Long-run and short-run linkages between stock prices and interest rates in the G-7

SIMON BROOME and BRUCE MORLEY

Department of Economics, University of Wales Aberystwyth, Aberystwyth, Ceredigion SY23 3DB, Wales, UK

The paper investigates the nature of the relationship between stock prices and interest rates, using the cointegration and co-dependence techniques. Using data for the G-7 economies, the evidence suggests that in general stock prices and interest rates do not exhibit a long-run common trend, but rather follow a short-run cyclical pattern.

I. INTRODUCTION

There has been a substantial amount of research on the interrelationships between the main stock markets and on the interdependence of the main bond markets around the world. However, there have been very few papers that have investigated the relationship between an individual country's stock market and interest rate, then compared this interrelationship over a number of countries. As markets across countries become more closely related due to technical progress and widespread financial deregulation, so different financial markets within countries should also become more closely integrated.

The aim of this paper is to determine whether stock prices and interest rates share a common trend or common cycle. The cointegration technique is used to test for a long-run common trend, and co-dependence analysis is used to test for a short-run common cycle. Co-dependence has been used by Vahid and Engle (1993) among others, to analyse common cycles between output and consumption. As both interest rates and stock prices are related to the business cycle, it would theoretically be expected that both should follow a cyclical pattern.

The relationship between bond markets is usually referred to as financial integration, so as interest rates become more closely correlated, so markets become more integrated. There is evidence that over the last twenty years bond markets have become more highly integrated (Holmes and Pentecost, 1992). These studies have used a variety of techniques, with cointegration being prominent. There has also been widespread analysis of the interdependence between stock markets; Kasa (1992) found that one common stochastic trend lay behind the co-movement of the stock markets in the UK, USA, Canada, Japan and Germany.

Although there have been very few attempts to analyse the interrelationship between stock prices and interest rates,[1] Rahman and Mustafa (1997) have recently analysed the direction of causality between interest rates and stock prices, as well as testing for cointegration. For US markets, there appeared to be a valid long-run relationship, although the evidence on the direction of causality[2] was less conclusive. An earlier study by Nozar and Taylor (1988), also using US data, appeared to broadly support the findings on causality.

The structure of this appear is as follows. Section II describes the empirical methodology, whereby we test for

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[1] For a theoretical approach to the inter-relationship between stock prices and interest rates see Blanchard (1981). In general it suggests that a rise in interest rates leads to a fall in stock prices and vice versa.

[2] Granger causality tests were also carried out, using first-differenced variables and including an error correction term, where there was evidence of cointegration. As with these other studies, the direction of causality was ambiguous, with slightly more evidence of causality running from the interest rate to the stock prices.

common trends and common cycles. Section III describes the data set and the results, while Section IV offers some policy conclusions.

II. METHODOLOGY

To determine the long-run equilibrium relationship between two time series variables, the most usual method used is cointegration, as developed by Engle and Granger (1987) and Johansen (1988). To ascertain whether common cycles exist, the method recently developed by Engle and Kozicki (1993) and Vahid and Engle (1993), termed co-dependence, is used. The main difference between these two techniques is that cointegration involves co-movement between a set of non-stationary variables and co-dependence represents co-movement among a set of stationary variables.

In general cointegration between two non-stationary time series, stock prices (s) and interest rates (i), where s is expressed in logarithms, indicates the two series exhibit a shared stochastic trend:

$$s_t - \beta i_t = u_t \qquad (1)$$

If u_t is stationary, then i_t and s_t are said to be cointegrated, where β is the cointegrating vector. In contrast a form of co-dependence between two stationary time series, say Δs_t and Δi_t, is defined as a serial correlation common feature, where a linear combination of the stationary variables removes all past correlation such that it is completely unpredictable with respect to any past information. According to Vahid and Engle (1993), 'Elements of Δs_t have a serial correlation common feature if there exists a linear combination of them, which is an innovation with respect to all observed information prior to time t' (p. 342). That is to say that Δs_t and Δi_t possess a common cycle if:

$$\Delta s_t - \omega \Delta i_t = \eta_t \qquad (2)$$

where ω is a parameter and η_t is a white noise error term. To test for a serial correlation common[3] feature, two-stage least squares is used, where the instruments are the lagged values of both variables, a constant and in the case of a cointegrating long-run relationship, the error correction term, that is:

$$\Delta s_t = \gamma_0 + \gamma_1 \Delta i_t + \nu_t \qquad (3)$$

where ν_t is a random error term. In the case of monthly data, the instrument set typically includes twelve lags of the change in the stock price index and change in the interest rate. If there is a cointegrating relationship between stock prices and interest rates, then the lagged residual is also included among the regressors. The overidentifying restric-

tions are tested by the LM-statistic, which has a chi-squared distribution and the degrees of freedom equal to the number of overidentifying restrictions. This test statistic is based on the Sargan (1958) test for the legitimacy of the instruments, which is $T. R^2 = \chi_k^2$, where k is the number of restrictions.

As Engle and Issler (1995) stress, cointegration does not prevent common serial correlation features occurring or imply that they do exist. Furthermore, if no cointegration is found, then it does not necessarily mean that common serial correlation features will not occur, although in this case the error correction term should not be included among the instruments.

III. THE DATA SET AND TEST RESULTS

The data set consists of monthly observations, from January 1980 to January 1998 for the G-7 countries. The interest rate is the three-month treasury bill rate for each country and the stock market data consist of the principle market[4] index. The data starts from 1980, as this avoids the start of the European Monetary System and a number of other important changes to the world economy, that occurred in 1979.

Table 1 shows that the Augmented Dickey–Fuller (ADF) tests suggest that all the stock market indexes and interest rates are integrated of order one, I(1). The Johansen (1988) Maximum Likelihood Procedure (Table 2) was used to test for cointegration between stock prices and interest rates. We first used the Akaike Information Criteria to determine the number of lags required for the test, although lags were not excluded if it introduced serial correlation. The trace results indicate that the USA and Italy produce a single cointegrating vector at the 5% level of significance, while Canada produces a single vector at the 10% level of significance. It is also evident that in all

Table 1. *Augmented Dickey–Fuller tests for stationarity*

Country	s	Δs	i	Δi
UK	−1.326	−10.427	−2.041	−14.959
USA	0.131	−14.550	−1.635	−5.190
Germany	−0.351	−14.207	−1.900	−5.103
Japan	−1.972	−13.964	−0.954	−5.024
Canada	−0.590	−14.046	−1.647	−4.979
France	−0.549	−12.805	−0.859	−7.414
Italy	−2.167	−13.081	−0.858	−10.551

s is the stock market index and i is the interest rate, Δ is the first-difference operator. The appropriate lag lengths were determined by the Akaike criteria, the critical value of the ADF statistic is −2.89 (5%).

[3] For a formal proof of the test for co-dependance, see Engle and Kozichi (1993).
[4] All data were taken from Datastream.

Table 2. *Johansen maximum likelihood test for cointegration (trace result only)*

Country	$r = 0$	$r \leq 0$	Lags	Long-run β
UK	17.136	4.678	1	
USA	20.269**	5.742	5	-0.366
Germany	10.110	2.682	2	
Japan	9.987	0.696	1	
Canada	19.299*	2.929	2	-0.120
France	12.677	3.131	1	
Italy	26.856**	3.305	1	-0.139
5%	*19.964*	*9.243*		
10%	*17.852*	*7.525*		

The values at the bottom of the table are the critical values.
* Significant at the 10% level; ** Significant at the 5% level.

Table 3. *Error correction models*

USA
$\Delta s = -0.010 - 0.009ect_{t-1} - 0.007\Delta i + 0.119\Delta s_{t-5} - 0.285D1$
$\quad\quad (1.120)\;(2.321)\quad\quad (1.818)\quad (6.190)\quad\quad (7.177)$
$R^2 = 0.223, DW = 2.206, LM(12) = 6.190, \text{Reset}(1) = 0.005$

Canada
$\Delta s = 0.002 - 0.043ect_{t-1} - 0.019\Delta i + 0.010\Delta i_{t-3} - 0.290D1$
$\quad\quad (0.795)\;(4.525)\quad\quad (5.214)\quad (2.578)\quad\quad (7.295)$
$R^2 = 0.311, DW = 2.054, LM(12) = 14.711, \text{Reset}(-1) = 0.712$

Italy
$\Delta s = 0.002 - 0.054ect_{t-1} - 0.014\Delta i + 0.134\Delta s_{t-3} - 0.161D1$
$\quad\quad (0.361)\;(3.943)\quad\quad (2.041)\quad (2.067)\quad\quad (2.332)$
$R^2 = 0.125, DW = 1.840, LM(12) = 5.088, \text{Reset}(1) = 0.450$

In the above equations, *ect* are the residuals from the cointegration tests, DW is the Durbin–Watson statistic, LM(12) is the Lagrange multiplier test for serial correlation, which has a chi-squared distribution with a critical value of 21.026 (5%). Reset is the Ramsey Reset test for functional form, with a critical value of 3.842 (5%). D1 is a dummy variable for October 1987.

Table 4. *Tests for co-dependence*

Country	γ_0	γ_1	LM statistic
UK	0.009 (2.755)	-0.042 (2.679)	29.065
USA	0.100 (3.488)	0.004 (0.474)	24.778
Germany	0.008 (2.036)	-0.016 (0.707)	11.435
Japan	0.004 (1.079)	-0.017 (0.345)	20.993
Canada	0.005 (1.571)	-0.025 (3.104)	20.616
France	0.008 (1.943)	-0.031 (1.738)	30.703
Italy	0.011 (2.173)	-0.028 (1.537)	15.606

The *t*-statistics are in parentheses for the constant and coefficient, based on equation (3). For the Sargan LM test, which has 23 degrees of freedom (except for the USA, Canada and Italy with 24 degrees of freedom) the 5% critical value is 35.173 (36.415 for the other three).

the countries tested, the relationship in the long run is negative as expected.

The error correction models (ECMs) for those countries (Table 3) that show evidence of cointegration are all well specified, although the coefficients on the error correction terms are fairly small, indicating a slow speed of adjustment back to equilibrium following an exogenous disturbance. There is evidence at the 5% level of significance that there are common cycles between all the countries tested. With the exception of the USA, the relationship between stock prices and interest rates is negative, with the coefficient being about 0.02 across the countries tested (Table 4).

IV. CONCLUSIONS

There is little evidence that stock prices and interest rates possess a common trend, with the exception of the USA and Italy. However, there is strong evidence of common cycles for all countries. These findings lend support to the view that bond markets and stock markets in different countries around the world are linked, but this is not through a common trend, but through a common cyclical pattern. This suggests that when modelling the interaction between the bond markets and stock markets, a dynamic error correction type framework needs to be considered.

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