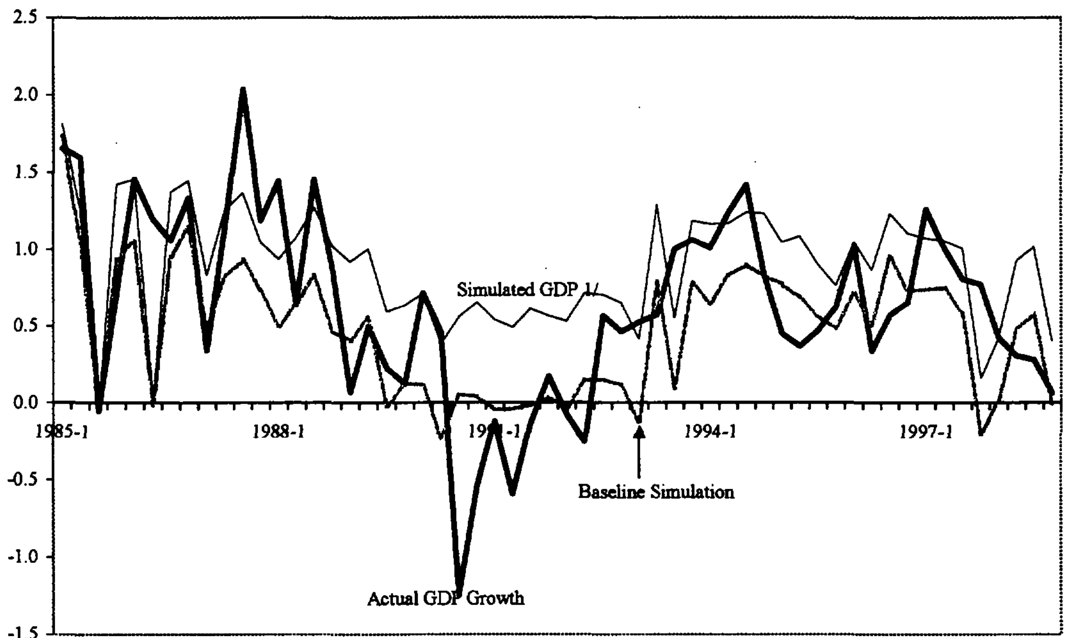


Figure 4. Simulations: Interest Rate and GDP Growth



1/ Simulation based on full accomodation to foreign interest rate

Figure 5. Simulated GDP Growth (quarter-on-quarter rates)



1/ Simulation based on full accomodation to foreign interest rate

Figure 6: Simulated Inflation Rate

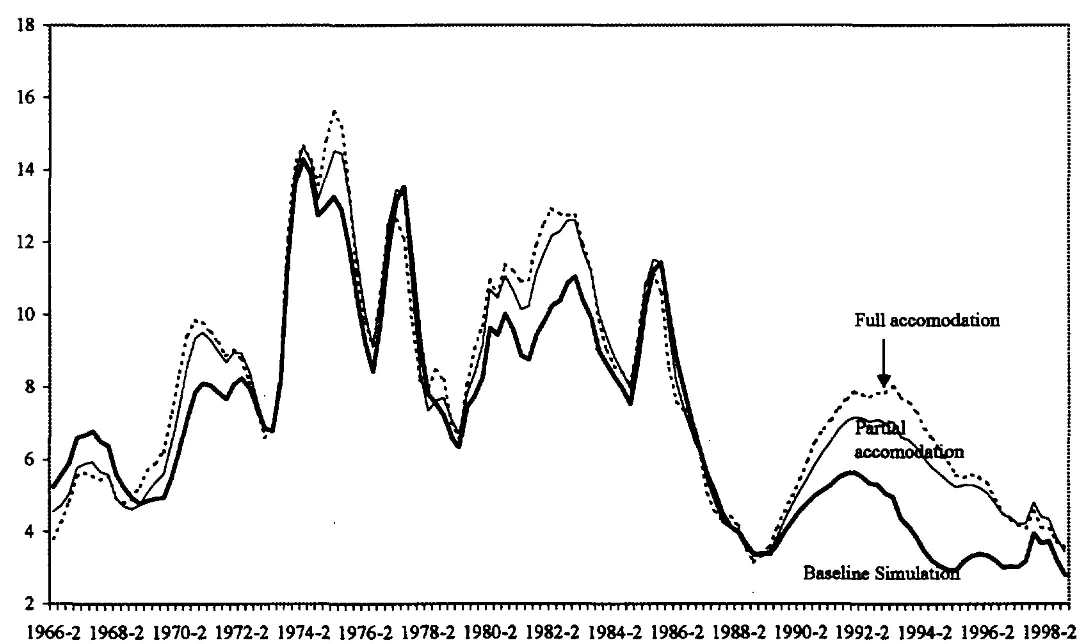


Table 5. Simulations

	Baseline	Partial Accommodation	Full Accommodation
		MEAN	
		Quarter-on Quarter percent Changes	
Output	0.41	0.78	0.86
Interest Rate	-0.09	-0.09	-0.07
Exchange Rate	1.00	-0.55	-0.89
Inflation	1.00	1.30	1.38
		Deviation from Baseline	
Output		0.37	0.45
Interest Rate		0.00	0.02
Exchange Rate		-1.55	-1.89
Inflation		0.30	0.38
		COEFFICIENT OF VARIATION 1/	
Output	0.88	0.41	0.35
Interest Rate	4.73	3.98	5.46
Exchange Rate	1.72	3.18	1.90
Inflation	0.31	0.29	0.34
		Deviation from Baseline	
Output		-0.47	-0.53
Interest Rate		-0.75	0.74
Exchange Rate		1.46	0.19
Inflation		-0.02	0.03

1/ Standard deviation divided by the mean

Table 6. Cross-Country GDP Correlations Based on Simulations 1/

	US	CA	FR	GE	IT
Baseline GDP	0.674	0.544	0.404	0.48	0.244
Simulated GDP 1/	0.643	0.521	0.454	0.539	0.319
% change	-4.6	-4.2	12.4	12.3	30.7

1/ Correlations of GDP de-trended series

2/ Simulated GDP based on full accommodation to foreign interest rate.

Before we examine the above alternative scenarios, to illustrate the importance of monetary conditions Figure 3 plots the simulated values for GDP using the estimated error-correction model for output, as well as the simulated values of the same model excluding the error correction term containing the monetary conditions variable. This shows clearly that monetary conditions have mattered, especially in explaining the downturn in the 1990-91 period.

Figure 4 shows actual and simulated interest rates under the three alternative scenarios discussed above. It is clear that when interest rates are more in line with foreign interest rates the simulated rates are significantly lower both during the 1987-91 period and more recently during 1996-98. Figures 5 and 6 plot the simulated GDP growth and inflation over the period 1985-1998. The simulation results suggest, not surprisingly, that both GDP growth and inflation would have been higher under the alternative scenarios of lower interest rates associated with closer ties with Europe. Table 5 shows the means and coefficients of variations of the simulated variables over the period 1987Q1-1998Q4 under the baseline and the two alternative simulation scenarios. It also includes deviations from the baseline values. Output variability is significantly lower under both alternative scenarios, while inflation volatility remains more or less unchanged.

To examine the implications for output synchronization, Table 6 shows correlations of growth cycles (corresponding to those in Table 1, albeit for a slightly shorter period) based on the simulated GDP series with full accommodation to the foreign interest rate. These show that under the simulated scenario the correlations of the U.K. GDP growth cycles, with those on the continent increase significantly—in the case of France and Germany by about 12 percent, and in the case of Italy by about 30 percent. These results should be treated with the usual degree of caution appropriate for this type of analysis, especially as far as EMU membership is concerned, which involves not only closely aligned interest rates (assumed in the above simulations) but also fixed intra euro-area exchange rates. Nevertheless, they have interesting implications for policy decisions in the United Kingdom. In particular, they could be interpreted as suggesting that higher output volatility and lower output growth in the past may have been caused by the need to contain the higher inflationary pressure in the United Kingdom relative to the average in Europe.

V. Conclusions

This paper provides evidence supporting the view that output fluctuations in the United Kingdom have been larger than in other major industrial countries, and relatively independent of those in major European countries. Estimation results from a cointegrating VAR system identify important roles for the interest rate and the exchange rate in generating output fluctuations. This is particularly the case during the downturn of the early 1990s and the upswing that followed it. The results also provide evidence that if interest rates had been more in line with those in European countries, output fluctuations might have been lower within the sample period and the business cycles more synchronized. They suggest, however, that inflationary pressures would have persisted under such a policy, thus creating a dilemma for policy makers. The implied tradeoff between output variability and inflation would, under a monetary union with no independent monetary policy, need to be addressed with appropriate fiscal and structural policies. To this end, the labor market reforms and the disciplined fiscal policies of recent years must have contributed notably to an improvement in this tradeoff.

While the results provide a case for adopting policies that enhance the likelihood of convergence, they also indicate the need for some pragmatism in making the entry decision. Divergence in the past has, in part, been the result of independent monetary policies and, perhaps, different inflation behavior. Entering a monetary union itself should create a tendency for greater business cycle synchronization (see also Buiter, 2000). Hence, the timing of the entry decision and the entry rate will remain key issues. The evidence presented in this paper suggest that stability-oriented macroeconomic policies are likely to increase the chance of achieving sustainable convergence but cannot be expected to necessarily weaken the impact of idiosyncratic shocks.

APPENDIX: Business Cycle Correlations

Table A1. Counts and Correlation of Business Cycle Regimes (Relative to Mean) for the UK and Germany 1/ [25]

	N00	N01	N10	N11	Cramer-C coefficient
			UK		
US	54	18	19	57	0.63
CA	45	27	23	53	0.43
FR	39	33	29	47	0.22
GE	40	32	33	43	0.17
IT	46	26	41	35	0.14
			GERMANY		
US	46	27	27	48	0.36
CA	45	28	23	52	0.41
FR	56	17	12	63	0.73
IT	57	16	30	45	0.51
			UK vs North America. EURO		
North America	52	20	19	57	0.60
Euro	37	35	29	47	0.18
			North America vs Euro		
North America	44	25	22	55	0.45

1/ A downturn (upturn) regime is denoted by 0 (or 1) and is defined as two consecutive declines (increases) below (above) the mean. Nij, i,j=0,1 denotes the number of occurrences (quarters) of regime i in UK (or Germany in the middle panel) and regime j in the other countries.

[25] See Artis, Kontolemis and Osborn (1997). *2x2* contingency tables for a pair (country i, country j) over the sample period are constructed recording expansion/contraction frequencies, denoted by n_{00}, n_{01}, n_{10} and n_{11}. A zero subscript denotes a downturn and a one an upturn. Thus, n_{00} denotes the number of coincidence of downturns, and so on. To examine correlation using this method, the Pearson's contingency coefficient is used. This is expressed as a percentage and corrected to lie in the range 0 to 100. This coefficient is defined as:

$$CC=\sqrt{\frac{\hat{\chi}^2}{N+\hat{\chi}^2}}, where\ \hat{\chi}^2=\sum_{i=0}^{1}\sum_{j=0}^{1}\frac{(n_{ij}-n_{i.}n_{.j}/N)^2}{n_{i.}n_{.j}/N}$$

For a *2x2* table, this maximal value is √½ and one obtain a statistic which lies between 0 and 100, namely C_{olr}. This corrected contingency coefficient has a straightforward interpretation as a correlation measure (for details see Sachs, 1984 and Siege and Castellan, 1988).

Table A2. Business Cycle Characteristics

GDP growth - Descriptive statistics (1960:1-1997:4) 1/

	UK	US	CA	FR	GE	IT	Euro	N. America
Mean	0.57	0.76	0.88	0.80	0.72	0.81	0.76	0.80
Variance	1.13	0.86	0.96	0.54	0.62	1.07	0.41	0.77
Skewness	0.47**	-0.24	0.45**	0.21	-0.21	0.55**	-0.62**	-0.24
Excess Kurtosis	2.67**	1.14**	0.90**	1.92**	0.21	2.73**	1.22	1.21**

Cumulative change in GDP (per cent) 2/

	UK	US	CA	FR	GE	IT
(1)growth	83.1	115	130	115.9	103.5	114.5
(2) decline	-16.1	-12.5	-9.6	-3.6	-8.3	-10.3
Ratio (2)/(1)*100	19.1	10.9	7.4	3.1	8.0	9.03
No of recessions	9	6	3	2	4	6

Duration and depth of major recessions (quarters, percent) - GDP 3/

	1973-75		1980-83		1990-93	
	Duration	Depth %	Duration	depth %	Duration	depth %
UK	2	-3.8	6	-4.6	8	-3.6
US	3	-3.1	2.4	-2.5.-3.0	3	-2.0
CA			2.6	-1.3.-5.2	4	-3.0
FR	2	-1.9	-	-	2	-1.6
GE	4	-3.2	5	-1.7	4	-2.1
IT	4	-4.1	4.2	-1.0.-0.6	5	-1.9

*1/ ** denote significance at 5 percent level*

2/ Based on 2-consecutive change rule (below/above zero)

3/ Cycles defined with 2-consecutive change rule (below/above zero)

4/ In some countries, the United States and Canada in particular, experienced two recessions during the period 1980-83. This result for the United States is in line with the official NBER classification of two short recessions in that period.

Bibliography

Artis, M.J. and Ehrmann M. (2000), "The Exchange Rate—A Shock-Absorber or Source of Shocks? A Study of Four Open Economies", CEPR Discussion Paper No. 2550.

Artis, M.J. (2000), "Should the UK join EMU?", *National Institute Economic Review*, No. 171, pp. 70-81.

Artis, M. J., Kontolemis, Z.G., and Osborn, D.R. (1997), "Business Cycles for the G7 and European Countries", *The Journal of Business*, Vol. 70, No. 2, pp. 249-279.

Artis, M.J. and Zhang, W. (1995), "International Business Cycles and the ERM: Is There a European Business Cycle?", *International Journal of Finance and Economics*, No. 2, pp. 1-16.

Barrell, R. and Dury, K. (2000), "Choosing the Regime: Macroeconomic Effects of UK entry into EMU", National Institute of Economic and Social Research, Discussion Paper No 168.

Bayoumi, T. and Eichengreen, B. (1992), "Shocking Aspects of European Monetary Unification", CEPR Discussion Paper No. 643.

Britton, E. and Whitley, J. (1997), "Comparing the Monetary Transmission Mechanism in France, Germany, and the United Kingdom: Some Issues and Results", *Bank of England Quarterly Bulletin,* (May), Vol. 37, No. 2.

Buiter, W. B. (1999), "Britain and EMU", Bank of England mimeo., February.

Buiter, W.B. (2000), "Optimal Currency Areas: Why Does the Exchange Rate Matter?", CEPR Working Paper No. 2366.

Burnside, C. (1998), "Detrending and Business Cycle Facts: A Comment", *Journal of Monetary Economics*, No. 41, pp. 513-532.

Canova, F. (1998), "Detrending and Business Cycle Facts", *Journal of Monetary Economics*, No. 41, pp. 475-512.

Christodoulakis, N., Dimelis, S. and Kollintzas, T. (1995), "Comparisons of Business Cycles in the EC: Idiosyncrasies and Regularities", *Economica*, No. 62, pp. 1-27.

Currie, David (1997), " The Pros and Cons of EMU", *H.M. Treasury*, July.

Doornik, J.A. and Hendry, D.F. (1994), "Modelling Linear Dynamic Econometric Systems", *Scottish Journal of Political Economy*, Vol.41, pp. 1-33.

Doornik, J.A. and Hendry, D.F. (1997), *Modeling Dynamic Systems Using PC Fiml 9.0 for Windows*, International Thompson Publishers.

Engle, R.F. and Kozicki, S. (1993), "Testing for Common Features", Journal of Business and Economic Statistics, Vol.11, No.4, pp. 369-395 (with discussion).

Ericsson, N.R., Hendry, D.F. and Mizon, G.E. (1998), "Exogeneity, Cointegration and Economic Policy Analysis", *Journal of Business and Economic Statistics*, Vol.16, pp. 370-387.

Escolano, J. (2000), "Costs and Benefits of Joining the EMU", IMF Staff Country Report, No. 00/106.

Garratt, A. Lee, K., Pesaran, M.H. and Shin, Y. (1997), "A Long Run Structural VAR Model of the UK Economy", mimeo, University of Cambridge.

Hendry, D.F. (1995) *Dynamic Econometrics*, Oxford:Oxford University Press.

H.M. Treasury (1997), "U.K. Membership of the Single Currency", October.

H.M. Treasury (1998), "Delivering Economic Stability: Lessons from Macroeconomic Policy Mix", *The Pre-Budget Report,* November.

Johansen, S. (1988a), "Statistical Analysis of Cointegrating Vectors", *Journal of Economic Dynamics and Control,* No. 12, pp. 231-54.

Johansen, S. (1988b), "Maximum Likelihood Estimation and Inference on Cointegration—with Applications to the Demand for Money", *Oxford Bulletin of Economics and Statistics,* No. 52, pp. 169-210.

Johansen, S. (1992), "Testing Weak Exogeneity and the Order of Cointegration in UK Money Demand", *Journal of Policy Modelling,* No. 14, pp. 313-34.

Johansen, S. (1995), Likelihood-Based Inference in Cointegrated Vector Autoregressive Models, Oxford:Oxford University Press.

King, R.G. and Rebello, S.T. (1993), "Low Frequency Filtering and Real Business Cycles", *Journal of Economic Dynamics and Control,* No. 17, pp. 207-31.

Lane, T.D. and van den Heuvel, S. (1998), "The United Kingdom's Experience with Inflation Targeting", IMF Working Paper, WP/98/87.

Obstfeld, M. And Peri, G. (1998), "Regional Non-Adjustment and Fiscal Policy", *Economic Policy,* April, pp. 207-259, with discussion.

Osborn, D.R. (1995), "Moving Average De-Trending and the Analysis of Business Cycles", *Oxford Bulletin of Economics and Statistics,* No. 57, pp. 547-58.

Ramaswamy, R. And T. Sloek (1997), "The Real Effects of Monetary Policy in the European Union: What Are the Differences?" International Monetary Fund, WP/97/160.

Sachs, L. (1985), *Applied Statistics*, Springer-Verlag.

Siegel, S. And Castellan, N.J. (1988), *Nonparametric Statistics*, McGraw-Hill.