INTERNATIONAL INTEREST RATE LINKAGES AND MONETARY POLICY: THE CASE OF AUSTRALIA

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This paper was prepared for a meeting on international interest rate linkages at the Bank for International Settlements (BIS). The meeting took place in Basle, Switzerland, on 16 and 17 November 1988. The paper was organised and presented by Ian Macfarlane, but it also contained major contributions by other members of the Research Department of the Reserve Bank. In particular, most of Sections 2, 3a and 3b were prepared by Glenn Stevens. Section 3c part (i) and Appendix 1 were the work of Dirk Morris, and Section 3c part (ii) and Appendix 2 were the work of Malcolm Edey. Useful comments were also made by Ric Battellino, Adrian Blundell-Wignall, Warwick McKibbin, Warren Tease and Rob Trevor. The questions addressed in the paper were contained in a questionnaire prepared by the BIS. Palle Schelde Andersen of the BIS also made some helpful comments on this paper.

ABSTRACT

This paper attempts to answer a number of questions about the relationship between movements in Australian long-term interest rates and movements in long-term interest rates abroad. In particular, it looks at the question of whether the relationship between interest rates in Australia and abroad has altered since the floating of the Australian dollar.

It concludes that the volatility of long-term interest rates in Australia has decreased and that they are now less closely synchronised with international rates than formerly. There is no evidence that the influence of short-term interest rates on long-term interest rates has become less pronounced; if anything, it is now stronger.

These are the standard sorts of results one would expect for a country that has moved from a quasi fixed exchange rate to a floating exchange rate regime.

The final section examines the transmission process of monetary policy from short-term interest rates to long-term interest rates. It also looks at the influence of the growth of the Euro-Australian dollar market. Two appendices give more details on the analytical techniques that have been used to answer the main questions set out above. The first appendix is based on the interest parity condition, and the second is based on the term structure of interest rates in Australia.

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INTERNATIONAL INTEREST RATE LINKAGES AND MONETARY POLICY: THE CASE OF AUSTRALIA

I.J. Macfarlane

1. Introduction

This paper is about the determination of long-term interest rates in Australia. It examines the role of domestic short-term interest rates and overseas rates in explaining movements in Australia's long-term rates. The main aim is to see whether there has been any change in the relationship over recent years.

In keeping with the BIS outline, the questions and conclusions of the paper can be summarised in four parts:

(i) Are long-term interest rates in Australia more volatile than formerly?

(ii) Are they more closely synchronised with international rates than formerly?

(iii) Are they less influenced by short-term interest rates than formerly?

(iv) Are any observed changes in the behaviour of long-term interest rates related to the increased liberalisation of capital movements or to the changed exchange rate orientation of monetary policy?

The work below suggests that the answers to the first three questions should be in the negative, but that the answer to the fourth should be positive. Such results - for example, that long-term interest rates are not more closely synchronised with world interest rates - may seem surprising in view of the experience of other member countries. However, we feel the result is not unusual - the explanation is to be found in recent structural changes to the Australian financial system and policy framework. It is necessary to take these into account before it is possible to make sense of the answers to the four questions above. For this reason, the next section of this paper outlines the major structural changes that have had an important bearing on the behaviour of interest rates and exchange rates.

2. Structural Background

Over the past decade or so, the Australian financial system has changed from being heavily regulated to being largely deregulated. In some cases, developments took place in a series of minor steps, but in others there were major events which clearly distinguished one period from another. The major changes were:

- the floating of the Australian dollar in December 1983. In the period before the float, the Australian dollar was set every day by the Reserve Bank under a crawling peg arrangement. While the exchange rate changed frequently, there was no market in foreign exchange and the system was more similar to the textbook fixed exchange rate regime than to a floating exchange rate regime. At the same time as the exchange rate was floated, exchange controls were abolished, which increased the scope for inward movement of capital, and opened up for the first time the opportunity for Australian investors to diversify into foreign fixed-interest assets;

- the introduction of the tender system for sales of government debt. This was done for short-term securities (Treasury notes) in 1979 and for longer-term government bonds in the middle of 1982. Prior to the introduction of the tender system for selling government bonds, yields had been set by the authorities under a tap arrangement. Thus, prior to the introduction of the tender, yields moved in a stepwise fashion, as the authorities adjusted them from time to time to changes in investor demand. Since the tender, yields in the secondary market have moved continuously and so the day-to-day variability has obviously been greater than under the administered system.

The tender also facilitated the development of a deep secondary market in government bonds, with turnover having expanded twentyfold since 1982;

- over the past decade or so, there have also been a number of moves to deregulate financial intermediaries' interest rates. This has been a gradual process, starting in the late 1960s. By 1980, all ceilings on bank deposits had been abolished, but there were a couple of remaining ceilings on bank lending rates. To all intents and purposes, these have now been abolished. The maturity restriction which prevented banks from paying interest on short-term (including overnight) borrowing was lifted in 1984;

- 16 foreign banks were allowed entry into the Australian market as full trading banks in 1985. Prior to that, the only foreign banks which could operate in Australia as trading banks were a couple that had been established in the last century. Other foreign banks had entered the Australian market through merchant banking subsidiaries.

Many changes have resulted from this widespread deregulation, of which several are important for the present paper. Two that are clearly visible from the graphs shown later in the paper are that long-term government bond rates only became fully market determined after mid 1982, and the exchange rate after the end of 1983.

There has also been a major change in the way the Reserve Bank conducts its monetary policy. Prior to the introduction of the tender system and the float, the setting of rates on long-term government paper was an important aspect of monetary policy. After deregulation, monetary policy has essentially been implemented through daily open market operations. The cost and availability of cash has been the operating objective. In periods when the Bank has wished to tighten, its domestic market operations have led to a rise in overnight rates in the professional money market. This has quickly translated to a rise in all short-term security yields.

3. The Main Questions

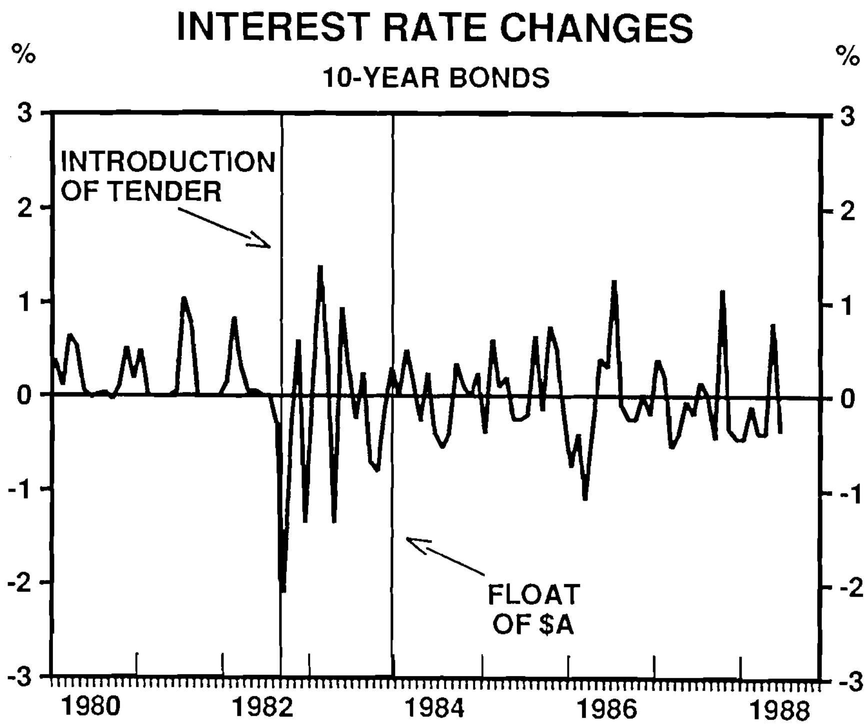
This section addresses directly the main questions raised at the outset of the paper.

3a. Have interest rates become more volatile?

Figure 1 shows monthly changes in the yields on 10-year bonds. There are three distinct periods:

- up to the middle of 1982, there was little volatility in the bond rate. This is to be expected, given that the yield was an administered one in this period;
- from mid 1982 until late 1983, monthly fluctuations in the bond yields were much more marked, as yields became market determined under the tender arrangements;
- from the end of 1983, volatility in yields declined, though it remained higher than in the period of administered rates.

Figure 1



Why is this the case? If, as is commonly believed, the volatility of world interest rates has generally increased, why has the volatility of Australian rates declined since 1983?

The important institutional explanation is that the Australian dollar was floated in December 1983. A major reason behind the floating of the exchange rate was, as in the textbooks, to gain greater monetary policy independence. Whereas a fixed or quasi-fixed exchange rate makes it very difficult to insulate domestic financial conditions from those abroad, a flexible exchange rate allows disturbances to be taken on the exchange rate rather than on interest rates (or asset prices).

Whether this is actually the case depends, naturally, on whether the authorities have any particular objectives for the exchange rate itself. No particular exchange rate has been sought in the floating period in Australia, though on occasions the Reserve Bank has been very active in the market in the interest of maintaining orderly conditions. Given this, after the floating of the exchange rate we might expect to see an increase in volatility of the exchange rate, a decline in volatility of interest rates, and Australian interest rates becoming more independent of those overseas.

Figure 2 shows the remainder of the story. The increased volatility seen in long rates in 1982 and 1983 (i.e. immediately prior to the float) was also observed in short rates. From end 1983, both long and short rates became less volatile, and the exchange rate more volatile, than had previously been the case.

Table 1 gives one simple statistical measure of variability, which shows the same story. Bond rates became more volatile after the introduction of the tender, but then became less volatile after the float. The volatility of short-term rates also declined noticeably after the float. The volatility of the exchange rate increased progressively throughout the period.

Figure 2

INTEREST AND EXCHANGE RATE CHANGES

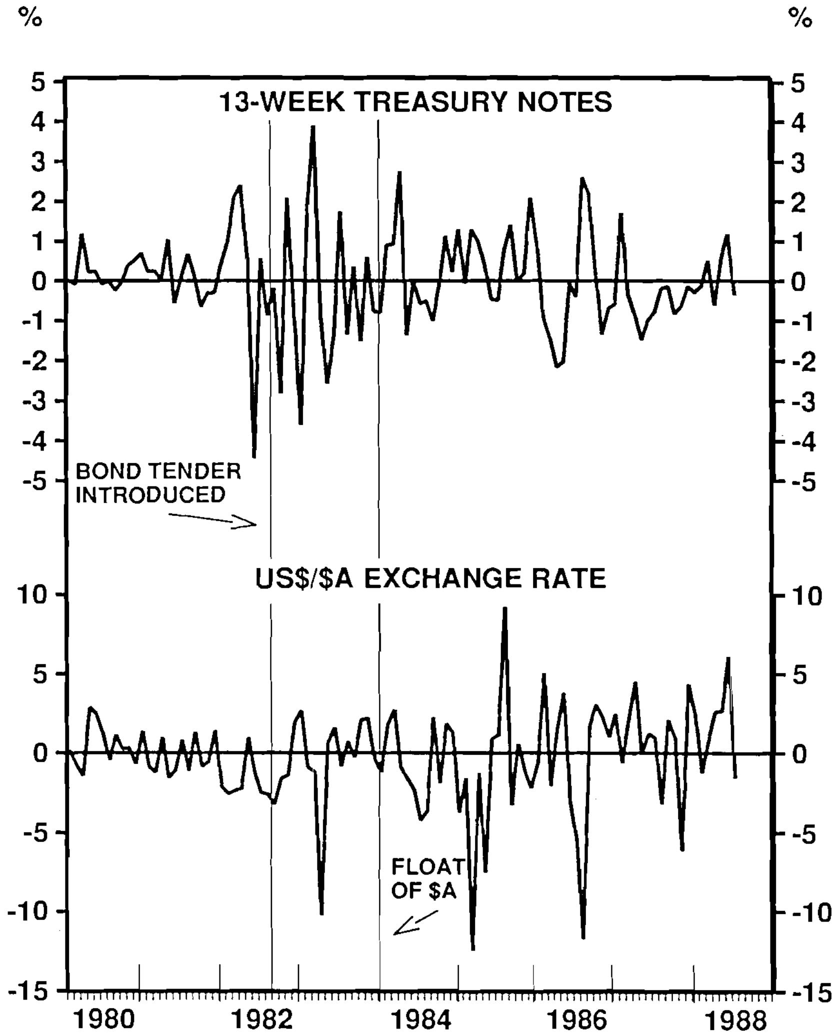


Table 1: Measures of Variability* of Interest and Exchange Rates

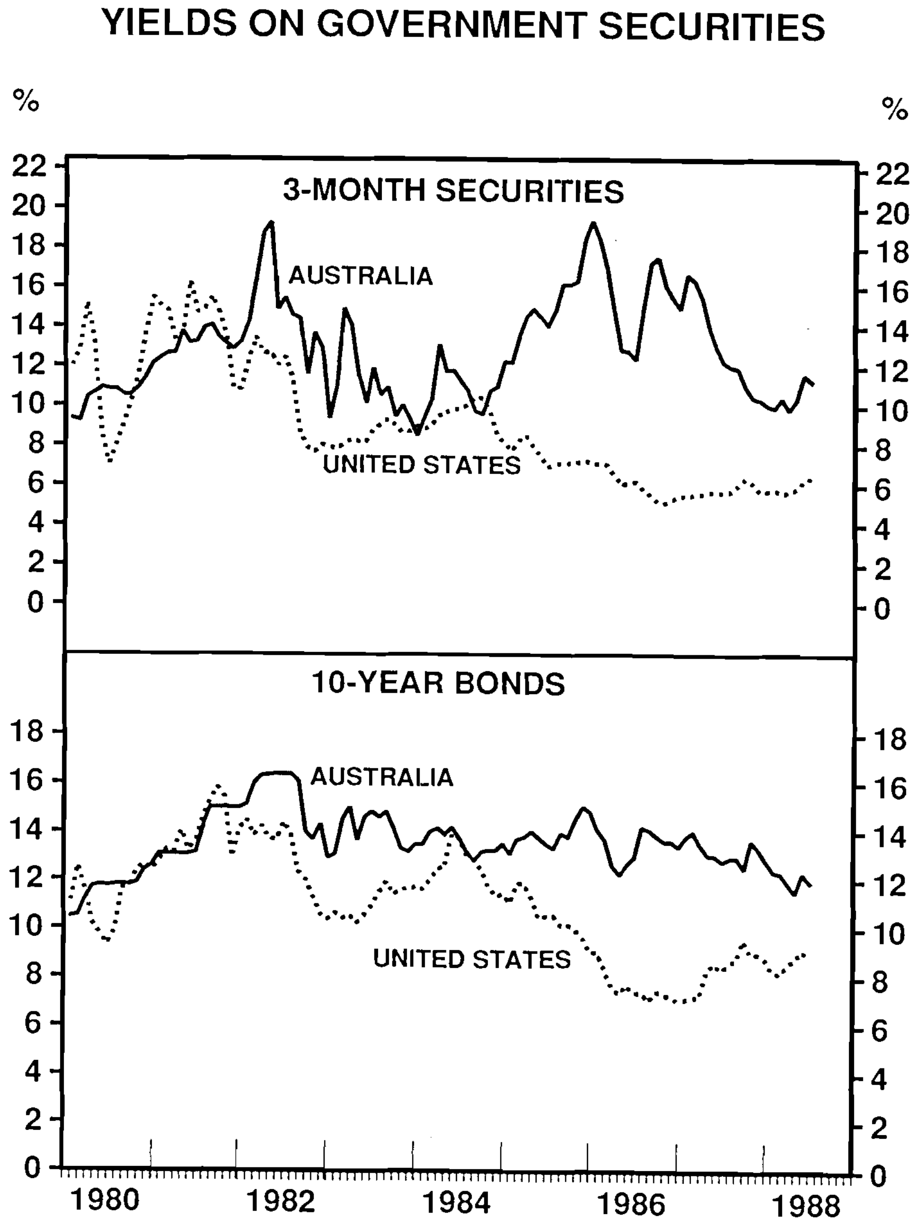
	Dec. 1979 to Jul. 1982	Aug. 1982 to Dec. 1983	Dec. 1983 to Jun. 1988
U.S. bond rates	0.86	0.55	0.45
Aust. bond rates	0.41	0.89	0.46
90-day bill rates	2.21	2.06	1.04
Official cash rate	1.33	1.43	1.11
A/US	1.52	2.97	3.90

* The measure used is the standard deviation of the first difference for interest rates and the standard deviation of the percentage change for the exchange rate. Data are monthly.

3b. Are Australian interest rates more synchronised with foreign rates?

Figure 3 shows interest rates for Australia and the United States over the 1980s. The upper panel shows yields on three-month government securities. Up to 1982, there were on occasion substantial differentials, but these did not persist for long. It is clear, however, that since early 1985, there has been a marked difference in experience. Differentials have been large, and persistent. Trends have frequently been in opposite directions.

Figure 3



The same is true for bond rates. The Australian rate was an administered one up until the middle of 1982, and this explains why it moved in a stepwise fashion. Even so, there was a reasonably close relationship to the U.S. bond yield for much of this period. From 1982, the two rates diverged. The differences became more marked from early 1985, with U.S. rates falling sharply, and those in Australia remaining at historically high levels. Then U.S. rates moved up over 1987, while Australia's rates trended down.

It is apparent from these charts that Australian interest rates have not become more synchronised with U.S. rates. While greater integration of financial markets across national borders would have been working towards greater synchronisation, the economic shocks affecting Australia in recent years, and the policy reactions to them, have caused interest rates to move differently from those in other countries.

Over 1985 and 1986, Australia suffered a major fall in its terms of trade and a widening in its current account deficit. Economic developments since then have been dominated by the need to bring about a medium-term correction of the current-account imbalance. The adjustment was on three fronts:

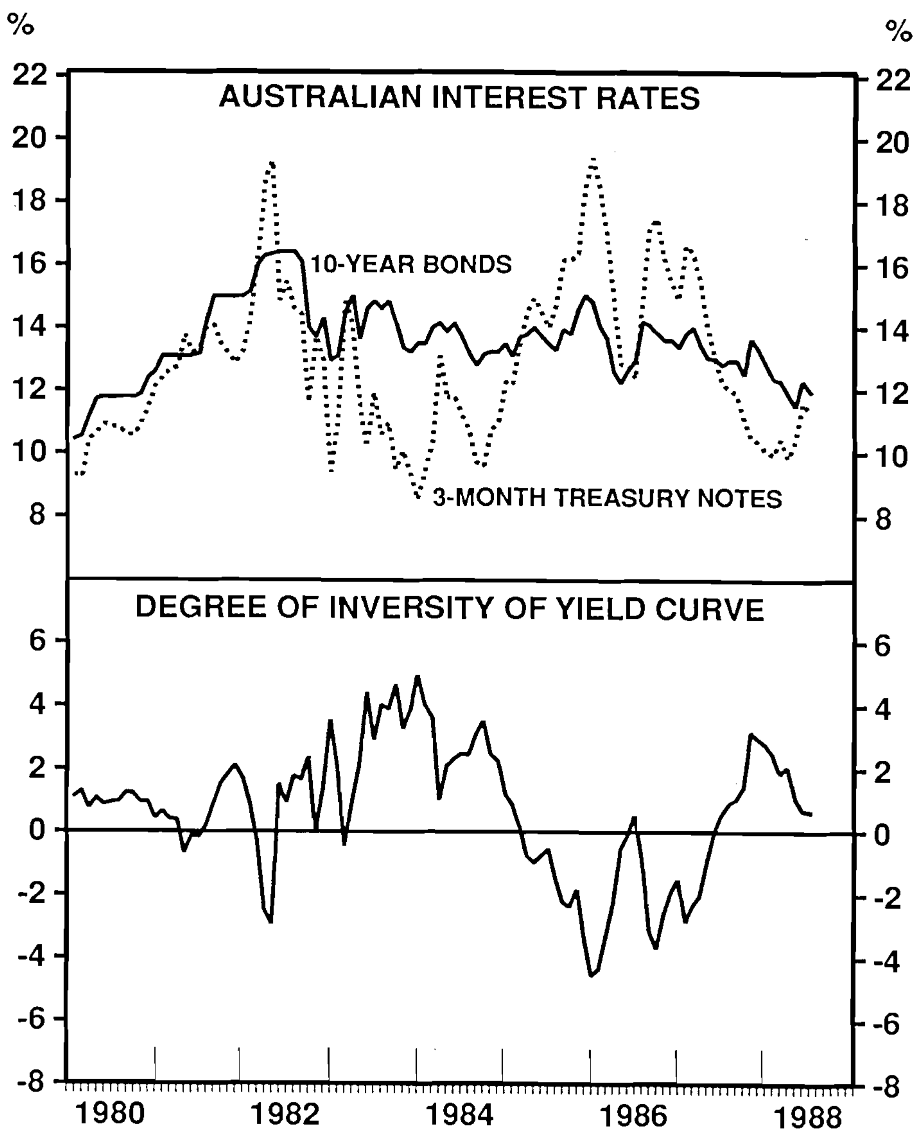
- the exchange rate depreciated. From the beginning of 1985 to mid 1986, the Australian dollar depreciated by nearly 40 per cent in real terms;

- fiscal policy was tightened. The central government budget moved from substantial deficit (4 per cent of GDP) in 1983/84 to an expected surplus of about 2 per cent of GDP in 1988/89. Over the same period, the total public sector budget position changed from a deficit of 7 per cent of GDP to balance; and

- monetary policy was also tightened substantially. Short-term interest rates at times reached nearly 20 per cent during 1985 and 1986.

The tightening of monetary policy meant that Australian short-term interest rates were much higher than U.S. short-term interest rates. Given that short-term rates affect long-term rates, this would help to explain why Australian long-term rates were higher than those in the other countries. Figure 4 shows the movements in yields on 10-year bonds and three-month Treasury notes over this period. The bottom panel shows a single line representing the difference between long-term and short-term interest rates (above the line is an upward sloping yield curve and below the line is an inverse yield curve). The period of monetary stringency from 1985 to 1987 shows up clearly as a predominantly inverse yield curve.

Figure 4



Another factor explaining the divergence between Australian and U.S. long-term interest rates over recent years was the fall in the Australian exchange rate and the increase in inflation over 1985 and 1986. Under some theories, nominal interest rates can only move out of line with those overseas when there is the expectation of an exchange rate change. If it were possible to measure exchange rate expectations, we could test to see whether the apparent divergence of long-term interest rates would disappear. Unfortunately, we cannot measure exchange rate expectations directly. A crude approximation would be to use past actual inflation rates to measure expected exchange rate changes, thereby assuming that expectations are adaptive and that exchange rates adjust to preserve purchasing power parity. This is the sort of assumption which would underlie, for example, comparisons of real interest rates in different countries. Rather than attempting to do this graphically, we examine this subject in the next section, where the methodology allows for the influences of short-term interest rates, inflation rates and foreign bond rates to be measured separately.

A third factor has been at work over the past year or two, when long-term rates in Australia have been falling whereas those in the U.S. have been tending to rise. The sharp tightening in fiscal policy in Australia in recent years, has produced Commonwealth Government budget surpluses and thereby reduced the supply of Commonwealth government bonds. The effect of this fall in the supply of bonds has been magnified by growing demand for such securities by banks, which are required to hold government securities for ratio purposes, and has led to strong competition for the available securities and a fall in their yields.

The effects of these various shocks affecting the Australian economy in recent years make it difficult to assess the extent to which there has been an underlying tendency for long-term interest rates in Australia to become more closely synchronised with those overseas. While at this stage there does not appear to have been greater synchronisation, a firm answer to the question cannot be given until the effects of the shocks have passed.

3c. The relative importance of domestic and international influences on long-term rates

This section adopts more formal empirical procedures, based on notions of interest parity and the term structure of interest rates, to look at the Australian long-term bond market. The two approaches are used to answer different questions. The interest parity approach examines the determinants of Australian bond yields and how these vary over time. In contrast, the term structure approach examines the behaviour of the bond market to test for market efficiency. Both approaches are compatible; it is possible that domestic long-term bond yields are determined in a way that is consistent with both interest parity and the term structure approach.

(i) The interest-parity approach

The interest parity framework is based on the proposition that the yield on a domestic bond is equal to the yield on an equivalent overseas bond plus or minus the expected change in capital value of holding that bond due to exchange rate variations.

The strength of this relationship depends on the degree of capital mobility and the exchange rate regime. The greater the degree of capital mobility, and the more fixed the exchange rate, the greater is the dependence of domestic bond rates on those in other countries. At one extreme, in the case of a credible fixed exchange rate system with capital mobility, the domestic bond rate is determined entirely by foreign rates. At the other extreme, if there is zero capital mobility, foreign interest rates have no impact on the domestic rate. Most countries, however, are in an intermediate position with some capital mobility and some exchange rate flexibility. There is thus a mixture of domestic and foreign influences that will impinge on the determination of long-term bond rates.

The important implications from this condition for the small open economy are:

- growing capital mobility reduces monetary policy's influence over the long-term interest rate; and

- increased flexibility of the exchange rate provides the authorities with improved control over the nominal long-term interest rate. However, if the authorities adopt exchange rate objectives, then domestic long-term interest rates may still be largely influenced by foreign rates.

The empirical work in this section uses an equation derived from the interest parity condition which separates the variation in domestic bond rates into the effects of changes in foreign bond rates, the differential movements in inflation and the short-term effects of the stance of monetary policy (measured by the short-term real interest rate differential).[1] The equation is:

$$R_t = R_t^* + (E_t\dot{p} - E_t\,\dot{p}^*) + (E_t rr - E_t rr^*) \qquad (1)$$

where R_t is the long-term bond rate, $\dot{p}$ are rates of change of prices, rr are real short-term interest rates, E represents expectations and an asterisk signifies an overseas variable.

Table 2 presents estimates over the 1980s, using monthly data and a weighted combination of U.S., German and Japanese interest rates as the foreign bond rate. The full-sample results show positive (as expected) and significant effects on the bond rate from a world average bond rate, from the inflation differential and from the short-term real interest rate differential. The results in the table have been corrected for serial correlation in the error term. The large size of the rho value suggests the possibility of missing variables and/or some dynamic mis-specification in the model. The model is extended in Appendix 1 to account for these possibilities: the results are generally consistent with the simpler version discussed here.

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1 Appendix 1 gives details of the derivation.

Table 2: Determinants of the Australian Bond Rate

Sample	Variables				Statistics		
	Const	R*	$(\dot{p} - \dot{p}^*)$	(rr - rr*)	DW	$\bar{R}^2$	Rho
1980:2 1988:6	7.15 (7.34)	0.55 (6.39)	0.31 (5.57)	0.21 (6.19)	2.03	.87	.71
1980:2 1983:12	6.72 (3.41)	0.56 (3.33)	0.41 (4.82)	0.22 (3.82)	1.99	.89	.64
1984:1 1988:6	9.00 (6.44)	0.35 (2.44)	0.20 (2.72)	0.27 (5.69)	1.94	.78	.62

Notes: R* is the 10 year world bond rate, $(\dot{p} - \dot{p}^*)$ is the difference between the Australian and world 12-month-ended growth in consumer prices, and rr - rr* is the difference between Australian and world real three-month security yields. "World" variables are a weighted average of U.S., German and Japanese data: the weights being 0.5, 0.2 and 0.3, respectively. Rho is the first-order autocorrelation coefficient used in the Cochrane-Orcutt procedure. Figures in brackets are t statistics.

Comparing the two sub-sample equations provides some interesting insights:

- First, the size of the coefficient on the bond rate does not rise in the 84:1-88:6 sample; in fact it declines slightly, though this is not statistically significant. This suggests that the synchronisation of domestic and foreign nominal interest rates has not increased in the recent period, when inflation differentials and the stance of monetary policy are taken into account. In fact, decomposing the fitted values from the equation into contributions from the various components (see Appendix 1) suggests that the foreign bond rate exerted a smaller influence on the Australian rate in the second sub-period.

- Second, there is a large and significant constant term in all equations, suggesting that the pure interest-parity condition is not met in Australia. This constant could perhaps be interpreted as a risk premium.

. Third, the real short-term interest differential has a stable, significant coefficient in all equations. This suggests that monetary policy's influence over the long-term rate through short-term real interest rates has not diminished in the post-float period.

(ii) The term structure approach

The conventional way to think about the relationship between domestic short-term and long-term rates is in the context of some sort of term-structure framework. In this approach, the long-term interest rate is thought to be equivalent to the average of expected future short-term rates over the relevant period. This is an equilibrium result which has a good deal of intuition. If it were not so, then there would be an incentive to either sell the long-term security and purchase the stream of short-term securities, or the reverse.

Put algebraically, the term structure relationship can be approximated by the following equation:

$$H_t - r_t = \alpha + \beta X_t + \varepsilon_t \tag{2}$$

where H_t is the holding yield on a long-term security in period t, r_t is the yield on a short-term security, and X_t is any relevant piece of information. ε_t is a zero-mean residual. In the pure "expectations hypothesis", $\alpha=\beta=0$.

This approach can be used to test the expectations hypothesis, and has been so used in many instances. But its particular usefulness in the present context is that it allows a test of whether foreign interest rates have any effect on domestic excess holding yields by including foreign bond rates in X.[2] It should be noted, however, that the model does not test for any contemporaneous linkages between domestic and foreign yields as in the previous framework. Even if long rates were determined by expected future short rates in Australia, it is possible that expected domestic short-rates move in a way that is consistent with the interest party condition outlined above.

2 Appendix 2 provides much more detail on the technique.

Applying this technique to weekly Australian and U.S. data over the period 1979-1987 yields several interesting findings. Firstly, the pure expectations hypothesis can be rejected. This is a result in keeping with international experience.

Secondly, the long-term rate tends to react more to changes in the short-term rates than would be predicted by the expectations theory: that is, the long-term rate is in some sense overly volatile.

Thirdly, and of more interest in the present context, the U.S. bond rate is statistically significant in the equation when it is estimated prior to December 1983. A rise in the U.S. bond rate was associated with a subsequent rise in the Australian bond rate. This is suggestive of sluggish adjustment of Australian interest rates to U.S. rates. In the second half of the data period, however (i.e. after December 1983), this apparent inefficiency was not statistically significant.

It is now worth trying to summarise and reconcile the results from the two empirical approaches adopted. From the interest parity equations there is no evidence of a growing external influence on domestic bond rates. While rising capital mobility has had the potential to undermine the domestic authorities control over the long rate, the floating of the $A appears to have offset this by giving the Reserve Bank more leverage over domestic inflation and short-term interest rates. However, the term structure model suggests that long rates are not fully explained by expectations of future short-rates; an element of over-reaction to short-term rates was evident, and overseas factors may have had an influence in the pre-float period which was independent of any link through short-term rates. Consistent with the first approach, this influence appeared to have diminished in the post-float period.

The next section looks at the role of long-term rates in the transmission process.

4. The Transmission of Monetary Policy

4a. Domestic Credit Markets

The main operational objective for monetary policy in Australia is the overnight interest rate in the professional money market. Daily market operations by the central bank are used to influence this interest rate, with the effects then flowing through to a wide range of interest rates and to the exchange rate.

Once a change in monetary policy is decided on, open market operations are directed to moving short-term interest rates higher or lower. When the market recognises that a new average level of overnight interest rates is being established, it perceives this as a change in monetary policy, and rates on other private short-term securities tend to change quickly.

Yields on instruments such as bills of exchange, bank certificates of deposit and Treasury notes move broadly in line with rates in the overnight cash market. This means that the central bank effectively has quite a strong influence over the whole short-term interest rate structure and, hence, over the rates charged by intermediaries.

The transmission mechanism for monetary policy is seen as working mostly through these short-term rates and rates charged by financial intermediaries. In Australia, most credit is provided through financial intermediaries. If the cost of wholesale funds to intermediaries rises because the whole short-term interest rate structure has moved up, banks and other financial intermediaries soon raise their prime or indicator lending rates. Most loans (including house mortgages) are variable interest rate loans, where the interest rates are changed periodically in line with movements in market rates. Thus, the central bank's influence on very short interest rates soon spreads to most intermediated lending.

Non-intermediated credit in Australia is provided mainly through the commercial bill market - a market for short-term debt. While this is non-intermediated in the sense that intermediaries do not hold large quantities of bills in their portfolios, it is facilitated by banks who act as acceptors for most of the bills on issue, and by a number of intermediaries who make a market in bank-accepted bills. The existence of reserve ratio requirements on banks' deposits encouraged enormous growth in this sort of financing over the past decade, to the point where it represented about one-third of total lending to the private sector by financial intermediaries.

The market for long-term debt has been dominated by the Commonwealth government (and to a lesser extent by semi-government and local government authorities). While this part of the market is well developed and deep, the corporate bond market is quite small. With the Commonwealth government moving into surplus, however, the private market is now beginning to develop, and it may become large in future years. This may be a factor which will increase a degree of integration of Australian and foreign long-term rates in the future.

4b. The Euro-Australian Dollar Market

While there is only a very fledgling on-shore private bond market, there is now a large Euro-Australian dollar bond market. Outstandings in this market now amount to about $30 billion (compared, for example to $40 billion for the domestic government bond market and $60 billion for the bank bill market). More than half of the Euro-Australian dollar raisings have been by non-Australian borrowers, though a fair proportion of these funds represented one leg of a swap transaction where an Australian borrower was the counterparty and ultimate user of the funds.

Has the growth of the Euro-Australian dollar bond market led to a closer integration of Australian interest rates with world rates? At the margin it must have had some effect. The introduction of any new market involving foreign investors will be a factor in increasing the tendency for Australian and foreign rates to move more closely together.

However, just how big this effect has been is another question. The Australian government bond market was already relatively internationalised before the growth of the Euro-Australian dollar market. By 1987, overseas interests held nearly a quarter of the outstanding stock of Australian government bonds, and at times were prepared to trade them heavily. Overseas holders of Australian government bonds can vary their positions according to their views about future movements in interest rates and exchange rates. The bonds are traded in a deep secondary market with low transactions costs and the availability of hedging instruments such as futures and options contracts.

Euro-Australian dollar bonds, on the other hand, do not trade as readily in the secondary market. They are mainly of interest to medium-term holders who are not liable for withholding tax and who are prepared to accept higher credit risk and reduced liquidity in order to gain higher yields. The Euro market is thus not as suited to speculative or arbitrage opportunities as is the government bond market. On the other hand, the capacity of the Euro market to provide fairly large volumes of new funds on short notice will go some way to keeping domestic and foreign yields aligned.

4c. Other Aspects of the Transmission Mechanism

Because most borrowings by the private sector are at the short end does not mean that long-term interest rates are unimportant. From the point of view of investors, of course, there is still a relativity between long-term bonds and alternative assets, including liabilities of intermediaries, commercial bills, equities and so on. Thus a change in bond yields can be important, but as explained in earlier sections, there is no evidence that central bank operations have lost any of their former ability to influence long-term rates. Indeed the evidence from the term structure equation suggests that long-term rates respond more to variations in short-term rates than logically they should.

Under the present approach to implementing monetary policy, there is no deliberate attempt to influence the long end of the official yield curve in Australia. The Reserve Bank's outright dealings in bonds are fairly small, and not designed to affect yields. There is a substantial amount of re-purchase activity in bonds, as part of liquidity-management operations, but those do not affect long-term yields.

Domestic interest rates are only part of the story of the transmission of monetary policy. In a world of capital mobility and floating exchange rates, a change in domestic financial conditions will, of course, affect the exchange rate.

We accept the evidence from a number of countries that much of the work of monetary policy is done by the exchange rate. However, it is difficult to produce evidence in the Australian case of a separate "exchange rate" channel through which monetary policy has worked. This is because in the five years since the float of the Austrtalian dollar, most of the tightening of monetary policy has coincided with periods when the exchange rate was falling (due to external shocks). Thus the tightening of monetary policy has usually co-existed with an improvement in international competitiveness. In time, when we have had the opportunity to see how the system operates under a wider variety of experiences, it is likely that the exchange rate channel will become more evident as in other countries.

5. Conclusion

The evidence in this paper suggests that Australian long-term interest rates have not become more volatile in recent years, nor have they become more closely aligned with foreign long-term rates. Australian short-term rates still have as much influence on the long end of the term structure as they did in the past.

The paper has argued that this result is to be expected, given that in the middle of the period under consideration, the exchange rate went from essentially being fixed to freely floating. It is also to be expected that Australia's interest rates have moved rather differently from those in other countries over recent years because of the shocks which have come through the balance of payments and which called for strong policy responses.

This is not to deny that financial conditions in the rest of the world are important - as a small economy with a large current account deficit, Australia is acutely aware of those linkages. Had there not been a necessity for strong policy responses over recent years, Australia's interest rates may well have shown up as closely related to foreign rates. Rather, the paper has suggested that the floating of the exchange rate has given domestic monetary policy a degree of flexibility of response that might have been expected.

APPENDIX 1: THE INTEREST PARITY CONDITION

This appendix uses the familiar interest rate parity relationship, which equates the returns on holding assets denominated in different currencies. It starts with the following equilibrium proposition:

$$R_t = R_t^* - E_t \dot{e} \tag{1}$$

where R_t is the long-term rate, e the exchange rate, a * indicates a foreign variable and a dot over a variable indicates the expected rate of change over the maturity of the bond. E_t is defined as the expectation as at time t.

The strength of this relationship depends on the degree of capital mobility. In the extreme case of zero capital mobility, foreign interest rates have no direct impact on the domestic rate. The degree of exchange rate flexibility will also determine the relative importance of domestic versus foreign influences on bond rates. In the case of a credible fixed exchange rate system and capital mobility, the domestic bond rate is determined only by foreign rates.

The term for the expected change in the nominal exchange rate is not observable, but it can be broken down into its real and price components for which observable proxies can later be found:

$$E_t \dot{e} = E_t \dot{p}^* - E_t \dot{p} + E_t \dot{s} \tag{2}$$

where $E_t \dot{p}$ is the expected rate of inflation and s is the real exchange rate, $s = ep/p^*$. Similarly, one can substitute out the expected long-run change in the real exchange rate using,

$$E_t \dot{s} = \theta(\bar{s} - s_t) + \varepsilon_t \tag{3}$$

where $\bar{s}$ is the steady-state or long-run real exchange rate and ε_t is a random error term. Finally, the short-term real exchange rate can be substituted out using the short-run real interest parity condition:

$$s_t = E_t s_{t+1} + (E_t rr - E_t rr^*) \qquad (4)$$

where rr is a real short-term interest rate. Substituting equations (2), (3) and (4) into (1) gives,

$$R_t = R_t^* + (E_t\dot{p} - E_t\dot{p}^*) + \theta(E_t rr - E_t rr^*) + \theta(E_t\bar{s}_{t+1} - \bar{s}) + \varepsilon_t \qquad (5)$$

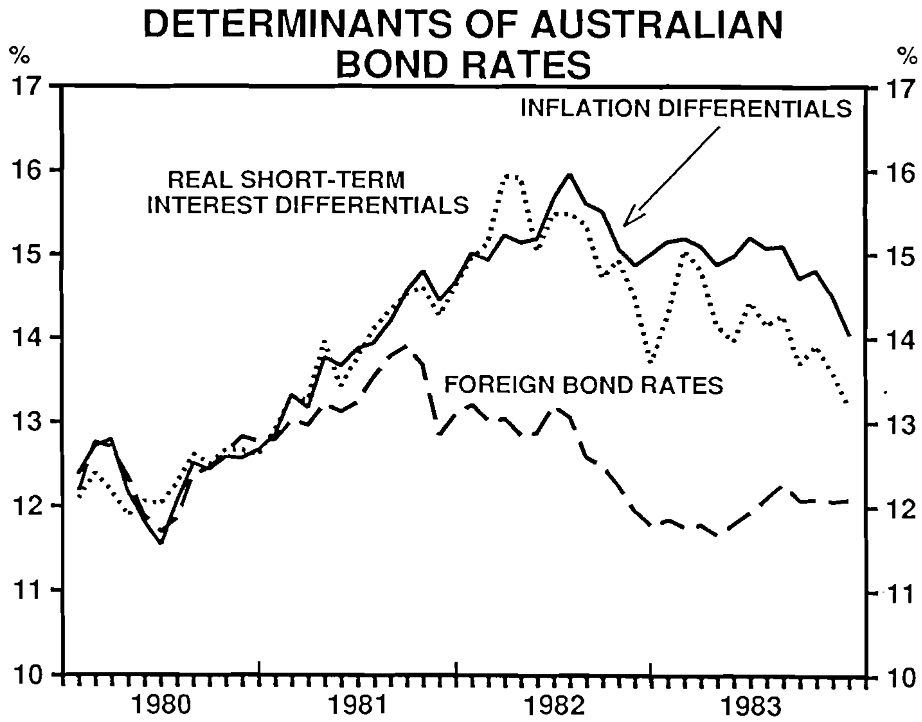
Equation 5 states that the domestic nominal long-term interest rate is determined by the foreign long rate, the expected long-term inflation differential, the short-term real interest differential and the expected future changes in the real exchange rate (equal to the sum of future real short-term interest rate differentials). It can be seen that domestic monetary policy influences the bond rate in the long run via inflation and in the short run by moving the short-term real interest rate (i.e., prices must be sticky).

Equation 5 is an identity, but it can be estimated because capital is not perfectly mobile and expectations of future variables are not observable. Given that proxies for all the expected future variables must be used, this introduces an "errors-in-variables" problem, and so the model is not a very powerful test of the interest parity condition. It does, however, provide a consistent framework for looking at the most important determinants of long-term rates under alternative exchange rate regimes. It should be pointed out that the expected coefficients on the foreign bond rate and the inflation differential should be close to unity under perfect capital mobility; the coefficient on the short-term real interest rate should be much smaller than unity.

Equation 5 is the basic model estimated in the text of the paper, with expected future changes to the real exchange rate (being unobservable) allocated to the error term. Given that such expectations may be correlated over time, some serial correlation of the errors was expected and was allowed for in the estimation stage.

To show more clearly the relative importance of the determinants of the long bond rate, figures A.1 and A.2 plot the contributions of the various right-hand-side variables from the two sub-sample equations. The dashed line in each figure shows the portion of the Australian long rate explained by the foreign long rate. Put another way, it is the bond rate that the equation predicts would have resulted if Australia had maintained its inflation and short-term real interest rates equal to those overseas. The solid line adds the variation in the bond rate caused by deviations in inflation from the foreign inflation rate. Finally, the dotted line adds the contribution from the short-term real interest rate.

Figure A.1

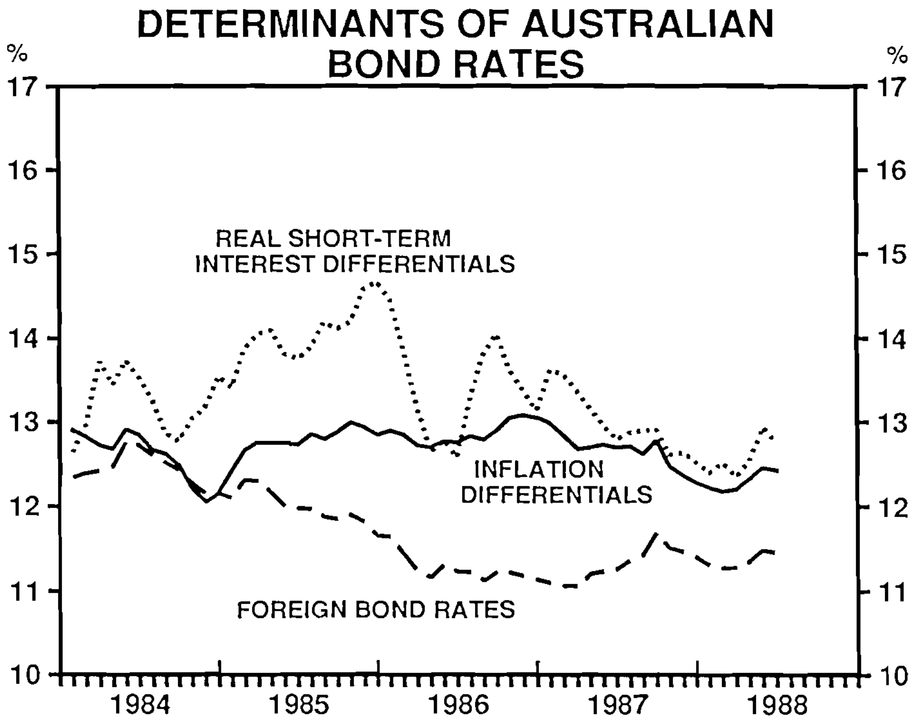


It is clear that in 1980 and 1981 (Figure A.1), the Australian long-term bond rate moved in line with the U.S. bond rate. This is at first glance surprising given that the bond rate was being set by the authorities during this period, but as mentioned earlier, the quasi-fixed nature of the exchange rate made for a fairly close relationship between Australian and international bond rates.

From 1982, the Australian inflation rate rose above world inflation, and pushed the Australian bond rate above world rates. In general, however, the <u>trends</u> in foreign bond rates were reflected in Australian bond rates.

In the post-float sample (Figure A.2), the links between foreign bond rates and the Australian rate were weaker. Over the first part of this period foreign bond rates were falling, while Australia's bond rate was rising. Similarly, the period since mid 1986 has seen foreign bond rates rising slightly, while Australian rates have been on a downward trend.

<u>Figure A.2</u>



In the results in the main paper, first-order autocorrelation was handled by using the Cochrane-Orcutt procedure. The Appendix now presents two alternative ways of addressing the problems posed by serial correlation. The first adjustment was to extend the model specification. This involved explicitly incorporating a proxy for the long-run expected real exchange rate ($\bar{s}$). A real commodity price was employed because the Australian dollar is often thought to be highly sensitive to movements in commodity prices (because of their high weight in Australian exports). A term which measured the stock of government debt was also added to test for the existence of a variable risk premium in the interest parity condition. The results are in Table A1.

Table A1: The Extended Model
1984:7 - 1988:6

Variables						Statistics	
Const	R*	$(\dot{p}-\dot{p}^*)$	(rr-rr*)	$\bar{s}$	Debt	DW	$\bar{R}^2$
9.92 (10.36)	0.56 (4.89)	0.09 (1.92)	0.30 (9.93)	-8.25 (-5.36)	5.98 (3.79)	1.61	.83

Notes: R*, $\dot{p} - \dot{p}^*$, rr-rr* are defined as in Table 2 of main paper. $\bar{s}$ is the Reserve Bank's commodity price index deflated by consumer prices. It is only available from July 1984. Debt is federal government securities in the hands of the private sector as a ratio to M3.

The commodity price term is significant and of the expected sign, confirming the importance of exogenous terms of trade shocks in Australia's recent history. The government debt term has the expected positive sign and is significant at conventional levels.

An alternative approach is to try and model long-run equilibrium relationships and the short-run dynamics together. An error correction model was therefore specified under the assumption that domestic and foreign bond rates are cointegrated[1]. Given

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1 The estimated cointegrating equation for the bond rate is:

Const	R*	$(\dot{p} - \dot{p}^*)$	(rr - rr*)	DW	$\bar{R}^2$	ADF(u)
4.61 (9.52)	0.75 (17.38)	0.45 (17.83)	0.27 (10.85)	.76	.79	-4.42

where ADF is the augmented Dickey-Fuller test statistic from the residuals (see Engle and Granger (1987)). It rejects the null of non-cointegration at the 95 per cent level. It should also be noted that while the coefficient estimates in the above cointegrating equation should be consistent, the t statistics (in parentheses) are not reliable.

the small sample involved, excessive weight should not be placed on the tests for cointegration, but rather the error-correction model should be seen as a cross check on the levels equation reported in the text. The results from the model are in Table A2.

The high level of significance of the residual (u_t) from the cointegrating equation supports the interest parity relationship as being an appropriate framework for modelling the long-run equilibrium determinants of the domestic bond rate. In regards to the short-run dynamics of the relationship, it is again the domestic short-term rate which has the most consistent positive impact on the dynamic adjustment of Australian long-rates. Changes in foreign rates, although significant over the full sample, are becoming less so when the sample is split in two.

Table A2: Determinants of the Australian Bond Rate: Error-Correction Model

Sample	Variables						Statistics	
	Const	u_{t-1}	R^*_t	R^*_{t-1}	$(\dot{p}-\dot{p}^*)_t$	$(rr-rr^*)_t$	$\bar{R}^2$	DW
1980:5-1988:6	0.01 (0.27)	-0.38 (-4.86)	0.29 (2.54)	0.28 (2.50)	0.16 (1.99)	0.23 (7.70)	.47	1.94
1980:5-1983:12	0.01 (0.15)	-0.49 (-3.61)	0.42 (2.41)	- -	0.23 (1.57)	0.18 (3.88)	.49	1.72
1984:1-1988:6	-0.00 (0.02)	-0.43 (-4.48)	0.23 (1.53)	-	0.14 (1.52)	0.31 (7.10)	.51	2.01

Notes: R^*, $(\dot{p} - \dot{p}^*)$ and $rr - rr^*$ are defined as in Table 2 of the main paper. u_t is the residual from the cointegrating equation. All variables are first differenced, except u_t.

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APPENDIX 2: EMPIRICAL EVIDENCE ON THE TERM STRUCTURE OF INTEREST RATES IN AUSTRALIA

1. Introduction

The expectations theory of the term structure states that any long-term interest rate is equal to the average of short rates expected to prevail over the life of the long-term security. This hypothesis has been quite extensively tested in a number of countries. Mankiw (1986) provides a fairly comprehensive survey of this work, as well as giving some new evidence of his own for the United States, Canada, the United Kingdom and Germany. He concludes that the evidence is strongly against the hypothesis for these countries, and suggests that standard explanations for this finding based on risk or term premiums are unlikely to account fully for the empirical rejections. These results were consistent with those reported in an influential earlier study by Shiller (1979), in which it was concluded that long-term interest rates in the U.S. typically overreact to movements in short-term rates; i.e. they tend to move further than would be justified under a pure expectations theory.

This appendix provides some comparable evidence on the relationship between short-term and long-term interest rates in Australia. Existing Australian evidence on the term structure is mainly to be found in two earlier studies carried out at the Reserve Bank by Tease (1986) and Trevor and Thorpe (1987). However, neither of these studies deals specifically with the issue of concern for this paper, which aims to investigate the link from the very short-term rates most directly influenced by the monetary authorities, to long-term rates of around 10 years. Section 2 of this appendix sets out an empirical framework for examining this relationship, and is followed in sections 3 and 4 by a discussion of the data employed and the empirical results. Briefly anticipating the conclusions, it is found that the expectations hypothesis is rejected in this framework, with the results being consistent with a tendency for long-term rates to over-react to changes in the short. Also, some significant overseas influences on Australian long-term rates are detected prior to the float of the $A, but not after the float.

2. Empirical Framework

A useful way to restate the expectations hypothesis is to consider it as an expected profit condition: if the hypothesis is valid, then the ex ante expected profit from borrowing at the short-term rate for a period in order to hold a unit of the longer security for the same length of time, should be zero. This can be written as

$$E_t\{H(t,k) - r(t,k)\} = 0 \qquad (1)$$

where H(t,k) is the realised holding yield when the long security is purchased at t and held for k periods

r(t,k) is the k-period interest rate at time t

E_t represents expectations conditional on information available at t.

Mankiw (1986) suggests that a general test of this relationship could take the form of the regression equation

$$H(t,k) - r(t,k) = \alpha + \beta X_t + \varepsilon(t,k) \qquad (2)$$

where X_t can in principle contain any variables observable at time t or earlier, and $\varepsilon(t,k)$ is the k-step ahead forecast error in predicting H(t,k). Under the null hypothesis, the α and β coefficients are jointly zero. The aim, of course, is to include in X_t any variables which seem likely to be associated with deviations from the expectations theory. In this regard, a number of variables have been selected for testing:

(i) The short-term rate r(t,k). A positive coefficient on the short-term rate would indicate that when the short-term rate is high, positive excess returns can be expected from holding the long security. Since this must arise from an expected capital gain, the interpretation would be that the long-term rate tends to overshoot when the short-term rate rises, giving rise to a capital gain in the subsequent period when the overshooting unwinds.

Thus a significant positive coefficient would be consistent with the overseas evidence that long-term rates over-react to short-term rates.

(ii) The long-short spread, $R(t)-r(t,k)$, where $R(t)$ is the long-term rate observed at t. A positive coefficient here would suggest that when the long-term rate is high relative to the short, there is a subsequent expected capital gain on holding the long-term security, whose yield would tend to revert towards the short-term rate.

(iii) The real stock of bonds outstanding, $B(t)$. This variable is used to capture the portfolio balance or risk premium effect. Some theories suggest that expected holding yields on bonds should rise as more are supplied to the market. If true, this variable would enter with a positive coefficient.

(iv) The change in the exchange rate, $\log e(t)-\log e(t-1)$ or ($\dot{e}$). It seems possible that a falling exchange rate, when it occurs, may induce a risk premium in returns on local securities, particularly at the longer end. This effect might lead us to expect a negative sign for this variable, implying that periods of a falling exchange rate are associated with higher relative holding yields on long-term domestic securities.

(v) The foreign bond rate, $R^*(t)$. This variable is included because it is often thought that substitution between local and foreign bonds is an important influence on Australian securities markets. It might be expected therefore that yields on Australian long-term securities would follow those on external securities, to a certain extent independently of expectations about local short-term rates. This kind of behaviour might also be interpreted as a kind of risk premium.

A final interesting hypothesis that can be tested in this framework is the hypothesis that the constant term α in equation (2) is zero. An alternative often associated with the name of Hicks is that risk averse investors have an inherent preference for short-term securities and require an expected term premium to induce them to hold longer maturities. This would imply that the yield curve would on average be upward sloping, and would make the α term in equation (2) a significant positive.

Econometrically, equation (2) is straightforward to estimate, except that under the null hypothesis the error terms are serially correlated because they contain overlapping forecast errors. (An exception is the special case where k=1, which occurs when the periodicity of the data is the same as the length of time covered by the short interest rate). We therefore use the method of Hansen and Hodrick (1980) to correct for the overlapping forecast problem. Hansen and Hodrick show that their method yields consistent and asymptotically efficient estimates of the coefficients and their standard errors.

3. Data Employed

The data set used in the study consists of weekly Wednesday observations covering the period from December 1979 to June 1988. This allows roughly equal numbers of observations in the pre and post-float periods, and confines the study to the period immediately after the deregulation of domestic interest rates.

The long-term interest rate used is a 10-year bond rate. This is really an indicator rate representing yields on the most heavily traded bonds of around 10 years to maturity at each date. To calculate the capital gains on holding a ten-year bond in each period, it was assumed that the coupon on each bond is equal to its yield at purchase, allowing the capital gain to be calculated from a standard bond pricing formula. The annualised capital gain was then added to the coupon to obtain an annualised holding yield. For the short-term rate, two alternatives were tried. The first was the 90-day bank bill rate, this being the main indicator rate used in Australia at the short end of the market. Unfortunately, this raises a problem of comparability with the long-term rate; results may be distorted if the 10-year bond rate is subject to influences not felt in markets for private paper, such as major increases or contractions in supply of government bonds. As a check on this, all tests were repeated using rates on 13-week Treasury notes as the measure of the short-term rate. As it turns out, results using the two rates are very similar. The overseas rate used in the study is the U.S. 10-year bond rate, and the exchange rate is the bilateral rate against the U.S. dollar. The stock of bonds is measured as a monthly trend figure taken as a ratio to trend nominal GDP.

4. Results

Estimation results are summarised in Table A3, and can be said to show consistent rejection of the pure expectations hypothesis in both sub-periods, as well as for the sample as a whole. These rejections take the form of significant positive coefficients on the short-term interest rate, and on the long-short interest rate spread, in each equation. In several cases, the foreign bond rate is also significant, with a negative-signed coefficient. The orders of magnitude of the estimated coefficients perhaps require some explanation. A coefficient of around 10 on the short-term interest rate indicates an expected annualised gain of 10 per cent on a long-term bond when the short-term rate rises by one percentage point; this is equivalent to a 2-1/2 per cent quarterly gain, which is what is actually measured in the data set. To translate this gain into a movement in percentage points of yield, we can use the rough rule of thumb that each percentage point movement in yield translates into a capital gain of about 5 per cent. It follows that the estimated coefficient is indicative of an expected fall over the next quarter of about half a percentage point in the long-term rate when the short-term rate rises by one percentage point. This may therefore be taken as a rough measure of the size of over-reaction of the long-term rate to changes in the short-term rate.

Table A3: Regression Results for Excess Holding Yields

Sample period	Observations	Short-term rate used	Constant	r_t	$(R_t - r_t)$	B_t	R_t^*	$\dot{e}_t$
1979:12 to 1983:12	207	Bill rate	-4.51	9.44	12.11	0.06	-4.34	0.03
			(1.47)	(3.36)	(4.24)	(0.21)	(2.18)	(0.04)
	207	TN rate	-2.86	8.81	12.82	0.06	-3.72	0.00
			(1.00)	(3.25)	(4.83)	(0.20)	(1.98)	(0.00)
1983:12 to 1988:6	222	Bill rate	1.69	20.32	23.70	-0.35	-2.86	0.78
			(0.49)	(4.93)	(3.84)	(0.64)	(1.14)	(1.19)
	222	TN rate	2.65	21.26	24.66	-0.30	-3.12	0.92
			(0.76)	(4.59)	(3.50)	(0.54)	(1.08)	(1.34)
1979:12 to 1988:6	432	Bill rate	0.01	10.85	13.45	0.18	-3.18	0.53
			(0.01)	(4.28)	(4.63)	(0.70)	(2.93)	(1.12)
	432	TN rate	0.01	11.16	14.01	0.25	-3.41	0.64
			(0.01)	(4.71)	(5.19)	(1.00)	(2.91)	(1.38)

Note: The table shows estimates of equation (2). Figures in parentheses are t-statistics.

Of further interest is the effect of U.S. bond rates on domestic rates. The estimated negative coefficients indicate that a rise in the U.S. bond rate tends to predict a rise in the Australian rate in the subsequent period. Using the same rules of thumb as before, the size of the pass-through is a little less than a quarter; in other words, a one percentage point rise in the U.S. bond rate predicts a rise of about a quarter of a percentage point domestically. This effect is statistically significant in the pre-float period but becomes insignificant for the post-float sample.

To complete the discussion of results, there is no evidence that holding yields are significantly influenced either by the real stock of bonds supplied, or by movements in the exchange rate; nor is there any evidence of a significant term premium as represented by the constant term in the regression equations.[1]

Conclusions

The empirical results reported here support three main conclusions. First, a rise in the 90-day interest rate tends to predict subsequent excess returns on bonds. Second, a rise in the spread between the long-term and the short-term rate similarly predicts an excess holding yield on bonds in the subsequent period. And thirdly, there is evidence that a pre-float link between domestic and foreign bond rates has significantly weakened or ceased to operate in the post-float period.

In interpreting the first two of these findings, it is important to note that it is a joint hypothesis which is being rejected; the estimates alone do not discriminate between a rejection caused by the presence of a risk premium, and a rejection caused by a failure of expectations to be unbiased. One could perhaps argue, for example, that when the short-term rate is high there is an inherent preference created for shorter securities, which raises the equilibrium holding yield on bonds. Nonetheless, the failure of the conventional portfolio balance effect to operate suggests that a convincing explanation for these results, based entirely on the concept of a risk premium, would be hard to support. Therefore, the presumption should probably be that the long-term rate has on average over-reacted to changes in short-term rates during the period covered in the study. Whether or not this feature carries over to other parts of the yield curve, remains a subject of continuing investigation.

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1 A potential econometric problem with all the estimates discussed here is that the right-hand-side interest rate variables used in the equations may be non-stationary in levels. As a check on the robustness of results the tests were repeated using differenced data for the relevant series (r_t and R^*_t). The results showed that rejections are harder to obtain when this form is used, but an excessive sensitivity to the short-term rate was still found in the post-float period.

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