

# THE YIELD SPREAD AND REAL ECONOMIC ACTIVITY: THE IMPACT OF GLOBALISATION

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## Abstract

One of the enduring linkages between financial markets and the real economy is that the shape of the interest rate curve is seen as a good predictor of future output growth. However, little is known about the effect of globalisation on this relationship. This paper examines whether, in the wake of the internationalisation of the Australian economy during the past decade and a half, there is today an identifiable relationship between the foreign yield spread and Australian GDP growth. Using the US interest rate spread as a proxy for the world yield curve, a link is found to exist with Australian GDP growth. There is evidence the link has strengthened as the economy has seen greater exposure to globalisation.

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# **THE YIELD SPREAD AND REAL ECONOMIC ACTIVITY: THE IMPACT OF GLOBALISATION**

## **1. INTRODUCTION**

The slope of the yield curve as a predictor of real macroeconomic activity has received growing empirical attention recently, particularly from central banks and the International Monetary Fund.<sup>1</sup> The results of these studies, from a variety of countries, together point to a good link between the yield spread of a given country and its real growth rate. In a leading longitudinal study using US data between 1955 and 1988, Estrella and Hardouvelis (1991) find that the slope of the yield curve predicts changes in real GNP within-sample up to four years into the future, where the spread is defined as the 10-year Treasury bond rate minus the 3-month Treasury bill rate. Haubrich and Dombrosky (1996) extend the work of Estrella and Hardouvelis to out-of-sample forecasts: using data from 1961 to 1995 and the interest rate spread lagged four quarters, they find that the US yield spread forecasts US output remarkably well. A multicountry study, by Hu (1993), finds similar results for a list of countries, showing that each country's yield curve predicts its own growth (to varying degrees) in France, Germany, Japan, Italy, Canada and the UK, respectively.

However, although such studies find solid support for the yield curve hypothesis in its domestic form (using the own-spread of the country in question), they have generally not been conducted with international effects in mind. There remains a need to place

the yield curve hypothesis in its full context by directly accounting for a growing factor that is changing the way economies function: globalisation. Baxter and Crucini (1993) suggest that when exposure to world economic shocks induces effects in globally integrated economies, these will be mediated in part by international interest rates. We might postulate, therefore, a 'world yield curve effect' on a given domestic economy. Plosser and Rouwenhorst (1994) provide some early testing of this idea, finding evidence that 'world interest rates' are a factor that is common to explaining the growth rate of the G7 countries. Further work is needed to explore the impact of the cross-border transmission effect.

The purpose of this paper is to examine the yield curve hypothesis with particular reference to the case of Australia, and against the background of globalisation. As a small open economy, Australia makes for an ideal test case for this issue, because of its traditional involvement in the world economy as a trading nation and also more recently due to the fact that since the mid-1980s, major policy changes have been put in place that have had the effect of greatly opening the economy to international exposure. In particular, the decade-and-a-half since 1984 has seen a floating exchange rate and free cross-border capital movements, and marks an era in which there has been a substantial acceleration in the Australian economy's financial and cyclical integration with the global economy. This raises the interesting question of whether the *foreign* yield spread is becoming important to explaining the domestic growth cycle of an economy such as Australia, and whether there is evidence that this relationship has been strengthening through time, with the onset of globalisation.

This paper seeks to fill a gap in Australian economic studies by conducting a dedicated empirical study of the yield curve hypothesis specifically for that country,

particularly now that over a decade of quarterly GDP data have accumulated under the globalisation policy regime. Australia has been included as one country among many in two past empirical studies of the conventional yield curve hypothesis. Bonser-Neal and Morley (1997) conducted a multicountry study of eleven countries including Australia, and found that the own-yield-spread was significant in explaining the following year's GDP growth for Australia. Notably, however, they found that the own-spread effect was clearly weaker for Australia than for large economies such as Canada, France, Germany, Italy, the UK and the US. This may point to another factor being involved for the smaller countries, such as the foreign spread. In a separate yet related study, Kozicki (1997) came to a similar result, once again showing that the yield spread in the smaller economies such as Australia performed less well as a predictor of four-quarter GDP growth than in large countries. For instance, the US equation had a R-squared of 39 per cent while the Australian equation had an R-squared of only 13 per cent.

From a general policy point of view, study of the yield curve hypothesis is worthwhile because of its relevance to stabilisation policy. The closer attention by central banks and finance economists in recent times to estimating this relationship follows logically from the well-documented switch in policy methodology by the authorities in the late 1980s, which saw traditional monetary aggregate targeting replaced by explicit use of nominal interest rates as the main policy instrument of central banks. With the interest rate assuming a pivotal role in the monetary policy transmission mechanism since the early 1990s, it has become important that central banks learn more about the strength and limits of the relationship between the yield spread and economic growth. Indeed, this remains an essential task and is one key motivation for

this paper.

The paper is structured as follows. Section two outlines the theoretical framework and section three explains the properties of the time series data. Section four gives the test procedure and presents the main empirical findings. The final section makes concluding comments.

## **2. METHODOLOGY**

The yield curve hypothesis was first put forward in its modern guise by Kessel (1965), who identified a correlation between the term structure of interest rates and business cycle phases such as recession and recovery. The hypothesis states that the spread between long-dated and short-dated yields on liquid financial instruments (the 'yield spread') is positively related to future economic growth. A positive spread is a precursor of future economic expansion, while a negative spread foreshadows future economic contraction.

The basis of the relationship is that in a rational economy, market interest rates contain efficient information about economic agents' expectations for the future and that this will be systematically reflected in the term structure. Define the yield to maturity ( $r_n$ ) of an  $n$ -year bond as the rate of return that makes the bond price today ( $P_n$ ) equal to the discounted present value of the flow of future payments (coupons  $C$  and face value  $F$ ) to the holder of the bond:

$$P_n = \sum_{k=1}^n \frac{C}{(1+r_n)^k} + \frac{C}{(1+r_n)^n} \quad (1)$$

Consider the relationship between today's (that is, from the standpoint of time  $t$ ) one-

year spot rate ( $r_{1t}$ ) and two-year spot rate ( $r_{2t}$ ). The well-known expectations hypothesis of the term structure holds that due to arbitrage between one- and two-year bonds, the price of two-year bonds is the present value of the payments in two years, effectively the multiplicative average using the current one-year spot rate ( $r_{1t}$ ) and next year's expected one-year rate,  $r_{1(t+1)}^e$ . The relation between the three yields in this simplest case can be summarised as:

$$(1 + r_{2t})^2 = (1 + r_{1t}) \left( 1 + r_{1(t+1)}^e \right) \quad (2)$$

where  $e$  is the expectations operator and subscript  $t$  denotes the current period. This says that the prevailing two-year spot rate equals the product of the current one-year spot rate and the currently expected one-year rate a year from now. Generalising to the  $n$ -year case, we have:

$$(1 + r_{nt})^n = (1 + r_{1t}) \left( 1 + r_{1(t+1)}^e \right) \left( 1 + r_{1(t+2)}^e \right) \dots \left( 1 + r_{1(t+1-n)}^e \right) \quad (3)$$

It follows that the expected one-year spot rate ( $r_{1(t+k)}$ ) for a chosen future period ( $k$ ) can be read today from the term structure at time  $t$  as follows:

$$\left( 1 + r_{1(t+k)} \right) = \frac{(1 + r_{kt})^k}{(1 + r_{(k-1)t})^{k-1}} \quad (4)$$

This allows us to put a macroeconomic interpretation on the information in the yield curve. An upward sloping yield curve tells us that financial markets expect short-term interest rates to increase in the future. Conversely, a downward-sloping yield curve tells us that financial markets expect short-term rates to fall in the future.

The next step is to postulate a relationship between the market's expectations of future interest rate movements as reflected in the term structure, and anticipated economic growth. This can be viewed in two ways. The first is the so-

called 'policy anticipations hypothesis', which says that the yield curve is seen as capturing the financial market's estimate of future economic policy. If agents believe the authorities will relax monetary policy in a recession, then those who expect a recession will expect interest rates to fall and will build this into the term structure. The other way to approach it is the 'structural equation approach', where agents observe that lower (higher) interest rates are associated in macroeconomic terms with recessions (recoveries). Accordingly, a downward-sloping (upward-sloping) yield curve is a rational response to expectations of a slump (boom).

This hypothesis, that the yield curve contains information about the future of the business cycle, can be expressed empirically in terms of a regression of the change in real output ( $\Delta y$ ) against the yield spread:

$$\Delta y = \alpha_1 + \beta_1(r_L - r_S) + \varepsilon_t \quad (5)$$

where  $r_L$  is the long term yield,  $r_S$  is the short term yield,  $\alpha_1$  is a constant,  $\beta_1$  is an estimated elasticity parameter and  $\varepsilon_t$  is a random error term. A standard OLS regression might not be satisfactory as a means of estimating equation (5), due to the likely presence of unit roots in both left and right hand side variables. Accordingly, the approach in this paper uses a cointegration methodology.

Equation (5) represents the standard domestic form of the hypothesis. Consider however the argument that under a globalised capital market with free movement of investment funds and arbitrage between one market and another, rates of return in local economies will not be independent of world rates. For instance, US Federal Reserve policy actions are likely to have flow-on effects to other countries, and the

domestic yield spread is likely to reflect movements in ‘world’ interest rates, because economic agents’ expectations about the future business cycle will be partly influenced by US (ie world) monetary policy. This leads to the proposition that the foreign yield spread will be systematically related to domestic output growth. The proposition to be tested is that in a globally integrated economy, the foreign interest rate spread will influence domestic output:

$$\Delta y = \alpha_2 + \beta_2 (R_L - R_S) + \eta_t \quad (6)$$

where  $\alpha_2$  is a constant,  $\beta_2$  is an elasticity parameter,  $R_L$  is the long foreign rate,  $R_S$  is the short foreign rate and  $\eta_t$  is an error term. If the parameter  $\beta_2$  is significant, then it tells us the foreign spread contains ‘world’ economic information which can be used as a predictor of swings in the home economy.

In what follows, we combine the two spreads and estimate equation (7):

$$\Delta y = \alpha + \beta_1 (r_L - r_S) + \beta_2 (R_L - R_S) + \delta_t \quad (7)$$

We can use  $\beta_2$  to assess whether the relationship of output to the foreign spread has become more important with time, by inferring the elasticity in different sample periods. To facilitate this, the models are estimated in logarithmic form. When using log form, the slope coefficient directly measures the elasticity of the dependent variable with respect to the RHS variable, giving us the percentage change in output growth for a given percentage change in the spread. If this has increased in later years compared with earlier, then it tells us the relationship between the spread and output has intensified with time.

### **3. TIME SERIES PROPERTIES**

Quarterly Australian data are used, reflecting the periodicity of published GDP statistics. The full estimation period spans from 1969(1) to 1999(4), providing a total of 128 observations. Later, this is split into two sub-samples in order to measure for any effect from the impact of globalisation. The first sub-period runs from 1969 to 1983(4) when the Australian dollar was floated, a period designated as 'pre-globalisation' for the purposes of this study. The second sample spans from 1984(1) through to 1999, and represents the 'post-globalisation' era when foreign exchange controls were relaxed, tariff barriers were dismantled, foreign firms were allowed easier entry to Australian markets and her financial markets grew rapidly in size and integration with the rest of the world.

The change in output is defined as the four-quarter-ended percentage change in GDP measured at constant prices, and is advanced four quarters ahead of the relevant interest rate spread. That is, if the spread (right-hand-side variable) is recorded as at quarter  $t$ , then the left-hand-side variable (percentage change in output) is observed as at time  $(t + 4)$ . This reflects that interest rates are forward-looking and contain information about future GDP, not contemporaneous GDP. (In turn, the cointegration procedure then selects the appropriate number of lags in the relationship.) Quarterly interest rate data are obtained by averaging the three monthly observations for the relevant quarter, so the observation is effectively centred in the middle of the quarter. The domestic yield spread is defined as the ten-year Australian Treasury annualised bond rate minus the three-month annualised Treasury note rate. The foreign spread is defined as the ten-year US Treasury bond yield minus the three-month Treasury bill rate. All variables are expressed in natural logarithms. Appendix A provides formal definitions and sources of economic statistics used.

Figures 1 to 3 give an overview of the key variables across the whole sample period: the annual percent change in GDP ( $\Delta$ GDP), the Australian yield spread (AS1090) and the foreign yield spread (US1090).

*[FIGURE 1]*

*[FIGURE 2]*

*[FIGURE 3]*

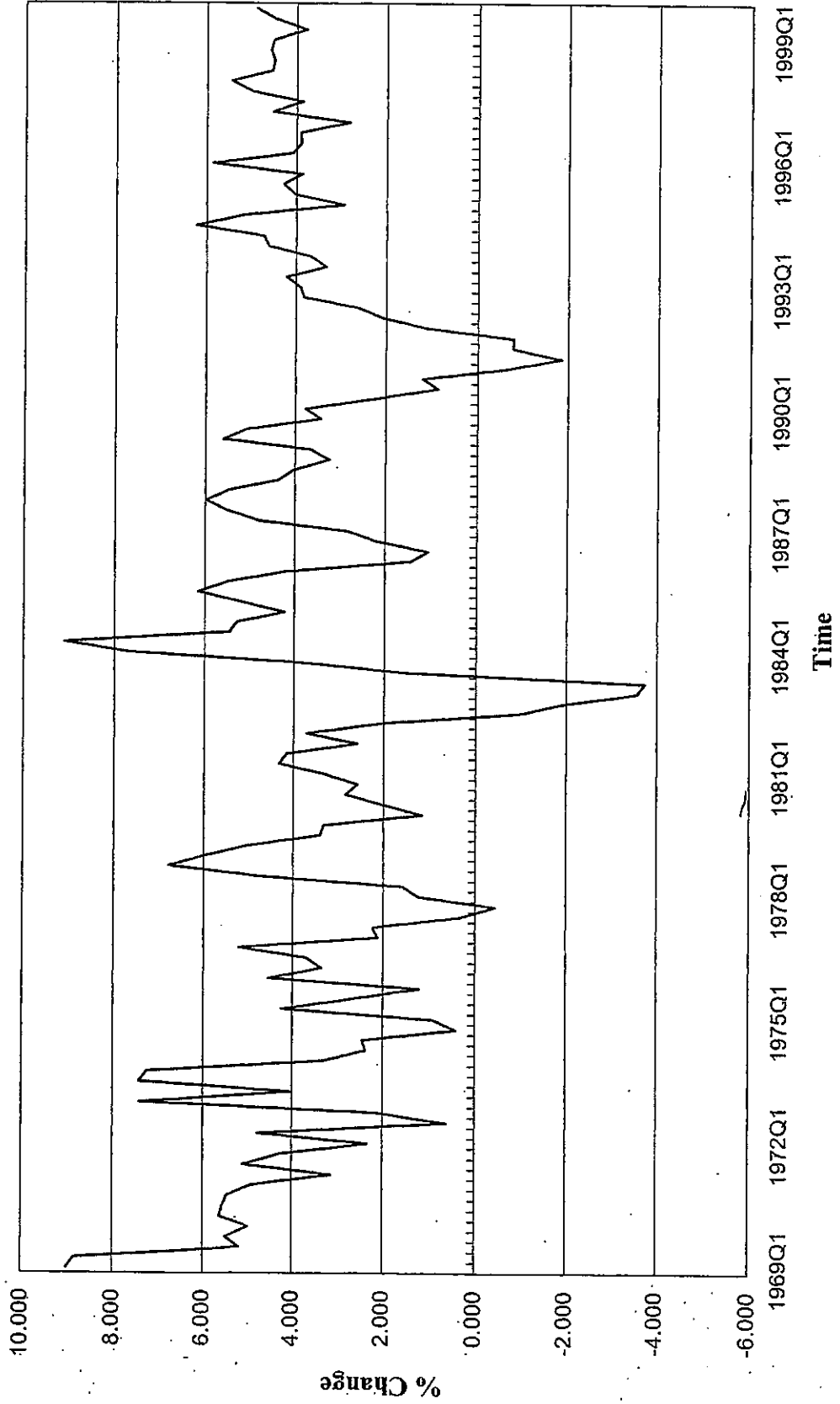
Visual inspection suggests that these series may contain unit roots. Only variables integrated of the same order may be cointegrated, and so the next step is to test for the presence of stochastic time trends in order to determine which variables (if any) are I(1), integrated of order one. The test used follows the augmented Dickey-Fuller (1981) or ADF procedure, in which the following regression is run:

$$\Delta x_t = \mu + vt + (\rho - 1)x_{t-1} + \sum_{i=1}^m \gamma_i \Delta x_{t-1} + \varepsilon_t \quad (8)$$

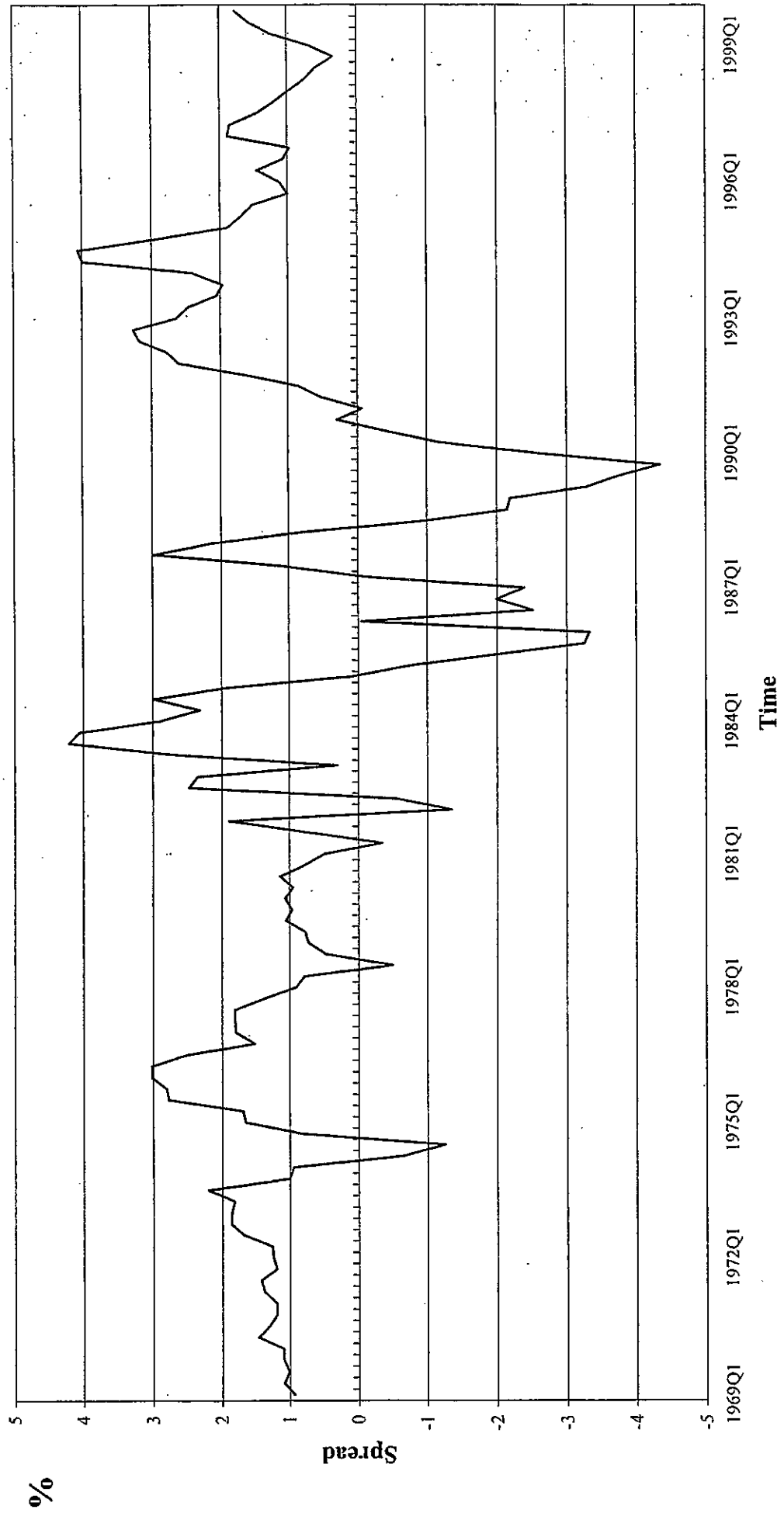
The preferred ADF equation includes a constant term but has no trend term, and the null hypothesis is that the series in question contains a unit root and this is confirmed if the log levels series yields a  $t$ -value less than critical value of the test statistic. The hypothesis that the series is integrated of order I(1) and not I(2) is confirmed if the first differences series has a  $t$ -value greater than the critical value. It should be noted that the augmented DF procedure has the feature that the program selects the optimum number of lags rather than imposing it, thereby allowing the regression to be corrected for autocorrelation. This number ( $m$ ) in each case is seen in column one of the table.

**FIGURE 1**

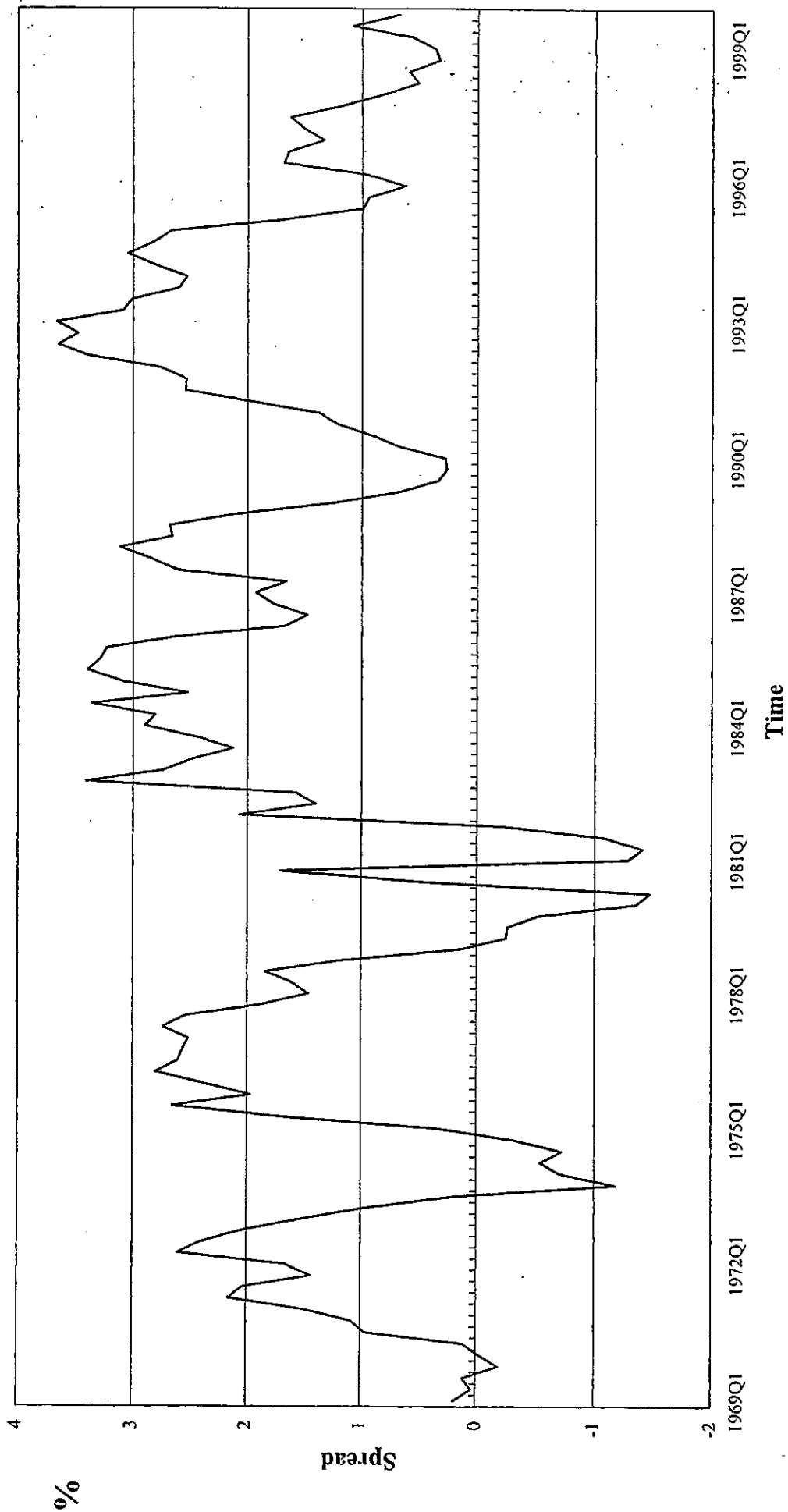
**Annual Per Centage Change in Australian Gross Domestic Product**



**FIGURE 2**  
**Spread of Australian 10 Years and 90 Days Interest Rates**



**FIGURE 3**  
**Spread of United States 10 Years and 90 Days Interest Rates**



**Table 1: Unit-root tests**

Variable	No. of lags (m)	constant term (t-statistic)	ADF statistic	ADF critical value (1% level)
<i>(a) Data in levels</i>				
$\Delta$ GDP	1	0.424 (3.138)	-3.259	-3.544
AS1090	0	0.097 (0.843)	-2.117	-3.593
US1090	1	0.021 (0.456)	-1.598	-3.534
<i>(b) Data in first differences</i>				
$\Delta$ GDP	1	-0.008 (-0.184)	-6.780	-3.546
AS1090	2	-0.083 (-0.977)	-2.552	-3.612#
US1090	1	-0.016 (-0.439)	-5.387	-3.534

# Critical values at 5% and 10% levels for AS1090 in differences are -2.940 and -2.608, respectively.

Notes to Table 1: ADF statistics are obtained using a regression with constant term and no trend. Critical values of the ADF statistic can be found in Fuller (1976, p. 373). ADF critical values differ slightly in each case because with a deterministic term the ADF statistic is conditional on significance level. Critical values for significance of the constant term in the presence of a unit root can be found in Dickey and Fuller (1981, p.1063). Sample period is 1969(1) to 1999(4).

The results for the unit root tests are shown in Table 1. Two sets of statistics are shown: the first for the data expressed in levels and the second after taking first-differences. In the case of levels, all three series are unambiguously I(1) and contain a unit root, because the estimated ADF statistic is in each case smaller than the test ADF statistic (shown in the far right hand column). Looking at the first-difference results, it is reasonable to believe that all three series are not I(2). This is clear for  $\Delta$ GDP and US1090 since their ADF estimate is higher than the 1% critical value. In the case of AS1090, the result is less certain, as the ADF estimate is not higher than the benchmark at the 1% level. However, at the 10% level, the estimated statistic

(-2.552) approaches the critical value (-2.608) and we can infer that at this level of likelihood that the AS1090 series is not integrated of order two.

Overall, the null hypothesis (of a unit root) cannot be rejected and this tells us that all three series are non-stationery. We therefore proceed to employ cointegration to examine for any relationship between the series.

#### **4. EMPIRICAL RESULTS**

The Johansen cointegration procedure is used. This is a sequential test, examining first of all the null hypothesis of zero cointegrating relationships, then that there is at most one relationship, then if that is accepted that there is at most two relationships present in the equation.

The maximum possible number of cointegrating relationships in equation (7) is two, and we seek to confirm that precisely two exist, for this will demonstrate that both the domestic spread and foreign spread matter for Australian GDP growth. The test says let  $p$  be the number of variables (in this case  $p = 2$ , being AS1090 and US1090) and  $r$  the rank (equals the number of cointegrating relationships), then tests the hypothesis that  $r \leq p$  against the alternative of stationarity. The maximal eigenvalue tests the hypothesis of at most  $r$  cointegrating vectors against the possibility of  $r+1$  cointegrating vectors.

**Table 2: Johansen Cointegration tests between  $\Delta$ GDP, ASI090 and USI090**

Eigenvalue	LR	$\lambda_{\max}$ critical test value (5%)	lag	hypothesis: number of cointegrating relationships
<i>(a) Full data sample: 1969(4)-1999(4)</i>				
0.232	21.76	34.91	2	0
0.140	10.16	19.96	2	1
0.077	3.51	9.24	2	2
<i>(b) Post-globalisation sample: 1984(1)-1999(4)</i>				
0.481	33.73	34.91	2	0
0.273	11.41	19.96	2	1
0.016	0.55	9.24	2	2

Notes: 1. Results include an unrestricted constant term.  
2. Critical values for the lambda test are at the 5 per cent level.  
3. Figures have been rounded to two or three decimal places.  
4. No autocorrelation was detected: the Durbin-Watson statistic is 1.0645 (which is less than the critical value of 1.960), therefore the null hypothesis of no autocorrelation is accepted.

The results of the cointegration tests are shown in Table 2. Two samples are shown: the full sample since 1969, and the sub-sample covering the second half of the period, the 'post-globalisation phase'. In both cases, the hypothesis accepted is that there exist the maximum number of cointegrating relationships, namely two. This is based on the estimated likelihood ratio statistic being less than the required  $\lambda$  value. If the hypothesis of zero cointegrating relationships is accepted, then we move to the second line. If that shows acceptance of the existence of one relationship, we move to the third line. Here, if the LR value was shown to be greater than the  $\lambda$  value it would rule out a second relationship and we would be forced to return to the line above and conclude there was only one relationship. That is not the case here. For both samples, there is convincing evidence that two cointegrating relationships are present. This

says both AS1090 and US1090 have a long-run econometric relationship with GDP growth.

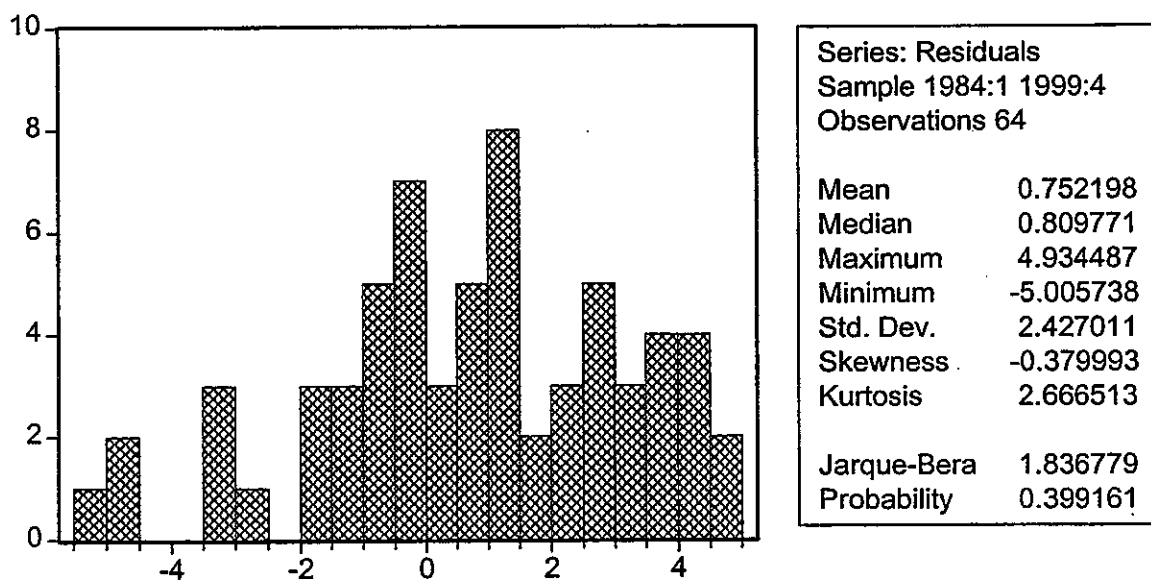
No evidence is found of any autocorrelation once the cointegrating equations were corrected, for either sample. The Prais-Winsten Transformation was used to correct the residuals for first-order serial correlation, with the calculated Durbin-Watson statistic of 1.0645 subsequently confirming this. The asymptotic normality of the residuals is also likely, although less clearcut. Figure 4 shows analysis of the residuals for the second-half sample period.

*[FIGURE 4]*

Visual inspection suggests that the error distribution, while slightly skewed, is most likely normal. Formally, the Jarque-Bera test for normality is reported, which is an asymptotic test that first computes skewness (in this case equal to  $-0.380$ ) and kurtosis (here equal to  $2.666$ ) then uses a test statistic that approximates the chi-squared distribution with two degrees of freedom.<sup>2</sup> If the probability (p) value calculated is very small, we can reject the null hypothesis of normally distributed residuals. However, as shown in the table that is part of Figure 4, the p-value (equal to 40%) is not small. We are accordingly entitled not to reject the null hypothesis.

Now we turn to the high-point of the results: empirical elasticities and the changing strength of the foreign spread effect over time. Having determined the relevant order of cointegration, we can identify the numeric value of estimated behavioural parameters and from that, the speed of adjustment coefficients. We first write down the cointegrating equation. A benefit of the Johansen procedure is that it allows for a

**FIGURE 4**



selection procedure of the most suitable cointegrating vector, based on the eigenvalues. The relationship with the largest eigenvalue is chosen, then the relationship is normalised with respect to the coefficient on the dependent variable ( $\Delta\text{GDP}$ ). This yields the optimal cointegration vector and forms the basis for obtaining the estimated parameters. Based on the selection criteria, the full sample (1969-1999) yields the following cointegrating relationship:

$$\ln(\Delta\text{GDP}) = 1.506 - 0.393 \ln(\text{AS1090}) + 0.106 \ln(\text{US1090}) \quad (9)$$

The negative sign on AS1090 in the full sample is not what we would expect, from economic theory. However, because of the effects of regulation prior to 1984 this may be explained by market distortions. Some support for this proposition comes from the observation that the 'wrong' sign is corrected when we look at the resulting cointegrating relationship from the more recent 1984-1999 sub-sample:

$$\ln(\Delta\text{GDP}) = 1.450 + 0.115 \ln(\text{AS1090}) + 0.198 \ln(\text{US1090}) \quad (10)$$

In the post-globalisation sample, the sign on AS1090 changes to positive and this suggests that the relationship since the mid-1980s is well-behaved: that since the deregulation of interest rates, free from the restrictions of rate ceilings, the yield curve effect has been allowed to operate in accordance with economic priors.

It is clear the foreign spread is systematically related to Australian GDP growth. The next question is: has this effect intensified in the globalisation era? We are now in a position to cast light on this issue. Since a logarithmic functional form is used here, the vector coefficients can be regarded as absolute values of the long-run elasticities. Comparing equations (9) and (10), we note that the coefficient on the US

spread (US1090) has increased, from 0.106 in the full sample to 0.198 in the second sub-sample. That is, the more recent period has seen a doubling of the elasticity of Australian GDP growth with respect to the foreign interest spread. In the full sample, the elasticity is around 10 per cent. In the latter period, it has risen to around 20 per cent. The indication from this is that the foreign yield curve has increased in importance to economic growth in the wake of globalisation of the economy.

The model also allows us to say something about the short-run relationship between the spread variables and GDP growth. The estimation procedure is consistent with a Vector Error Correction Model (VECM) which generates terms measuring any disequilibrium factor in the short run. The following general model applies:

$$\Delta y_t = \gamma_0 + \gamma_1 \Delta X_t - \gamma_3 (y_{t-1} - \xi - \psi X_{t-1}) + \omega_1 \quad (11)$$

where  $y$  is the model variable under consideration. This gives the disequilibrium in a particular variable from period  $(t-1)$ . The equation implies that the percentage change in  $y$  is dependent on the percentage change in  $X$  and the extent of disequilibrium in the previous period. Because of its formulation, there is no autocorrelation or multicollinearity present. Three cases of equation (11) are produced in our case, one for the dependant variable ( $\Delta$ GDP) and one each for the explanatory variables (AS1090, US1090) respectively. In each case, the parameter we are interested in is  $\gamma_3$ , which gives the short-run coefficient from the related cointegrating equations. This parameter provides an explanation of short-run deviations from long-run equilibrium, and significant values imply that last period's disturbances affect the current time period. The results for  $\gamma_3$  are shown in Table 3.

**Table 3: Error-correction model, short-run coefficients**

	$\Delta$ GDP	AS1090	US1090
(a) <i>Full sample:</i> 1969(1)-1999(4)	-0.491 (-1.266)	-0.776 (-2.265)*	0.044 (0.163)
(b) <i>Half-sample:</i> 1984(1)-1999(4)	-0.741 (-4.360)*	-0.619 (-1.517)	0.229 (0.982)

**Notes:**

1. Figures in parenthesis are t values. Asterisk indicates value is significant at the 5% level.
2. AIC and SBC estimates (see text for full explanation): for full sample AIC=4.649 and SBC =6.717; for half sample AIC=2.305 and SBC =3.786.

If the  $\gamma_3$  term is statistically significant, then identifiable short-run disturbances exist and the term indicates the direction of the impact. If this term is not significant, there exist no short-run disturbances of note and the system under investigation is said to be always in short-run equilibrium. The results in Table 3 for the short-run impacts from the VECM indicate that short term effects are present in two cases. First, we observe that the AS1090 parameter is significant in the full sample, indicating the presence of disturbances; however this may be the result of institutional restrictions during the period. The second case is more interesting: in the half-sample, the GDP parameter is significant. The implication is that GDP growth does not adjust rapidly to interest rate changes, but instead takes longer than one quarter to fully reflect the impact.

How long does it take for GDP to adjust to changes in domestic and foreign spread shocks? The VECM permits the choice of best-fit lag length using selected criteria. In the tests reported in Table 3, two criteria are applied: the Akaike Information Criterion (AIC) in which  $AIC = T \ln(\text{residual sum of squares}) + 2n$ , and the Schwartz Bayesian Criterion (SBC) where  $SBC = T \ln(\text{residual sum of squares}) + n \ln(T)$ . In minimising the AIC or SBC, we minimise the natural logarithm of the residual sum of

squares, adjusted for sample size ( $=T$ ) and the number of parameters ( $=n$ ). The results are in Table 4.

**Table 4: Error-correction model adjustment lag lengths**

	AIC	SBC
<i>Full sample:</i>	4.649	6.717
<i>Half sample:</i>	2.305	3.786

In the full sample it took between 4.6 and 6.7 quarters for GDP growth to adjust to a shift in the yield spread. This is consistent with generalised anecdotal evidence that GDP often takes up to eight quarters to adjust to an interest rate shock, in part because of delays by retail banks in passing on interest rate shocks and partly because goods and labour markets take time to react. For the half sample, the indications are that GDP has a reaction time of between 2.3 and 3.8 quarters, indicating a significantly faster transmission mechanism in recent years. It seems clear that the responsiveness of GDP growth to the two yield spreads has got faster in the recent era, being approximately halved since the mid-1980s compared with the longer timeframe.

## **5. CONCLUDING COMMENTS**

In this study the link from the yield spread to real output is found to operate not only domestically but also internationally. Using the United States interest rate spread as a proxy for the world yield curve, a robust cointegrating relationship exists with Australian GDP growth. This is especially evident since the advent of full economic globalisation (defined here as the late 1980s and 1990s). The elasticity of domestic

Australian output with respect to the US yield curve has strengthened during the period studied, and generally the speed of adjustment of GDP to the yield curve effect has doubled in the recent sample period. A degree of short-run disequilibrium still remains in the relationship, with GDP growth taking longer than one quarter to substantially reflect shocks to the yield curve.

These results have implications for financial markets and policymakers. In future years, as the integration of small open macroeconomies (such as Australia's) with the rest of the world becomes further entrenched, we might expect foreign monetary policy to play an increasingly determinative role in the growth performance of those countries. The business cycle of a country like Australia is likely to mirror more closely that of the US and other G7 nations. Perhaps we are already witnessing a diminution of the independence of the home country's central bank in influencing its own growth pattern, and this has implications for the ability to conduct an autonomous policy towards controlling inflation. From the point of view of financial markets, they will look more and more to the Federal Reserve as the monetary policy leader and are likely to use Fed actions as a guide to future monetary policies of the home country.

There is room for further research to be done in this area. The within-sample results presented here raise the question of using the yield curve, both domestic and foreign, to predict GDP growth out-of-sample. Some work has been done on this in the US context by Bonser-Neal and Morley (1997). Also there is the issue of inflation and its relationship to the yield curve, as to whether the results found here for output carry over to a link from the foreign yield spread to inflation (and to what degree, especially since 1990 when central banks explicitly began using interest rate policy for inflation

targeting). These issues will make for fruitful follow-on research from the present paper.

## FOOTNOTES

1. See for instance Hu (1993), Haubrich & Dombrosky (1996) and Kozicki (1997).
2. The Jarque-Bera test statistic is defined as:

$$JB = n [ S^2/6 + (K-3)^2/24 ]$$

where n is the number of observations, S represents skewness and K represents kurtosis.

## **APPENDIX: DATA DEFINITIONS AND SOURCES**

- $\Delta$ GDP - Four-quarter-ended percentage change in Gross Domestic Product measured at constant prices (Source: Australian Bureau of Statistics Cat. No. 6401.0)
- AS1090 - Australian yield spread, measured as the 10-year Commonwealth Government bond rate minus the 90-day bank-accepted commercial bill rate. Interest rates are average for the quarter. (Source: Reserve Bank of Australia *Bulletin*, Tables F.1 and F.2, various issues).
- US1090 - Foreign interest rate spread, proxied as the US 10-year Treasury bond rate minus the US 3-month bill rate. Interest rates are average for the quarter. (Source: Reserve Bank of Australia *Bulletin*, Tables F.10 and F.11, various issues)

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