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Do Australian and the US macroeconomic news announcements affect the USD/AUD exchange rate? Some evidence from E-GARCH estimations

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Abstract

This paper examines the effects of scheduled Australian and US macroeconomic announcements on daily USD/AUD exchange rate changes. EGARCH(1,1) models are used to investigate news effects on the conditional mean and volatility of the changes over various time horizons encompassing the announcements. A higher than expected Australian current account deficit announcement depreciated the AUD while an unexpectedly higher Australian GDP growth rate appreciated it on the announcement day during the Australian market trading. The conditional volatility was higher in response to the Australian current account deficit and inflation news, while the retail sales news lowered it. The US announcements, in general, had little effect during the US market trading, however, news effects measured over wider time horizon encompassing the next calendar day's Australian trading turned out to be more significant. Unexpectedly large US trade deficit and unemployment announcements appreciated the AUD while the trade deficit and retail sales news raised the conditional volatility and the unemployment news lowered it. © 1998 Elsevier Science B.V. All rights reserved.

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1. Introduction

Information contents of scheduled releases of macro-economic variables by relevant government authorities have been widely investigated for their significance in pricing financial assets. These include weekly US money announcement surprise (Engel and Frankel, 1984; Hardouvelis, 1988 and Thornton, 1989, etc.) and US

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balance of trade announcement surprise (Hardouvelis, 1988; Deravi et al., 1988; Hogan et al., 1991; Aggarwal and Schirm, 1992, etc.). Also, it has been suggested that US macro-economic announcement news can have a spill over effect in non-US markets (Becker et al., 1995a,b; Kitchen, 1996). Australian news announcements have also attracted attention. Australian current account announcement news was studied by Doraisami (1994), Karfakis and Kim (1995), and Singh (1995); and the CPI announcement news by Kim (1996). These studies, in general, examine the effects of announcement news on the changes of exchange rates and interest rates and other financial prices. However, the effects of announcement news can also be present in the volatility of price changes. That is, both the mean and variance of the price changes can be affected by surprise announcements.

This paper aims to investigate the news effects of scheduled Australian and US macroeconomic announcements on the first and second moments of daily USD/AUD exchange rate returns. Due to the bivariate nature of an exchange rate, it is natural to investigate the effects of announcement news from both ends since surprise announcements of either Australian or US economic variables will have an implication for the relative economic performances of the two economies which determine equilibrium value of the exchange rate. Investigations are carried out through modelling the daily exchange rate returns over various time horizons using the exponential generalized autoregressive heteroskedasticity (EGARCH) approach. The rest of the paper is organized as follows: Section 2 discusses the economics of announcement news effects on the conditional mean and volatility of the daily exchange rate returns; Section 3 describes the data employed and discusses the modelling issues; Section 4 provides analyses of empirical results; and Section 5 offers some conclusion.

2. Economics of announcement news effects

2.1. News effects on the mean of exchange rate returns

The responses of the exchange rate to announcement news can be either market equilibrium adjustments or market adjustments in anticipation of monetary and/or foreign exchange intervention policy response by the monetary authority (The Federal Reserve for the US and the Reserve Bank of Australia (RBA) for Australia). That is, assuming informationally efficient financial markets, the exchange rate observed prior to the announcements of the economic variables represent equilibrium given the market participants' best forecasts of the announcements. If an announced figure is significantly different from the expectations market participants would have to quickly adjust to new information in such a way as to restore equilibrium: alternatively, they may anticipate the monetary authority's monetary policy and/or foreign exchange market intervention responses to the news and adjust their positions on the exchange rate accordingly. This depends on the current monetary and intervention policy objectives of the monetary authority at the time of the news announcements.

2.2. News effects on the variance of exchange rate returns

In addition to the news effects on the price of assets, the volatility of price changes may also respond to significant news announcements. This may be due to the effects of the news announcements on the volumes of trade. Madura and Tucker (1992) find higher ex-ante (option price implied) volatility of the US exchange rates in response to the US trade balance announcement news. Ederington and Lee (1995) and Johnson and Schneeweis (1994) find higher US exchange rate volatility on the days of the announcements of US macro-economic variables. In general, the volatility of the exchange rate can either be higher or lower on the day of the information release. An increased volatility may be due to higher uncertainties created by news. This may be because of a possible lack of market consensus regarding the effects of news on the exchange rate and the likelihood of a policy (monetary and/or foreign exchange market intervention) response by the RBA (or the Fed). A fall in the volatility may be a sign of reduced uncertainties in the markets due to the reduction of speculation tradings based on incorrect information. That is, the release of new information may create a more level information playing field in the markets. Alternatively, market participants have a uniform view on the necessary direction of price change following each type of news announcements (higher or lower than expected announcements) and so the volatility of the exchange rate returns should be lower following the announcements of news.

2.3. Combined effects of news on the mean and variance of exchange rate returns

Table 1 summarizes possible combinations of the news effects on the mean and variance of the daily exchange rate returns. Cases 1, 2 and 3 are relevant if market participants are caught by surprise by the announcements and so they need to adjust their positions quickly, thus leading to market price adjustments. The effects on the value of the AUD depend on the type of surprise (i.e. unexpectedly higher or lower actual announcements) and the likelihood of an intervention policy. Case 1 is valid when there exists a market consensus regarding the effects of a particular news announcement and so new equilibrium price is reached without affecting the conditional volatility. Case 2 is relevant if the conditional volatility of the AUD rises in response to news. This would be the case if new information creates added uncertainty in the markets due to a lack of consensus of the effects of the particular announcement and the necessary course of action. For example, market participants might be using different economic models to determine their optimum equilibrium

Table 1
Possible responses of mean and variance of USD/AUD changes to the news announcements

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Mean	Rise	Fall		No change	No change	No change
Variance	No change	Rise	Fall	No change	Rise	Fall

response and so the heterogeneity of market responses to news creates a higher conditional volatility of returns on the announcement day. Alternatively, when there is a perception of less than clear cut monetary policy and/or foreign exchange market intervention policy objectives, announcements of a significant departure from the market expectations would create uncertainties regarding the responses of the monetary authorities to news. In either case, the heterogeneous expectations would lead to higher volatility through increased trading activities at divergent prices. Case 3 is supported if a lower conditional volatility is associated with a news announcement. This may be due to reduced uncertainties in the markets and this would be the case if scheduled release by the relevant authorities in each country is the only credible source of information for a particular macroeconomic variable.

Case 4 is relevant if an announcement has no news content, that is, the announced figure for the macro-economic variable is in line with the market participants' expectations and so no after-announcement adjustments to their positions are necessary leaving both the mean and volatility of returns unaffected. Cases 5 and 6 might be explained by added noise or reduction of noise due to information release. An alternative explanation is an existence of different exchange rate responses to some of the news announcements due to government policy regime shifts or changed perceptions of government policy response to news over different time periods. This would lead to nullified effects of news on the mean of the exchange rate returns if announcements are investigated over the time periods encompassing sub-periods with opposite news effects, however, the effects on the conditional volatility would remain.

3. Data and econometric methodology

3.1. Data description and statistical properties

The USD/AUD exchange rate is measured as units of the USD per one unit of the AUD so that an increase in the rate is an appreciation of the AUD. It is daily inter-bank rate recorded at the Sydney foreign exchange market opening (around 8 am) and closing (around 4 pm) by the Commonwealth bank of Australia for the period 1 February 1985 to 16 April 1995, yielding 2536 observations. The scheduled Australian and the US macro-economic announcements were obtained from the Australian Bureau of Statistics (ABS) and Money Market Services (MMS), respectively. Five news announcements for each country are considered: current account deficit (trade balance deficit for the US), CPI inflation rate, GDP growth rate, unemployment rate and retail sales growth rate (see Table 2). All announcements are made monthly except for the GDP announcement for both countries and the CPI announcement for Australia which are quarterly. The news variables are constructed as the unexpected component of each announcement as measured by the difference between the actual figures announced and the market participants' expectations proxied by the median survey expectations of MMS. That is, they measure the extent to which the announcements contain new information. These monthly and

Table 2
Actual and expected announcement data

	Australian announcements					US announcements				
	Credit account deficit (CAD)	Consumer price index (CPI)	Gross domestic product (GDP)	Unemployment rate (UE)	Retail sales growth (RET)	Trade deficit (TD)	Consumer price index (CPI)	Gross domestic product (GDP)	Unemployment rate (UE)	Retail sales growth (RET)
Frequency of announcements	Monthly	Quarterly	Quarterly	Monthly	Monthly	Monthly	Monthly	Quarterly	Monthly	Monthly
Source: actual	ABS no. 301, balance of payment, monthly	ABS no. 6401, consumer pice index, quarterly	ABS no. 5206, quarterly estimates of national income and expenditure	ABS no. 6203, the labour force Australia, monthly	ABs no. 8501, retail sales of goods, monthly	MMS international				
Source: market expectations	MMS Australia					MMS international				
Unit of Measurement	$A billion	% change in CPI from previous quarter	% change in GDP from previous quarter	Unemployment rate, %	% change in gross retail sales from previous month	$ US billion	% change in CPI from previous month	% change in GDP from previous quarter	Unemployment rate, %	% change in retail sales from previous month
Announcement time: AEST (GMT + 10) and USEST (GMT − 5)	11:30am	9am up to the December quarter 1988, and 11:30am thereafter	Two at 8am and three at 7:30am early in the sample, and 11:30am thereafter	11:30am	11:30am	8:30am				
Data period	July 1958 to February 1995	June quarter 1985 to December quarter 1994	June quarter 1985 to December quarter 1994	August 1985 to February 1995	August 1988 to February 1995	February 1987 to January 1995	March 1987 to March 1995	First quarter 1987 to fourth quarter 1994	March 1987 to March 1995	March 1987 to March 1995
Total number of announcements within data period	116	39	39	115	79	96	97	32	97	97
Total number of MMs survey	116	39	39	91	64	96	97	32	97	97
Definition of news		Actual figure — (MMS median survey expectations)					Actual figure — (MMS median survey expectations)			

For Australian market expectations, MMS Australia surveys approximately 20–25 economists in various postings and financial market participants every week and the results of the survey are released to subscribers usually on Fridays. The market expectations of the five economic announcements are proxied by the median response in the last survey on the relevant economic variable conducted before the announcement.

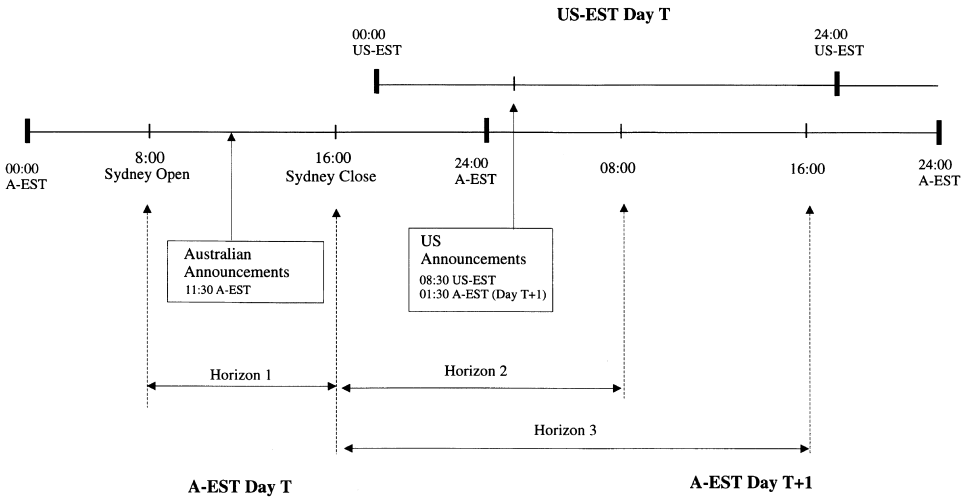

Fig. 1. Time line of Australian and the US market trading times.

quarterly news variables were transformed into daily variables by assigning the value of zero for days without the particular news announcement and the magnitude of the news for announcement days.

The Australian announcements are made at 11:30am Australian-EST (GMT + 10) while the Australian foreign exchange market is trading, whereas US announcements at 8:30am USEST (GMT − 5) which is about an hour after the New York market opening and so only the US market is trading.[1] The effects of announcement news can be ascertained by examining the movements of the price and conditional volatility of the USD/AUD exchange rate returns over a fixed time horizon containing announcements. Fig. 1 shows three different time horizons that encompass the news announcements.

- Horizon 1 measures the exchange rate changes over the opening ($S_{t,o}$) to the closing rate ($S_{t,c}$) on each day.
- Horizon 2 is over the closing rate on day $T(S_{t,c})$ to the opening on day $T+1(S_{t+1,o})$.
- Horizon 3 is over the closing rate on day $T(S_{t,c})$ to the closing rate on day $T+1(S_{t+1,c})$.

The changes are calculated as percentage changes (log changes multiplied by 100) and so they represent rates of return. Horizon 1 contains Australian announcements while horizons 2 and 3 include US announcements.

Table 3 summarizes the statistical properties of the exchange rate returns over the three horizons. Significant skewness and excess kurtosis are present in all cases. These are due to higher peaks and longer tails of the distributions compared to the corresponding normal ones. The second section reports the tests of linear and non-

[1] Hsieh and Kleidon (1996) report that activities start at around 7:30am US-EST and persist until around 6:30pm in the New York market.

Table 3
Statistical properties of the daily USD/AUD changes

	Horizon 1	Horizon 2	Horizon 3
	Summary statistics		
Mean	−0.0018	−0.0017	−0.0034
Variance	0.2150	0.2999	0.4372
Skewness	−0.5518	−0.5734	−0.6359
Excess kurtosis	9.8830	12.2065	7.7620
	Test of serial correlation[a]		
$Q(50)$: $\chi^2(50)$	59.7758	60.8668	68.5169*
	{0.1621}	{0.1396}	{0.0420}
$Q^2(50)$: $\chi^2(50)$	438.3420**	1187.5413**	977.1897**
	{0.0000}	{0.0000}	{0.0000}
	Engle and Ng (1993) sign bias tests[b]		
Sign bias	0.2398	1.3614	3.8346**
	{0.8105}	{0.1735}	{0.0420}
Negative sign bias	−5.9526**	−7.1456**	−13.2974**
	{0.0000}	{0.0000}	{0.0000}
Positive sign bias	2.6108**	4.3158**	−0.8245
	{0.0091}	{0.0000}	{0.4097}
Joint test: $\chi^2(3)$	56.2699**	93.1929**	184.1121**
	{0.0000}	{0.0000}	{0.0000}
	Unit root test[c]		
ADF	−19.7479	−25.7846	−30.0002
Lag	6	3	2
P–P $Z(t)$	−49.1510	−51.0038	−51.4354

Changes in the daily exchange rate are defined as $\Delta S_t = (\ln S_t - \ln S_{t-1}) \times 100$.
[a]$Q(50)$ is the Ljung–Box test statistic for serial correlation of up to 50th order for the exchange rate changes.
$Q^2(50)$ is the Ljung–Box test statistic for serial correlation of up to 50th order for the squared exchange rate changes.
[b]Sign bias test is the t-test of the slope coefficient of the regression of z_t^2 on S_{t-1}^-. Negative sign bias is the t-test of the slope coefficient of the regression of z_t^2 on $S_{t-1}^- \cdot \epsilon_{t-1}$. Positive sign bias is the t-test of the slope coefficient of the regression of z_t^2 on $S_{t-1}^+ \epsilon_{t-1}$. Joint test is the LM test of joint significance of all three regressors. (In this case, $\epsilon_t = \Delta S_t - \mu$ and $z_t^2 = (\epsilon_t/\sqrt{\sigma^2})^2$, where u and σ^2 are the unconditional mean and variance of the daily changes.)
[c]ADF denotes augmented Dicky–Fuller test, and the lags in the tests are the number of lagged dependent variable included to yield residual white noise at 5% using the Ljung–Box test. P–P $Z(t)$ denotes Phillips–Perron Z-test for unit root with the window size of 4.
* means significance at the 5% level; ** means significance at the 1% level. Numbers in {…}s are asymptotic p-values.

linear serial independence of the returns. They are the Ljung–Box Q tests for the null of white noise (with the lag length equal to the square root of sample size, $\sqrt{N=2536} \approx 50$) for the returns and the square of returns, respectively. While there is a highly significant serial dependence in the squared returns in all cases, linear dependence is significant only for horizon 3 at 5%. This suggests an existence of a

time-varying conditional heteroskedasticity of the daily exchange rate returns over the three horizons. Sign bias diagnostic tests (Engle and Ng, 1993) are reported in Section 3.[2] The negative sign bias and joint tests are significant in all cases, and significant positive sign bias is detected for the returns over horizons 1 and 2. This indicates that an unexpected change in the USD/AUD rate raised the volatility of the future changes with an unexpected depreciation of the AUD having a bigger impact than an unexpected appreciation. This is because the magnitude of the coefficient for the negative sign bias is greater than that of the positive sign bias in all cases. Lastly, both the Phillips–Perron and the augmented Dickey–Fuller unit root tests confirm that the daily returns over the three horizons do not have a unit root. In sum, the daily returns of the USD/AUD exchange rate show leptokurtosis, timevarying conditional heteroskedasticity and asymmetric volatility responses to unanticipated changes, and so the modelling of the daily returns should properly address these statistical properties.

3.2. *Econometric modelling of news announcements*

The effects of the scheduled economic announcements are modelled by investigating the effects of the news on the daily changes of the USD/AUD exchange rate. The daily changes are shown to be leptokurtic and exhibit time-varying heteroskedasticity, and there is an evidence of an asymmetric conditional volatility response to unexpected returns. Parsimonious GARCH(1,1) models with a standardized t distribution for the residuals are shown to be useful for modelling the time-varying nature of daily exchange rate returns (Hsieh, 1989; Baillie and Bollerslev, 1989), and the exponential GARCH (EGARCH) modelling approach (Nelson, 1991)is useful in addressing the asymmetric effects.[3] The model of choice for this paper is

[2] These are based on the idea of a news impact curve which defines how new information or innovations are incorporated into volatility estimates. If a model is specified correctly, the squared standardized residuals (i.e. $z_t^2=(\epsilon_t/\sqrt{h_t})^2$, where ϵ_t and h_t are the residuals and conditional variance of the model, respectively) are white noise and so they can not be consistently predicted by variables observed in the past. The simple versions of their sign bias, negative sign bias and positive sign bias tests involve running three simple regressions of z_t^2 on S_{t-1}^-, (which takes the value of one when $\epsilon_{t-1}<0$, and 0 otherwise), $S_{t-1}^-\cdot\epsilon_{t-1}$, *and* $S_{t-1}^+\cdot\epsilon_{t-1}$ (where S_{t-1}^+ takes the value of one when $\epsilon_{t-1}>0$, and 0 otherwise), respectively. The tests are carried out by testing the significance of the included variables using the usual t-tests. In addition, the joint test includes all three regressors and is an LM test. These tests can be carried out on the daily changes of exchange rates to ascertain the existence and nature of a time varying volatility. In this case, $\epsilon_t=\Delta S_t-\mu$ and $z_t^2=(\epsilon_t/\sqrt{\sigma^2})^2$ where μ and σ^2 are the unconditional mean and variance of the changes.

[3] EGARCH models have the flexibility to allow for the asymmetric effects as well as the magnitude effects of shocks to the exchange rate changes. That is, in addition to a larger shock of any sign having a larger effect, positive and negative shocks are allowed to have a different efrect on the future volatility of changes. If $\beta_{\epsilon 1}$ in (1a) is negative, an unexpected depreciation of the AUD increases the future volatility while an unexpected appreciation decreases it; and if and $\beta_{\epsilon 2}$ is positive, larger shocks have bigger impact regardless of the type of shocks. There is also the advantage of not having to impose positivity requirement on the coefficients in the conditional variance equation.

EGARCH(1,1) as shown below:[4]

$$\Delta S_t = \alpha_c + \sum_{i=\mathrm{MON}}^{\mathrm{THU}} \alpha_i D_{it} + \alpha_{\mathrm{HOL}} D_{\mathrm{HOL}t} + \sum_{j=\mathrm{CAD}}^{\mathrm{RET}} \alpha_j \mathrm{NEWS}_{jt}^{\mathrm{AUS}} + \sum_{k=\mathrm{TD}}^{\mathrm{RET}} \alpha_k \mathrm{NEWS}_{kt}^{\mathrm{US}} + \epsilon_t,$$

$$\epsilon_t = z_t \sqrt{h_t} \sim (0, h_t), z_t \sim iid(0, 1), \tag{1}$$

$$\ln h_t = \beta_c + \beta_{\epsilon 1} \frac{\epsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\epsilon 2} \left(\frac{|\epsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right) + \beta_h \ln h_{t-1} + \sum_{i=\mathrm{MON}}^{\mathrm{THU}} \beta_i D_{it} + \beta_{\mathrm{HOL}} D_{\mathrm{HOL}t}$$
$$+ \sum_{j=\mathrm{CAD}}^{\mathrm{RET}} \beta_j |\mathrm{NEWS}_{jt}^{\mathrm{AUS}}| + \sum_{k=\mathrm{TD}}^{\mathrm{RET}} \beta k |\mathrm{NEWS}_{kt}^{US}|, \tag{2}$$

where

D_{it}	Daily dummy which takes the value of one for day i and zero otherwise.
$D_{\mathrm{HOL},t}$	Holiday dummy which takes the value of one for the days immediately following public holiday and zero otherwise.
$\mathrm{NEWS}_{jt}^{\mathrm{AUS}}$	The five Australian news variables transformed into daily variables by assigning the value of zero for days without the particular news announcement an magnitude of the news (deviation of actual announcement from the expectations) for announcement days. These are included in Horizons 1 and 2 estimations only.
$\mathrm{NEWS}_{kt}^{\mathrm{US}}$	The five US news variables constructed as per the Australian news variables. These are included in Horizons 2, 3 and 4.
h_t	Conditional variance of daily exchange rate changes.

A conditional standardized t distribution with variance h_t and d degrees of freedom is used for the residuals, ϵ_t, to account for possible conditional leptokurtosis (see Bollerslev, 1987). The log likelihood function is as below:

$$\ln L = T \left[\ln \Gamma\left(\frac{d+1}{2}\right) - \ln \Gamma\left(\frac{d}{2}\right) - \frac{1}{2} \ln(d-2) \right]$$
$$- \frac{1}{2} \sum_{t=1}^{T} \left[\ln h_t + (d+1) \ln \left(1 + \frac{\epsilon_t^2}{h_t (d-2)} \right) \right], \tag{3}$$

where $\Gamma(\cdot)$ denotes the gamma function. As d approaches infinity the t distribution converges to the standardized normal.

Eqs. (1) and (2) are the conditional mean and variance equations of the daily exchange rate returns, respectively. In addition to the standard EGARCH parameters, which would pick up the overall statistical characteristics of the time varying nature of the daily returns, additional exogenous variables are included in the conditional mean and variance equations which are designed to pick up the daily conditional mean and volatility movements specifically caused by them. These are the announcement news variables and the seasonal variables.

Testing of the existence and the nature of the news effects is carried out by

[4] Higher order models failed to improve on the results obtained for the EGARCH(1,1) models.

examining the sign and the significance of the coefficients of the new variables in the conditional mean and variance equations. The news variables in the conditional mean equation would pick up the news effects on the mean of the exchange rate returns on the days of their announcements. If the news announcements also have an impact on the conditional volatility of the returns, their non-linear influence would still be present in the residuals of the conditional mean equation after their linear influence have been removed. The coefficients of the news variables in the conditional mean equation convey information regarding the effects of the news announcements on the price changes which depends on the equilibrium relationship between the announced economic variable and the exchange rate, and the market perceptions regarding the likelihood of monetary and/or exchange rate intervention policy response by the authorities.

The seasonal dummies are used to account for possible day of the week effect and holiday effect in the daily returns which are essentially due to possible differences in the amount of available information on different days. The daily dummies take the value of one when the observation is on the relevant day of the week, and the holiday dummy for any day the market was closed the previous day for any reason other than being a weekend.

4. Empirical results

4.1. The effects of announcement news

Table 4 reports the maximum likelihood estimation results for Eqs. (1) and (2) over the three time horizons.[5]

4.1.1. Australian news announcements

The estimation results for horizons 1 show that announcements of higher than expected current account deficit caused the AUD to depreciate, whereas unexpectedly higher GDP growth announcements significantly appreciated it. A one billion unexpected deficit depreciated the AUD by 0.72%, while a one percentage point higher than expected GDP growth caused it to appreciate by 0.16%. This confirms the traditional link between these variables and the exchange rate. The CPI news seems to have insignificant effect on the AUD. This does not, however, imply that markets were indifferent to the CPI news. Rather, higher than expected CPI announcements depreciated the AUD prior to April 1988 and appreciated it thereafter. This is because higher future inflation expectations was the dominant response to the news prior to April 1988, while an anticipation of a tight monetary response by the RBA was more relevant thereafter (see Kim, 1996). Thus, the estimation over the whole sample neutralized the opposite responses of the exchange rates to the CPI news.

In the conditional variance equation, the current account deficit and inflation

[5] Estimations were carried out using RATS version 4.3 on a Pentium PC. The convergence algorithm chosen was that of Berndt et al., 1974).

Table 4
Modelling of the Daily USD/AUD rate with economic news: estimations

	Horizon 1		Horizon 2		Horizon 3	
	Coeff	S.E.	Coeff	S.E.	Coeff.	S.E.
α_c	−0.0100	(0.0121)	−0.0039	(0.0170)	0.0048	(0.0198
α_{MON}	0.0271	(0.0174)	0.0246	(0.0228)	0.0239	(0.0287)
α_{TUE}	0.0420*	(0.0175)	0.0126	(0.0234)	0.0347	(0.0291)
α_{WED}	0.0380	(0.0170)	0.0242	(0.0241)	0.0572*	(0.0284)
α_{THU}	0.0106	(0.0171)	0.0190	(0.0240)	−0.0097	(0.0279)
α_{HOL}	−0.0072	(0.0252)	−0.0121	(0.0363)	0.0186	(0.0485)
α_{CAD}	−0.7249**	(0.1111)				
α_{CPI}	−0.0903	(0.1896)				
α_{GDP}	0.1622**	(0.0591)				
α_{UEMP}	−0.0329	(0.1243)				
α_{RET}	−0.0047	(0.0210)				
$\alpha_{TD\text{-}US}$			0.0278	(0.0241)	0.0650†	(0.0349)
$\alpha_{CPI\text{-}US}$			0.3124	(0.3282)	0.4044	(0.3552)
α_{GDPUS}			0.1938*	(0.0972)	0.0844	(0.1228)
$\alpha_{UE\text{-}US}$			0.2596	(0.2166)	0.4276†	(0.2523)
$\alpha_{RET\text{-}US}$			−0.0520	(0.0512)	−0.0862	(0.0758)
β_c	−0.0947	(0.1060)	−0.0477	(0.0939)	−0.1526	(0.0930)
$\beta_{\epsilon 1}$	−0.0600	(0.0262)	−0.0223	(0.0156)	−0.0378	(0.0177)
$\beta_{\epsilon 2}$	0.3319**	(0.0451)	0.1816**	(0.0263)	0.2278**	(0.0298)
β_h	0.9209**	(0.0139)	0.9744**	(0.0074)	0.9557**	(0.0095)
β_{MON}	0.0018	(0.1671)	−0.1655	(0.1539)	0.2519	(0.1563)
β_{TUE}	0.0928	(0.1479)	0.1683	(0.1383)	0.2320I	(0.1365)
β_{WED}	−0.0554	(0.1460)	0.0659	(0.1375)	0.0602	(0.1334)
β_{THU}	−0.0194	(0.1723)	0.0743	(0.1589)	0.0246	(0.1522)
β_{HOL}	−0.1799†	(0.1070)	0.0068	(0.0735)	0.0464	(0.0849)
β_{CAD}	2.1231**	(0.4153)				
β_{CPI}	1.6973**	(0.5314)				
β_{GDP}	0.2634	(0.2508)				
β_{UEMP}	0.6104	(0.5076)				
β_{RET}	−0.1611†	(0.0972)				
$\beta_{TD\text{-}US}$			0. 1199†	(0.0617)	0.2643**	(0.0685)
$\beta_{CPI\text{-}US}$			0. 1686	(0.7173)	−0.5145	(0.7595)
$\beta_{GDP\text{-}US}$			0.0869	(0.1903)	0.3397	(0.2234)
$\beta_{UE\text{-}US}$			−0.4494	(0.5328)	−1.1312*	(0.5614)
β_{RETUS}			−0.0182	(0.1373)	0.2896†	(0.1554)
d	2.8945**	(0.2195)	3.3862**	(0.2757)	3.9510**	(0.4053)
Ln L	433.44		−141.90		−664.15	

d is the estimated degrees of freedom parameter of the t distribution for the standardized residuals.
Ln L is the maximized log likelihood function value.
† means significance at the 10% level; * means significance at the 5% level; and ** means significance at the 1% level.

news announcements resulted in a higher conditional volatility on the day of announcement. This suggests that surprised announcements of these variable added to uncertainty in the market due to the heterogeneity of the interpretation of the news and/or expectations of the RBA's intervention policies. The conditional volatil-

ity did not respond to the GDP news announcements although they had a significant effect on the mean of the returns. This fits the Case 1 explanation above. The retail sales news had a marginally market calming effect. Apparently the release of the retail sales information added to the information set of market participants and so resolved the information asymmetry without causing heterogeneity of expectation of intervention policy.

4.1.2. US news announcements

The exchange rate returns measured over horizon 2 encompass US news announcements. The estimation results show a significant GDP news effect in the mean equation. The positive news coefficient indicates an appreciation of the AUD in response to a higher than expected GDP growth announcement which is at odds with a prior expectation.[6] The trade deficit news raised the conditional volatility but the coefficient is significant only at 10%. In general, the US news announcements did not have significant effects in horizon 2. The horizon 3 estimation, however, shows more significant US news effects. The AUD appreciated in response to higher than expected trade deficit and unemployment announcements, and the conditional volatility was significantly higher in response to the former and lower in response to the latter. In addition, there is some evidence of a higher conditional volatility in response to an unexpectedly higher retail sales growth announcement. The horizon 3 results indicate that there are delayed responses to the US news announcements. That is, the effects of the US news announcements are not fully incorporated during the overnight US market adjustments leaving some room for Australian market's response to the news,. The Australian foreign exchange market responded to the US news during the Australian trading hours one calendar day after the US announcements. This may be explained by noting that the effects of the US news announcements on the US economy and so the US financial prices are best understood by the US financial market participants, while the indirect effects of the US news announcements on the Australian economy are better understood by the Australian financial market participants. Thus, the Australian financial market participants react to the US news announcements during the Australian trading time and so the final adjustments of the USD/AUD rate to the US news announcements will not be finished until the end of horizon 3. In other words, the Australian market participants need some time to digest the impact of the overnight US announcements. In addition, they may also wish to wait until the RBA's position in the short-term money market is known at 9:30am in the morning after.[7] This is because the RBA's position determines short-term interest rates for the day and so the exchange rate would be affected.

[6] This may be rationalized as follows. Unexpected US economic activities may indicate unexpected global boom, if so demand for commodities would be higher in the future. This would be translated into improved terms of trade for Australia and so an improvements in the spot USD/AUD exchange rate.

[7] Overnight developments in the US and other financial markets are considered for their impact on the Australian financial markets and the RBA may act on some US news announcements if it anticipates any potential adverse ellects on the Australian financial markets. When the RBA finalizes its position for the day it announces its daily dealing intentions in the official cash market at 9:30am each morning.

4.2. Modelling of the daily returns of the USD/AUD exchange rate

The modelling of the daily returns through the EGARCH models are shown to be effective. The EGARCH parameters are significant and they show a strong presence of both the magnitude and the negative asymmetric effects (except for the horizon 2 estimation) of unexpected exchange rate returns on the future volatility of returns, that is, $\beta_{\epsilon 1}$ is negative and $\beta_{\epsilon 2}$ is positive.[8] The conditional variance is highly persistent as shown by β_h which is close to one in all cases. The daily dummies are generally insignificant in the conditional mean equations except for the Tuesday and the Wednesday ones in the horizon 1 estimation and the Wednesday dummy in the horizon 3 estimation. The AUD tend to appreciate, on average on these days over these horizons. The holiday dummy is not significant in any estimation. Also, there are virtually no seasonal effects in the conditional volatilities except for the positive and significant Tuesday dummy in the horizon 3 estimation and the holiday dummy for the horizon 1 estimation. It is rather surprising to find that the latter is negative indicating a lower conditional volatility, on average, on days following public holidays. This is the exact opposite to the usual explanation of higher volatility due to higher trading volume induced by information accumulation over non-trading days. One rationalization would be that the information accumulation helps market participants to form more accurate expectations regarding the equilibrium price and so transactions based on incorrect and incomplete information are reduced. Lastly, estimated d is small in all cases which confirms the leptokurtosis of the standardized residuals and thus the usefulness of the standardized t distribution for the residuals.

4.3. Diagnostics of the estimations

Table 5 reports the diagnostics of the estimations. These are the statistical properties of the estimated standardized residuals, z_t. Although still significantly different from zero, the skewness and kurtosis are substantially reduced in size compared to the ones reported in Table 2 indicating that the adoption of the standardized t distribution for the residuals is an improvement over the normal distribution. The significant serial correlation for both the linear and the squared returns are eliminated in the standardized residuals in all cases as can be seen from the insignificant Q test statistics. In addition, the asymmetry in the conditional volatility is also elimindted as shown by the insignificant Engel and Ng's sign bias test statistics in all cases except for the horizon 3 estimation. In sum, EGARCH models address the statistical properties of the daily returns of the exchange rate very well.

[8] The negative asymmetric effect of unexpected changes is explained by the 'leverage effect' in the case of stock returns where an unexpected fall in the return causes a rise in the debt-equity ratio raising the future volatility of returns. In the current context, the observed negative relationship between current changes of the exchange rate and future volatility of changes does not seem to have an obvious interpretation. However, it might be the case that an unexpected depreciation of the AUD would cause greater uncertainty than an unexpected appreciation since a depreciation might be due to an unexpected deterioration in the terms of trade, and this would lead to an upward pressure on inflation and nominal interest rates leading to added uncertainties regarding the stability of the economic conditions.

Table 5
Modelling of the daily USD/AUD rate with economic news: diagnostics

	Horizon 1	Horizon 2	Horizon 3
	Summary statistics on z_t		
Mean	−0.0267	−0.0298	−0.0379
Variance	0.8238	0.9263	0.9360
Skewness	−0.4804	−0.3839	−0.3265
Excess kurtosis	8.7519	5.6240	2.4543
	Tests for *iid* of z_t[a]		
$Q(50)$: $\chi^2(50)$	44.9780	24.9025	36.7541
	{0.6746}	{0.9989}	{0.9186}
$Q^2(50)$: $\chi^2(50)$	36.7034	42.7723	50.1478
	{0.9195}	{0.7559}	{0.4675}
	Engle and Ng (1993) sign bias tests[b]		
Sign bias	−0.7718	0.0287	2.0092*
	{0.4403}	{0.9771}	{0.0446}
Negative sign bias	0.6866	−1.3471	−4.3266**
	{0.4924}	{0.1781}	{0.0000}
Positive sign bias	−0.1308	0.9128	−1.9984*
	{0.8959}	{0.3614}	{0.0458}
Joint test: $\chi^2(3)$	1.1348	3.6376	19.7645**
	{0.7687}	{0.3034}	
	Unit root test for V_h		
$\chi^2(1)$: H_0: $v_h = 1$	32.6256**	11.9446**	21.8695**
	{0.0000}	{0.0005}	{0.0000}

[a] $Q(50)$ is the Ljung–Box test statistic for serial correlation of up to 50th order for z_t. $Q^2(50)$ is the Ljung–Box test statistic for serial correlation of up to 50th order z_t^2.
[b] Sign bias test is the t-test of the slope coefficient of the regression of z_t^2 on S_{t-1}^-. Negative sign bias is the t-test of the slope coefficient of the regression of z_t^2 on $S_{t-1}^- \cdot \epsilon_{t-1}$. Positive sign bias is the t-test of the slope coefficient of the regression of z_t^2 on $S_{t-1}^+ \epsilon_{t-1}$. Joint test is the LM test of joint significance of all three regressors.
* means significance at the 5% level; ** means significance at the 1% level. Numbers in {…}s are asymptotic p-values.

5. Summary and conclusion

This paper examined the effects of the news created by the scheduled releases of Australian and US macro-economic variables on the first and second moments of daily USD/AUD exchange rate returns over three time horizons. It has been shown that unexpected developments in some of the variables are shown to have a significant effect on the value of the AUD. The AUD appreciated when higher than expected Australian GDP growth figures were announced, and depreciated in response to unexpectedly high Australian current account deficit announcements. More importantly, the announcement news also have significant effects on the conditional volatility of the AUD changes. Unexpectedly high Australian current account deficit,

inflation announcements raised the conditional volatility of the returns on the days of their announcements. A higher conditional volatility in response to the news may be explained by a lack of market consensus regarding the effects of (and so the equilibrium response to) the news and/or extra uncertainty created regarding the likelihood of policy responses by the RBA. Some US news announcements have significant effects. The AUD appreciated in response to higher than expected US trade deficit, GDP growth rate and unemployment announcements; and the conditional volatility of the exchange rate rose in response to the trade deficit and retail sales news, and the unemployment news significantly lowered the conditional volatility over horizons 2 and 3. In general, the US news effects are delayed. This may be because the US announcements are made while the Australian market is closed and the Australian market participants may consider the overnight US market response to be inadequate since the RBA may respond to the US news and the effects of the US news on the Australian economy are better understood by the Australian. market participants. The Australian market participants may need time to adjust their positions to the US news when they begin trading at market opening in Australia, and this apparently led to further adjustments in the mean and volatility of the exchange rate change. In general, the announcements of these variables are watched carefully by market participants for their news contents and they adjust their positions in anticipation of and immediately after the announcements, thus leading to changes in the price and conditional volatility of the AUD.

In addition, it was shown that the daily changes of the USD/AUD exchange rate possess time-varying heteroskedasticity, leptokurtosis and asymmetry in the conditional volatility, and the EGARCH models with a conditional t distribution account for the observed statistical properties very well.

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