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Minute-by-minute dynamics of the Australian bond futures market in response to new macroeconomic information

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Abstract

This paper investigates the response efficiency of the 10 year Australian Commonwealth bond futures market to the news content of the Australian scheduled information release from January 1993 to July 1997. Using Money Market Services market expectations data to generate the news component of announcements, we find that the futures price falls in response to higher than expected current account deficit, inflation, GDP and retail sales announcements, whereas an unexpected rise in unemployment raised it. In addition to the price response, there is strong evidence of elevated volatility of the price and of trading volumes following all five news announcements. More importantly, most of the market adjustments (of price and volatility) to new information were completed during the first minute following each news announcement suggesting market efficiency of the Australian futures market. The trading volumes, on the other hand, continue to respond to news for 1 h following the news release. This suggests that, after the new equilibrium price has been quickly established and its volatility dispersed, volume trading persists for the purposes of portfolio re-balancing by liquidity traders and for establishing a complete consensus amongst traders. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

There is an extensive literature on the role of scheduled information releases in the financial markets. The information contents of scheduled announcements of macro-economic variables by relevant government authorities have been widely investigated for their significance in pricing financial assets. The effects of announcement news (as measured by the difference between the actual announced value and the expected value obtained from Money Market Services) on various asset price returns were investigated by Engel and Frankel (1984), Hardouvelis (1988), Thornton (1989), Hogan et al. (1991), Aggarwal and Schirm (1992, 1998), etc. for various US macroeconomic announcements; Goodhart and Smith (1985), Hakkio and Pearce (1985) for the UK announcements; and Singh (1995), Karfakis and Kim (1995), Kim (1996) for Australian information releases.

The common theme amongst these studies is to explain the economics of price movements of financial assets following scheduled economic announcements. In addition to the news effects on the price movements, the responses of various measures of returns volatility also received attention. These include Madura and Tucker (1992), Bonser-Neal and Tanner (1996), Hung (1997) who used option price implied volatilities for the US Dollar exchange rates to look into the news effects on the volatilities. Kim (1998) implemented the GARCH methodology to analyze the news effects on the Australian dollar exchange rate volatility, and Kim and Sheen (2000) estimated a bivariate GARCH model for Australian and US interest rates (short-term and long-term) and showed that Australian and US macro news have local as well as international effects (in the case of the latter) on both conditional means and volatilities. These studies report, in general, an elevated volatility of asset returns in response to new information.

Both types of research utilize daily price and volatility movements to investigate the news effects. Typically, changes in prices and volatilities are measured over two successive days of market closing observations and they are regressed on the news components of economic announcements. Thus, the primary focus is on the discovery of existence and direction of inter-daily movements in price and volatility of financial assets. These studies shed some light on the process of price formation of financial assets and on market expectations of government policy reactions to announcement news. The efficiency of markets in making use of relevant information is analysed by examining responses to the expected component of any macroeconomic announcement.

However, with regard to the speed of arbitrage processes, inter-daily changes are inadequate for revealing microstructural aspects of the price adjustment mechanism. Ederington and Lee (1993, 1995) made an important contribution in this regard by utilising tick data from eurodollar futures prices and showing that most of the price adjustments to the US macroeconomic announcement news are concluded within the first min of an information release. Fleming and Remolona (1997a) studied a year's worth of tick data from the 5 year US treasuries market and investigated the effects of the scheduled US information releases on the price volatility and trading volume. They reported some stylised facts regarding bond market behavior in response to announcements which includes a significant rise in price volatility and a noticeable but delayed rise in trading volume. They explained this as a heightened heterogeneity of information processing immediately following an information release and as stimulated trading owing to portfolio re-adjustments following significant price changes.

One common weakness of these papers, however, is that they do not make use of market-based expectations to derive the news content of the announcements. Instead, they use price deviations measured by the difference between the current price and the average (time-of-day) sample price. Becker et al. (1996) suggested that this approach is inadequate for investigating market efficiency with regard to the news releases since "these deviations are not conditioned on available information and can only be used to derive estimates of the relationship between the releases and the unconditional volatility of returns (p. 132)." Becker et al. (1996)'s methodology is to examine the intra-day adjustment speed of the US and the UK futures market to the US macro-economic announcement news by concentrating on the unexpected components of the announcements measured by the deviation of the actual values from the MMS survey expectations. They found significant price adjustments during the first 15 and 30 min time periods following some of the scheduled information releases (CPI inflation, non-farm payrolls and merchandise trade balance). Furthermore, they found some evidence of delay in market adjustments to the merchandise trade balance news as evidenced by significant news coefficients throughout the trading day. They attributed this to a possible unspecified bias in the MMS expectations data or market inefficiency. Fleming and Remolona (1997b) used the expectations data published in the Wall Street Journal and reported significant price and trading volume responses to the unexpected components of the announcements.

The aim of this paper is to adopt Becker et al. (1996)'s approach to investigate the news effects of Australian scheduled macroeconomic announcements on the Australian 10 year government bond futures traded on the Sydney Futures Exchange. The contribution of this paper to the literature is the investigation of the speed of adjustments of not only the bond futures prices but also the holding period return volatility and trading volume of the futures contracts in response to the news content of the information release. The results of the investigation indicate that both the price and return volatility of the Australian 10 year bond futures respond significantly to new information, and most of the price adjustments and the volatility responses are concluded within the first min of trading after the 11:30 am information release. This result of rapid market response is in line with that of Ederington and Lee (1995). Furthermore, there is a delayed and sustained effect on the trading volume. This is a similar finding to that of Fleming and Remolona (1997a). The rest of this paper is organised as follows. Section 2 outlines the data and the econometric methods employed, Section 3 provides the estimation results, and Section 4 offers conclusions.

2. Data and econometric models

The scheduled Australian macroeconomic announcements examined are the current account deficit, the CPI inflation rate, the GDP growth rate, the unemployment rate and the retail sales growth rate (see Table 1). The information release to the general public is at 11:30 am² and the release dates and the actual values of each announcement are obtained from the Australian Bureau of Statistics (ABS)³. The unexpected component of each announcement is measured as the difference between the actual value and the market expectation, proxied by the median survey expectation of the Money Market Services (MMS) survey.⁴ The news content of each information release is used to explain the price and volatility movements immediately after each announcement.

The futures contract used for this study is the 10 year Australian Commonwealth Government bond contract for near delivery traded on the Sydney Futures Exchange (SFE).⁵ The floor trading of the contract commences at 9:30 am each day

⁴ The unbiasedness property of the MMS expectations is tested by running the following regression:

ActualValue_t = a + b MMSExpectations_t + ε_t ,

and jointly testing the null hypothesis of a zero constant and a unit slope coefficient. The *P*-values of the test statistic are 0.3189, 0.3716, 0.2309, 0.6659 and 0.036 for the CAD, the CPI, the GDP, the retail sales and the unemployment variables, respectively. The hypothesis of unbiasedness is not rejected in all cases except for the unemployment rate expectations which shows significance at less than 5%.

⁵ Other interest rate futures contracts traded on the SFE that were initially considered for this paper include the 90-day bank bill futures and the 3-year Commonwealth bond futures. The former was excluded from the analysis as there are insufficient price movements within 1 and 10 min holding periods for the near delivery contract. This is because there are up to five contracts, with different delivery dates, trading at a given point in time which disperses trade volumes across the delivery spectrum. The results for the latter are not reported as they do not add anything different to the findings reported for the 10 year bond futures.

² Each information release is embargoed until 11:30 am (Eastern Standard Time) on the day of release and the information is released in a printed form to interested parties present in the ABS offices in Canberra and Sydney for the release. The attendees of the announcement sessions are typically agents for financial institutions and journalists and they are allowed to have an open line established prior to the information release so as to enable immediate communication to their main offices upon the release. The summary of major figures (such as headline CPI inflation figure, CAD figure, etc) of each release are reported on the cover page of each publication for easy perusal, and the financial service providers such as Reuters and Bloomberg re-release the information through their services, which feature prominently in dealing rooms of exchanges and financial institutions. The resulting dissemination of information after the 11:30 am release in the ABS offices to the financial markets is very rapid, with the process taking only a few seconds.

³ There were a total of 192 days of 11:30 am announcements made for the five economic indicators, and except for 5 days, all announcements were made on different days. Five out of 53 retail sale announcements were made at the same time as other announcements (3 CAD and 2 GDP announcements). To avoid an identification problem of the news effects on these dual information release days, the five retail sales announcements, the 3 CAD announcements and the 2 GDP announcements were dropped from the analysis and the results compared with the full sample analysis (which is reported in this paper). The results are that there is little difference in the outcome and so those overlapping announcement days do not have any effect on the analysis.

	Current account deficit (CAD) ^a	Consumer price index (CPI) ^b	Gross domestic product (GDP)	Retail sales growth (RET)	Unemployment rate (UE)
Frequency of	Monthly	Quarterly	Quarterly	Monthly	Monthly
Publication detail	ABS No. 5301, balance of payment, monthly	ABS No. 6401, consumer price index, quarterly	ABS No. 5206, quarterly estimates of national income and expenditure	ABS No. 8501, retail sales of goods, monthly	ABS No. 6203, The Labour Force Australia, monthly
Unit of measurement	\$A billion	% change in CPI from previous quarter	% change in GDP from previous quarter	% change of gross retail sales from previous month	Unemployment rate, %
Number of announcements made during January 1993–July 1997	50	19	18	52	53
Average magnitude	\$A 1.67b	0.61%	0.93%	0.44%	9.38%
Proportion of higer than expected announcements (numbers)	44% (22)	26% (5)	72% (13)	60% (30)	32% (17)
Proportion of lower than expected announcements (numbers)	66% (28)	74% (14)	18% (5)	60% (20)	6 8% (3 6)

Table 1 Details of scheduled economic announcements

^a Seasonally adjusted figures. ^b Headline figures are used from September quarter 1994.

121

for the morning trade session which continues until 12:30 pm, while the afternoon session starts at 14:00 pm after the lunch break. We choose to investigate the responses to the news of the bond futures' price, volatility and trading volume following the 11:30 am announcements until the 12:30 pm market-closing, thus avoiding the break in trading continuity if the afternoon trading was included. We also examine the pre-announcement market behavior (from 11:00 to 11:30 am) by investigating the market movements during the half-hour periods leading up to the announcements. We obtained from the SFE tick-by-tick transactions data on the contract, which include the price and volume for each trade with the trading time recorded to the second, for the period January 2 1993–July 31 1997.

Starting from 11:00 am and ending at 12:30 pm on the days of macroeconomic announcement, 1 min consecutive holding periods are calculated and four different price observations are made (open, high, low and close) for each time period.⁶ The holding period returns on the bond futures are calculated as the log-difference between the closing and the opening price within a time period (i.e. Return = $\ln P_{close} - \ln P_{open}$). The volatility of price movements for each period is calculated using all four price observations following the method of Garman and Klass (1980) who show that there is a significant efficiency gain for this measure of volatility over a simpler one such as squared or absolute price changes as adopted in Fleming and Remolona (1997a).⁷ The Garman–Klass measure of volatility for each holding period is calculated as below:

G - K Volatility =
$$\frac{1}{2} [\ln(P_{\text{high}}/P_{\text{low}})^2 - (2\ln(2) - 1)\ln(P_{\text{open}}/P_{\text{close}})^2].$$
 (1)

During the pre- and post-announcement periods the bond futures price returns, the G-K volatilities and the trading volumes for each consecutive 1 min holding periods are calculated for each of the five economic variables for the whole sample period.

Our investigation of the announcement news effects begins by examining the behavioral patterns of the bond futures market following the information release. This is accomplished by analyzing the time series of the mean values of the return, volatility and trading volume of the consecutive 1 min holding periods across the sample for the pre- and post-announcement 1 min holding periods starting at 11:00 am for each of the five announcements. Then we regress the holding period returns, volatility and trading volume on the days of information release on the respective news variable created by taking the difference between the actual and the MMS

⁶ The pre-announcement periods are from Period-29 (11:00-11:01 am) to Period 0 (11:29-11:30 am), and the post announcement periods are from Period 1 (11:30-11:31 am) to Period 30 (12:29-12:30 pm).

⁷ Other measures of volatility include but are not limited to option price implied volatility and GARCH type volatility. These are not considered in this paper as it is impractical to generate appropriate volatility measures using these approaches for various time intervals. The Garman-Klass measure is easy to compute and sufficiently informative for our purposes.

expected values. That is, the announcement news effects on the bond futures market are investigated by running OLS regressions of the following models:

$$\operatorname{Returns}_{i,t} = \alpha_{i,i} + \beta_{i,i} \operatorname{News}_{i,t} + \varepsilon_{i,i,t}, \qquad (2)$$

Volatility_{*i*, *t*} =
$$\eta_{i,j} + \mu_{i,j}$$
 News²_{*i*, *t*} + $v_{i,j,t}$, (3)

$$Volume_{i, t} = \delta_{i, j} + \phi_{i, j} \operatorname{News}_{j, t}^{2} + \omega_{i, j, t},$$
(4)

where *i* is index of 1 min holding periods before and after the 11:30 am announcement. It goes from -29 to 60; *j* is refers to the types of announcement news; *t* is announcement day subscript. The presence of news effects is ascertained by examining the sign and significance of the slope coefficients in (2)-(4) above.

Each of the five macroeconomic news variables has a direct and/or indirect linkage with the price of a bond. They are related to the level of economic activity and of price inflation, and both current and expected future levels of these variables influence the equilibrium price. If the bond futures price observed just before an information release represents an equilibrium value, an arrival of new information relevant to bond pricing will cause an immediate market reaction with the information incorporated into the new equilibrium price quickly. The direction of price movement following the news depends on the equilibrium relationship between the bond futures price (or the yield) and the relevant economic variable, and on the market's expectation of the central bank's monetary and/or exchange rate policy response to the news. For example, if an announced CPI inflation is significantly higher than the one incorporated into the current bond futures price, there will be a fall in the bond futures price reflecting the higher inflation expectations component of the underlying interest rate. Alternatively, a lower bond futures price may emerge as a result of an impending tightening of the monetary policy stance aimed at removing further inflationary pressure. The other economic variables considered are more closely associated with economic activity, and higher than expected activity (that is, a higher than expected CAD, GDP, Retail sales figures and a lower than expected unemployment rate) would lead to higher real (and thus nominal) interest rates and lower bond futures prices.

The effects of news on the volatility of returns may depend on whether the new information excites or calms the market. An arrival of new information may be interpreted differently by the traders in the trading pit, owing to the inherent heterogeneity of information processing capabilities, expectations of policy response, beliefs etc. among traders. As a consequence, there might be greater trading activities at a wider range of prices than otherwise, leading to a higher price volatility following the information release. On the other hand, a news event may calm market activity by moderating the level of information uncertainty in the market by creating a level information playing field. This is particularly relevant if the official data release is the most credible source of information for those economic variables in the sense that there are no adequate leading indicators, publicly or privately available, and that the implications of the data release are easily predictable. Once the official figure is released there is a reduced need to speculate about its implications, and so trades based on inadequate information

may cease. As a result bond futures price volatility will be reduced in response to the news.

Market efficiency requires that price adjustments to new information are completed sufficiently quickly to avoid unnecessary arbitrage windows, and so the speed of market adjustment to news may be used to judge the degree of market efficiency. The speed of market adjustment in price and the resulting effects of news arrival on the volatility are explored by examining the magnitude and the statistical significance of the news coefficient in the regressions (2)-(4) throughout the hour following the announcements. We expect that unless there are further information releases regarding the economic variable (e.g. an official statement from monetary authorities regarding the desirability of any policy response), market efficiency dictates that the price adjustments to news be completed quickly. That is, the bond returns and volatilities recorded for holding periods further away from the 11:30 am release should not be significantly affected by the news. Also, if there is no information leakage before the announcements, the news variables are not expected to have any effect during the pre-announcement holding periods.

3. Results

3.1. Patterns of market movements

The first columns of Figs. 1, 2 and 3 show the average (across the sample) returns, G-K volatilities and trading volumes, respectively, for the consecutive 1 min holding periods starting from 30 min prior to the 11:30 am announcement to the 12:30 pm market close of morning trade (11:00-11:01 am, ..., 11:30-11:31 pm, ..., 12:29–12:30 am) for each of the five information releases on the days of announcement. The pre-announcement periods are included in the analysis to provide a base of comparison for the post-announcement (especially during the first 1 min period) market response to the information release. There are no discernible market activities prior to the announcements as shown by the generally dormant indicators during the pre-announcement period (represented by the shaded area in the figures). However, there seems to be slightly elevated trading volumes and G-K volatilities a few min prior to the announcements, indicating the existence of (speculative) trading activities in anticipation of the impending information release. In contrast, there is a noticeable pattern in the post-announcement periods. The G-K volatility rises significantly in the first 1 min period compared to the pre-announcement period suggesting a heightened level of uncertainty as the new information arrives. The volatility then drops swiftly after the second 1 min period although it remains at a noticeably higher level compared to the pre-announcement level throughout the post-announcement periods. The trading volume also rises significantly in the first 1 min period, and it continues to rise until the fourth 1 min period in the case of the CAD and the CPI announcements, and until the second 1 min period in the others before starting to fall. The decline in trading activities is gradual, and the volume remains higher than the



Returns





Volatility

Fig. 2. Time series plots of average volatility and volatility news coefficients. Pre- and post-announcement 1 min holding periods: Period-29 (11:00-11:01 am) to Period 60 (12:29-12:30 pm).



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pre-announcement level in all cases throughout the hour. In sum, we observe that the volatility responds immediately to the announcements, declines rapidly but remains at elevated levels, while the trading volume increases continuously over a few minutes, by which time volatility has substantially been reduced, and remains at higher levels throughout the post-announcement periods. This is a similar finding to Fleming and Remolona (1997a) for the US treasuries market.

The increased volatility and trading volume in the first 1 min period may be attributed to the trading activities surrounding the release of new information that market participants must incorporate into their information set and thus market price. Owing to the inherent heterogeneity of information processing ability, and opinions, the same piece of information may be interpreted differently, leading to turbulent price movements as traders act on their different beliefs. This combined with a moderate rise in trading volume might suggest that traders mostly trade on the public information that was just released. The continued higher levels of volatility from the second 1 min period onwards, although at substantially lower levels compared to the first minute levels, combined with a further surge in trading volume suggests that traders might be trading to discover and confirm the beliefs of other traders. That is, trades may be mostly based on private information (as opposed to public information that was more relevant in the periods immediately following the announcements). Eventually, trades settle down when a sufficient degree of consensus has been established. He and Wang (1995)'s model of investors with information heterogeneity provides a good explanation of this empirical finding of higher and sustained volatility and trading volume following an information release.

The initial rise in the trading volume may be due to the heterogeneity in the market, which is also associated with higher volatility that dies down during the first 10 min or so after the announcements, while the delayed rise and slow decline in trading volume may be explained by liquidity traders' need to re-balance their portfolio after significant price changes. They would avoid periods of high volatility and thin volume, and enter the market when the volatility dies down after the initial rush of trades following the information releases and their trades will continue until their positions are fully re-balanced. Fleming and Remolona (1997a) suggest an optimal reaction lag imposed by transactions costs, which leads to liquidity traders reacting to new information with lags and generating high volumes even after the initial hike in volatility has died down. In addition, the persistence of trading volumes throughout the post-announcement periods may also represent trades undertaken by traders to unwind their speculative positions built up during the few minutes prior to the announcements.

3.2. OLS estimations of news effects

Table 2 reports the OLS estimation results for the holding period returns, the G-K volatilities and the trade volumes over successive 1 min holding periods

		11:30-11:31	11:31–11:32	11:32–11:33	11:33–11:34	11:34–11:35
Current acco	ount deficit	ь				
Returns	News	-13.3069***	0.8635	0.8863*	-0.0471	-0.6516
		(-6.6136)	(1.5246)	(1.9155)	(-0.1030)	(-1.1596)
	R^{2a}	0.5271	0.0276	0.0463	0.0002	0.0560
Volatility	News ^{2c}	2.0491***	0.1709**	0.6967***	0.1288**	0.2751***
		(5.3434)	(2.1110)	(3.1190)	(2.0987)	(3.1760)
	R^2	0.3504	0.0273	0.04271	0.0853	0.5971
Volume	News ²	1.7790	2.3713**	2.9503***	2.1421***	1.1501
		(1.5148)	(2.3528)	(2.8731)	(2.8543)	(1.0441)
	R^2	0.0861	0.0620	0.0642	0.0365	0.0190
Consumer p	rice index ^b					
Returns	News	-30.0738***	1.7923	-0.0373	1.4064	0.9211
		(-13.8404)	(0.4318)	(-0.0254)	(1.0087)	(0.7285)
	R^2	0.7767	0.0213	0.0000	0.0691	0.0247
Volatility	News ²	15.6340**	0.6130	2.1681**	1.2160***	0.0468
		(2.5201)	(0.8002)	(2.2175)	(2.8556)	(0.5133)
	R^2	0.3808	0.0174	0.4234	0.2113	0.0053
Volume	News ²	4.7834**	15.9657	3.9788***	-0.5952***	1.9123***
		(0.9548)	(1.6179)	(0.5864)	(-0.0484)	(0.3253)
	R^2	0.032611	0.167958	0.00968	0.00019	0.002464
Gross dome	stic product	b				
Returns	News	-8 1935***	0.4515	0 3021	-0.3478	0.0679
reetariio	1.0.00	(-6.0148)	(0.6438)	(0.5513)	(-0.8077)	(0.2603)
	R^2	0 7145	0.0148	0.0142	0.0287	0.0026
Volatility	News ²	2.6868	-0.0066	0.0368	0.0484	0.0187
, one of the second	1.0.00	(1.5020)	(-0.0824)	(0.5736)	(1.2558)	(1.0018)
	R^2	0 3769	0.0003	0.0131	0.0150	0.0237
Volume	News ²	2 4020***	1 8588**	2.5730**	1 8363***	1 0844
volume	110005	(3 7993)	(2.1640)	(2.2489)	(3.0124)	(1.4638)
	R^2	0.3572	0.1253	0.2760	0.2041	0.1242
D . 11 1 1						
Retail sales	NT.	1 1005***	0 1200**	0.0440	0.0710	0.0102
Returns	News	-1.1225***	0.1308**	0.0449	0.0/18	0.0102
	D ²	(-4.9562)	(2.1381)	(0.46/6)	(1.0492)	(0.2089)
X7 1	R^2	0.4859	0.0776	0.0056	0.0305	0.0010
Volatility	News ²	0.0122*	-0.0009	0.0016	-0.0012	-0.0003
	D ²	(1.6838)	(-0.6651)	(1.1435)	(-0.6538)	(-0./956)
** 1	R^2	0.1761	0.0013	0.0292	0.0030	0.0025
Volume	News ²	0.1774***	0.1173***	0.0958*	0.1040**	0.0381*
	- 2	(3.6526)	(3.5550)	(1.8791)	(2.4287)	(1.6/35)
	R^2	0.2/8/	0.0854	0.0680	0.0784	0.0247
Unemploym	ent ^b					
Returns	News	11.5135***	-1.7456	-1.6229**	-1.0085	-1.8523**
		(4.5624)	(-1.5443)	(-2.2998)	(-1.2942)	(-2.3215)
	R^2	0.2387	0.0487	0.0940	0.0362	0.1669
Volatility	News ²	4.4041	-0.0066	0.3013*	0.6153*	0.2648
		(1.4176)	(-0.0345)	(1.7940)	(1.8849)	(1.2790)

Table 2 Estimation results for successive 1 min holding periods^d

		11:30-11:31	11:31-11:32	11:32–11:33	11:33–11:34	11:34–11:35
Volume	R ² News ²	0.0921 2.0220 (1.0587)	0.0000 8.6530*** (3.6030)	0.0616 2.6053 (0.9050)	0.1434 5.8835** (2.0584)	0.1157 5.7943* (1.6737)
	R^2	0.0158	0.1447	0.0129	0.1042	0.0875

Table 2 (Continued)

^a To save space only the news coefficient and R^2 are reported. The details of the estimations are available from the author upon request.

^b There are 50, 19, 18, 52 and 53 observations for the regression for the CAD, CPI, GDP, RET, and UE, respectively.

^c News coefficient for the returns are multiplied by 10^4 , and News² coefficient for volatility and volume are multiplied by 10^7 and 10^{-2} , respectively.

* Denote siginificance at 10%.

** Denote significance at 5%.

*** Denote significance at 1%.

^d Numbers inside brackets are t-ratios calculated from Newey-West standard errors.

 $\operatorname{Returns}_{i, t} = \alpha_{i, j} + \beta_{j, t} \operatorname{News}_{j, t} + \varepsilon_{i, j, t}$

Volatility_{*i*, *t*} = $\eta_{i,j} + \mu_{i,j}$ News²_{*j*, *t*} + $v_{i,j,t}$

Volume_{*i*, *t*} = $\delta_{i,j} + \phi_{i,j}$ News²_{*j*, *t*} + $\omega_{i,j,t}$

following the 11:30 am information release.⁸ The results show that the response of the bond futures price to each of the five news events is highly significant and the announcement news explain most of the movements in price in the first 1 min holding period following the announcement in all cases. This is shown by the high $R^{2^{\circ}}$ s for the regressions (ranging from 0.78 for the CPI news and 0.24 for the unemployment news).

The price fell in response to all news announcements, except for the unemployment news, which indicates that unexpectedly high values of the current account deficit, the CPI inflation, the GDP growth rate and the retail sales growth rate caused the bond futures price to fall significantly, which corresponds to a rise in the underlying interest rate.

The negative effect of unexpected current account deficits may be due to the market expectation of a future tightening of monetary stance by the Reserve Bank in response to the unexpected deficit. A rise in the real interest rate will be filtered through to a higher long-term interest rate leading to a fall in the interest rate futures price. Alternatively, it may arise from a fear that the higher implied international indebtedness might mean that the risk quality of A\$ denominated assets will be downgraded, raising the risk premium attached to Australian bonds which would results in them being traded at a discount.

⁸ Only the results for the first five 1 min periods are reported to save space. The news coefficients for the rest of the 1 min periods and the pre-announcement periods are significantly smaller compared to the first 1 min period as shown in the second columns of Figs. 1, 2 and 3, and are mostly insignificantly different from zero.

The negative effects of the unexpected inflation and higher than expected economic activities (GDP and retail sales growth) on the futures price can be explained by the higher inflation expectations brought on by higher values of these variables, leading to a fall in the bond futures price. An unexpectedly high unemployment rate, however, had a significant positive impact on the price. This may suggest that market participants expected a possible loosening of monetary stance aimed at stimulating economic activity with a consequence of an eventual fall in the long-term interest rate. The unemployment may represent excess capacity, and so the expected easing of monetary policy may not lead to significant inflation.

The price adjustments are concentrated in the first 1 min period after the information release in all cases. This is shown by the size of the news coefficient that drops in the subsequent 1 min holding periods to a fraction of the size of that in the first 1 min interval in all cases. There is also some evidence of a price correction after the initial response as evidenced by the opposite sign of the news coefficient from the second 1 min holding period onwards in all cases (see also the second column of Fig. 1). That is, the price reactions during the first 1 min periods seem to be over-reactions. The cumulative abnormal returns (CAR) of the post-announcement 1 min holding periods are shown in Fig. 4 (and in Table 4). Corrections to the initial over-reaction continue to the third minute in the case of the CAD news and to the ninth minute for the retail sales news. At the lowest level, CAR is as low as 33% of the first minute return for the unemployment news in the sixth minute and as high as 90% in the sixth minute in the case of the GDP news. The CAR for the first 10 min after the announcements is still smaller than the first minute return for the GDP, retail sales and unemployment news. The market's over-reaction is at its highest in the case of the unemployment news and then the retail sales news suggesting that market participants were sensitive to these information releases. In general, however, cumulative price reversals are relatively small in magnitudes compared to the first minute's response so as not to undermine the initial price response to news in all cases.

The G-K measure of volatility of price movements during the 1 min holding periods for each news variables is considerably larger than the pre-announcement period volatilities and is statistically significant in all cases except for the unemployment news where the positive effect on the volatility is significant only from the third 1 min period and for the GDP news. The trading volume also responded significantly to each of the five announcements. There is an immediate rise in trading activity as a direct consequence of the information release, and the news coefficient is significant from the first 1 min period in the cases of the CPI, the GDP and the retail sales news, though the significance occurs from the second 1 min period for the CAD and the unemployment news.

In sum, the significant news coefficients for the three indicators of market activity suggest that the news content of each announcement provides a significant motivation to trade in bond futures contracts. The second columns of Figs. 1, 2 and 3 show the time series graphs of the news coefficients for the returns, the G-K volatility and the trade volumes, respectively, for the 30 pre- and the 60 post-announcement 1 min intervals for each of the five economic variables. There is no evidence of information leakage prior to the 11:30 announcements as shown by the

132

news variables' inability to elicit market reactions during the pre-announcement periods. During the post-announcement periods the market response to the unexpected information is essentially finalized during the first minute following the news announcement for the returns and the volatilities. From the second 1 min periods, there is some minor evidence of reversing the initial price response that continues for up to 10 min. The response of the trade volume to news, however, continues to be felt throughout the hour.



Fig. 4. Time series plots of cumulative 1 min returns. (11:30 am-12:30 pm).

)	1				
		11:30–11:40	11:40-11:50	11:50-12:00	12:00-12:10	12:10-12:20	12:20–12:30
Current accoun	ut deficit						
Returns	News	-14.3102^{***}	-0.5754	-1.9635	-1.7469*	-0.9691	-0.4415
		(-4.6002)	(-0.4609)	(-1.6248)	(-1.9020)	(-0.6693)	(-0.9077)
	R^{2}	0.4865	0.0064	0.0762	0.0601	0.0374	0.008
Volatility	$News^2$	5.1786^{***}	0.5284^{*}	0.6494^{**}	0.6693	2.14123**	0.1294
		(4.4089)	(1.8487)	(2.8514)	(1.1057)	(2.6474)	(1.5246)
	R^{2}	0.2039	0.0210	0.0901	0.0278	0.5447	0.0063
Volume	$News^2$	17.5673^{***}	21.0605^{***}	16.9637^{***}	10.7110^{***}	11.9196	7.7776***
		(3.5375)	(6.4115)	(3.5694)	(3.1576)	(7.0877)	(3.8842)
	R^2	0.0868	0.2103	0.1938	0.0777	0.1399	0.0764
Consumer price	? index						
Returns	News	-35.0414^{***}	0.7488	-0.0997	-0.3962	-2.0397	-2.2914
		(-4.0408)	(0.1989)	(-0.0429)	(-0.1024)	(-1.4831)	(-1.1929)
	R^{2}	0.5059	0.0018	0.0001	0.0010	0.0711	0.0760
Volatility	$News^2$	30.5389^{**}	3.0732**	-0.9221	-0.2590	1.2586	2.0942
		(2.1902)	(2.0015)	(-0.3393)	(-0.2025)	(1.0009)	(1.5296)
	R^2	0.3808	0.1150	0.0060	0.0018	0.0610	0.2398
Volume	$News^2$	14.1983^{***}	20.9130^{***}	15.8435***	8.4029***	9.1631^{***}	5.6859***
		(3.5069)	(9.7283)	(3.0958)	(2.5975)	(7.5354)	(3.4769)
	R^{2}	0.2089	0.5506	0.3640	0.1166	0.4022	0.1619
Gross domestic	product						
Returns	News	-10.0573^{***}	-0.9056	-0.7691	0.3940	1.1112	-1.6561*
		(-4.0089)	(-0.6039)	(-0.8629)	(0.3588)	(1.0976)	(-1.7423)
	R^2	0.4063	0.0247	0.0200	0.0051	0.0571	0.1479
Volatility	$News^2$	6.5139	0.8356^{**}	0.0657	-0.1028	-0.0605	0.1368
		(1.6237)	(1.9647)	(0.5232)	(-0.4270)	(-0.3866)	(0.6158)
	R^2	0.4043	0.1888	0.0034	0.0030	0.0036	0.0167
Volume	$News^2$	13.9647^{***}	20.7350***	15.6119***	7.8346**	8.8527***	5.8363***
		(3.4054)	(9.6524)	(3.0467)	(2.4748)	(7.6273)	(3.5378)
	R^2	0.2048	0.5492	0.3613	0.1140	0.4219	0.1719

Table 3 Estimation results for successive 10 min holding periods^a S.-J. Kim, J. Sheen / J. of Multi. Fin. Manag. 11 (2001) 117-137

133

		11:30–11:40	11:40-11:50	11:50-12:00	12:00-12:10	12:10-12:20	12:20-12:30
Retail sales							
Returns	News	-0.9210^{***}	0.1005	-0.0347	0.1182	-0.1091 -	-0.0186
		(-3.7810)	(0.9296)	(-0.4850)	(1.3168)	(-1.2095)	(-0.3543)
	R^{2}	0.1640	0.0087	0.0024	0.0182	0.0183	0.0007
Volatility	$News^{2}$	0.0368	-0.0070	-0.0043	-0.0086	-0.0082	-0.0104^{*}
·		(0.7619)	(-0.7944)	(-0.8174)	(-1.1733)	(-1.3892)	(-1.9278)
	R^2	0.0186	0.0048	0.0063	0.0116	0.0176	0.0350
Volume	$News^2$	17.5673^{***}	21.0605^{***}	16.9637^{***}	10.7110^{***}	11.9196^{***}	7.7776***
		(3.5375)	(6.4115)	(3.5694)	(3.1576)	(7.0877)	(3.8842)
	R^2	0.0868	0.2103	0.1938	0.0777	0.1399	0.0764
Unemployment							
Returns	News	6.3743^{**}	1.3397	-1.3924	-0.5474	0.9813	0.3453
		(2.4028)	(1.0739)	(-1.4544)	(-0.5478)	(0.9758)	(0.6382)
	R^2	0.0770	0.0199	0.0331	0.0070	0.0256	0.0043
Volatility	News ²	19.2860^{**}	2.3610	-0.6975	1.0626^{*}	1.3506	0.1289
		(2.3390)	(1.1868)	(-1.3207)	(1.7589)	(1.2325)	(0.3058)
	R^2	0.1959	0.0610	0.0241	0.1212	0.1754	0.0013
Volume	$News^2$	17.5673***	21.0605^{***}	16.9637^{***}	10.7110^{***}	11.9196^{***}	7.7776***
		(3.5375)	(6.4115)	(3.5694)	(3.1576)	(7.0877)	(3.8842)
	R^{2}	0.0868	0.2103	0.1938	0.0777	0.1399	0.0764

Table 3 (Continued)

Returns_{*i*, *i*} = $\alpha_{i,j} + \beta_{j,t}$ News_{*j*, *i* + $\varepsilon_{i,j,t}$ Volatility_{*i*, *i*} = $\eta_{i,j} + \mu_{i,j}$ News_{*j*}², *i* + $\upsilon_{i,j,t}$ Volume_{*i*, *i*} = $\delta_{i,j} + \phi_{i,j}$ News_{*j*}², *i* + $\omega_{i,j,t}$}

в

135

Holding period	CAD	СРІ	GDP	RET	UE
11:30–11:31 am	100	100	100	100	100
11:30-11:32 am	94	94	94	88	85
11:30-11:33 am	87	94	91	84	71
11:30–11:34 am	87	89	95	78	62
11:30-11:35 am	92	86	94	77	46
11:30–11:36 am	91	88	90	72	33
11:30-11:37 am	96	86	106	74	35
11:30–11:38 am	100	90	98	71	41
11:30-11:39 am	108	96	94	66	47
11:30-11:40 am	109	101	97	73	42

Table 4 Measure of over-reaction of returns to announcements^a

^a Standardised cumulative 1 min returns: first-minute returns = 100.

Table 3 presents the estimation results for the 10 min holding period returns, volatilities and trading volumes for the post-announcement periods. The results are comparable to the 1 min interval estimations in that the bulk of the adjustments are carried out in the first response period and the news effects on the volatility are in general longer-lived than those on the bond returns. It is also observed that the trading volumes continue to respond positively and significantly to news during all six 10 min post-announcement holding periods in all cases. As in the previous subsection, we explain this by suggesting the existence of liquidity traders who react to news with a lag so as to avoid high volatility (and so high cost) periods (Table 4).

4. Conclusion

The scheduled release of Australian economic variables are investigated for their impact on the 10 year Australian Commonwealth Government bond futures contract traded on the Sydney Futures Exchange. We have shown that the news component of each of the five macro-economic information releases significantly affects market activities (in the form of returns, volatilities and trading volumes). The initial responses to the news announcements are such that the bond futures price fell significantly immediately following the releases of news on the CAD, the CPI, the GDP and retail sales, but was significantly raised following the unemployment news announcement. The underlying economic reasons for their responses vary across the news variables. We attribute the positive price response to the CPI. the GDP and the retail sales news to higher inflation expectations pushing the bond futures price down. The price response to the CAD and the unemployment rate news may be related to the market's expectation of monetary policy response to these news announcements. Following an unexpected deficit news release, a tightening of monetary stance aimed at dampening domestic demand for imports, while a higher than expected unemployment may indicate a possible future loosening of the stance to stimulate economic activities. The CAD response may also be due to a fear of risk-quality downgrading of A\$ denominated assets.

In addition to the news effects on the returns, the behavior of volatilities and trading volumes following the news release are investigated. We find that both the bond volatility and trade volumes are significantly raised in response to the surprise component of each announcement suggesting that when the market is presented with new information relevant for bond pricing, trading activity is amplified resulting in higher price volatility and volumes.

We have also found some evidence of market efficiency in the Australian 10 year bond futures market. The market responses to the news components of scheduled release of macro-economic information have been shown to be rapid; most of the adjustments to the bond futures price occur within the first minute following the news release. The effects of news on the bond futures price volatility are also relatively short-lived with most of the volatility concentrated in the first minute. In contrast, the news announcements had a sustained effect of raising trade volume throughout the 1 h post-announcement period. This may be explained, as in Fleming and Remolona (1997a), by the need of liquidity traders to adjust their portfolios after a significant price change in response to news announcements, and for traders to establish a complete consensus. They will choose to enter the market when the market has re-established equilibrium and this is likely to be at least 1 min after the announcements. In sum, we have found evidence of strong futures market response to the news component of scheduled economic information release, and furthermore the speed of adjustment is shown to be rapid.

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