14 The Use of Financial Spreads as Indicators of Real Activity

E. P. Davis and S. G. B. Henry[1]

14.1 INTRODUCTION

A number of recent papers in the US have suggested that financial spreads are useful indicators of real activity. Stock and Watson (1989) is perhaps the most cited, but work with similar general findings is reported by Friedman and Kuttner (1991), and Bernanke (1990) among others. These papers report tests for information (by which read statistical significance) in financial spreads in a multi-variate dynamic model of output. The models proposed for output and methods of estimating these differ between the different papers, and these are described more fully below. But in what has been a variety of approaches each undertaken within a VAR framework, persuasive evidence has appeared that financial spreads may have an informational role. Of course there are questions about the interpretation to be put on these empirical findings; both in the interpretation they may have for economic behaviour and, relatedly, for the policy implications they may have. Answers to both depend in part on the spreads themselves, as discussed more fully below. The US exercises cited above have focused on the spread between yields on commercial paper and treasury bills. Other spreads figuring in the empirical work have included the long corporate bond–government bond yield differential (Bernanke, 1983; Davis, 1992); the yield curve differential (Estrella and Hardouvelis, 1989; Laurent, 1988, 1989; Bernanke and Blinder, 1992; Mishkin, 1989; Browne and Manasse, 1989) and, in the UK only, reverse yield gaps (bond less equity yield) (see Davis and Henry, 1992a, and Davies and Shah, 1992).

The present chapter is a review of the issues of interpretation and estimation of VAR models which use financial spreads, and provides some new evidence using the UK as the example. The chapter is organised as follows: the next section provides an economic interpretation of the spreads we shall use and their likely significance;

Section 14.3 discusses some econometric issues in estimating VAR models and outlines issues which arise with policy analysis using these models; Section 14.4 provides an empirical illustration of a VAR model which includes financial spreads. The final section offers conclusions, and proposals for further work.

14.2 WHY SPREADS?

Why are spreads expected to have information in accounting for changes in output? The reason spreads exist is that assets are imperfect substitutes for each other. In the framework of asset pricing theory, there are a variety of different influences on the yields of the alternative assets which are used to form the spreads discussed below, and which give rise to imperfect substitutability on the part of investors. These depend in turn on differences in liquidity, maturity, risk and levels and covariances of yields on alternative assets, modified by taxes and any direct limits to substitution, e.g. arising from portfolio regulations. A further key distinction in the present context is between cyclical and structural influences on substitutability. For example, taxation may affect equilibrium differentials in yields, but may not vary cyclically (although their incidence may increase with the level of interest rates, if nominal returns are taxed). On the other hand, default risk is clearly cyclical, and hence will affect the spread *vis-à-vis* risk-free assets, given a positive discount rate. That spreads embody cyclical effects is obviously crucial if they are to be useful as leading indicators.

Where such stable cyclical effects have been found, the underlying correlations have been seen as particularly important given the disappointing results of the money/income relation, which is widely seen as unstable, as a consequence of structural change and deregulation. A lively debate in the US has identified a number of interpretations of such movements in spreads which suggest why movements might correlate with changes in output.

These have focused particularly on the *commercial paper–treasury bill spread*. For example, Bernanke (1990) provides interpretations based on the impact of monetary tightening (a rise in the Federal Funds rate at which banks can obtain interbank credit) which independently induces an economic slowdown. This may force banks to restrain credit inducing a shift by companies into commercial paper, increasing relative supply. Given either imperfect substitutability with Treasury Bills arising from taxation or liquidity – or heterogeneity of borrowers because new issuers in such circumstances are worse credit risks[2] – this drives up the relative yield. Alternatively, it might induce banks to issue certificates of deposit, which via arbitrage leads to a rise in the commercial paper rate as well. According to this view, the spread thus directly responds to the stance of monetary policy, which in turn is a key determinant of future economic activity. This explanation is supported by the fact its correlation with measures of monetary policy such as the Federal Funds rate is high.

An alternative 'credit crunch' view of the monetary policy indicators properties of the spread is that prior to the abolition of interest rate ceilings in the US monetary policy tightening, which led the ceilings to bite would often lead to outflows of deposits from banks, as depositors sought higher open market yields than banks were able to offer. But because commercial paper was only available in large minimum denominations this demand was focused on Treasury Bills, driving down their yield relative to commercial paper. Banks did not buy commercial paper to offset this shift, because Treasury Bills had unique qualities (e.g. their use for satisfying capital adequacy and collateralising overnight repos) not available from commercial paper. The tightening of monetary policy operating on interest rate ceilings would in turn tend to induce recessions via a 'credit crunch', thus there would be a correlation between the indicator and real economic conditions. (See Cook, 1981.)

Third, as suggested by Friedman and Kuttner (1991), there may be changes in the behaviour of borrowers in the commercial paper market, independent of the stance of monetary policy, due to their changing cash requirements over the course of the business cycle. In the final stages of an upturn, as revenue declines while costs continue to rise, firms' credit requirements increase, thus raising the supply of commercial paper and increasing the spread, given imperfect substitutability. This could help explain why the spread may remain wide in the recession even after monetary policy has eased. Varying liquidity over the cycle in commercial paper (which is not mirrored by Treasury Bills), or at least variation in the value investors attach to such liquidity as uncertainty regarding their own cashflow increases, could also produce cyclical correlation, separate from effects of monetary policy.

Bernanke (1990) notes that in each of these cases, a decline in the predictive power of the spread in the 1980s could be anticipated. In the first case this would be because due to changing Federal Reserve procedures, meaning in turn that interest rates have become less reliable indicators of monetary policy. The second would change due to the abolition of interest rate ceilings in the early 1980s. Finally, both the first and third cases should weaken because financial innovation and deregulation have increased substitutability between different assets.

Meanwhile, an alternative view, that the spread shows perceptions of increased default risk in a cyclical downturn, was felt by all analysts to be rather unimportant to this spread since commercial paper, although unsecured, is only available to issuers of high credit quality, who rarely default. There are in any case better measures of default risk such as the corporate bond–government bond yield differential (Bernanke, 1983; 1990; Davis, 1992), as discussed below. Some residual default risk effect (related to the level of interest rates) may remain however, as may tax effects operating via levels of interest rates (commercial paper is taxed, Treasury Bills are not).

Turning to the *long-term credit quality spread*, between yields on corporate and government bonds of the same maturity, the interpretation is one of default risk. Note that in contrast to the explanations relating to the commercial paper–Treasury bill spread, it is not suggested that this reflects monetary policy directly. Default risk refers to the possibility of not collecting coupon and principal as promised in the debt contract, even if a bond is collateralised.[3] The lender is likely to demand a higher expected return to compensate for the extra risk. An indicator of the market's assessment of default risk is the differential between the yield on a private bond and public bond of the same maturity, callability and tax features.

The overall default risk on a debt instrument varies with the risk position of the borrower and the economic environment. The risk position of the borrower is obviously conditioned by the ability to generate enough cash flow to cover interest and principal (the coverage ratio, or its inverse, income gearing), the variability of cash flow and the availability of liquidity or other assets to repay the debt. Traditional theory suggests that for an individual agent such default risk may be broken down into three elements. First, the risk position varies 'internally' with balance sheet ratios such as the debt-to-equity ratio (there is no contractual obligation to pay equity holders). These ratios are choice variables arising from the budget constraint. Secondly, 'business risk' is defined largely on the type of business the agent is in and is thus partly beyond his control. Thirdly, and introducing the cyclical indicator element, default risk for all firms depends on the state of the economic cycle and other macroeconomic variables such an interest rates and factor prices; most defaults occur during recessions. Note that the incidence of these macro variables on default risk is not independent of the firm's 'internal' choices, e.g. the proportion of variable rate debt in the balance sheet.

Together these risks influence the probability of default by the bond issuers.[4] To the extent that the market bases its expectations of future defaults on them, they will be reflected in the yield spread of corporate over government debt. The difference between market indices of yields (as opposed to yields on individual bonds) illustrates the weighted average expectation of default, washing out the idiosyncratic/diversifiable elements associated with individual balance sheets and business risk. Thus, to the extent that such expectations are accurate, changes in the spread will predict downturns in economic activity. If expectations embody information from disparate sources, or which it is otherwise difficult to quantify or summarise, the spread will have predictive power even in the presence of other business-cycle indicators.

Additional to the default risk element, an increase in the long-term credit quality spread, other things equal, might lead some firms to postpone investment, resulting in a decline in aggregate demand. Also when monetary policy is tight, firms may shift credit demand to the bond market (though, as discussed below, bank loans may be less substitutable with bonds than with commercial paper or trade credit).

The indicator effect of the *yield curve*, i.e. that a declining yield curve signals a future slowdown in economic activity, is consistent with a macroeconomic theory where short (real) rates are temporarily high, perhaps due to restrictive monetary policy, which in turn leads to a postponement of investment and decline in future economic activity. Or if market participants feel future growth will be low, and expect a Phillips curve relation to hold, then inflation would be expected to drop and the yield curve to invert. These explanations assume monetary policy works through interest rates, and that inflation and output growth are positively correlated. They are less consistent with a real business cycle model where the marginal product of capital equals the interest rate and where persistent productivity shocks drive the business cycle. In that case, a positive productivity shock would lead to a high marginal product of capital, which would decline over time as investment and output increase. Finally, a shift in the yield curve might influence the attractiveness to banks of purchasing securities and making loans which could on a monetarist view boost money and hence activity (Laurent, 1988).

Although this is not the main focus of this chapter, it is important to note that yield curves may also have an important role in forecasting inflation (Mishkin, 1989; Browne and Manasse, 1989). The differential equals the expected change in inflation, if the expectations hypothesis applies (i.e. if the long-term rate is the weighted average of present expected short-term rates), there is no imperfect substitutability between issues of different maturities and the real rate is expected to be constant.

In fact, due to factors such as taxation, time varying risk premia or variations in real interest rates across maturities (due to changes in demand for loanable funds resulting, e.g. from government deficits) the linkage to inflation will be imperfect (Lown, 1989). Indeed, Browne and Manasse (1989) suggested that if the loanable funds mechanism predominates in the long term then the yield curve indicates the real and not nominal term structure, and contains useful information about real output, as suggested above.

Turning finally to the *reverse yield gaps* between bond and equity yields, a further monetary transmission mechanism may operate via agency costs of lending, which Bernanke and Gertler (1989) suggest are related to firms' net worth. If declining equity prices following a monetary tightening reduce net worth, then this in turn may make it more difficult for firms to obtain credit, because of increased moral hazard and adverse selection in lending to firms with low net worth. They then postpone investment, precipitating a recession. This effect can be reflected in the reverse yield gaps. There could also be differential indicator properties between reverse yield gaps based on earnings and dividends. This is because the earnings yield reflects actual cashflow whereas the dividend yield, by reflecting dividend decisions, may be an important indicator of managers' views of firms' prospects based on their private information. Given the signalling properties of dividends lenders may react differentially to these in restricting credit.

Other effects operating via share prices, which will again be reflected in reverse yield gaps, include the anticipation of lower earnings or dividends growth in a recession, the role of equity prices as a determinant of the cost of capital and through wealth effects on consumption. The first mechanism is not, unlike agency costs, a direct manifestation of the monetary transmission mechanism but an indicator of expectations regarding its effect. (Note that according to the dividend discount model, variations in the differential depend on changes in expected future dividends and a risk premium.) Markets may again respond differentially to changes in dividends relative to earnings, for example a cut in earnings may be seen as durable if followed by a cut in dividends. The cost of capital and wealth effect hypotheses, while clearly operating via equity prices, are more ambiguous in relation to the reverse yield spread than is the agency cost hypothesis, since they could equally operate via falls in *bond* prices.

Considering the UK in the light of the theories reviewed above, most of these effects might also be expected to operate here. In the UK we have also seen a breakdown in relations between monetary aggregates, GDP (and prices), and have deep and liquid securities markets. It can be argued that activity in securities markets has been much less subject to the type of structural change that affects relations between key economic variables, than has money. Also even if spreads are simply treated as a signal for activity, they have the advantage of being immediately observable and, unlike much UK macroeconomic data, they are never revised. There are, however, counter arguments to the view that spreads may have a systematic role in explaining UK activity. For example, there may have been changes in liquidity in markets for corporate bond which might distort indicator properties (Davis, 1992) and there have been some tax changes that might again influence substitutability. Also yields may be subject to long-term shifts in risk premia, so called 'fads'; and it is also possible they may have been affected by the quite frequent structural shifts in monetary policy reaction functions.

A key distinction is between aspects of spreads' behaviour that reflects the monetary transmission mechanism itself (this interpretation is emphasised by Bernanke), and cases where the spread reflects investor expectations of changes in output. In general, the interpretation emphasised here is that UK spreads act in the second sense, i.e. they act as indicators, partly because none of the spreads captures a consistent and measurable substitution out of bank credit (although there may be elements of this in the credit quality spread). Indeed, it has been suggested that monetary tightening in the UK leads firms to shift to trade credit or retentions rather than a securities market – and yields or spreads on these do not exist. This need not necessarily be a disadvantage, since indicators of expectations will capture recessions not provoked by tighter monetary policy in a way that those tied directly to monetary policy will not (this was thought by Stock and Watson (1991) to be the reason why the paper-bill spread did not capture the US recession of 1990–91).

Finally, it is important to note, the spreads typically chosen for analysis of the UK – as in the illustration in Section 14.4 – are slightly different from those used in the US, notably as a result of the lack until recently of a commercial paper market in the UK. Instead the spreads used here are: (i) the long-term credit quality spread – yield on corporate bonds in the secondary market less 20 year government bonds (CQS); (ii) the term structure or yield curve differential – the government bond yield in the secondary market less a short rate (this is the 3 month interbank) (YC); (iii) the reverse yield gap (earnings) – the yield on government bonds less the earnings yield on equities as measured by the FT-500 index (RYGE) and (iv) the reverse yield gap (dividends) – the yield on government bonds less the dividend yield on equities (RYGD).

14.3 LEADING INDICATORS AND VAR MODELS

This section first discusses indicator models, and then outlines issues when estimating non-structural models and interpreting the empirical results.

14.3.1 Indicator models

There are two forms in which tests of the informational content of financial spreads have been done; tests of information in a dynamic model; and leading indicator models, including the single index model (sim) of Stock and Watson.

(i) *Tests of the information of indicator variables in a dynamic model*

In this application, tests for the informational content of financial spreads can be done by establishing whether they have information in an equation for output apart from that contained in the serial correlation in output itself, allowing for the possible effect of other potentially relevant variables, such as government expenditure, inflation, etc. As an example of this, Friedman and Kuttner (1991) estimate

$$\Delta x_t = \alpha + \sum \beta_i \Delta x_{t-i} + \sum \gamma_i \Delta P_{t-i} + \sum \delta_i Z_{t-i} + u_t \qquad (14.1)$$

where x is real output, P the GNP deflator and Z a set of financial spread variables. (All variables measured in logs.) The lag length is indexed by i, and choice of appropriate lag length is usually based on a standard test such as Akaike's Information Criteria (AIC).

Tests of an informational role for Z_t can then be done fairly simply by

(a) Orthodox tests for exclusion of the Zs, using 't' or 'F' texts.
(b) Tests of financial spreads as against, e.g., monetary aggregates by including these additional variables and re-running exclusion tests. Thus Friedman and Kuttner when doing this report that financial spreads contain information for changes in output, whereas other financial variables – which include M_2, credit and interest rates – do not.

(ii) *Single index models*

It is useful to distinguish the single index model from (i) above since it is more consciously directed at a leading indicator interpretation than is the example given in (i). According to leading indicator methodology a leading indicator (LI) is a variable which is regularly associated with (usually but not invariably, preceding) cycles in activity. If anything, the LI approach is *less* concerned with the possible behavioural interpretation of the estimated relationship than is eqn (14.1) which, we suggest below, may have a behavioural interpretation under certain conditions.

Tests of a leading indicator function for a particular variable could be done using eqn (14.1) above of course. Stock and Watson (1991), however, have introduced a single index or dynamic factor model which has extended the methodology of LI modelling in an interesting way. Their model is

$$\Delta x_t = \beta + \gamma(L)\,\delta C_t + u_t \tag{14.2}$$

$$D(L)u_t = \Sigma_t \tag{14.3}$$

$$\phi(L)\Delta C_t = \delta + v_t \tag{14.4}$$

where $\gamma(.)$ and $\phi(.)$ are polynomials in the lag operator L. In this model the common index C enters into each of the set of x variables contemporaneously. Equation (14.2) therefore hypothesises that the movements in each of the xs is determined by movements in the *unobservable* common index C together with an idiosyncratic term plus measurement error u_t. Both the unobservable variable, C_t, and the idiosyncratic variable u_t are modelled as linear stochastic processes.

The basic idea in the model (14.2) – (14.4) is that there is a 'reference-cycle', or business cycle. Equation (14.2) formalises this idea, postulating that each variable is given by a 'state of the economy' variable C_t (the reference cycle), and an idiosyncratic component. As written, this is in the form of a coincident index. The leading indicator element of the model can then be introduced by augmenting the model above with a VAR linking C_t with LI variables Y_t, i.e.,

$$\Delta C_t = u_1 + \lambda_1(L)\Delta C_t + \lambda_2(L)Y_{t-1} + V_{1t} \qquad (14.5)$$

$$Y_t = u_2 + \lambda_3(L)\Delta C_{t-1} + \lambda_4(L)Y_{t-1} + V_{2t} \qquad (14.6)$$

In a formal mathematical sense, models (i) and (ii) are obviously similar. Their interpretation, however, is different. Models estimated like (i) have been in the strand of 'atheoretical' modelling, with its linking of reduced form and structural modelling (the identification problem. See 14.3.2 below). Those in (ii) have emphasised leading indicator properties in predicting turning points, i.e. they need have no behavioural or policy implications, the LI variables are simply useful information. The issue of identification therefore need not arise in the latter case.

14.3.2 VAR models: some estimation and analytical issues

The discussion so far has related purely to the use of VARs to test for information and indicator properties. Following Sims seminal work the starting point in obtaining VAR estimates is to postulate that the underlying model is a joint process of all variables – including policy ones. The next stage is to determine whether this statistical model does more than summarise correlations (in the data) in a convenient way. This is the issue of identification. Then the problem is – according to Sims – one of using minimal restrictions, just sufficient to make a purely forecasting framework capable of policy analysis, rather than the strong 'incredible' restrictions typically imposed, but rarely tested explicitly, in orthodox macroeconometric models (Sims, 1980).

Although the principle of minimal restrictions has some appeal, the application of the principle may be exceedingly problematic in practice. There are essentially three ways which have been adopted and which are briefly described next. To begin with, the question of non-stationarity data is postponed. How this might be dealt with is noted in (b) below.

(a) *Stationary variables*

A general form for a structural model is[5]

$$A_0 Y_t = \sum^{M} A_i Y_{t-i} + e_t \tag{14.7}$$

The matrix A_0 incorporates simultaneous feedbacks among all the Y variables which, it should be recalled, will typically include policy variables. The matrix A_0 will not normally be diagonal. The unrestricted VAR is then

$$Y_t = A_0^{-1} \sum A_i Y_{t-i} + A_0^{-1} e_t \tag{14.8}$$

$$= \sum C_i Y_{t-i} + u_t \tag{14.9}$$

The variance/covariance matrix of the unrestricted VAR, or reduced form, is $u'u = \Sigma$, and again in general this will not be diagonal.

Although (14.9) can be estimated, this reduced form or VAR model cannot be used for policy analysis. In the present context, policy analysis is described as identifying the effect of innovations in the 'structural' disturbances e_t upon the Y_t. So the question is: what are the minimal identification restrictions necessary to establish the effects of innovations in e_t on Y_t, if we have previously estimated the reduced form effects of innovations in u_t on Y_t? Methods proposed by Sims (1986) on the one hand and Blanchard (1989) on the other, have received considerable prominence.

(i) Sims

This is the method used in obtaining impulse responses and variance decomposition in Section 14.4 below, so the steps involved are described next.

From eqns (14.7) and (14.9) we know

$$u_t = A_0^{-1} e_t \Rightarrow A_0 u_t = e_t$$

The variance/covariance matrix of the structural innovations is $e'e = \Omega$, but is unknown. However, it is linked to the estimated reduced form variance/covariance matrix by the equation

$$A_0 \sum A_0' = \Omega \tag{14.10}$$

The method proposed by Sims, uses the Choleski decomposition of Σ whereby the unique decomposition

$$\sum = LDL' \tag{14.11}$$

is applied, where L is lower triangular and D is a diagonal matrix. Then from (14.10) and (14.11)

$$A_0 = L^{-1}$$

and $\Omega = D$

Hence inverting the estimated VAR as an infinite MA process, which by Wold's decomposition theorem will always be possible for a stationary series, gives

$$Y_t = u_t + G_1 u_{t-1} + G_2 u_{t-2} + \cdots \tag{14.12}$$

where $G_i = (1 - Ci)^{-1}$

Then the response of Y_t to an innovation in a structural disturbance e_t is given from the relation $A_0^{-1} e_t = u_t$, i.e.

$$Y_t = A_0^{-1} e_t + G_1 A_0^{-1} e_{t-1} + \cdots$$

Hence the impulse response is

$$\frac{\delta Y_{t+s}}{\delta e_t} = G_s A_0^{-1} = G_s L \tag{14.13}$$

(ii) Blanchard's Structural Vector Autoregression (SVA)
For completeness this alternative is described very briefly as we will not be using it in the empirical examples reported later. The SVA approach offers a 'structural' set of identification restrictions, unlike the Sims orthogonalisation via Choleski's decomposition – which is an implicit method of identification – Blanchard places restrictions on the structure of A_0 matrix and on the short-run effect of innovations on the Y variables.

Rewriting the Structural Model as

$$A_0 Y_t = \sum^{M} A_i Y_{t-i} + Ce_t \tag{14.14}$$

Assume $e'e = \Omega$ as before, which is taken to be diagonal. In this case, unlike (14.7), $C \neq I$ is assumed. Hence we have the relationship between structural and reduced form innovations,

$$A_0 u_t = Ce_t \tag{14.15}$$

Blanchard then applies restrictions making both A_0 and C lower triangular. In effect this is equivalent to Sims's assumption that A_0 is lower triangular in (14.7) above (because now $u_t = A_0^{-1}Ce_t = Ve_t$, and the assumptions ensure V is lower triangular).

The specific assumptions made by Blanchard need not detain us since they are specific to the aggregate demand-supply case he considered. However, the characteristic of the approach is that it uses structural or prior information to achieve identification, the use of which Sims was trying to avoid.[6]

(b) *Non-stationary variables*

Although the empirical applications made in this chapter are based on the methods discussed so far, it is important to stress their limitations when variables are non-stationary, and the possibility of co-integrating relationships between them exists.

If the Y_t variables are non-stationary, the most obvious procedure is to estimate the VAR using differences of $I(1)$ variables and the remaining $I(0)$ variables (Blanchard and Quah, 1989). Note that in this case there will be an obvious difference in the interpretation of innovations depending on whether variables are $I(1)$ or $I(0)$; since a temporary shock has a transitory effect on changes but a permanent effect on the level of a differenced variable. These features can be used to provide identification – this time of long-run effects (see Bayoumi and Eichengreen, 1991).

Estimation of a VAR by first differencing $I(1)$ variables where co-integration exists in the set of $I(1)$ variables is inappropriate and will produce biased estimates. To extend the model to this case recent work has considered Vector Error Correction Models (VECMs), (but these extensions will not figure in the results presented here; See King *et al.*, 1992; Clements and Mizon, 1991 and Davis and Henry, 1992b for examples of these extensions.)

14.4 AN EMPIRICAL ILLUSTRATION

The following results, drawn from Davis and Henry (1992a), give an example of the LI methodology applied to a model of the UK. It is, however, cast within the framework described in 14.3(i), and not that of the single indicator model of Stock and Watson. Hence, as financial spreads enter the model, the questions posed are: do the financial spreads have information, in the sense described earlier, and relatedly, do they have a leading indicator role?

14.4.1 The basic VAR model

We start with a model *without* financial spreads, and show estimation results for a dynamic model for a vector Y. The variables used in the Y vector are the log of real GDP, the log of the GDP deflator (log PGDP), the real exchange rate (RXR), the current balance (normalised on nominal GDP) (BAL), the PSBR (also normalised on nominal GDP) (PSBR) and short-term interest rates (R) – the three month interbank rate. Tests of variable stationarity (Table 14.1) indicate they are all $I(1)$ hence may be differenced to obtain stationarity.

Next we detail the estimation results for the vector autoregressions. First the parsimonious version of the GDP equation, obtained by eliminating insignificant parameter estimates, is shown in Table 14.2.

These results show that lagged values of other variables, beside lags of GDP itself, contribute to its overall explanation. Thus lagged

Table 14.1 Tests for stationarity

	*Level**		*First difference*[†]	
	DF	*ADF*	*DF*	*ADF*
log GDP	−2.0	−1.4	−10.4	−6.6
log PGDP	−1.2	−1.5	−4.5	−3.1
BAL	−2.8	−2.1	−13.6	−9.2
PSBR	−3.8	−2.6	−12.9	−8.2
RXR	−2.5	−3.0	−8.0	−6.6
R	−2.6	−3.2	−7.8	−6.0
CQS	−2.2	−2.4	−8.7	−5.9
YC	−2.8	−3.3	−8.0	−5.5
RYGD	−3.0	−3.0	−9.0	−7.7
RYGE	−2.5	−3.3	−7.5	−6.4

* With trend; critical value −3.5.
[†] Without trend; critical value −2.9.

Table 14.2 GDP equations

Sample		*Without spreads 1969:2–1990:4*		*With spreads 1969:2–1990:4*		*1969:2–1982:4*
Const		0.03		0.03		0.027
		(6.0)		(3.3)		(2.5)
Δlog GDP (−1)		−0.3		−0.36		−0.43
		(3.2)		(4.2)		(4.1)
Δlog GDP (−2)		−0.17		−0.22		−0.25
		(1.9)		(2.6)		(2.4)
Δlog GDP (−3)		−0.25		−0.24		−0.29
		(2.8)		(2.7)		(2.5)
Δlog PGDP (−1)		−0.22		−0.19		−0.2
		(3.2)		(1.9)		(1.3)
ΔRXR (−4)		−0.058		−0.05		−0.072
		(2.0)		(1.8)		(1.5)
ΔBAL (−1)		−0.23		−0.19		−0.26
		(2.8)		(2.5)		(2.3)
ΔBAL (−2)		−0.16		−0.12		−0.18
		(1.8)		(1.5)		(1.6)
ΔBAL (−3)		−0.15		−0.15		−0.1
		(1.9)		(2.0)		(0.9)
R (−2)		−0.0014		−0.005		−0.005
		(3.9)		(4.7)		(3.0)
D731		0.05		0.05		0.05
		(5.3)		(5.2)		(4.6)
D741		−0.037		0.041		−0.043
		(4.0)		(4.6)		(4.1)
CQS (−1)				0.014		0.013
				(2.3)		(1.4)
CQS (−2)				−0.011		−0.01
				(1.8)		(1.1)
YC (−2)				−0.005		−0.005
				(3.7)		(2.1)
YC (−3)				0.0027		0.0029
				(2.8)		(2.2)
RYGD (−3)				0.006		0.0055
				(4.0)		(2.4)
RYGE (−1)				0.001		0.001
				(1.7)		(1.0)
RYGE (−2)				−0.002		−0.002
				(2.6)		(1.5)
R^2		0.53		0.65		0.73
DW		2.0		2.2		2.4
LM(4)		2.8		3.2		8.7
NORM(2)		2.7		1.0		0.4
HETERO(1)		0.8		0.5		0.4
PRED(46)		38.0		39.0	(34)	25.0
Exclusion of spreads	F	–	(7.69)	3.3	(7.37)	1.8
	LR	–	(7)	25.3	(7)	16.3

values of the difference of the GDP deflator, the real exchange rate, the current balance to nominal GDP ratio, and nominal interest rates all appear to influence Δlog GDP, in other words there is Granger causality between GDP and these variables. There are two dummy variables – one for 1973:1, the other for 1974:1 – which prove to be highly significant. One interesting side issue is to consider whether the use of financial spreads variables can obviate the use of dummy variables for these periods. We test this below, but find they are still necessary. Returning to the general properties of the equation, its overall fit is acceptable for a difference equation, and its other properties – absence of serial correlation as shown by the DW and LM tests, normality of errors (indicated NORM in Table 14.3), and heteroskedasticity (HETERO) – are also acceptable. Most noteworthy is the apparent stability of the equation when re-estimated up to 1979 (as shown by the predictive failure test (PRED)). On statistical grounds the model for output seems good, so will offer a stringent test of the financial spread variables, when they are added to it. We return to this issue below, after noting the results for the remaining equations.

Briefly, the remaining five equations, are estimated in a similar way to that for output, although to save space they are not given in full here. Generally it can be reported that the remaining equations fared quite well in terms of statistical properties. The GDP deflator was a relatively simple equation, with output and the real exchange rates appearing to be the only independent variables. Again the equation appears very stable when estimated up to 1979 Q4. The equation for interest rates is less successful overall, with a lowish R^2, and some variables not significant at conventional levels. The subsample estimate is again quite stable.

The real exchange rate equation, like that for interest rates, did not fit that well overall, but attracted a reasonably high number of significant lagged variables. It was unstable over the 1980s, perhaps unsurprisingly. Similar remarks hold in general for the remaining two equations: the current balance to nominal GDP ratio, and the PSBR to nominal GDP ratio. There was a smattering of significant lagged variables, and the equations had largely satisfactory statistical properties. Their explanatory power was not high, however.

Finally, note that in some cases interest rates occur in levels, but elsewhere in differences. This is not a substantive difference, however; where they appear as levels, the interest rate effects may usually be reparameterised as differences, with some – albeit small – gain in efficiency.

14.4.2 Adding financial spreads

The next stage of the exercise considers whether financial spreads add to the explanatory power of the basic model. Tests for this are fairly straightforward, and amount to adding lagged values of the spreads to the previously obtained – preferred – form of the estimated VAR. We would conclude that financial spreads have additional explanatory value for predicting real output if they appear significant in the GDP equation. This is referred to later as a strong form of test. The distinction is made with a weaker test, but one which would still confirm an explanatory role for spreads, which occurs when the financial variables are not significant in the GDP equation but are significant in the other equations. In this second case this means that spreads affect the GDP deflator, the real exchange rate, the ratio of current balance to nominal GDP, or interest rates. As will be seen, however, the results confirm that financial spreads have significant affects in all the equations, including GDP.

The results for the GDP equation are already shown in Table 14.2. These show that financial spreads are significant for GDP (as shown by the '*t*' values and the 'F' and Likelihood Ratio (LR) tests for exclusion of spreads). The results carry over to separate equations for other indicators and for the spreads themselves. These results are summarised in Table 14.3. The equations are also successful in statistical tests for autocorrelation, normality and heteroskedasticity; in addition the CUSUM and CUSUMQ tests show recursive residuals always remain in the 5 percent confidence interval, and the recursive coefficients are stable.

The predictive tests show that most of the equations appear highly stable when estimated over subsamples – the exceptions are the PSBR and exchange rate. This provides a general confirmation that there is informational content in financial spreads, when other posible influences upon GDP are allowed for.

In a final exercise the spreads themselves were also estimated as dynamic VARs, so as to give a complete model for dynamic simulations. In each case it proved possible to obtain equations with satisfactory statistical properties. All of the equations except the credit quality spread passed the prediction test. This finding is consistent

Table 14.3 Summary of VAR equations including spreads

	Equation						
	Δlog*PGDP*	Δ*BAL*	Δ*PSBR*	Δ*RXR*	Δ*R*	Δ*YC*	Δ*CQS*
Lagged regressions							
ΔlogPGDP	**	*	**	**	**	*	**
ΔlogGDP	**	**	**	θ	**		
ΔRXR	*	**			**	**	
ΔR		*	*	θ		**	**
ΔPSBR		**		*	**		
ΔCQS	**	*	*	**	*	**	
ΔYC	*	*		*	**		**
ΔRYGD	*			*	**	*	
ΔRYGE	**		**	*	**	*	**
R^2	0.68	0.37	0.35	0.39	0.44	0.32	0.36
PRED(46)	33.0	30.0	86.0	58.0	27.0	28.0	58.0

	Δ*RYGE*	Δ*RYGD*
ΔlogPGDP		
ΔlogGDP	**	**
ΔRXR		
ΔR	**	**
ΔPSBR		
ΔCQS	**	**
ΔYC		
ΔRYGD	**	
ΔRYGE	**	*
R^2	0.58	0.3
PRED(46)	32.0	41.0

* Signifies at least one lagged value significant at 5 per cent,* signifies that at least one lagged value is significant at 10 per cent. θ signifies variables are unsignificant. Lagged dependant variables are not quoted.

with a change in market conditions for corporate bonds over the 1980s (Davis, 1992).

Before leaving this part of the empirical results, we give one further confirmation of this feature of stability in the estimated equations, in re-estimation of the GDP equation over a much smaller sample. Reverting to Table 14.2 illustrates what happens when the ouput equation is estimated over the sample 1963:1–1982:4, i.e. dropping eight years of data. As can be seen, the estimated parameters hardly change between the two samples – the equation apparently has an impressive degree of robustness when estimated over different sample periods.

14.4.3 Model evaluation

Having established that there are strong econometric grounds for including financial variables in a model of output and prices, the next step is to evaluate what the quantitative effects of these variables are. To do this we need to orthogonalise the estimated VAR model – which is in the reduced form as given by eqn (14.3) above – to identify the effect of shocks to the innovations in the X_t variables.

If it were possible to treat the spreads as exogenous, then the procedure is straightforward. Thus if

$$A(L)\Delta\tilde{X}_t = \beta(L)\Delta V_t + \eta_t$$

where $\tilde{X}$ is the sub-set of variables excluding spreads and V_t the financial spreads ($X = \hat{X} + V$ in our earlier notation), then we are interested in $\Delta(\Delta X_t) = A^{-1}(L)\beta(L)\Delta(\Delta V_t)$, which is usually easy to evaluate. However, if the spreads are treated as jointly determined with the rest of the variables in the system – as we treat them in this model – then the familiar problems of identifying impulse responses in VAR models arise. We have treated this by adopting a 'standard' approach, using a Choleski decomposition. Identification then uses the Sims's triangular ordering.

The problem with Sims's triangular ordering is that it is arbitrary, and most users normally provide impulse and variance decomposition for a set of alternative orderings. We have adopted this approach, and have computed results when the four financial spreads come last in the set of ten variables and, as an alternative, when they are first. In our case the results did not vary much, so only the first set of results are commented upon further. Even so, with a model of this sort there is a large amount of output generated by this exercise: ten equations, subject to ten different shocks gives 100 solutions. So we have selected a few representative and key results for presentation. We report only the response of ΔLGDP and ΔLPGDP to shocks in the innovations to the spreads.

The resulting variance decompositions are shown in Table 14.4. These show that shocks to ΔYC account for about 1 per cent of the variance in ΔLGDP and just under 8 per cent of the variance in inflation in the GDP deflator. An innovation to CQS on the other hand accounts for about 2.3 per cent of the variance of changes in output and 10 per cent of the variance of changes in the GDP deflator. The other spreads – RYGE and RYGD – have smaller

Table 14.4 Variance decompositions for innovations to spreads

Spread	ΔYC	ΔCQS	$\Delta RYGE$	$\Delta RYGD$
LGDP	1.1	2.4	8.7	4.1
LPGDP	7.6	10.5	4.9	3.4

Variance evaluated for first ordering, after 24 quarters.

effects on the GDP deflator. Overall, these calculations suggest that spreads contribute in a small but significant way to the explanation of the variance of changes in output and prices.

14.5 FORECASTS USING THE VAR

This section describes the implication of the estimated dynamic model, by using it to produce predictions for output. Two types of forecasts of GDP from the model are described; a single equation forecast depending on lagged actual values of the other variables in the equation; and a full dynamic simulation where VARs for each variable are run dynamically, so predicted values for all model variables are used. It is of considerable interest to evaluate these models in terms of their forecasts over the period, given the failure of conventional macro models to predict the timing and length of the UK recession of 1990–2.

14.5.1 Single equation dynamic predictions for output

For this section the results are for GDP only, so the GDP equation alone is relevant. First, the model was estimated to 1991Q2 and used to predict the third quarter, given actual values of all right-hand side variables. Second, using data on the right-hand side variables (including the spreads) for 1990 and 1991, coupled with a GDP equation estimated on data ending in 1989Q4, we report dynamic predictions for 1990 and 1991 (the first three quarters).

(i) A one step ahead prediction from the GDP equation for 1991Q3 was that the quarterly change in GDP would be 0.27 per cent. This compared with an outturn of 0.26 per cent. In this one step mode the VAR model was suggesting that recovery would be very sluggish; a result confirmed by the actual data.

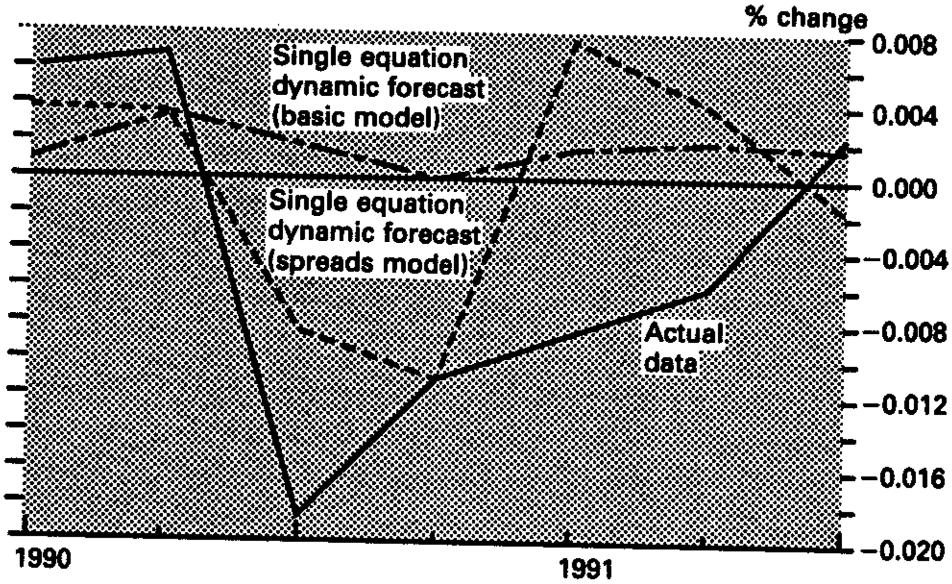

Figure 14.1 Quarterly forecasts for real GDP growth (using estimates up to 89 Q4)

(ii) The next illustration shows the equation's predictions for 1990/91. Figure 14.1 shows forecasts from the GDP equation when the equation is estimated up to 1989Q4, and is then used to predict all subsequent periods until 1991Q3. The results show that the model correctly predicts a fall in GDP in 1990Q3 and Q4 and, although it shows increases in the succeeding two quarters, output growth is predicted (correctly) to be around zero in Q3. Notice that, in this mode, the model's prediction for 1991Q3 is different from the one-step prediction above. Here the Q3 prediction uses predicted values of lagged GDP, (i) above uses the value actual. A further comparison shows what the model predicts when the equation without spreads is used. As the figure shows, the forecast using the GDP equation without spreads largely misses the recession.

14.5.2 Full model predictions

The exercises reported in this section are very different from those given earlier in that now the full VAR model comprising the 10 equations given in Table 14.3 is used. Although leading indicator models are not often used in this way, there is no logical reason why they should not. Since the dynamic VAR is autonomous it can be used to produce n-step predictions, using information available up to the present only, giving solutions for all endogenous variables

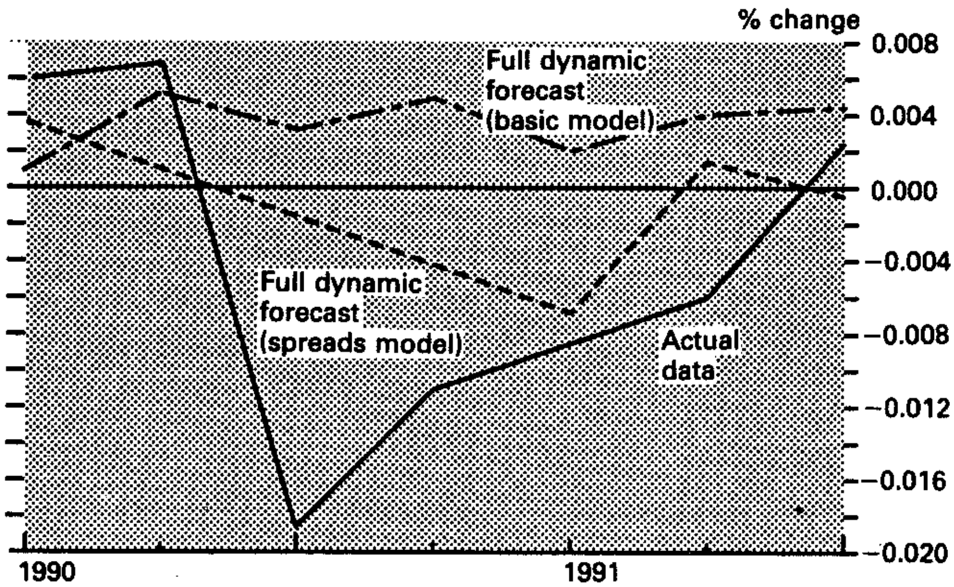

Figure 14.2 Quarterly forecasts for real GDP growth (using estimates up to 89 Q4)

over the entire forecast interval. In the present case this includes endogenous solutions for the financial spread themselves.

In this section, two exercises are reported; one repeats the forecast in 14.5.1(ii) above but this time using predicted values of all right-hand side variables, and the other shows a six-year prediction from the model, starting in 1986Q1.

(i) The predictions from the full VAR model use a version of the model which is estimated on data up to 1989Q4. The estimation results show that the properties of the model would not differ much if an earlier vintage of the model were used. Predictions from the model from 1990:Q1 to 1991Q3 are shown in Figure 14.2. This shows that output growth is predicted to be very sluggish in the first half of 1990, but that it is then predicted to be negative, and there is positive growth only in 1991Q2. Again, the quarterly profile in this exercise differs from (14.5.2)(ii); the present case is conditioned on predicted values for all lagged variables. If in 1989 this model had been used to make forecasts, there would have been a clear message from it about an impending recession.

(ii) The next exercise is run entirely on historical data, but this mimics an *ex-ante* exercise none the less. The model (estimated on the full data set) is used to produce forecasts over the period 1986 Q1 onwards. This is an extremely testing exercise, and the

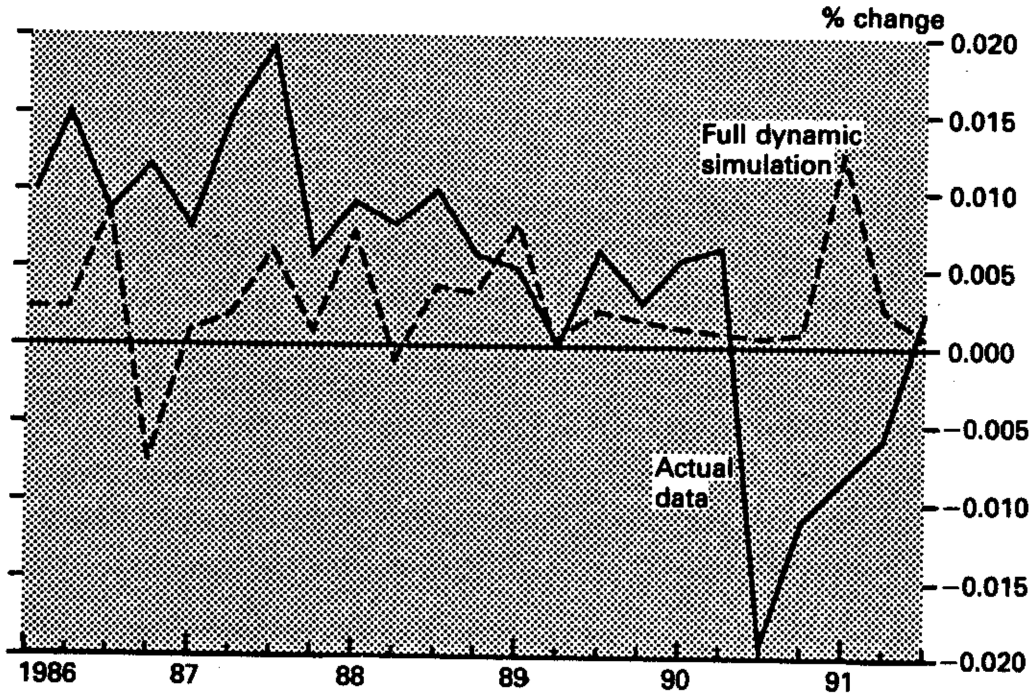

Figure 14.3 Quarterly forecasts for real GDP growth (using estimates up to 85 Q4)

relatively poor fit of some of the equations which make up the complete VAR must be re-emphasised again. None the less the profile of the predictions for GDP are interesting (Figure 14.3). Generally, it does not capture the very rapid rise in GDP over 1986–8. Output is predicted to grown relatively slowly over this period, compared with actual growth. Furthermore, the model does not capture the fall in output in 1990, and although it predicts slow growth in that year, the model also suggests quite slow growth in earlier years as well. Finally, it predicts a significant improvement at the end of 1990, thus giving a substantial error.

What this last result suggests is that VAR models may not be as useful for medium term predictions as they are for short-run ones.

14.6 CONCLUSIONS

Indicator models have come to prominence recently, this development stimulated, in part, by the well-publicised forecast failures of conventional macroeconomic models in the wake of financial liberalisation. This chapter has reviewed both the theory and the application of financial spreads as indicator variables, to establish whether they may be usable in a forecasting mode. In theory financial spreads fulfil a useful indicator role, since they are affected by the expectations of market participants. The variety of spreads available offer quite a rich menu of evidence on different aspects of the economy, so there is considerable scope for testing, and the present chapter reports preliminary results of one such exercise.

The empirical evidence reviewed here suggests financial spreads may have an indicator function in the UK especially in informing about short-run movements in the real economy. This general conclusion echoes similar findings in the USA. The significance and stability of the models we report, particularly those including spreads, as well as their effect on forecasting performance, are quite encouraging.

Notes

1. The contents of this chapter are the responsibility of the authors. The views expressed here do not necessarily represent those of the Bank of England. Thanks for comments are due to participants in seminars at the Financial Market Groups (LSE), the City of London Polytechnic and East London University.
2. See Kashyap *et al.* (1990).
3. One may distinguish illiquidity risk – that the collateral may cover the value of the loan, but be hard to sell – and insolvency risk – that owing to changing relative prices the collateral no longer covers the value of the principal.
4. An alternative way of drawing similar results can be obtained from option pricing models (Merton, 1974) which stresses the importance to bond returns of the value of the firm and the variance to its returns. The three factors outlined above are key influences on value and variance.
5. Sims actually uses $\Sigma \, B_j e_{t-j}$, but later restricts B_0 (the only part which matters) to be unity.
6. The estimation of (14.15) depends on the precise identification restrictions used, but Blanchard uses a version of IV estimation after the estimation of the VAR.

REFERENCES

BERNANKE, B. S. (1983) 'Non-monetary Aspects of the Financial Crisis in the Propagation of the Great Depression', *The American Economic Review*, **73**, 257–76.

BERNANKE, B. S. (1990) 'On the Predictive Power of Interest Rates and Interest Rate Spreads' *New England Economic Review*, November/December, 51–68.

BERNANKE, B. S. and BLINDER, A. S. (1992) 'The Federal Funds Rate and the Channels of Monetary Transmission', *American Economic Review*.

BERNANKE, B. S. and GERTLER, M. (1989) 'Agency Costs, Net Worth and Business Fluctuations', *American Economic Review*, **79**, 14–31.

BLANCHARD, O. J. (1989) 'A Traditional Interpretation of Macroeconomic Fluctuations', *American Economic Review*, **79**, 1146–64.

BLANCHARD, O. J. and QUAH, D. (1989) 'The Dynamic Effects of Aggregate Supply and Demand Disturbances', *American Economic Review*, **79**, 655–73.

BROWNE, F. and MANASSE, P. (1989) 'Information Content of the Term Structure of Interest Rates; Theory and Practice', OECD Working Paper No 69.

CLEMENTS, M. P. and MIZON, G. E. (1991) 'Empirical analysis of macroeconomic time series – VAR and structural models' *European Economic Review*, 35, 887–932.

COOK, T.Q. (1981) 'Determinants of the Spread between Treasury Bill Rates and Private Sector Money Market Rates', *Journal of Economics and Business* (Spring/Summer) pp. 177–87.

DAVIES, G. and SHAH, M. (1992) 'New Methods for Forecasting GDP Growth in the UK', *The UK Economics Analyst*, Goldman Sachs, June.

DAVIS, E. P. (1992) 'Credit Quality Spreads, Bond Market Efficiency and Financial Fragility', Manchester School, **55** (supplement) 21–46.

DAVIS, E. P. and HENRY, S. G. B. (1992a) 'An Aggregate VAR Model with Financial Spreads', mimeo, Bank of England, London.

DAVIS, E. P. and HENRY, S. G. B. (1992b) 'The Role of Financial Spreads, Empirical Analysis of Spreads and Real Activity', forthcoming, *The Manchester School.*

ESTRELLA, A. and HARDOUVELIS, G. A. (1989) 'The Term Structure as a Predictor of Real Economic Activity', Federal Reserve Bank of New York, Research paper no. 8097, May.

FRIEDMAN, B. M. and KUTTNER, K. N. (1991) 'Why is the Paper-bill Spread such a Good Predictor of Real Economic Activity', mimeo, Harvard University and Federal Reserve Bank of Chicago.

HARVEY, A. C. (1981) *Time Series Models*, (Oxford: Philip Allen).

KASHYAP, A., STEIN J. C. and WILCOX, W. (1990) 'Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance', Mimeo, Federal Reserve Board.

KATO, K. (1991) 'The Information Content of Financial and Economic Variables: Empirical Tests of Information Variables in Japan', *BOJ Monetary and Economic Studies*, **9**, 61–86.

KING, R. G., PLOSSER, C. T., STOCK J. H. and WATSON, M. W. (1991) 'Stochastic trends and economic fluctuations', *American Economic Review*, 81, 819–40.

LAURENT, R.D. (1988) 'An Interest-based Indicator of Monetary Policy', *Economic Perspectives*, Federal Reserve Bank of Chicago, (Jan./Feb.) 3–14.

LAURENT, R.D. (1989) 'Testing the Spread', *Economic Perspectives*, (July/Aug.) 22–34.

LOWN, C. (1989) 'Interest-rate Spreads, Commodity Prices and the Dollar: a New Strategy for Monetary Policy?' *Economic Review Federal Reserve Bank of Dallas*, July, 13–26.

MISHKIN, F. S. (1989) 'The Information in the Longer-maturity Term Structure about Future Inflation', NBER Working Paper No. 3126.

MODIGLIANI, F. and COHN, R. (1979) 'Inflation, Rational Valuation and the Market'. *Financial Analysts Journal* (Mar./Apr.), 24–44.

PAIN, D. (1992) 'The UK Economy: Forecasting with Leading Indicators', *National Institute Economic Review*, 1992/2, 13–16.

SIMS, C. A. (1980) 'Macroeconomics and Reality', *Econometrica*, **48**, 1–48.

SIMS, C. A. (1986)

STOCK, J. H. and WATSON, M. W. (1989) 'New Indices of Coincident and Leading Economic Indicators', in S. Fischer and O. Blanchard (eds) *NBER Macroeconomic Annual* (Cambridge: MIT Press).

STOCK, J. H. and WATSON, M. W. (1991) 'Predicting Recessions', mimeo.

WADHWHANI, S. (1986) 'Inflation, Default Premia, Bankruptcy and the Stock Market', *Economic Journal*, **96**, 120–38.