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Recent developments in the pattern of UK interest rates

by

D K Miles

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I

DEVELOPMENTS IN THE PATTERN OF UK INTEREST RATES: INTRODUCTION

In the UK economic and financial conditions in the 1980s have been very different from those in the 1970s. Inflation since 1982 has been much lower than the average over the previous decade; it has also been much less variable. Financial markets, partly in response to deregulation but also as a result of the volatility of inflation and interest rates in the 1970s, have changed dramatically in the 1980s with rapid innovation in the provision of new financial instruments and greater competition in the provision of products which had in the past only been provided by a limited number of institutions. There have also been significant developments in the operation of macroeconomic policy in general, and of monetary policy in particular; the abolition of exchange controls in the UK in 1979 and the reduced reliance on other forms of direct controls over financial markets have, for example, changed the transmission mechanisms from the instruments of monetary policy to prices, wages and output.

All these developments will have had an impact upon the way in which interest rates are determined and upon the ways in which changes in rates impinge on the wider economy. Many of the factors which will have changed the way rates are determined are common to the major industrial economies, though there are important developments - the abolition of exchange controls in October 1979 is one - which are specific (though not unique) to the UK.

One of our aims in this paper is to assess whether the developments seen over the 1980s have significantly changed the pattern of interest rates relative to earlier periods. While it is hard to evaluate with much precision the independent effect of a particular development - eg the introduction of a new financial instrument - upon the pattern of interest rates we can hope to assess whether there have been overall changes in, for example, the volatility of nominal rates or in the shape of the yield curve. The major part of the paper is devoted to testing a number of specific hypotheses about changes in the pattern of interest rates. International comparisons form a major part of our study.

Before describing the statistical tests used we briefly discuss ways in which some recent developments might have affected the pattern of interest rates (Section II). In the light of the empirical results of Section III we then discuss some implications for the operation of monetary policy in Section IV.

II

DETERMINANTS OF THE STRUCTURE OF NOMINAL INTEREST RATES

There are four aspects of the pattern of nominal interest rates that we isolate:

(a) Trends in the general level of rates, as measured, for example, by an average of the nominal rates offered on default free bonds of a particular maturity over a particular period.

(b) The volatility of rates over time - the variation in the level of nominal rates of a particular maturity over time.

(c) The relation between rates on debt (of comparable default risk) of different maturity - ie the shape of the yield curve.

(d) The relation between the levels of rates at a particular maturity across countries - the issue of whether rates are more or less closely linked across countries at one time compared with another.

One would expect rather different factors to influence (a) to (d). Most economists would probably accept that the factor responsible for most of the longer-term trends in the general level of nominal rates over the past twenty five years has been changes in the expected rate of inflation. This hypothesis would follow if the ex ante equilibrium real rate of interest[1] which cleared the market for savings and loans had been significantly less volatile than the rate of inflation and if expected inflation in the medium term had not diverged very far from actual inflation. [The first of these conditions is probably less contentious than the second.]

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1 Abstracting for the moment from the fact that there are numerous rates of interest within an economy at any one time.

Short-term volatility of nominal rates will depend less on longer-term trends in inflation and more on month-to-month changes in the expected level of inflation, on changes in the equilibrium real rate and on the way in which monetary policy is operated. The shape of the yield curve, which has been the subject of a huge amount of empirical work, is likely to depend on rather different, though related, factors. Under the pure expectations hypothesis the shape of yield curve reflects expectations of short-term nominal interest rates at different points in the future: changes in the shape of the yield curve then reflect a reassessment of the path along which future short-term rates will move. This expectations theory has not, however, fared well empirically (see Shiller (1979) and Shiller, Campbell and Schoenholtz (1983)). An alternative theory is that nominal rates on bonds of different maturities reflect the supplies and demands of agents who, because of risk aversion and specific requirements for funds at particular dates, only operate on a rather limited part of the maturity spectrum. This theory suggests that the arbitrage condition, which ties rates of different maturities to the expected path of future short-term rates, will not operate and that the major determinant of changes in the shape of the yield curve will be variations in the demands and supplies of funds of those trading instruments of particular maturities. In practice one would expect there to be different types of agents operating on bond markets. Most agents might be risk averse and operate in restricted ranges of the yield curve but some, speculators or arbitrageurs, move freely between maturities. The degree to which the latter are constrained by missing markets or are also risk averse will introduce risk premia into the shape of the yield curve and corrupt the expectations hypothesis.

A consideration of changes in the degree to which nominal rates move together across countries points to a still different range of factors. Changes in the transactions costs of moving funds denominated in one currency into another will clearly be relevant here as will any developments which affect the ability to hedge currency risk. Potentially more significant in affecting the correlation between interest rates in different countries are expectations about the future path of exchange rates. In the medium term, trends in the bilateral rates between currencies are likely to reflect persistent differences in inflation rates; this in turn suggests that the longer-term trends in the degree to which nominal interest rate levels will converge across countries depends crucially upon the expected paths of inflation in the countries.

The main point to emerge from all this is that the factors which determine different aspects of the pattern of nominal interest rates are, to a large extent, distinct. In isolating certain key developments in the financial environment over the past decade we therefore hope to identify their potential for changing a particular aspect of the pattern of interest rates.

There are four factors which we briefly consider:

(a) The effect of new financial instruments.
(b) The effect of removing capital controls in the UK.
(c) Changes in macroeconomic policy.
(d) Changes in the pattern of financial flows.

The effect of developments falling under any of these headings upon the pattern of interest rates will rarely be unambiguous. Two general points illustrate the difficulty in predicting the impact of changes. First, most developments are to some extent endogenous; that is they reflect, as well as influence, the pattern of interest rates. This is particularly important in cases (a) and (d) where financial innovations and changes in the pattern of flows are clearly affected by the behaviour of interest rates. Second, it needs to be emphasised that the pattern of interest rates reflects the decisions made by borrowers and lenders. Whilst the effects of some development on one side of the market - say on borrowers - may be clear this will not imply an unambiguous effect on the pattern of interest rates unless it can be safely assumed either that the exogenous change has no significant impact on the other side of the market for funds, or that any effects act in the same direction.

(a) <u>The effect of new financial instruments</u>

The dramatic rise in the use of new financial instruments, most noteably swaps, options and financial futures, has been well documented. [For a detailed discussion of new financial instruments see the Bank for International Settlements' report of 1986 "Recent Innovations in International Banking" and the update to that volume "Recent Trends in Innovations and International Capital Markets" published in 1987 by the Federal Reserve Bank of New York.] Financial futures permit risk trading to take place and can allow traders to hedge interest rate or currency risk. Options and swaps can perform the same function. A major factor behind the dramatic growth in the use of such instruments was the increased volatility in interest rate movements in the 1970s.

Interest rate swaps have also traditionally been viewed as an instrument which allow agents with a comparative advantage in raising funds in one market (say by issuing medium-term fixed rate bonds) to trade to mutual advantage with an institution which enjoys relatively favourable terms in raising funds in another market (eg the short-term floating-rate paper market). In this sense interest rate swaps facilitate arbitrage between what would otherwise be segregated areas of the market.

There are several hypotheses about the effect of these types of new instruments on interest rates: (i) if agents can now hedge interest rate risk more efficiently than in the past one would expect risk premia on debt of various maturities to fall. This could cause a general lowering of the yield curve, it would also make the shape of the yield depend relatively more on expectations of future short rates and, thereby, on future inflation; (ii) if risk premia tend to be higher on longer-term debt (which is neither theoretically nor empirically obvious but is the usual assumption in, for example, macroeconometric models) one might also expect some flattening of the yield curve; (iii) currency swaps and futures may have significantly reduced the cost of hedging foreign exchange risk, encouraging borrowers and lenders to trade in instruments denominated in different currencies. Other things equal this might cause some convergence in interest rates across currencies; (iv) options, swaps and futures can allow speculators to take open positions on very little capital, so enhancing the extent of risk taking. If, as a result, speculators came to have more influence on the shape of the yield curve one would expect the expectations theory to more nearly hold. The effect of a greater ability for speculators to take risk on volatility is less clear cut. The debate on whether greater speculation increases or reduces volatility in the underlying commodities goes back several hundred years and no conclusions have yet emerged. [See, for example, Denton (1985); Hart and Kreps (1986); De Long, Schleifer, Summers and Waldmann (1987); Stein (1987); De Bondt and Thaler (1985).] We merely note that an enhanced ability to take risk may affect interest rate volatility.

The quantitative importance of any one of these effects is hard to gauge. We aim to estimate the net impact of a whole range of developments in section III.

(b) The impact of removing capital controls

Exchange controls have been removed in several industrialised countries during the late 1970s and 1980s. In late 1979 exchange controls were abolished in the UK. Controls had been in force in the UK in various forms since the 1930s. In principle one effect of controls is to decouple UK interest rates from those in the other financial centres of the industrialised economies and the abolition of controls would be expected to re-establish a link between interest rate differentials and expected movements in exchange rates. In practice, the impact of abolition is less clear cut both because it was clear in the late 1970s that financial disintermediation and the movement of business offshore already went a long way towards undermining the effectiveness of controls; and because the degree to which most instruments denominated in different currencies are substitutes is far from perfect. The first point meant that the existence of exchange controls by no means enabled interest rates in the UK to be insulated from interest rate developments in other countries. The second point means that a wedge can be driven between interest rates in different countries even when bilateral exchange rates are expected to remain constant. If, however, there has been some convergence in interest rates across countries one would expect it to be more marked for longer-term rates than at the short end. Very significant interest rate differentials may exist at the short end to offset expected imminent movements in bilateral exchange rates. Longer-term rates might diverge to the same extent only if continued one way movements in exchange rates were expected.

(c) Changes in macroeconomic policy

Conservative governments since 1979 have used monetary policy as the key instrument in the fight against inflation. This contrasts with much of the 1970s when prices and incomes policy had been used on several occasions to try to curb price increases. In the 1980s short-term interest rates have been varied when necessary to bring about appropriate downward pressure on inflation; there has been a greater inclination to move short-term rates as conditions change. One notable feature of the 1980s relative to the 1970s has been that real rates of interest have remained positive. This reflects the fact that monetary policy has been consistently used to fight inflation. Inflation has fallen so nominal rates have not needed to remain higher than in the mid-1970s (when ex-post real rates were at their most negative) to preserve a positive real return to lenders.

This trend in real interest rates is common to most of the G7 countries, as is the greater use of interest rates to control inflation and less reliance on various forms of direct controls, though as we shall see below changes in the overall pattern of nominal interest rates - reflecting volatility and the slope of the yield curve as well as the overall level of interest rates - are by no means similar across the major economies.

Two international policy developments have occurred over the period since the mid-1970s which might be expected to lead to some convergence in the behaviour of interest rates. First, there have been agreements between countries to aim at greater stability in exchange rates. The Louvre and Plaza agreements are the most notable of these. Second, the EMS has developed as a more formal mechanism to preserve stability in bilateral rates between the member countries. The impact of these policy developments on interest rates is not, however, clear cut. For example, attempts to preserve exchange rate stability could, in principle, result in significantly higher interest rate volatility, and higher levels of interest rates, for a country which tries to peg its rate at too high a level or at a level which might be perceived as unsustainable in financial markets. Conversely, a credible and sustainable agreement to reduce exchange rate volatility by co-ordinated action could remove the necessity for a single country to move short-term interest rates by large amounts to preserve exchange rate stability by unilateral action.

In short, the impact of international exchange rate agreements for the behaviour of interest rates cannot be divorced from the long-term sustainability of the pattern of exchange rates agreed upon. The feasibility and sustainability of international agreements will, in turn, depend upon the degree to which inflationary pressures converge across countries. It then becomes hard to assess whether any convergence in interest rates and exchange rates which might follow an international agreement simply reflects the prior convergence of inflationary pressures which made the agreement possible. Certainly there has been a common downward trend in inflation across the industrial economies in the 1980s.

(d) Changes in the pattern of financial flows

In terms of identifying causal factors which impinge on the pattern of interest rates, problems of endogeneity are most clear in the case of flows of funds. But some more or less exogenous factors can be identified. In 1985 the UK government ended the policy of selling more long-term debt than was needed to fund the public sector borrowing requirement - a policy known as overfunding. In recent years the real PSBR has also fallen dramatically. The impact of both these developments upon outstanding stocks of government bonds is suggested by Table 1.

Table 1

Stock of UK Public Sector Debt (At Market Prices) Held by the UK Private Sector (Consolidated):

	£ million	% of GDP
End of 1976	30,427	24.5
1978	44,909	26.8
1980	62,925	27.3
1982	85,890	30.9
1984	102,761	31.8
1985	110,626	31.2
1986	116,873	30.8
1987	121,312	29.3

At the same time as government bonds were falling as a proportion of GDP (and of the UK private sector's gross financial wealth), there has been a revival in issues of fixed-rate sterling bonds by both British and overseas companies, and by overseas governments and their agencies. The existence of swap facilities has encouraged foreign banks to take advantage of opportunities to issue fixed-rate sterling eurobonds and swap the proceeds into floating-rate paper, allowing UK companies (often the counterparties) to access fixed-rate funds at a cost lower than if they had to raise funds directly. Table 2 shows the scale of fixed-rate sterling bond issues in recent years and, for comparison, shows the level of funding of the PSBR through net sales of British government securities. The figures for sterling bond issues are gross, but because outstanding stocks at the start of the 1980s were very low the figures are comparable to the net figures in column 2.

Table 2

	Gross sterling fixed-rate bond issues[3]	Net sales of British government securities[2]	Total
£ million			
1980	641	7,628	8,269
1981	696	8,095	8,791
1982	2,065	6,225	8,290
1983	1,728	8,299	10,027
1984	3,290	7,454	10,744
1985	3,279	6,364	9,643
1986	4,751	3,323	8,074
1987	9,166	1,452	10,618

The net effect of these two developments - lower public and higher private bond issues - on the position and shape of the yield curve is not clear, even in theory. In purely numerical terms the decline in sales of UK gilts has been largely matched by an increase in non-public sector fixed-rate sterling

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2 Net sales to UK non-bank private sector.

3 Other than by UK public sector.

bonds. It remains hard to predict the impact on the yield curve for two reasons. First, the degree of substitutability between the types of bonds is unclear. Second, the effect of changes in the outstanding amount of bonds of a particular maturity upon yields is hard to gauge. Empirical work has generally revealed little impact of the quantities of bonds issued upon yields [see Modigliani and Sutch (1966) and Goodhart and Gowland (1977 and 1978)]. Research in this area is, however, particularly difficult because of the endogeneity of the supply of bonds with respect to yields which would tend to reduce any correlation between yields and quantities.

Summary

Several possible effects of recent developments upon the pattern of interest rates have been put forward. Some of these are offsetting, and on a priori grounds the quantitative significance of any of them is hard to judge. We now turn to an empirical analysis of changes in the pattern of interest rates.

III

THE STRUCTURE OF INTEREST RATES SINCE THE 1960s: EMPIRICAL RESULTS

In this section we aim to assess whether there have been significant changes in the pattern of interest rates over various periods since the 1960s. We noted above various hypotheses which would suggest that the behaviour of nominal rates may have changed in the 1980s. We will focus primarily on nominal UK interest rates though we shall also present results for the other major industrial economies. Four propositions will be considered in some detail:

(a) That there has been a change in the volatility of nominal interest rates.
(b) That there has been a significant change in the level of nominal rates.
(c) That the shape of the yield curve has undergone significant changes.
(d) That the degree to which rates move together across countries has changed.

There is no obviously correct or most powerful test of any of these hypotheses. Measuring volatility, in particular, is problematic. We aim to present a range of statistics in connection with (a)-(d). One general point is, however, important. In terms of volatility and the degree to which rates are related across countries we feel that analysis of changes in the level of

interest rates is more revealing than is analysis of the levels of rates. This is particularly true of longer rates where changes in the level are often connected with the revelation of news and could be seen as measuring the extent of uncertainty in markets. The idea that it is changes in the level of long rates which are the natural focus of attention in assessing volatility is most strongly implied by the pure expectations theory of the term structure. As noted above this theory makes the prime determinant of long rates expectations of short rates over the term to maturity. To a first order approximation the change in long rates between periods should then reflect changes in expectations of future short rates.[4] It makes sense,

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4 Under the expectations theory, assuming constant risk or liquidity premia for paper of a fixed maturity, Shiller has shown that the following equation holds:

$$RL_t = \frac{1-\gamma}{1-\gamma^L} \sum_{i=0}^{L-1} \gamma^i E_t (r_{t+i}) + \phi_L$$

where L is the number of periods to maturity and RL_t is the yield to maturity of the bond. ϕ_L is a risk or liquidity premium on debt with L periods to maturity. $E_t(r_{t+i})$ is the expectation at time t of the short-term interest rate in period t+i. The difference in yields between two periods is then:

$$RL_t - RL_{t-1} = \frac{1-\gamma}{1-\gamma^L} \left[\sum_{i=0}^{L-2} \gamma^i E_t (r_{t+i}) - \gamma^{i+1} E_{t-1} (r_{t+i}) + \gamma^L E_t (r_{t+L-1}) - r_{t-1} \right]$$

Since γ will generally be close to unity and since r_{t-1} and $E_t (r_{t+L-1})$ will not usually differ by much, for long L this expression is approximately equal to the average of the changes in expectations of all future short rates. Under rational expectations this should be unpredictable from past behaviour which implies that it is a white noise process with a mean of zero.

under this theory, to use a measure of the average size of changes in long rates from one period to the next to measure volatility. A natural way of testing hypotheses about the degree to which rates are linked across countries would also be to analyse the extent to which changes in long rates were correlated across countries; if common factors came to dominate the way in which rates were determined in different countries one would expect the degree to which changes in rates were correlated to rise.

The expectations theory remains, however, only one of several theories of the term structure and one, as noted above, which has not stood up well to econometric tests. But the hypothesis that it is changes in rates which are most revealing for assessing volatility and connectedness across countries is valid under a much wider set of models. Under almost any theory of long-term rates, the level of those rates at one point in time will reflect long-term expectations and it seems likely that changes in long rates over short periods will primarily reflect changes in expectations - the arrival of news. Once again the degree to which news relevant to domestic interest rates exerts a common influence across countries is a natural measure of the degree to which rates are linked.

The data

We use data on nominal interest rates on default-free bonds. This allows us to abstract from changes in the degree to which various instruments are affected by risks specific to the institution issuing the paper and to focus on more systematic, or economy wide, determinants of rates. Wherever possible we have tried to measure the end of month gross of tax yield to maturity of holding paper of varying maturity.[5] This has proved difficult with cross country comparisons since it is not easy to obtain long runs of end-month data on gross yields of default-free paper of the same maturity across countries. Some trade off has to be made between achieving

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5 No attempt has been made to try to adjust yields for the ever changing pattern of effective tax rates upon coupons and capital gains across countries.

consistency in terms of a common maturity and consistency in terms of month average as opposed to mid-month or average of month data. Details on the exact data sources are given in an appendix; details of the series used are kept to a minimum in the text.

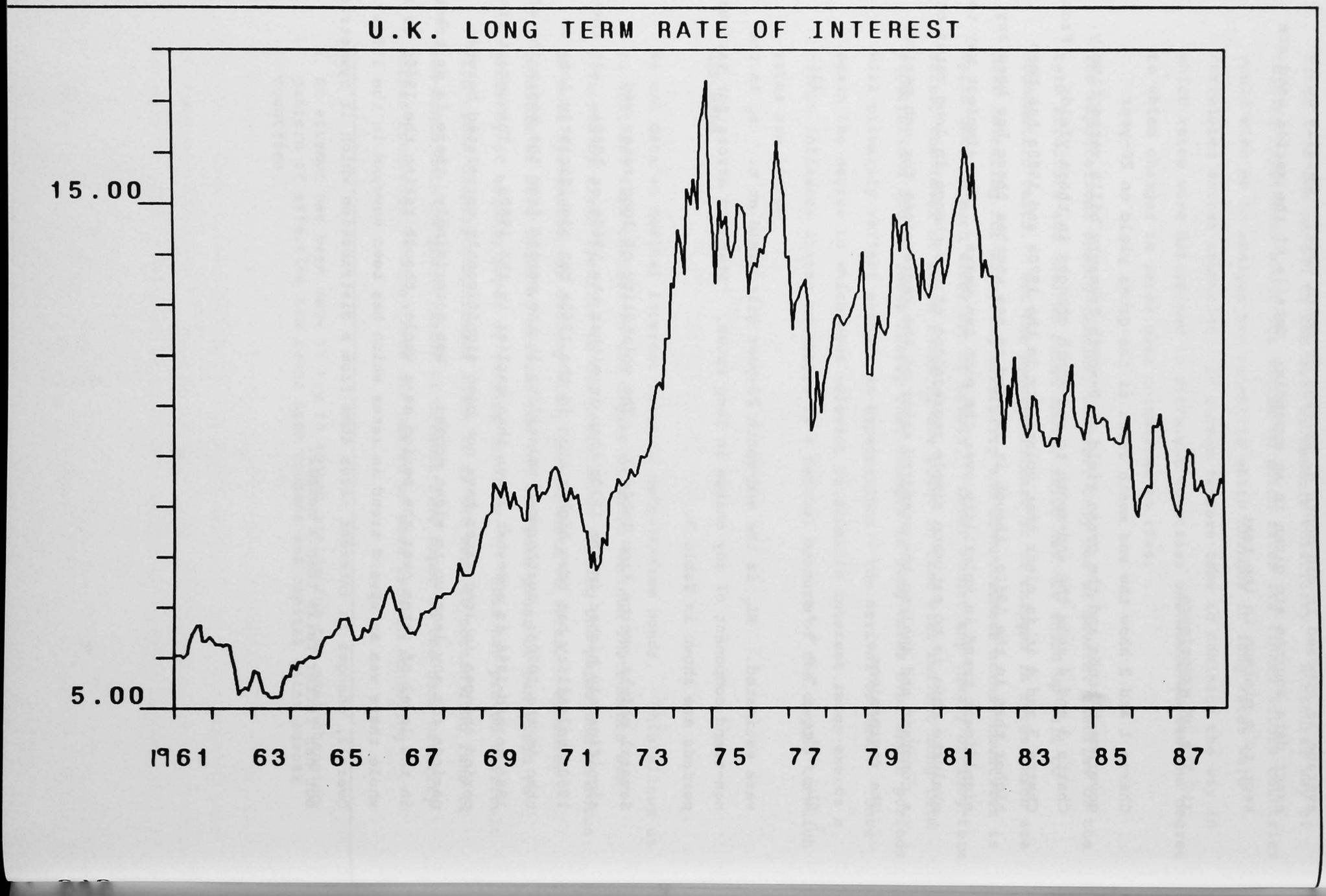
(i) The UK experience

Charts 1 and 2 show the end month level of the gross yield on 20-year government bonds and the gross yield on 3-month Treasury bills respectively. Charts 3 and 4 show the end-month to end-month changes in these yields. From Charts 3 and 4 it is clear that volatility in the 1970s and 1980s has been higher than in the 1960s, though it is hard to see whether there has been any significant trend in volatility over the past ten years. The simplest way to evaluate this is to estimate simple regressions of the change in long rates on a constant and analyse the standard error of the regressions for sub periods. The regressions

$$RL_t - R_{Lt-1} = \alpha + \epsilon_t \qquad (1)$$

were estimated. RL_t is the end-month 20-year gilt yield at t. ϵ_t is the non-trend component of any change in long rates. Standard errors for various periods are shown in Table 3.

Several points emerge from Table 3. The volatility of long rates was significantly higher in the 1970s than in either the 1960s or 1980s. In the 1980s volatility has been higher than in the 1960s but significantly less so than in the 1970s; furthermore volatility in the period from the beginning of 1984 to mid-1988 is somewhat lower than earlier in the 1980s. Throughout the period changes in long rates have not been significantly correlated between periods for any lags up to eight months. Not surprisingly, there is no trend in the level of rates over the period as a whole, though taking the 1960s as a whole there was an upward trend in rates which has been unwound in the 1980s. Overall, changes in interest rates come from a distribution which is symmetric but has fatter tails than a normal.


U.K. LONG TERM RATE OF INTEREST
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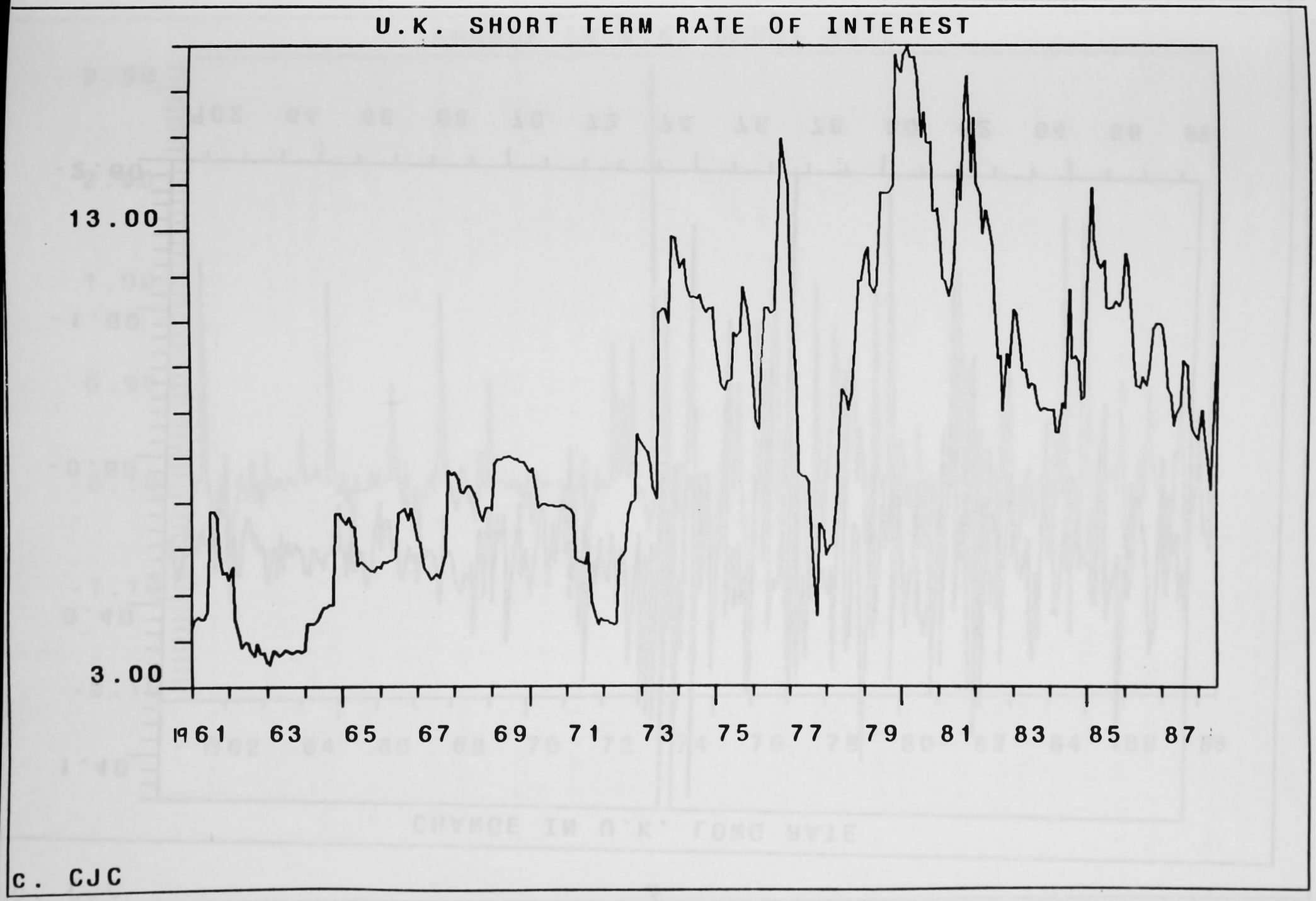
5.00
1961
63
65
67
69
71
73
75
77
79
81
83
85
87


U.K. SHORT TERM RATE OF INTEREST
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3.00
1961
63
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75
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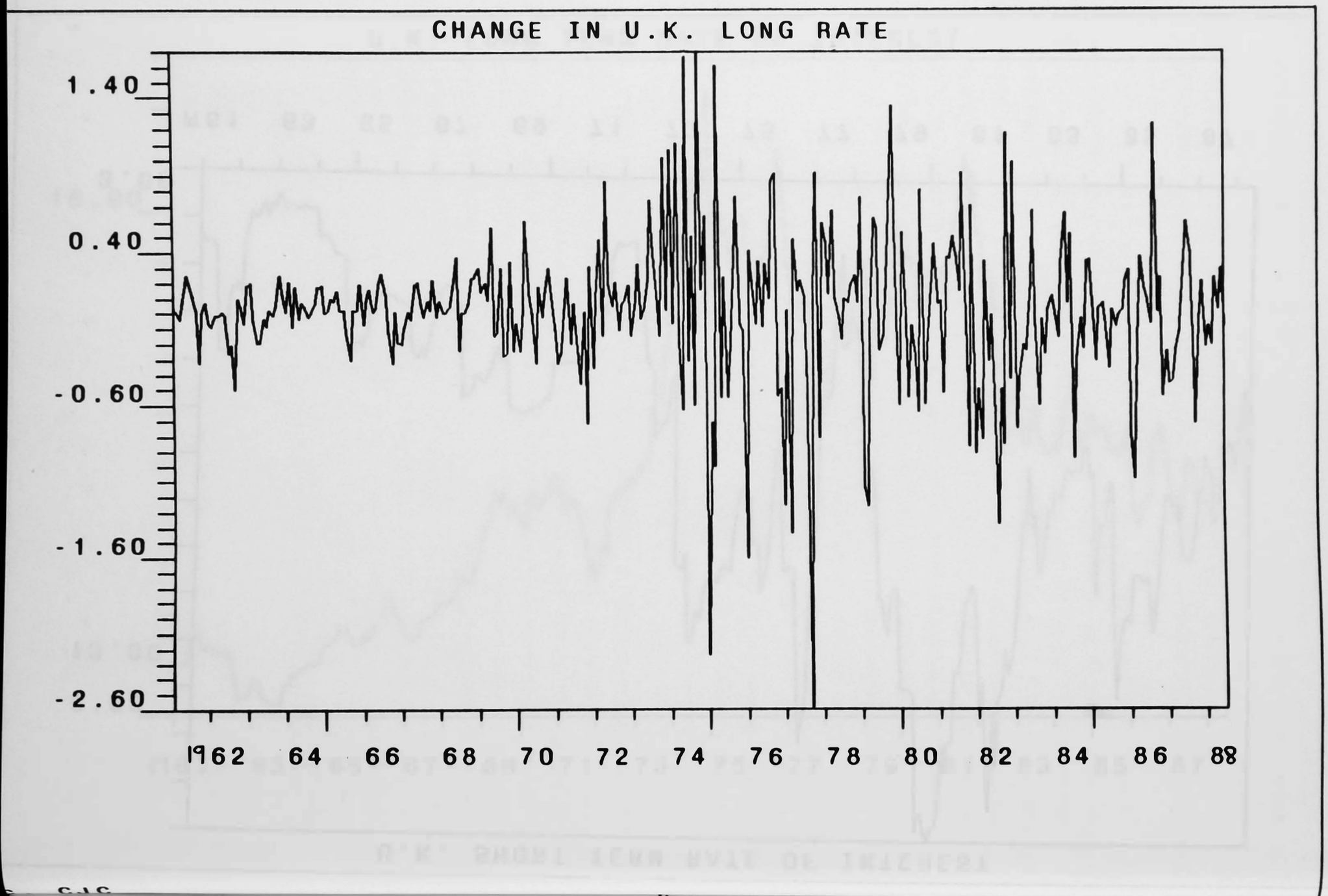
85
87

c. CJC


CHANGE IN U.K. LONG RATE
1.40
0.40
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-2.60
1962
64
66
68
70
72
74
76
78
80
82
84
86
88

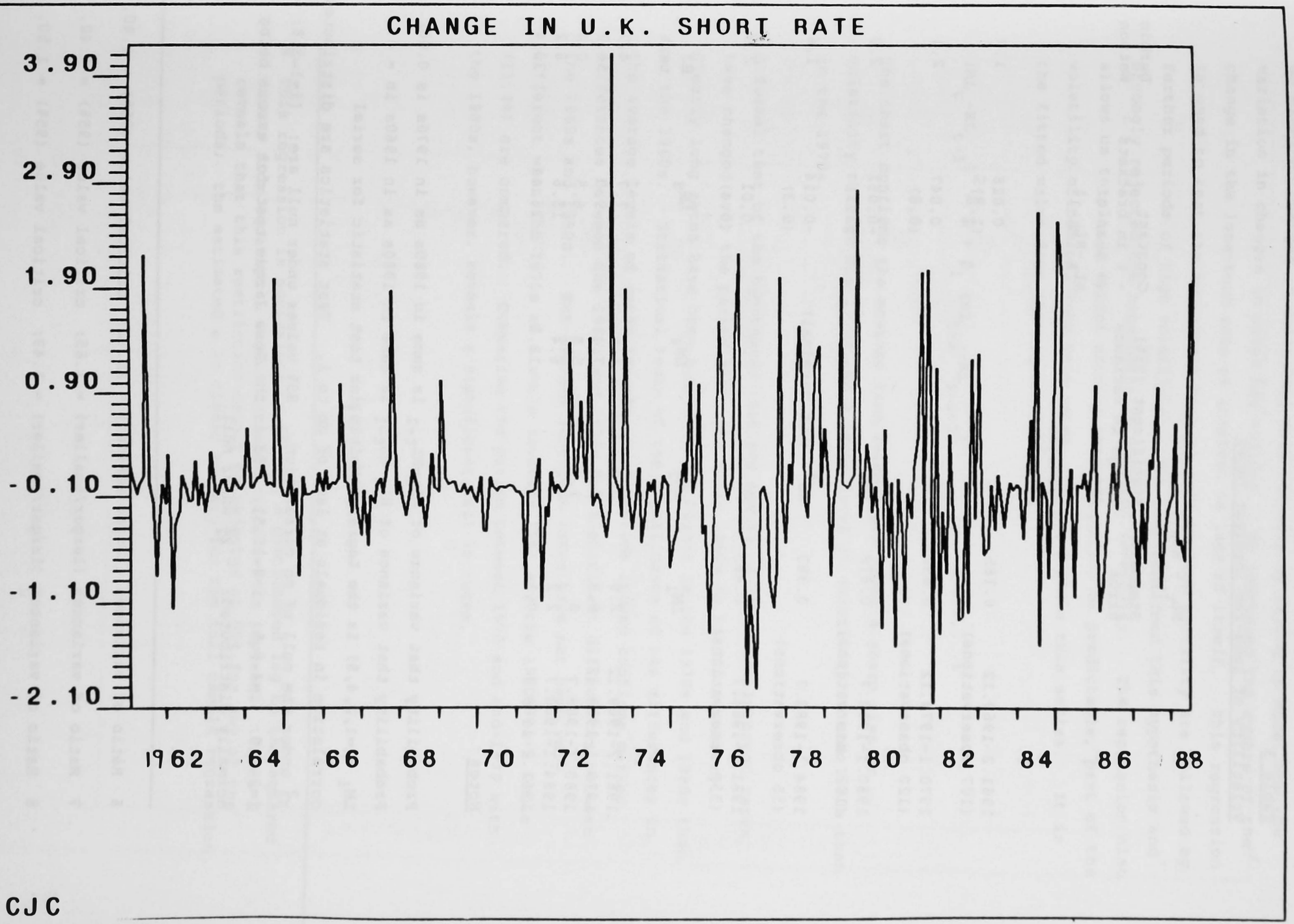
CHANGE IN U.K. SHORT RATE
3.90
2.90
1.90
0.90
-0.10
-1.10
-2.10
1962
64
66
68
70
72
74
76
78
80
82
84
86
88

Table 3

Volatility of long-run interest rates

	$RL_t - RL_{t-1}$			
	Standard error	Significant (95%) change in variance relative to previous period	Constant - t in brackets - (= mean of $RL_t - RL_{t-1}$)	Durbin Watson
1961.2-1969.12 (107 observations)	0.165		0.028 (1.8)	1.7
1970.1-1979.12 (120 observations)	0.652	Yes[6]	0.047 (0.8)	2.1
1980.1-1988.7 (103 observations)	0.479	Yes[7]	-0.051 (1.1)	2.0
1984.1-1988.7 (55 observations)	0.393	No[8] (but marginal)	-0.014 (0.3)	1.6
1961.2-1988.7 (330 observations)	0.485		0.01 (0.4)	2.0

	LM_1	LM_2	LM_4	LM_8	BJ test
1961.2-1969.12	2.8	3.0	7.6	7.7	4.7
1970.1-1979.12	0.3	0.8	7.4	9.0	58.1
1980.1-1988.7	0	1.0	5.8	6.5	0.4
1984.1-1988.7	2.2	2.7	6.4	15.6	6.2
1961.2-1988.7	0.1	1.7	13.5	16.44	35.4

Notes

Probability that variance of $RL_t - RL_{t-1}$ is same in 1980s as in 1970s is 0.002. Probability that variance of $RL_t - RL_{t-1}$ is same in 1980s as in 1960s is $\simeq 0$. LM_i (i=1,2,4,8) is the Lagrange Multiplier test statistic for serial correlation in residuals at lags of up to i. Test statistics are distributed χ^2_i under the null of no correlation. 95% values under null are: [i=1→3.8; i=2→6.0; i=4→9.5; i=8→15.5]. BJ is the Bera Jarque test for errors being normally distributed; $\sim \chi^2_2$ under null.

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6 Ratio of variances (larger/smaller) = 15.62; critical value (95%) $\simeq$ 1.40.

7 Ratio of variances (larger/smaller) = 1.85; critical value (95%) $\simeq$ 1.40.

8 Ratio of variances (larger/smaller) = 1.49; critical value (95%) $\simeq$ 1.50.

We examined changes in volatility more formally by trying to model how the variation in changes in rates has evolved. We regressed the square of the change in the long-term rate of interest on lags of itself. This regression is used to test the hypothesis that periods of high voltility are followed by further periods of high volatility. The test confirmed this hypothesis and strongly rejected the hypothesis of constant volatility. The regression also allows us to plot a series showing the systematic, or predictable, part of the volatility of nominal long term rates. Chart 5 shows this series. It is the fitted value from the regression:[9]

$$(RL_t - RL_{t-1})^2 = \alpha + \beta_i \, (RL_{t-i} - RL_{t-i-1})^2 \qquad i=1,2,\ldots 6$$

The chart confirms the message from Table 3 and shows a sharp rise in volatility through the 1970s and a lower level of volatility in the 1980s than in the 1970s.

A formal test of the hypothesis that the levels of long-term interest rates have changed over the period since the early 1960s is hardly necessary. Clearly long rates have been significantly higher in the 1970s and 1980s than in the 1960s. Statistical tests of the significance of the differences in the average levels of rates for the three periods indeed confirms marked differences between the 1960s and 1970s and significant differences between the 1960s and 1980s. But average long-term rates have not been very different when the 1970s as a whole (average 12%) and the 1980s as a whole (11.4%) are compared. Comparing the period between 1973 and end-1979 with the 1980s, however, reveals a significant fall in rates.

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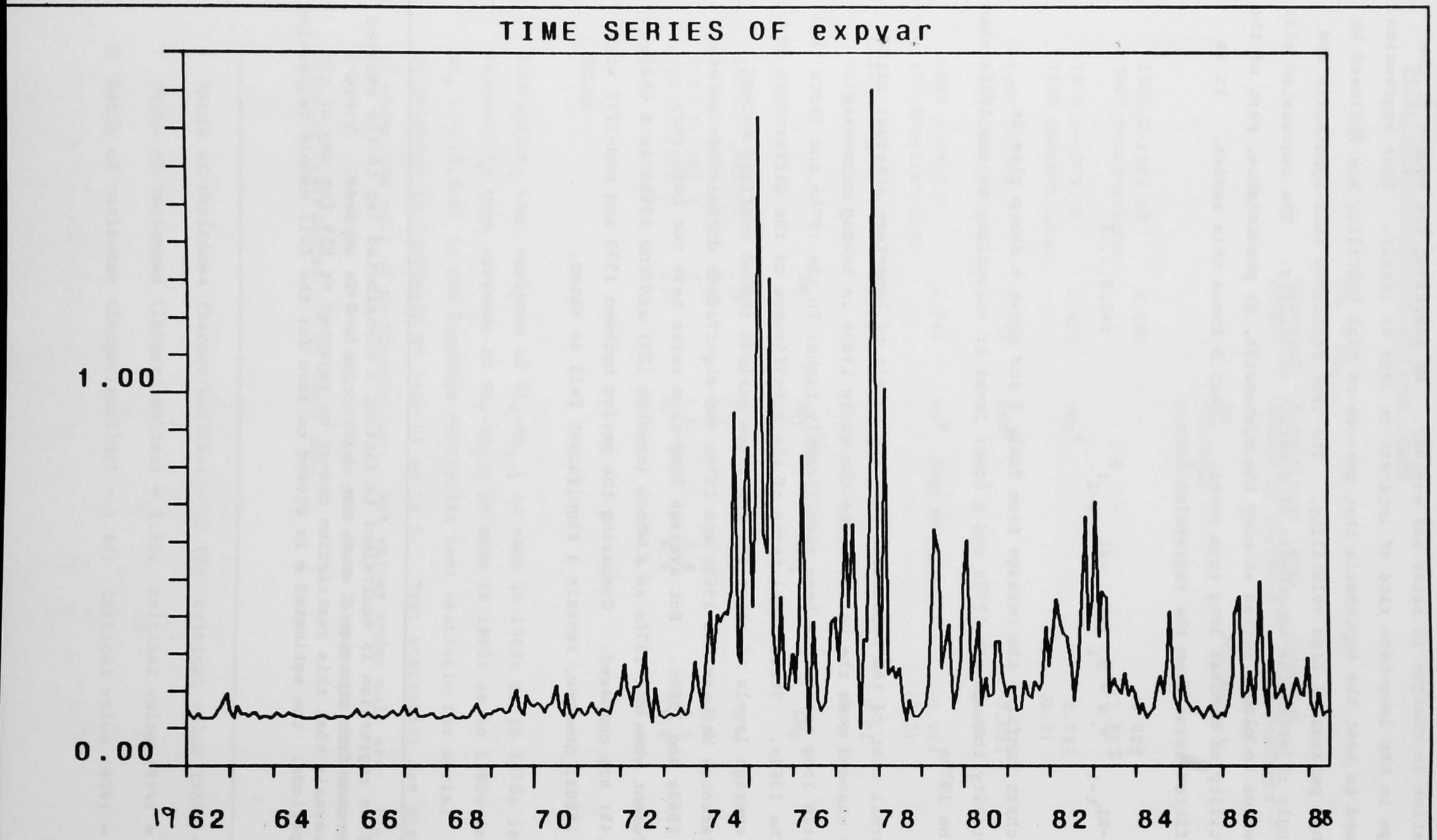
9 This regression is equivalent to fitting a distributed lag to the squared errors from equation 1 where the restriction $\alpha=0$ is imposed. Table 3 reveals that this restriction cannot be rejected at 95% for any of the periods; the estimated α is closed to zero for the full sample regression.


TIME SERIES OF expvar
1.00
0.00
1962
64
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86
88

Results from an analysis of volatility in short term UK rates are shown in Table 4. The short rate is the gross yield on UK 3 month Treasury bills. As with longer nominal rates there is a sharp rise in volatility in the 1970s when compared with the 1960s. But unlike with long rates volatility in short rates has not been significantly different in the 1980s than in the 1970s. Within the 1980s there also appears to be no discernible trend in volatility - indeed there is a marked stability in the degree to which the short-term rate has moved about over the past fifteen years. This stability in the 1980s might seem surprising given the major change in the importance of monetary policy relative to earlier periods. We believe the overall constancy in variability reflects a greater willingness of the authorities to use short rates as a counter-inflationary weapon (which in itself might <u>increase</u> the volatility of short rates) occuring over a period when inflation and the volatility of inflation has fallen relative to the mid and late 1970s (which in itself would tend to <u>reduce</u> interest rate volatility).

The average level of nominal rates has been higher in the 1980s than in the 1970s as a whole, though the difference remains statistically insignificant.

<u>Table 4</u>

<u>Variability of UK short-run interest rates</u>

Regression $RS_t - RS_{t-1} = \alpha + \epsilon_t$

	Standard error	Significant change from previous period standard error	Constant - t in brackets - (= average rate of change)	Durbin Watson
1961.2-1988.7	0.736		0.019 (0.5)	1.8
1961.2-1969.12	0.431		0.033 (0.8)	1.9
1970.1-1979.12	0.843	Yes	0.072 (0.9)	1.6
1980.1-1988.7	0.845	No	-0.058 (0.7)	2.0
1984.1-1988.7	0.852	No	0.027 (0.2)	1.8

	LM_1	LM_2	LM_4	LM_8	BJ test
1961.2-1988.7	3.2	3.3	5.1	13.2	44.0
1961.2-1969.12	0.4	0.5	2.2	10.4	76.2
1970.1-1979.12	5.2	5.4	6.9	10.0	15.9
1980.1-1988.7	0.1	0.4	2.3	6.0	23.0
1984.1-1988.7	0.5	2.1	4.1	11.9	21.4

For notes see Table 3.

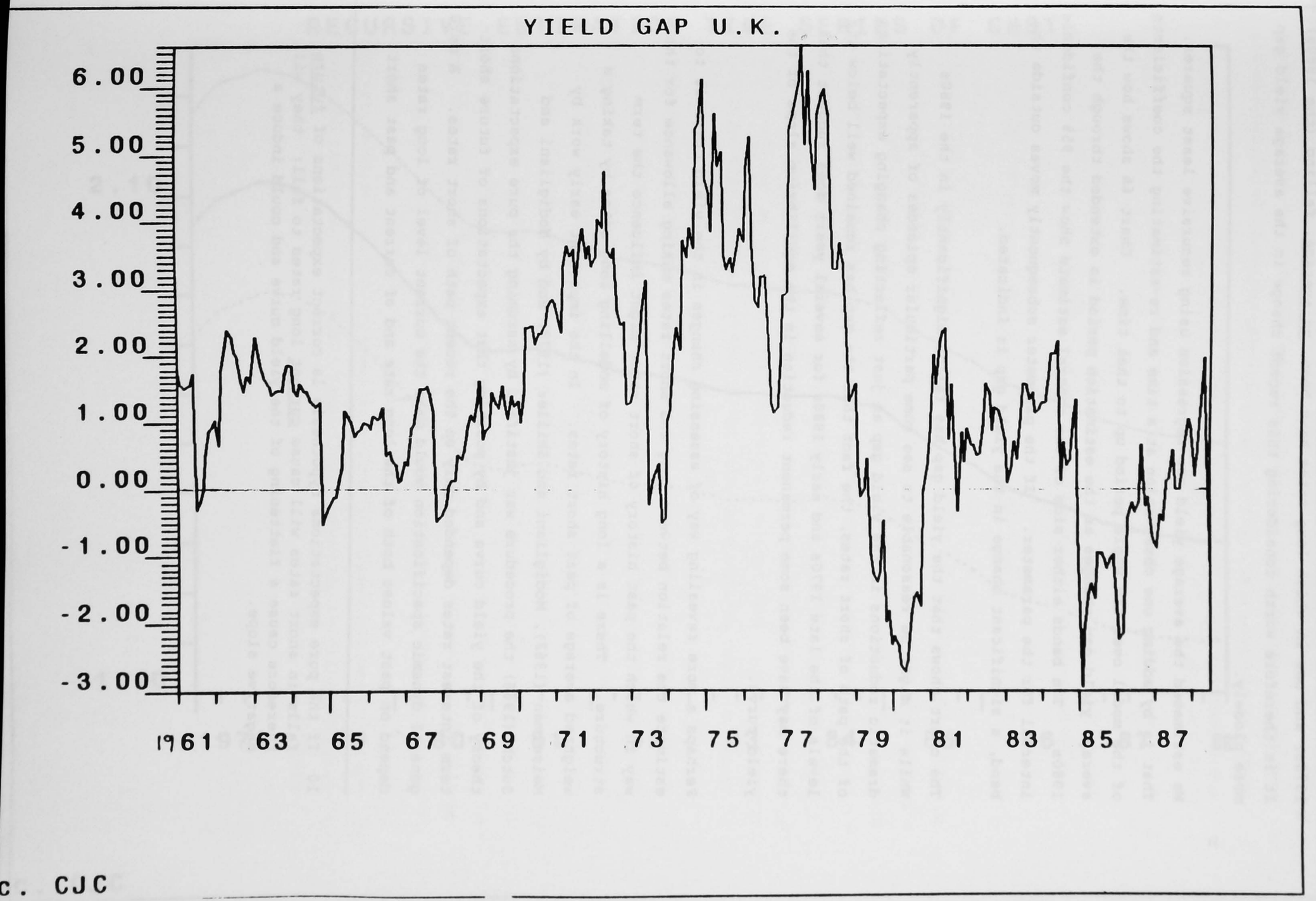
A further set of hypotheses which we aim to address concerns the yield curve. Over long periods, when perceptions of either rising or falling short-term rates would be expected to cancel out, the average difference between long (say 20-year) rates and short rates could be expected to reflect average risk or liquidity premia. The size, sign and stability of such premia are a matter of doubt. We began our empirical analysis of the yield curve by studying how the average gap between the short yields (3-month) and the longest (20-year) has varied over time.

Chart 6 shows the yield gap (the long rate minus the short rate) month by month over the past twenty five years. Table 5 shows the average yield gap between the long and short end for various periods. We calculated these gaps by regressing the long-short diffferential on a constant. The standard errors on these equations show the variability in the yield gap around the average. Not much weight should be attached to the t statistics or standard errors in these regressions since, not surprisingly, the yield gaps in successive periods are highly correlated, biasing standard errors and t statistics.

Table 5

	Average yield gap (t statistic in parenthesis)	Standard error	Durbin Watson
1961.2-1988.7	1.39 (13.89)	1.82	0.13
1961.2-1969.12	1.03 (15.4)	0.69	0.35
1970.1-1979.12	2.83 (16.3)	1.90	0.17
1980.1-1988.7	0.1 (0.8)	1.32	0.25
1984.1-1988.7	-0.1 (0.7)	1.19	0.37

There appears to have been a marked reduction in the average slope of the yield curve in the 1980s. It is hard to analyse how much this is due to comparing a period during which long rates were, on average, rising (the


YIELD GAP U.K.
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
1961
63
65
67
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85
87

c. CJC

1970s) and one in which long rates have been, on average, falling (the 1980s).[10] It is therefore worth considering this recent change in the average yield gap more closely.

We estimated the average yield gap regression using recursive least squares. That is by adding one observation at a time and re-estimating the coefficients of the model over the whole period up to that time. Chart 6A shows how the average yield gap changes as the estimation period is extended through the 1980s. The bands either side of the central estimate show the 95% confidence interval for the parameter. If the parameter subsequently moves outside the band, a significant change in the yield gap is indicated.

The chart shows that the yield gap has fallen significantly in the 1980s. While it might be reasonable to see some particular episodes of apparently dramatic reductions in the yield gap as just reflecting changing expectations of the path of short rates, the fact that the gap has remained well below its levels of the late 1970s and early 1980s for several years does suggest that there may have been some permanent reduction in the equilibrium slope of the yield curve.

Perhaps a more revealing way of assessing changes in the yield curve is to estimate the relation between long and short rates making allowance for the way in which the past history of short rates might influence the term structure. There is a long history of modelling long rates by taking a weighted average of past short rates. In the important early work by Meiselman (1962), Modigliani and Shiller (1973) and by Modigliani and Sutch (1966) the procedure was justified by assuming the pure expectations theory of the yield curve and by positing that expectations of future short-term interest rates depended only on the recent path of short rates. A more general dynamic specification would make the current level of long rates depend on past values both of the long rate and of current and past short

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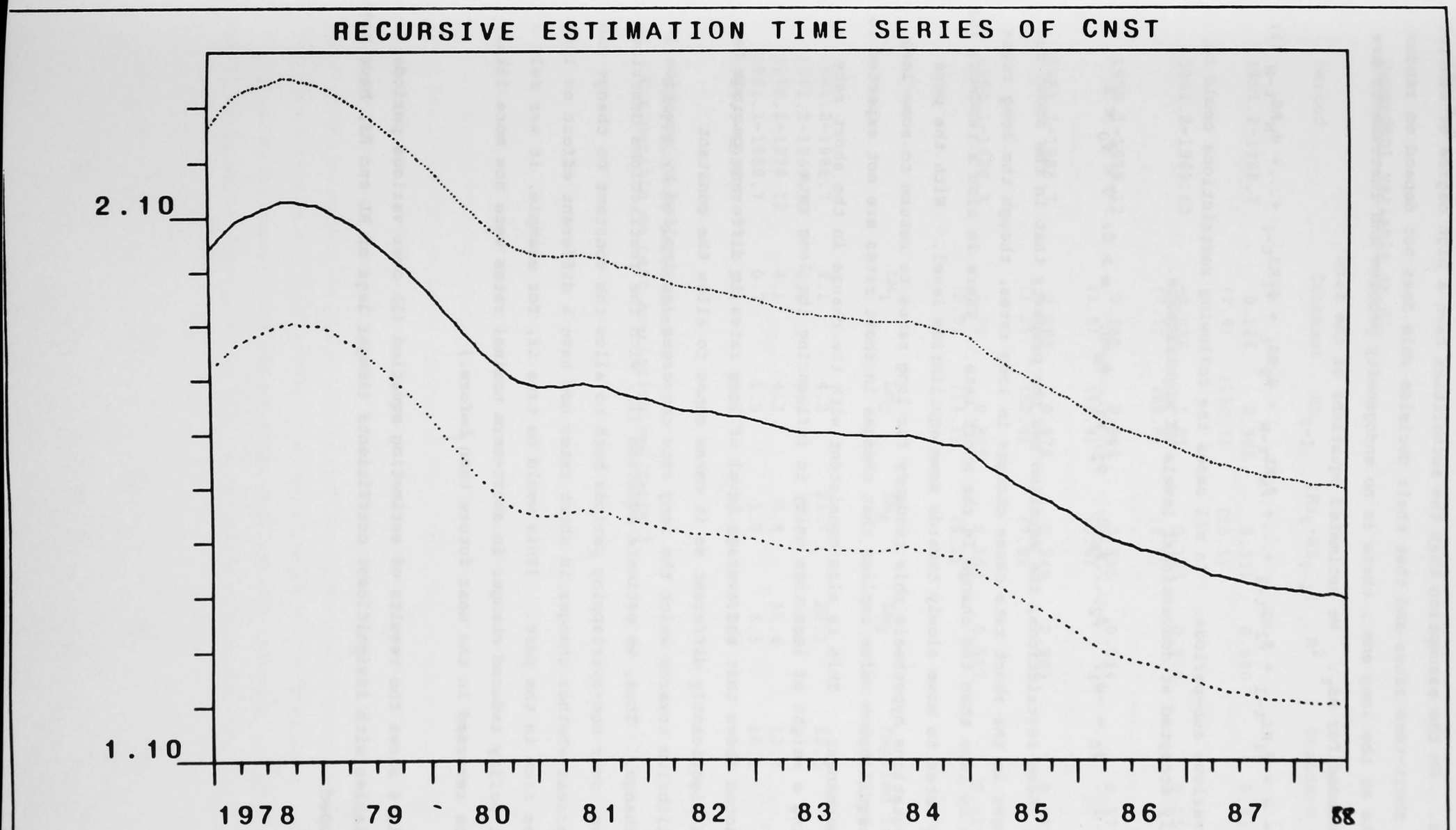
10 If the pure expectations hypothesis is correct expectations of future falls in short rates will cause current long rates to fall; they will therefore cause a flattening of the yield curve and could induce a negative slope.


RECURSIVE ESTIMATION TIME SERIES OF CNST
2.10
1.10
1978
79
80
81
82
83
84
85
86
87
88

c. CJC

rates. On the assumption that the authorities have a high degree of control over short-term rates and that their decision rule does not depend on random shocks at the long end , there is no endogeneity problem and instruments are not needed for RS_t. We estimated equations of the form:

$$RL_t = \alpha + \beta_1 RL_{t-1} + \beta_2 RL_{t-2} + \ldots + \beta_N RL_{t-N} + \psi_0 RS_t + \psi_1 RS_{t-1} + \ldots + \psi_N RS_{t-N} \quad (1)$$

for various sub-periods. In all cases the following restrictions could be easily accepted at conventional levels of significance.

$$\beta_1 < 1; \quad \psi_0 = -\psi_1; \quad \beta_2, \ldots \beta_N = 0; \quad \psi_2, \psi_3 \ldots \psi_N = 0; \quad \alpha > 0; \quad 0 < \psi_0 < 1$$

With these restrictions, the equation has the property that in the short run changes in the short rate cause changes in long rates, though the long rates move by less than the change in the short rate. There is also a tendency for long rates to move slowly towards some equilibrium level. With the pure expectations hypothesis this tendency for long rates to return to some long run equilibrium value implies that changes in short rates are not expected to be permanent. This is also consistent with the change in the short rate having a weight of less than unity in influencing the long rate.

We noted above that the average level of long rates in different periods has been signficantly different so it makes sense to allow the constant equilibrium towards which the long rate converges (as implied by equation 1) to change. Thus, we estimate equation (1), with the restrictions described above, over non-overlapping periods both to allow the constant to change and to assess whether changes in short rates now have a different effect on long rates from in the past. [This would be true if, for example, it was felt that policy induced changes in short-term nominal rates were now more likely to be reversed in the near future than before.]

Table 6 shows the results of estimating equation (1) over various periods. Variables with insignificant coefficients (longer lags of RL and RS) have been dropped.

Table 6

Dependent variable is RL_t

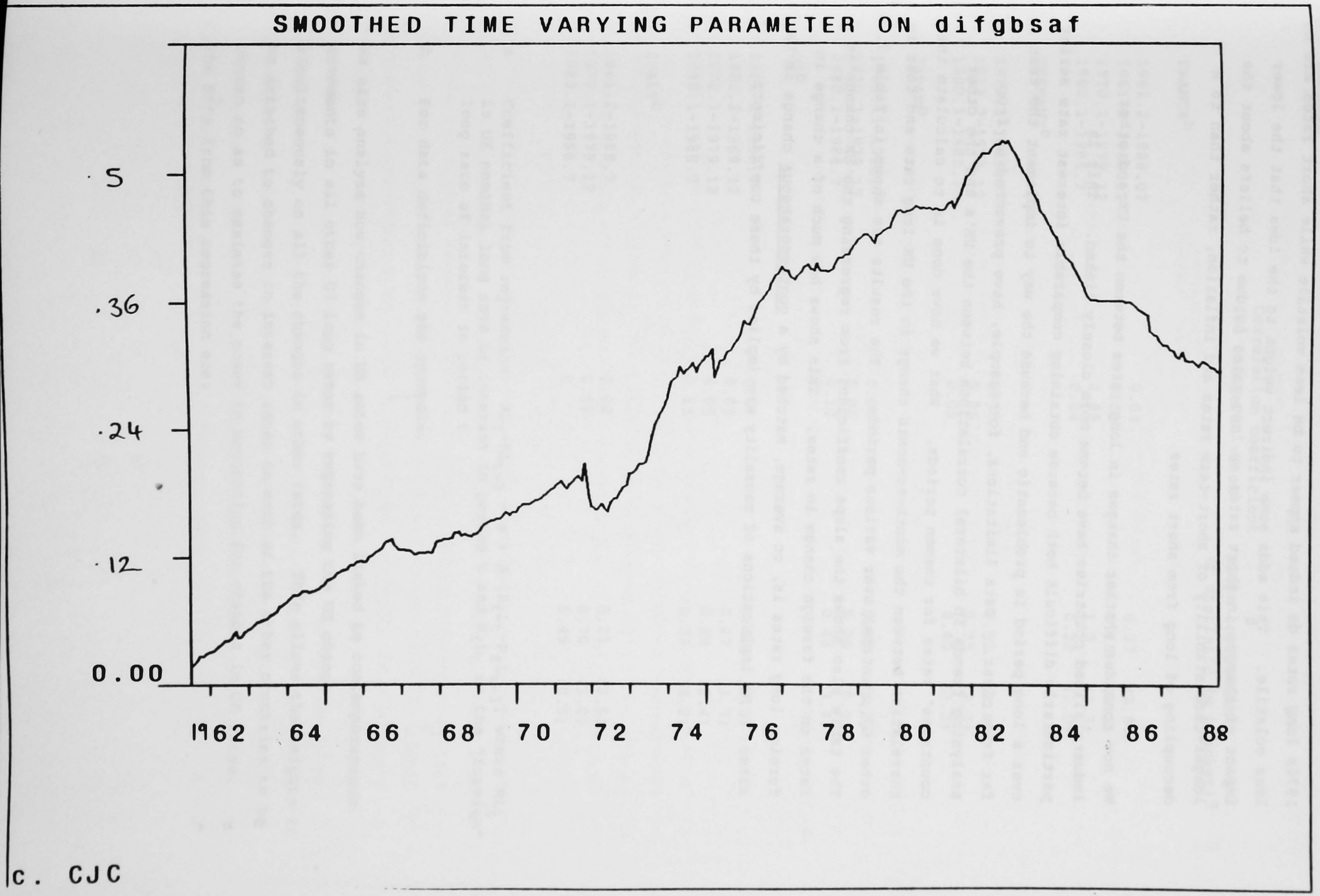
Period	Constant	RL_{t-1}	$[RS_t - RS_{t-1}]$	R^2	Standard error
1961.2-1988.7	0.126	0.988	0.331	0.980	0.418
	(1.6)	(130.7)	(10.5)		
1961.2-1969.12	-0.036	1.01	0.123	0.978	0.156
	(0.1)	(68.8)	(3.5)		
1970.1-1979.12	0.389	0.969	0.355	0.944	0.577
	(1.5)	(44.4)	(5.6)		
1981.1-1988.7	0.263	0.974	0.349	0.965	0.375
	(1.2)	(52.4)	(7.9)		
1984.1-1988.7	1.72	0.827	0.262	0.827	0.315
	(2.9)	(14.1)	(5.2)		

	LM_1	LM_2	LM_4	LM_8	Implied long-run equilibrium RL
1961.2-1988.7	4.1	4.2	25.7	22.1	10.5
1961.2-1969.12	0.6	0.7	7.6	10.2	*
1970.1-1979.12	4.1	4.3	8.8	11.4	12.7
1981.1-1988.7	0.7	1.5	5.0	6.5	10.1
1984.1-1988.7	5.4	5.5	10.9	13.4	9.9

* long-run not determined
For details on test statistics see Table 3.

For the period as a whole it appears that around one third of a change in short rates is reflected in movements in long rates. There are, however, quite significant variations over time. In the 1960s there was much less of an impact of changes in short rates on long rates than in later periods. In the 1970s the impact was marginally higher than in the 1980s. Interestingly, there does seem to be some evidence of a recent (since 1984) reduction in the impact of changes in short-term interest rate changes on long-term rates. We investigated this further by allowing both the target towards which long rates would tend at each point and the influence of changes in short rates to vary continuously over time. The Kalman filter was used to test whether parameters do show significant time variation and to show the paths along which parameters evolve. Very significant time variation was evident. Chart 7 shows how the parameter reflecting the impact of changes in short-run interest rates on long term-rates varies through time. [In the chart this parameter is called "difgbsaf".] The finding from the regressions over sub-periods, summarised in Table 6, is confirmed by the time varying parameter estimation: the influence of changing short rates upon long rates was much higher in the 1970s and early 1980s than in the 1960s but has declined in recent years.

There are several possible interpretations of these results. One is that the monetary authorities while retaining significant control over short-term rates can no longer use variations in those rates to influence longer rates to the same extent as before. This would follow if there was a decoupling of long rates from the future path of domestic short rates. A very different interpretation, but one equally consistent with the facts, is that the authorities have achieved a high level of credibility in the anti-inflation battle and agents believe that in the medium to long-term inflation and nominal interest rates will remain stable. Movements in short-term nominal rates might then be interpreted as adjustments by the authorities designed to keep inflation under control and a sharp rise in rates at the short end might be seen as making a reduction in inflationary pressures, and a subsequent reversal of the rise in rates, likely. If this were true one would expect short-term movements in rates to have little impact on long rates; but this would not imply that the authorities have somehow lost influence. What it does suggest, however, is that long rates should become less variable, both absolutely and relative to short rates. We noted above that relative to the


SMOOTHED TIME VARYING PARAMETER ON difgbsaf
.5
.36
.24
.12
0.00
1962
64
66
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c. CJC

1970s long rates do indeed appear to be less volatile while short rates are no less volatile. This adds some indirect weight to the idea that the lower impact of changes in short rates on long rates is due to beliefs about the longer-term stability of short-term rates and inflation, rather than to a decoupling of long from short rates.

We now consider whether changes in long rates between the UK and other industrialised countries have become more closely linked. This is particularly difficult both because obtaining comparable interest rate series over a long period is problematic and because the way to implement the test is far from clear. Data limitations, for example, have prevented us from analysing trends in bilateral correlations between the UK's and the other countries' rates for common periods. What we have done is to calculate the correlation between the month-to-month change in the UK long rate and that in other G7 countries over various periods. The results are shown in Table 7. The table also shows the slope coefficient from regressing the UK change in rates on the foreign change in rates. This shows how much of a change in foreign long rates is, on average, matched by a <u>contemporaneous</u> change in UK rates. No implications of causality are implied by these coefficients.

Table 7

	Correlation coefficient for change in rates	β slope coefficient (t statistic in bracket)[a]	
FRANCE[b]			
1961.2-1988.07	0.04	0.37	(3.8)
1961.2-1969.12	0.01	0.15	(1.1)
1970.1-1979.12	0.09	1.0	(3.3)
1980.1-1988.7	0.04	0.22	(2.0)
GERMANY[b]			
1973.2-1988.7	0.04	0.52	(2.8)
1973.2-1979.12	0.05	0.73	(2.0)
1980.1-1988.7	0.05	0.40	(2.3)
JAPAN[b]			
1966.11-1988.7	0.04	0.39	(3.2)
1970.1-1979.12	0.01	0.26	(0.9)
1980.1-1988.7	0.10	0.43	(3.4)
US[b]			
1961.2-1988.7	0.07	0.45	(5.0)
1961.2-1969.12	0.03	0.27	(1.7)
1970.1-1979.12	0.05	0.80	(2.4)
1980.1-1988.7	0.15	0.39	(4.2)
ITALY[b]			
1961.2-1988.7	0.02	0.21	(2.5)
1970.1-1979.12	0.09	0.70	(3.0)
1980.1-1988.7	0	0.49	(0.5)

a Coefficient from regression: $RL_t - RL_{t-1} = \alpha + \beta [R_fL_t - R_fL_{t-1}]$ where RL_t is UK nominal long rate of interest in period t and R_fL_t is the "foreign" long rate of interest in period t.

b For data definitions see appendix.

We also analyse how changes in UK rates have been linked to contemporaneous movements in all other G7 long rates by regressing the UK change simultaneously on all the changes in other rates. This allows the weights to be attached to changes in interest rates in each of the other countries to be chosen so as to maximise the power in accounting for changes in UK rates. The R^2's from this regression are:

	R^2	(significant difference in R^2 from previous period)
1973.2-1988.7	0.121	
1973.2-1979.12	0.230	Yes
1980.1-1988.07	0.206	No
1984.1-1988.07	0.342	Yes

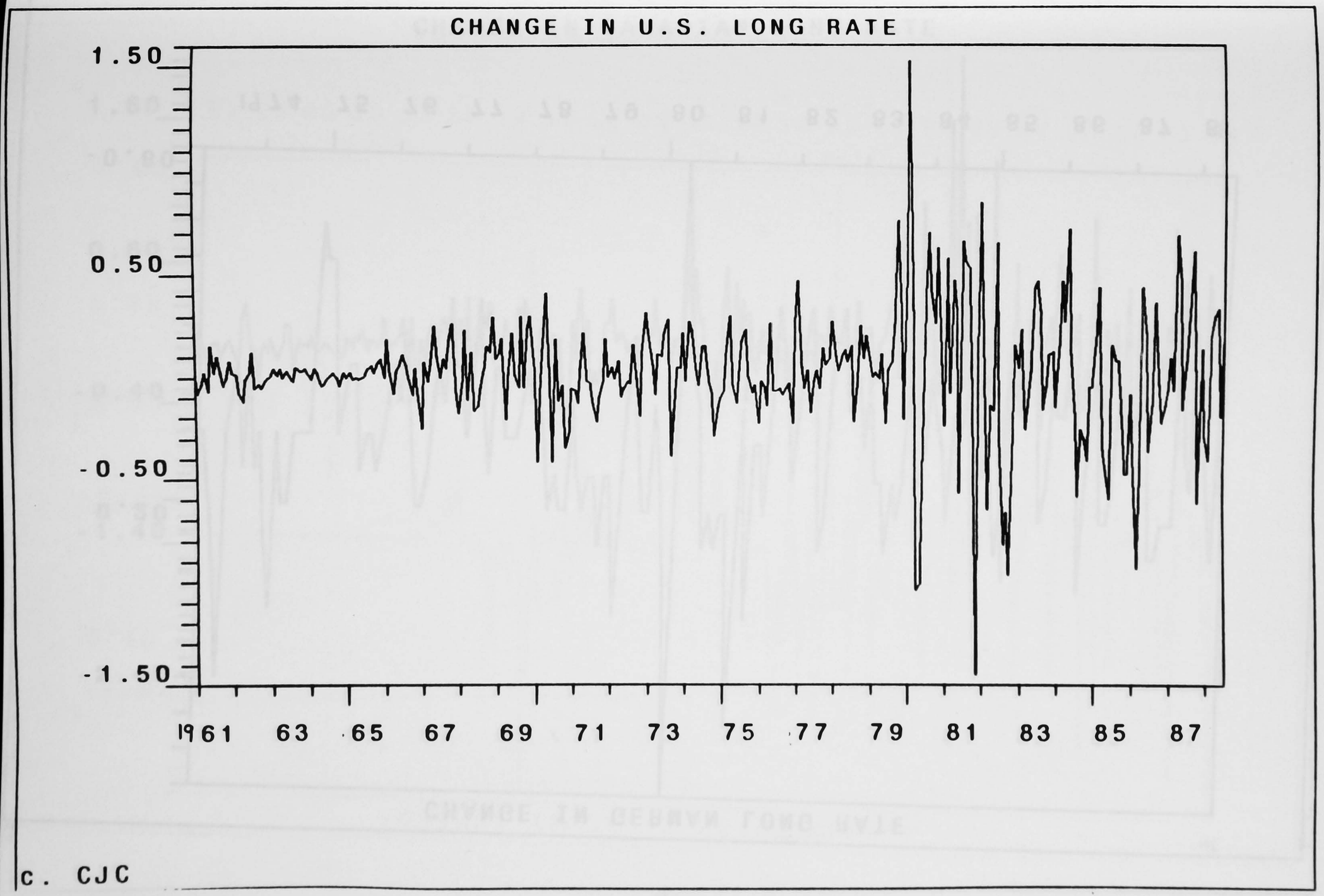
In these regressions the weights attached to changes in rates in other countries varied significantly across the sub-periods. For the whole period, changes in UK rates were most strongly linked to changes in Canadian, US and French long rates. In the 1970s UK rates moved most closely with long rates in Italy, France and the US. In the most recent period (1984-88) UK long rates have moved more closely in line with Japanese rates.

These results would seem to point to a tendency for interest rate changes to be somewhat more highly correlated in the most recent period (1984-88) than in earlier periods. But by far the greater part of the short-run variability in long-term UK rates still reflects factors which are specific to the UK.

(ii) The G7 countries

It is interesting to investigate whether the tendency for long-term interest rate changes in the UK and in other G7 countries to move slightly more closely is mirrored by convergence in other aspects of the pattern of interest rates across countries - in particular in volatility and in the shape of the yield curve.

We repeated some of the tests undertaken on the UK interest rate data with data from the other G7 countries. Because it has proved difficult to find exactly comparable series it is not sensible to compare results for actual levels of volatility or for the slope of the yield curve across countries at a point in time. Changes in volatility or yield curve slopes for a particular country over time can, however, be analysed with more confidence. Charts 8 to 13 show changes in long rates for the major economies over as long a period as reliable data is available. Table 8 shows the standard error of the change in long rates for various periods for each of the other G7 countries. [The UK figures were analysed in Table 3 above.] The table reveals that relative to the 1970s there has been a significant rise in the volatility of


CHANGE IN U.S. LONG RATE
1.50
0.50
-0.50
-1.50
1961
63
65
67
69
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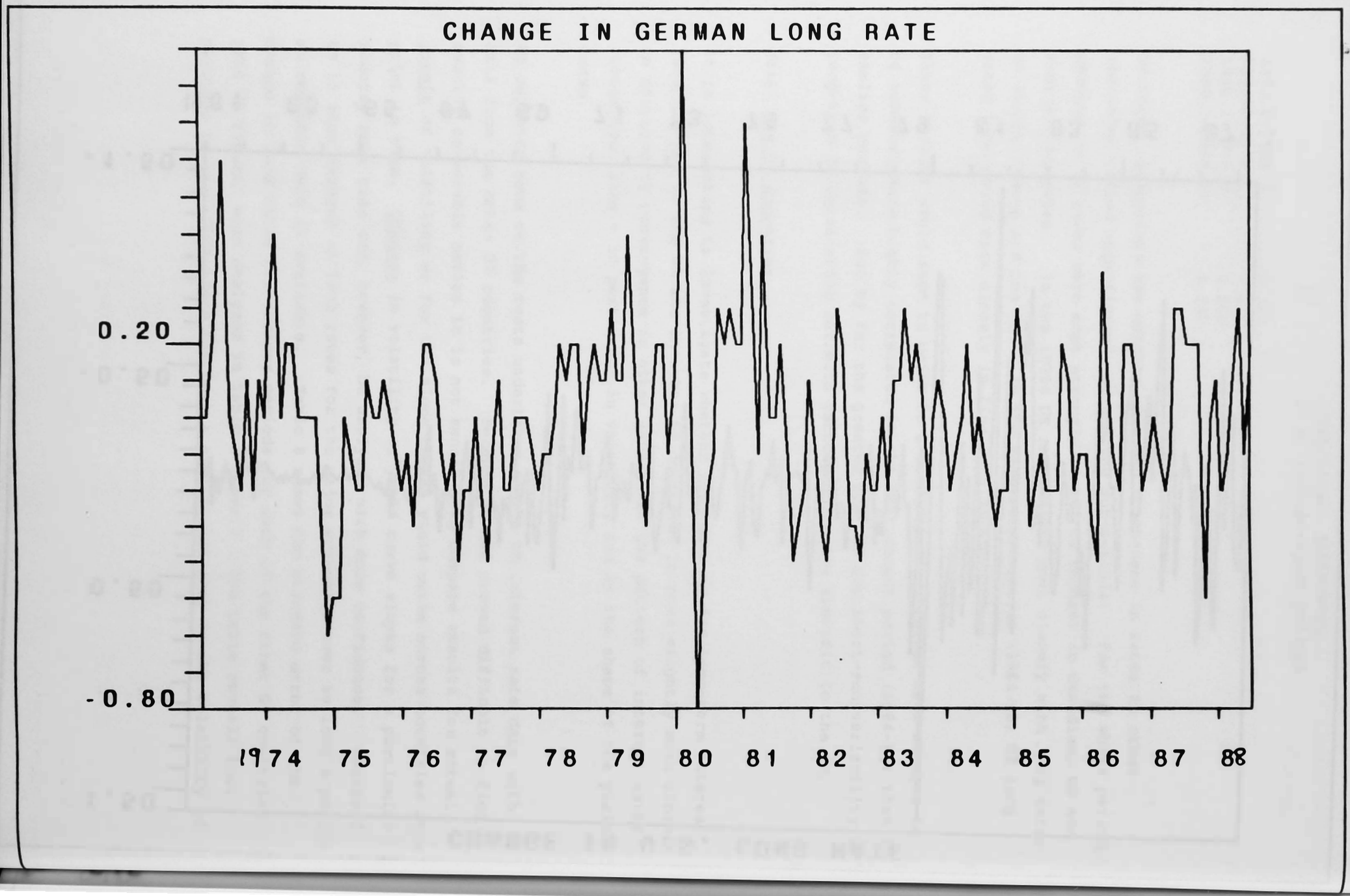
85
87

c. CJC


CHANGE IN GERMAN LONG RATE
0.20
-0.80
1974
75
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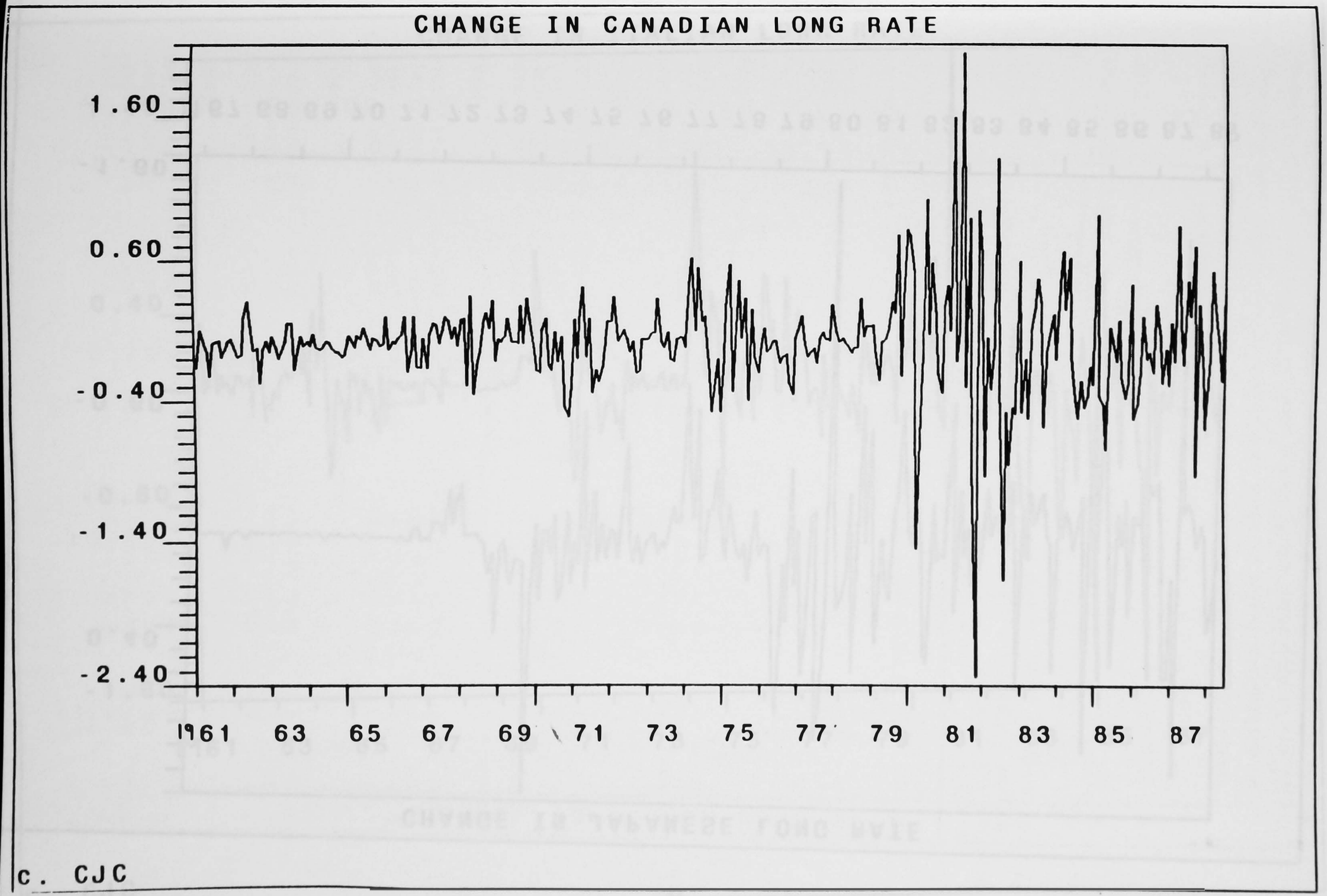
CHANGE IN CANADIAN LONG RATE
1.60
0.60
-0.40
-1.40
-2.40
1961
63
65
67
69
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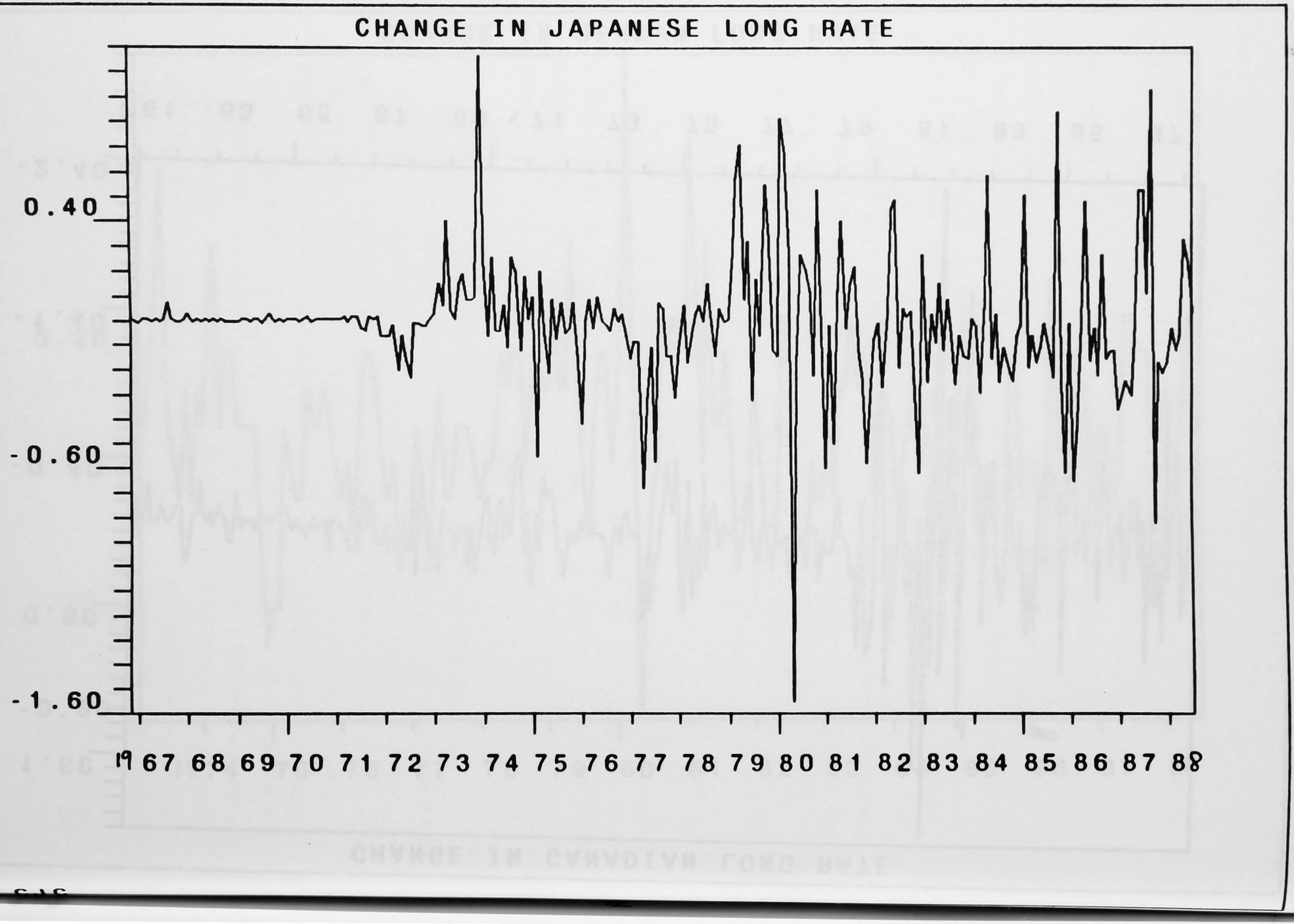
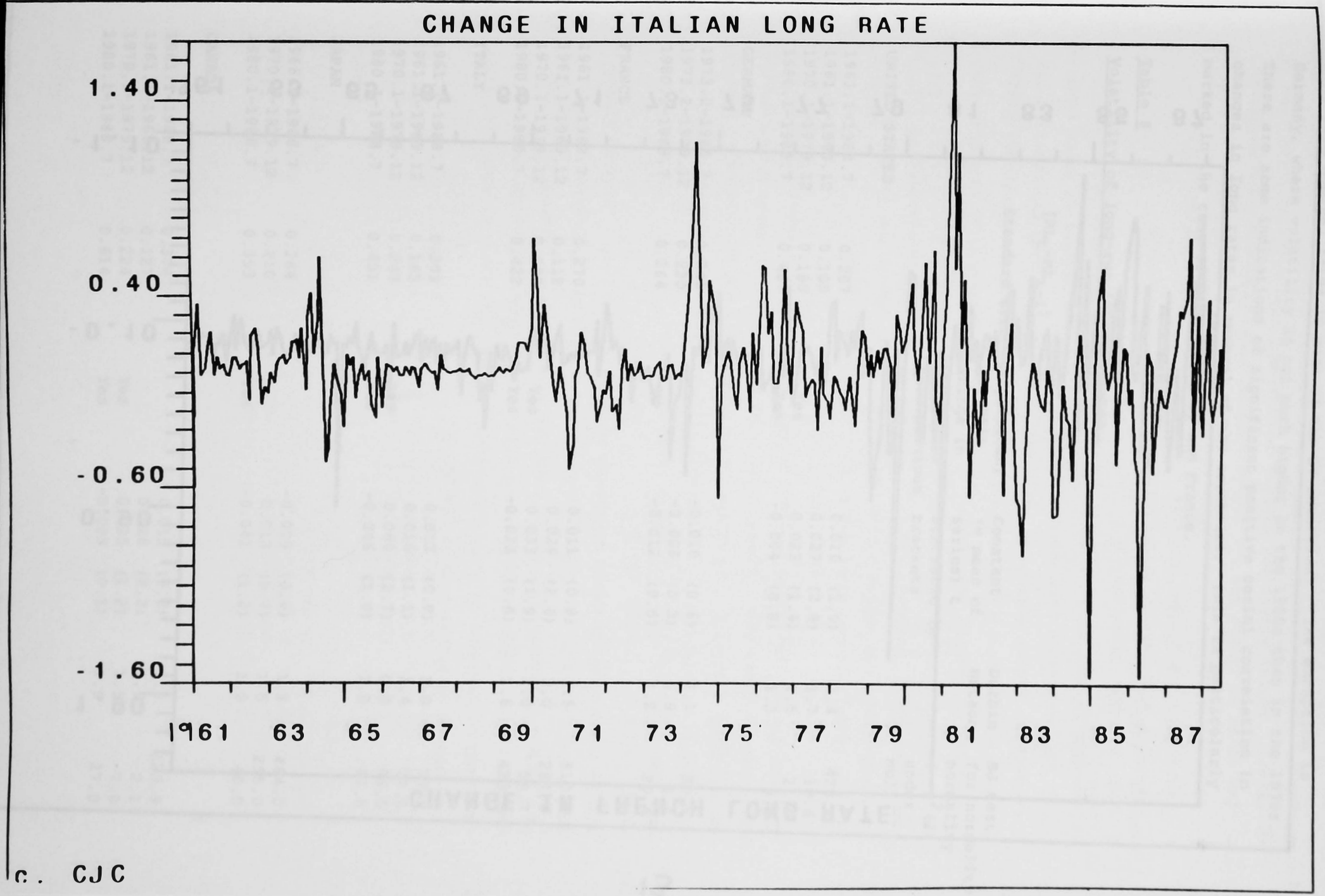
83
85
87
c. CJC


CHANGE IN JAPANESE LONG RATE
0.40
-0.60
-1.60
19 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88


CHANGE IN ITALIAN LONG RATE
1.40
0.40
-0.60
-1.60
1961
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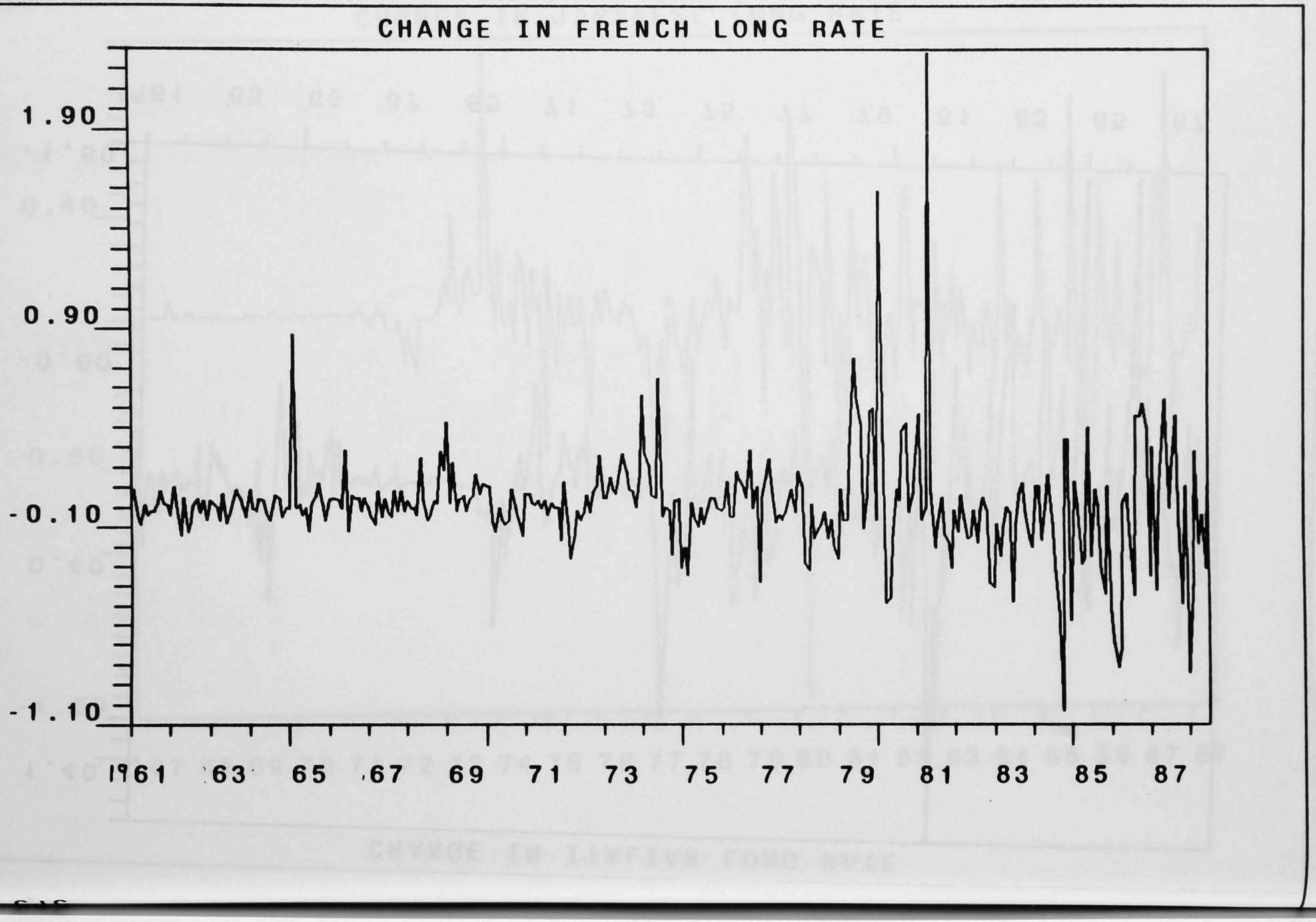
87

c. CJC


CHANGE IN FRENCH LONG RATE
1.90
0.90
-0.10
-1.10
1961
63
65
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69
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long-term nominal rates in most of the G7 countries. The exception is Germany, where volatility is not much higher in the 1980s than in the 1970s. There are some indications of significant positive serial correlation in changes in long rates in several of the countries; this is particularly marked in the case of Germany, Italy and France.

Table 8

Volatility of long-run interest rates

	$[RL_t - RL_{t-1}]$ Standard error	Significant (at 95%) change in volatility from previous period	Constant (= mean of series) t statistic in brackets		Durbin Watson	BJ test for normality normality (~ $\chi^2(2)$ under null
UNITED STATES						
1961.1-1988.7	0.287		0.016	(1.0)	1.4	423.1
1961.1-1969.12	0.100		0.027	(2.8)	1.7	10.6
1970.1-1979.12	0.180	Yes	0.023	(1.4)	1.5	21.0
1980.1-1988.7	0.467	Yes	-0.004	(0.8)	1.3	3.2
GERMANY						
1973.2-1988.7	0.245		-0.010	(0.6)	1.1	30.5
1973.2-1979.12	0.220		-0.008	(0.3)	0.9	4.4
1980.1-1988.7	0.264	No	-0.012	(0.5)	1.2	20.4
FRANCE						
1961.1-1988.7	0.270		0.011	(0.8)	1.5	510.5
1961.1-1969.12	0.118		0.029	(2.6)	2.0	267.6
1970.1-1979.12	0.187	Yes	0.033	(1.9)	1.0	59.7
1980.1-1988.7	0.422	Yes	-0.033	(0.8)	1.6	423.3
ITALY						
1961.1-1988.7	0.309		0.013	(0.8)	1.0	77.0
1961.1-1969.12	0.165		0.016	(1.1)	1.4	71.1
1970.1-1979.12	0.247	Yes	0.060	(2.7)	0.9	98.0
1980.1-1988.7	0.451	Yes	-0.046	(1.0)	1.0	47.8
JAPAN						
1966.1-1988.7	0.264		-0.009	(0.6)	1.8	464.0
1970.1-1979.12	0.210		0.013	(0.7)	1.5	255.0
1980.1-1988.7	0.353	Yes	-0.041	(1.2)	1.9	40.0
CANADA						
1961.1-1988.7	0.374		0.015	(0.8)	1.8	123.9
1961.1-1969.12	0.127		0.028	(2.3)	1.9	2.1
1970.1-1979.12	0.224	Yes	0.025	(1.2)	1.5	7.0
1980.1-1988.7	0.614	Yes	-0.009	(0.1)	1.9	27.0

Table 9 and Charts 14 to 19 show a rather different picture for short-term rates. Whilst volatility appears considerably higher in the 1980s than in the 1970s in Canada and the United States, in Germany, Italy and Japan volatility has, if anything, fallen. Once again there are signs of positive correlation in changes in rates between months close together, and most strongly for adjacent months.

Changes in both long and short rates appear to be non-normally distributed. It is conceivable that the distribution from which changes in rates comes is such that finite moments do not exist so one must be wary in attaching too much significance to variances or standard errors. Exact quantitative results on changes in volatility are not to be deduced; we feel that the finding that long-term nominal rates are more volatile in the 1980s in these countries is, however, robust. This is in contrast to the finding for the UK where there was evidence that volatility had fallen in the 1980s relative to the 1970s, and had continued to fall through the 1980s.

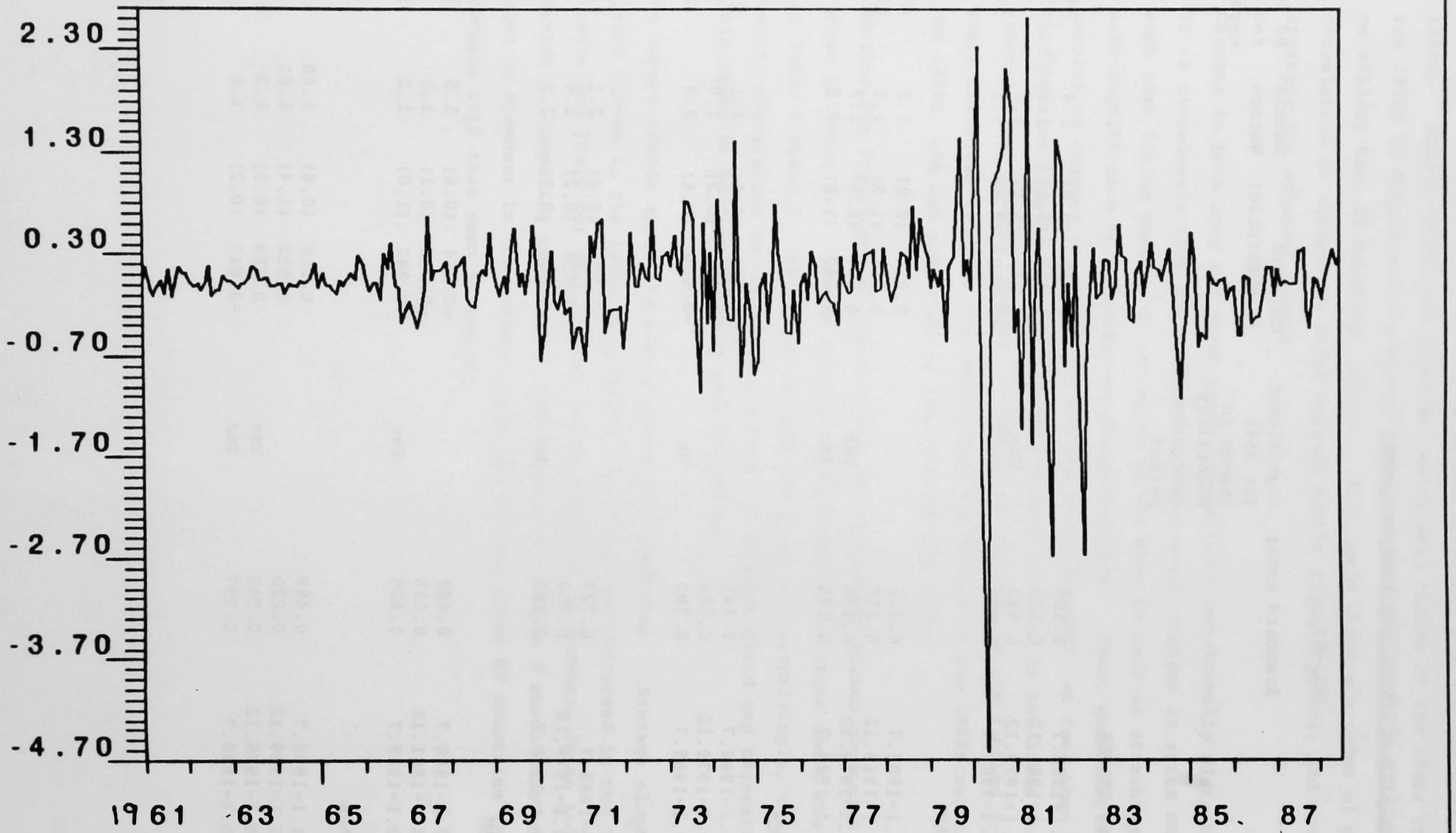
Results for the slopes of yield curves in the industrialised countries are shown in Table 10. [These results can be compared to those shown for the UK in Table 5 above.] As in the UK case there is, not surprisingly, very strong serial correlation in the residuals from the average yield gap regressions. This makes it hard to formally test hypotheses.

No common trends appear to emerge across all countries. Average slopes of yield curves in the 1980s relative to the 1970s have increased in the US, France and Italy but seem to have fallen slightly in Germany, Japan and Canada. Comparing the results from Table 5 with Table 9 shows that there has been no movement in the average yield gap for the other G7 countries to compare with that seen in the UK.

Table 9

Variability of short-run interest rates

	$RS_t - RS_{t-1}$					
	Standard error	Significant (at 95%) change in volatility from previous period	Constant	(t statistic)	Durbin Watson	BJ test for normality
UNITED STATES						
1961.1-1988.7	0.599		0.032	(0.4)	1.4	348.0
1961.1-1969.12	0.173		0.017	(3.1)	1.3	36.9
1970.1-1979.12	0.440	Yes	0.035	(0.9)	1.5	4.1
1980.1-1988.7	0.928	Yes	-0.052	(0.6)	1.3	191.7
GERMANY						
1961.1-1988.7	0.308		0.01	(0.0)	1.3	477.0
1961.1-1969.12	0.210		0.021	(1.0)	1.5	291.7
1970.1-1979.12	0.395	Yes	0.020	(0.5)	1.2	18.7
1980.1-1988.7	0.275	Yes	-0.042	(1.5)	0.9	215.0
FRANCE						
1969.2-1988.7	0.741		-0.002	(0.0)	2.1	777.0
1970.1-1979.12	0.706		-0.014	(0.2)	1.9	10.8
1980.1-1988.7	0.790	No	-0.050	(0.6)	2.2	100.7
ITALY						
74.6-1988.7	0.727		-0.022	(0.4)	2.1	89.2
1974.6-1979.12	0.750		0.018	(0.2)	1.4	46.8
1980.1-1988.7	0.713	No	-0.049	(0.7)	2.3	47.0
JAPAN						
1977.3-1988.7	0.443		-0.024	(0.6)	1.5	785.0
1977.3-1981.12	0.636		-0.006	(0.1)	1.5	68.0
1980.1-1988.7	0.435	Yes	-0.042	(1.0)	1.3	122.6
CANADA						
1961.1-1988.7	0.488		0.015	(0.6)	1.68	143.0
1961.1-1969.12	0.229		0.032	(1.4)	1.61	162.0
1970.1-1979.12	0.345	Yes	0.028	(0.9)	1.3	6.6
1980.1-1988.7	0.757	Yes	-0.017	(0.2)	1.8	73.0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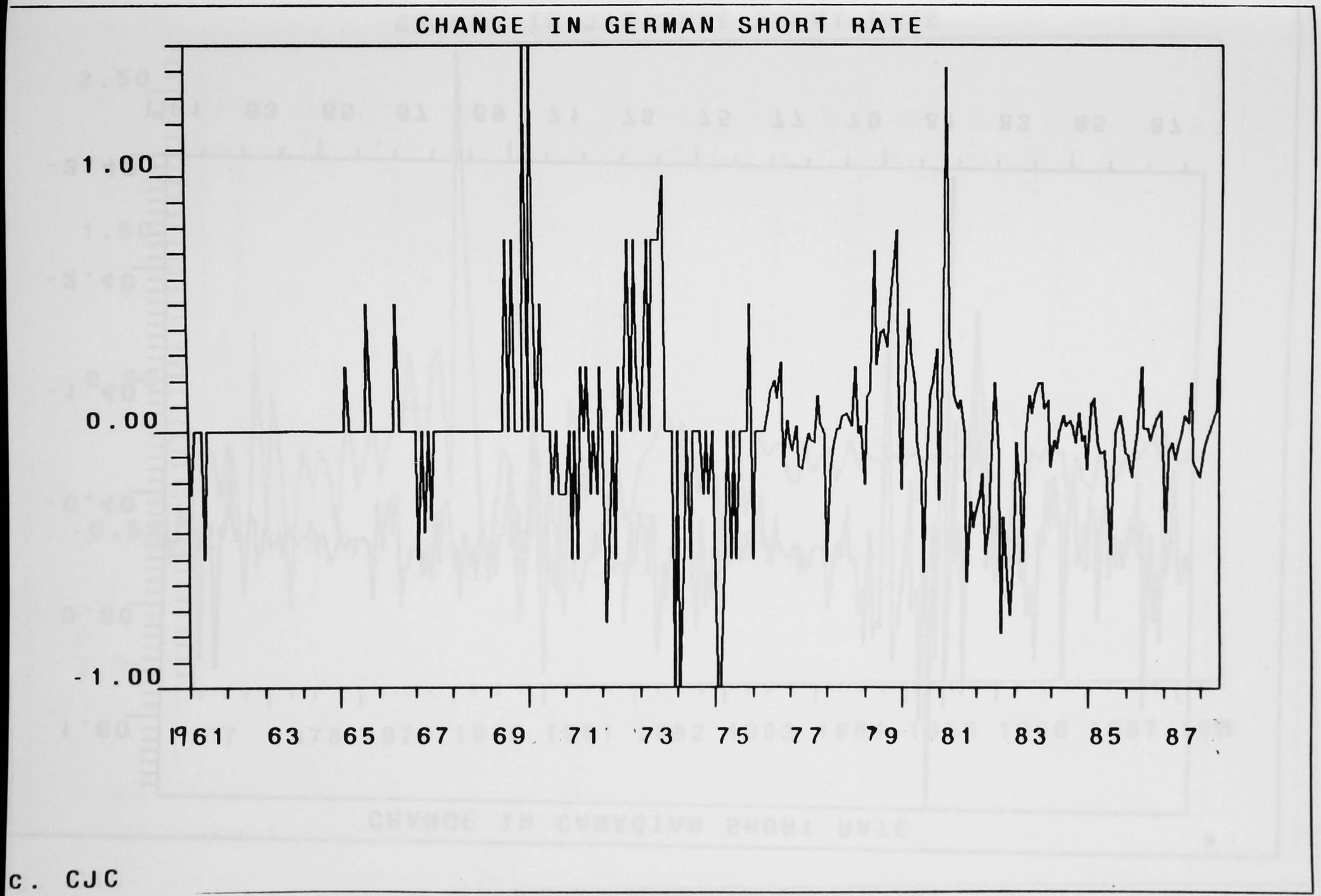
1.30
0.30
-0.70
-1.70
-2.70
-3.70
-4.70
1961
63
65
67
69
71
73
75
77
79
81
83
85
87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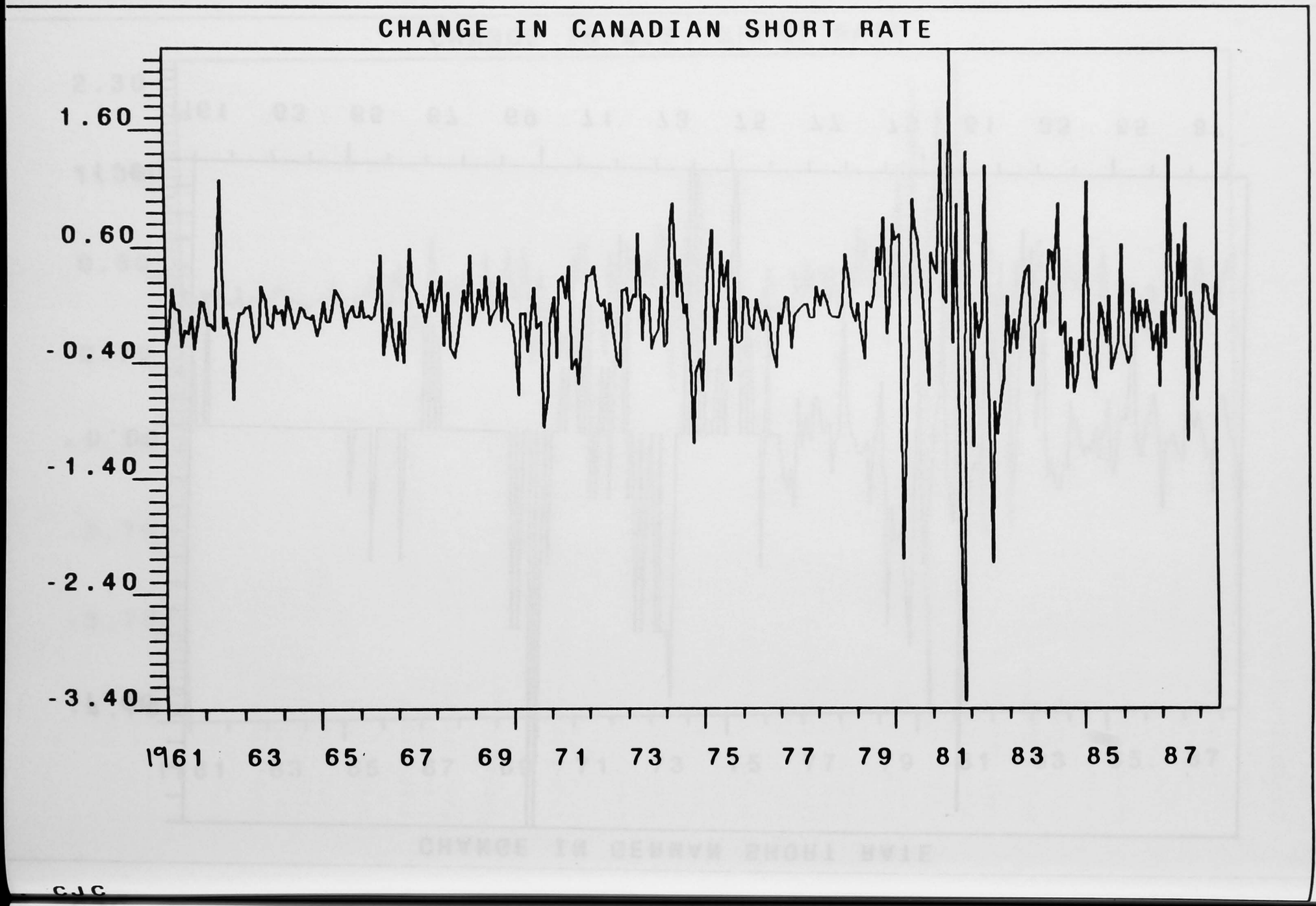
1.00
0.00
-1.00
1961
63
65
67
69
71
73
75
77
79
81
83
85
87

c. CJC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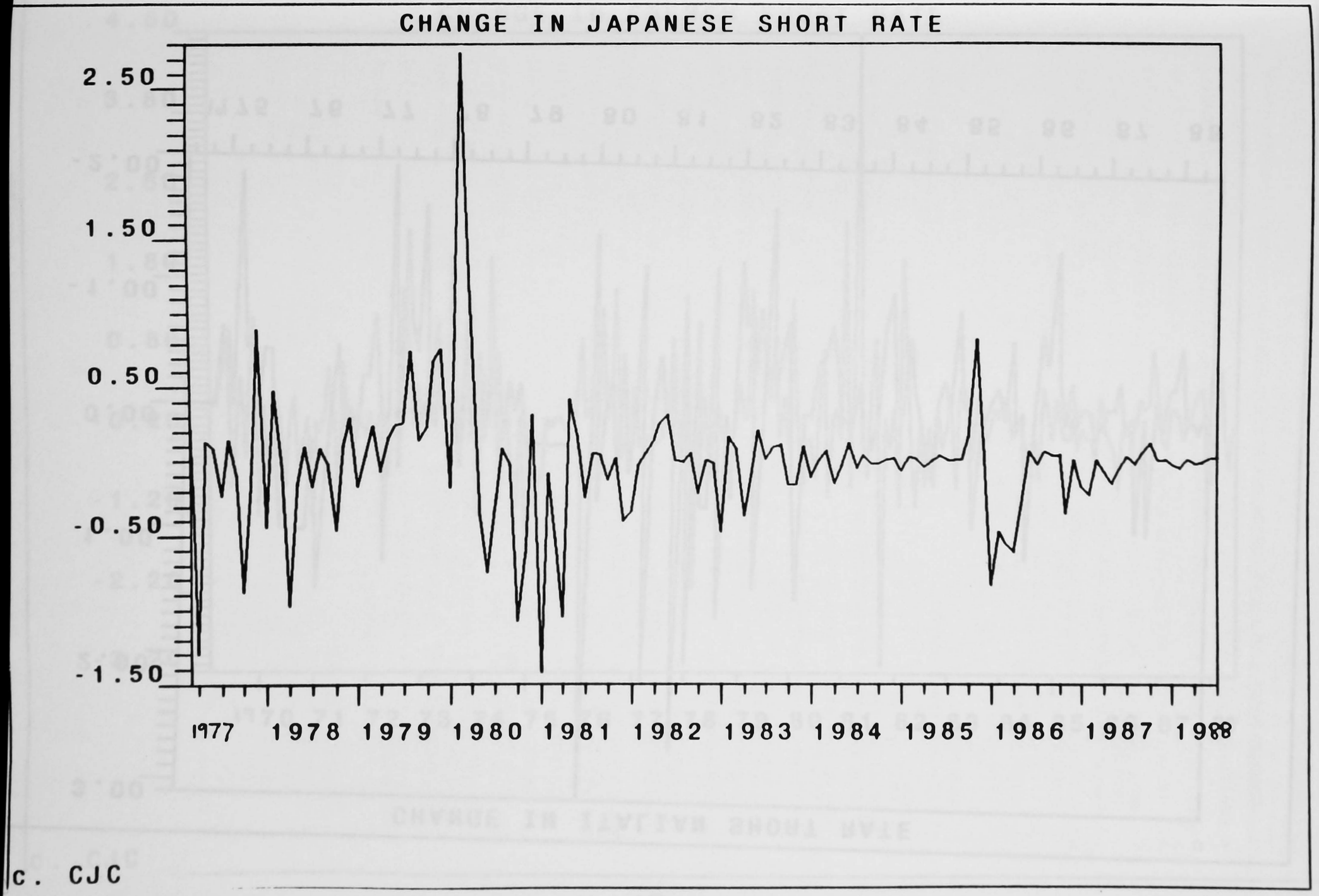
1.60
0.60
-0.40
-1.40
-2.40
-3.40
1961
63
65
67
69
71
73
75
77
79
81
83
85
87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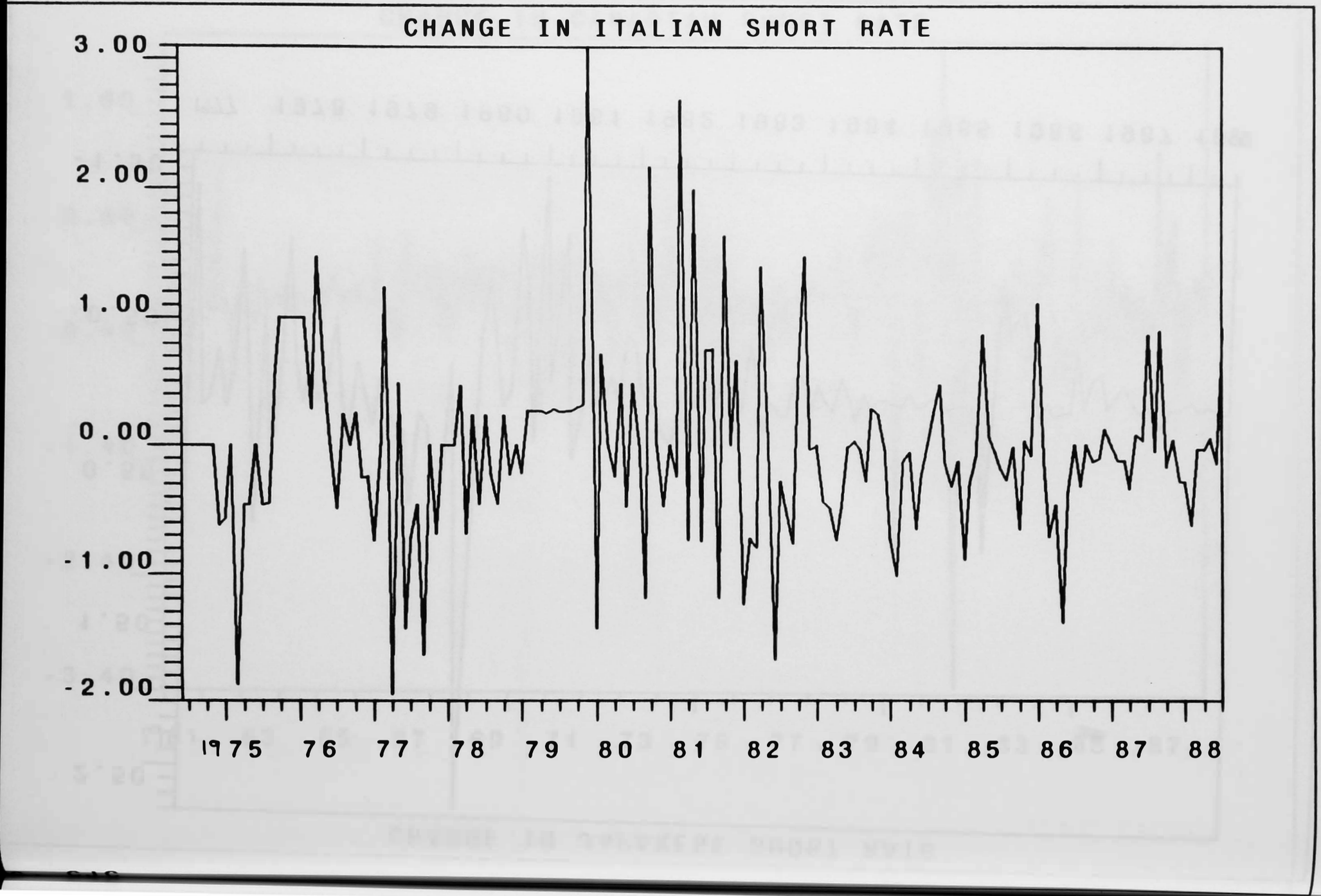
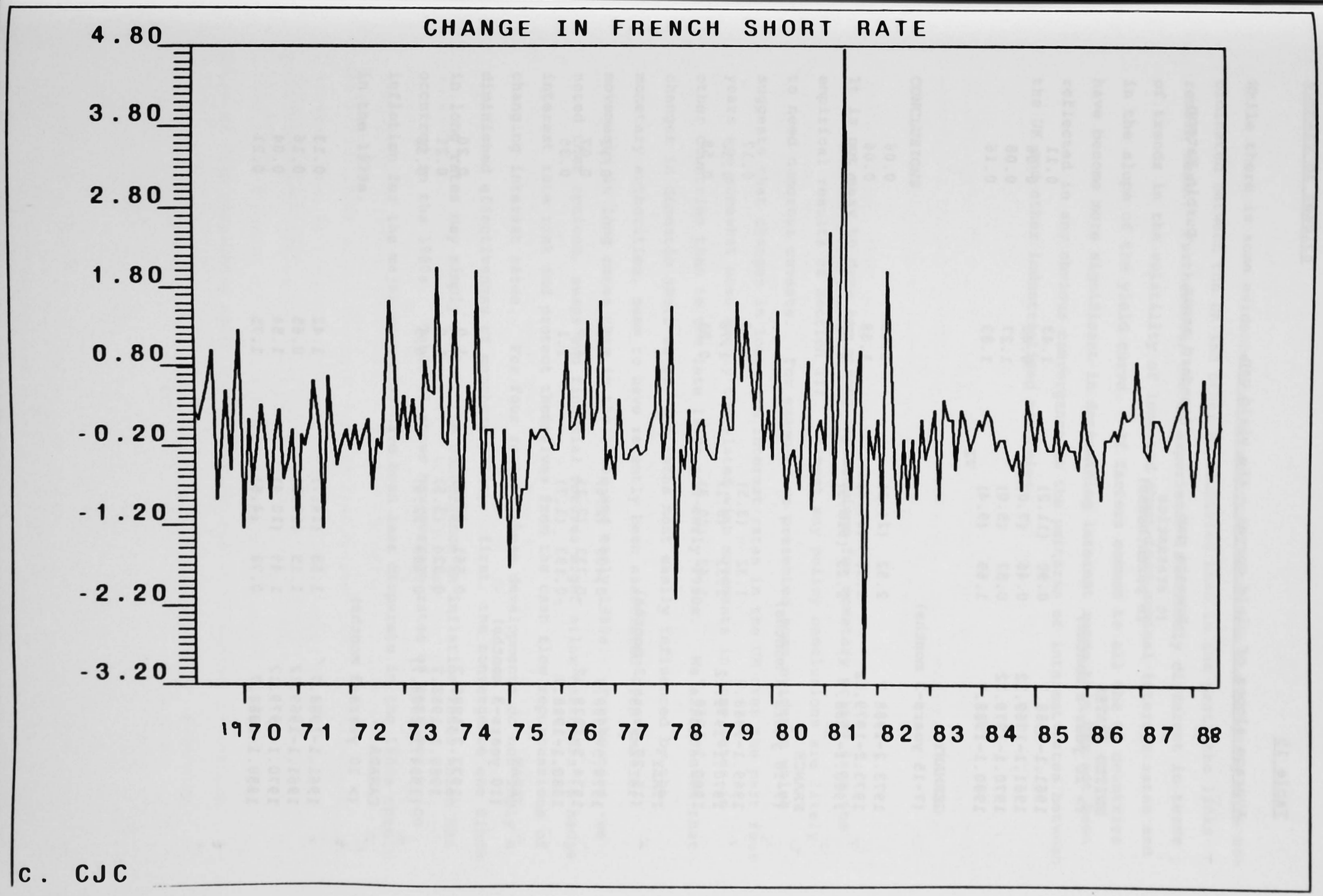
2.50
1.50
0.50
-0.50
-1.50
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988

c. CJC


CHANGE IN ITALIAN SHORT RATE
3.00
2.00
1.00
0.00
-1.00
-2.00
1975
76
77
78
79
80
81
82
83
84
85
86
87
88


CHANGE IN FRENCH SHORT RATE
4.80
3.80
2.80
1.80
0.80
-0.20
-1.20
-2.20
-3.20
1970 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88

C. CJC

Table 10

Average slopes of yield curves - the yield gap

	Average gap (t statistics in parentheses)		Standard error	Durbin Watson
UNITED STATES (> 10 year-3 months)				
1961.1-1988.7	0.90	(11.2)	1.43	0.11
1961.1-1969.12	0.46	(7.0)	0.68	0.06
1970.1-1979.12	0.57	(5.0)	1.27	0.08
1980.1-1988.7	1.69	(9.4)	1.83	0.16
GERMANY (7-15 years-3 months)				
1973.2-1988.7	2.52	(24.2)	1.43	0.06
1973.2-1979.12	2.90	(16.7)	1.58	0.06
1980.1-1988.7	2.23	(918.5)	1.22	0.05
FRANCE (7-10 years-3 months)				
1969.1-1988.7	1.32	(3.5)	1.50	0.17
1970.1-1979.12	1.31	(8.1)	1.78	0.12
1980.1-1988.7	1.62	(20.3)	0.81	0.58
ITALY (15-20 years-3 months)				
1974.5-1988.7	-0.408	(2.6)	2.0	0.13
1974.5-1979.12	-0.733	(2.1)	2.8	0.07
1980.1-1988.7	-0.193	(1.7)	1.1	0.35
JAPAN (10 years-3 months)				
1977.2-1988.7	0.561	(6.5)	1.0	0.20
1980.1-1988.7	0.324	(3.3)	1.0	0.21
(1984.1-1988.7)	0.189	92.6)	0.5	0.52
CANADA (> 10 years-3 months)				
1961.1-1988.7	1.15	(14.7)	1.42	0.13
1961.1-1969.12	1.15	(18.3)	0.65	0.16
1970.1-1979.12	1.45	(10.4)	1.54	0.04
1980.1-1988.7	0.78	(4.5)	1.75	0.21

Summary of results

While there is some evidence that movements in rates are now slightly more co-ordinated between the UK and other G7 countries than in the past, the links remain weak. Furthermore, the UK experience is markedly different in terms of trends in the volatility of long and short-term nominal interest rates and in the slope of the yield curve. If factors common to all the G7 countries have become more significant in determining interest rates this has not been reflected in any obvious convergence in the patterns of interest rates between the UK and other industrialised economies.

IV

CONCLUSIONS

It is not easy to draw any strong implications for monetary policy from the empirical results of Section III. Almost any policy conclusions are likely to need numerous caveats. For example, we presented some evidence which suggests that changes in long-term interest rates in the UK over the past four years are somewhat more highly correlated with movements in long rates in other countries than in the late 1970s and early 1980s. We also showed that changes in domestic short rates, the rates most easily influenced by the monetary authorities, seem to have recently been associated with smaller movements in long rates than in the 1970s and early 1980s. Furthermore, we noted that options, swaps and financial futures might allow borrowers to hedge interest rate risk and protect themselves from the cash flow repurcussions of changing interest rates. For four reasons these developments do not imply a diminished effectiveness of monetary policy; first, the convergence one finds in long rates may simply reflect the convergence in inflation rates which has occurred in the 1980s. Table 11 shows how average rates of consumer price inflation for the major economies have been less disparate in the 1980s than in the 1970s.

Table 11

Average annual rate of increase in consumer prices

	1971-1980	1981-1987
UK	13.9	5.1
Germany	5.1	2.1
US	7.6	3.9
Japan	9.0	1.5
Canada	8.0	5.6
Italy	16.0	10.4
France	9.8	6.8
Average	10.0	5.1
(Variance)	(12.3)	(7.8)

Second, we noted that if the private sector were confident that inflation would remain in a relatively narrow band over the medium to long term one would expect long-term rates to become less volatile and less responsive to movements in short-term rates. Finally, the abandonment of overfunding in 1985 in favour of the policy of fully funding the public sector borrowing requirement - which removed one potential way of actively impacting on the shape of the yield curve - was a policy decision. One should not, therefore, interpret our empirical findings as implying a loss in control.

Third, a given change in long rates in an environment where long rates are themselves less volatile may have a greater impact than when long rates are highly variable. We noted above that long rates have been significantly less volatile in recent years in the UK.

Fourth, even if companies were able to hedge themselves completely against movements in interest rates it does not follow that intertemporal resource allocation will become unresponsive to interest rate changes. [For a discussion of these developments as they relate to the personal sector see Dicks' Bank of England Technical Paper No 20.] Changes in real interest rates certainly continue to influence the cost of capital; the opportunity cost of funds for new investment will still move with interest rates even if changes in nominal rates may not affect cash flows associated with existing borrowing.

DATA APPENDIX

We have aimed to use data on the gross yields on default-free debt with common maturities. Some trade-off proved inevitable between matching maturity across countries, obtaining a long run of data, measuring rates at common points within a month and ensuring that debt is free of default risk. There is much scope for debate about how this trade-off should be made. Wherever possible we have repeated the tests reported in the paper on alternative measures for each country and give some indication of the robustness of conclusions. The data used in the charts and tables in the paper are:

UK long rate: This is the gross yield to maturity on 20-year government bonds measured at end-month. The yields are calculated from a mathematical model of the par yield curve constructed by the Bank of England.

UK short rate: The yield on three-month Treasury bills measured at end-month.

Canadian long rate: The yield on the secondary market on government bonds with at least ten years to maturity; measured at the end of the month.

Canadian short rate: Yield on three-month Treasury bill at tender measured on the last Thursday of each month.

French long rate: The yield on government backed bonds issued by public works boards measured at end-month. Average maturity is probably between 7 and 10 years.

French short rate: The three-month offer rate on the interbank market measured at month-end.

Japanese long rate: Month-end yield on interest bearing government bonds with average maturity of 10 years.

Japanese short rate: Rate of interest on CDs and deposits with maturity of 1-4 months.

German long rate: Average yields on secondary market of government bonds with between 7 and 15 years to maturity. Yields are calculated as monthly averages.[11]

German short rate: Rates paid to lenders on time deposits with between 1 and 3 month maturity. Average through the month.[11]

Italian long rate: Yield on government bonds with between 15 and 20 years to maturity; month average.[11]

Italian short rate: Three-month Treasury bill rate; month average.[11]

US long rate: Secondary market yield on US notes and bonds with more than ten years to maturity; month average.[11]

US short rate: 3 month Treasury bill yield; month average.[11]

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11 The use of monthly averages for some countries and month end data for makes comparisons of volatility measures across countries problematic. The month average data is smoothed and changes from month to month would generally have a lower variance than with end-month data. Comparisons of changes of volatility over time for a country where long and short rates are consistently end-month, or consistently month averages remain informative. Ideally, we should have liked to use month-end data throughout.

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