

Do macro-economic news announcements affect the volatility of foreign exchange rates? Some evidence from Australia

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This paper investigates the role of Australian macro-economic announcement news on five major Australian dollar (AUD) exchange rates. Specifically, the daily changes of the exchange rates are modelled to ascertain the existence and the nature of the news effects in the conditional mean and variance of the changes. It is found that a higher than expected current account deficit and unemployment rate announcements depreciated the AUD, and an unexpectedly higher GDP growth announcement appreciated it. Current account deficit, CPI and unemployment news announcements significantly raised the conditional volatility of the changes of the AUD on the days of their announcements, except for the BP/AUD for the CPI news, and there is some evidence of retail sales news reducing it. In general, the evidence is consistent with a view that a release of new information creates uncertainty in the markets due to a lack of consensus on the effects of the particular news announcement and the necessary course of action. In addition, the EGARCH(1,1)-in-Mean modelling of the daily changes of the exchange rates is found to be very successful in addressing the observed statistical properties of the daily changes: leptokurtosis, time-varying heteroscedasticity and asymmetric response of the conditional volatility to unexpected changes.

I. INTRODUCTION

Information contents of scheduled announcements of macro-economic variables by authorities have been widely investigated for their significance in pricing financial assets. These include the US money announcement surprise (Engel and Frankel, 1984; Hardouvelis, 1988; Thornton, 1989), and the US balance of payment announcement surprise (Hardouvelis, 1988; Deravi et al., 1988; Hogan et al., 1991; Aggarwal and Schirm, 1992). Australian current account announcements were studied by Doraisami (1994), Karfakis and Kim (1995), and Singh (1995); and CPI announcements by Kim (1996a). These studies examine the effects of the announcement news on the changes of financial prices (most commonly, exchange rates and interest rates). In general, the responses of exchange rates and interest rates 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, exchange rates and interest rates 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. Market participants may also anticipate the monetary authority's monetary policy and/or foreign exchange market intervention responses to the news and adjust their positions on exchange rates and interest rates accordingly. This depends on the current monetary and intervention policy objectives of the monetary authority at the time of the news announcements. In addition to the news effects on the price of assets, the volatility may also respond to significant news announcements. This may be due to the effects of news announcements on the volumes of trade. Madura and Tucker (1992) find higher ex-ante (option price implied) volatility of 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.

The aim of this paper is to investigate the news effects of scheduled announcements of Australian macro-economic variables on the volatility of Australian dollar (AUD) exchange rates on the days of their announcements. The investigations are carried out through modelling the daily changes of exchange rates using the exponential generalized autoregressive heteroscedasticity in mean (EGARCH-M) approach. The possible effects of the news announcements on the conditional volatility of the AUD changes are summarized below:

• Announcements have no significant effect on either the mean or the conditional volatility of the changes on the days of their announcements (Hypothesis 1).

Announcements significantly affect the value of the AUD (either appreciate or depreciate it), and

- the conditional volatility is not affected (Hypothesis 2);
- significantly raise the conditional volatility on the days of their announcements (Hypothesis 3);
- significantly reduce the conditional volatility on the days of their announcements (Hypothesis 4).

Hypothesis 1 is relevant if an announcement has no news content, that is, the announced figure for the macroeconomic variable is in line with the market participants' expectations and so no after-announcement adjustments to their positions are necessary. This suggests that neither the value nor the conditional volatility of the AUD exchange rates would be affected by the announcement. Hypotheses 2, 3 and 4 would eventuate if market participants are caught by surprise and 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 announcement) and the likelihood of an intervention policy. Hypothesis 2 would be relevant if there exists a market consensus regarding the effects of a particular news announcement so that the new equilibrium price is reached without affecting the conditional volatility. Hypothesis 3 is supported if the conditional volatility of the AUD rises in response to the news. This would be the case if the 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 response and so the heterogeneity of market responses to the news creates a higher conditional volatility 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 significant departure from market expectations would create uncertainties regarding the responses of the monetary authorities to the news. Hypothesis 4 would be supported if a lower conditional volatility is associated with a news announcement. This may be explained by reduced uncertainties in the markets due to the reduction of speculation based on incorrect information. That is, the release of new information may create a more level information playing field in the markets. This is the case if the scheduled ABS release is the only credible source of information for a particular macro-economic variable.

The rest of the paper is organized as follows: Section II discusses data employed and modelling issues, Section III presents empirical results, and Section IV offers some conclusions.

II. DATA AND METHODOLOGY

Data description and statistical properties

Australian dollar exchange rates used in this study are measured in terms of foreign currency units so that an increase in the rates is an appreciation of the AUD. They are daily wholesale rates against the US dollar (USD), the Deutsche mark (DM), the Japanese ven (JY), the British pound (BP) and the Swiss franc (SF) reported in the Australian Financial Review for the period 2 January 1985 to 16 April 1995, yielding 2557 observations. Daily changes are measured as $\Delta s_t = (\ln S_{tc} - \ln S_{to}) \times 100$, where $\ln S_{tc}$ and $\ln S_{to}$ are the natural logarithms of daily wholesale closing and opening rates. Table 1 displays statistical properties of the daily changes of the five exchange rates. 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 distributions. The second section of Table 1 reports the tests of linear and non-linear serial independence of the changes. 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, $\sqrt{N = 2557} \approx 50$) for the changes and the squared changes, respectively. While there is a highly significant serial dependence in the squared changes in all cases, linear dependence is generally weak and observable only in the cases of the USD/AUD, the BP/AUD and the SF/AUD at the 5% level of significance. This suggests an existence of a time-varying conditional heteroscedasticity in all five daily changes, and it is formally confirmed as shown by the highly significant

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	ΔUSD/AUD	$\Delta DM/AUD$	$\Delta JY/AUD$	Δ BP/AUD	ΔSF/AUD			
	Summary statisti	ics						
Mean	-0.0031	-0.0040	-0.0240	0.0015	-0.0078			
Variance	0.2195	0.3207	0.3446	0.3053	0.3228			
Skewness	-0.7261	-0.3120	-1.0894	-0.5667	-0.6538			
Excess kurtois	10.8851	8.9546	7.2046	7.0873	7.2062			
Minimum	-3.9708	-3.9888	-4.9195	-4.2912	-4.3602			
Maximum	4.4245	4.7868	2.6897	3.1170	3.8252			
	Test of white no	Test of white noise ^(a)						
L-B Q(50): $\chi^2(50)$	70.5551*	62.6478	55.6594	71.9127*	73.4246*			
	{0.0293}	{0.1080}	{0.2703}	{0.0228}	{0.0171}			
L-B $Q^2(50)$: $\chi^2(50)$	497.7404**	317.1570**	174.4253**	423.1155**	215.9254**			
	{0.0000}	{0.0000}	{0.0000}	{0.0000}	{0.0000}			
ARCH(50): $\chi^2(50)$	279.93465**	181.69479**	117.53336**	196.58628**	127.47106**			
	$\{0.0000\}$	{0.0000}	{0.0000}	{0.0000}	{0.0000}			
	Engel and Ng sig	gn bias tests ^(b)						
Sign bias	0.6452	0.1467	1.3247	1.3153	-0.0518			
e	{0.5188}	{0.8834}	{0.1854}	{0.1885}	{0.9587}			
Negative sign bias	-6.4016**	-4.6583**	-6.0530**	-3.9654**	-5.7298**			
	{0.0000}	{0.0000}	{0.0000}	{0.0001}	{0.0000}			
Positive sign bias	2.2419*	1.7693†	0.7371	2.3256*	2.2715*			
	{0.0251}	{0.0770}	{0.4611}	{0.0201}	{0.0232}			
Joint test: $\chi^2(3)$	58.5565**	33.5756**	44.3921**	29.8255**	52.2900**			
	$\{0.0000\}$	{0.0000}	{0.0000}	{0.0000}	$\{0.0000\}$			
	ADF unit root t	ests ^(c)						
Trend and constant	- 19.8564**	-37.5198**	-49.7702**	- 50.6141**	-49.8733**			
Lags	6	1	0	0	0			
Constant	-19.8252**	-37.5136**	-49.7343**	-50.5868**	-49.8572**			

 Table 1. Statistical properties of the daily exchange rate changes

Changes in the daily exchange rates are defined as $\Delta s_t = (\ln S_{tc} - \ln S_{to}) \times 100$.

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 $^{(a)}Q(50)$ is the Ljung-Box test statistic for serial correlation of up to 50th order for the exchange rate changes.

1

 $Q^{2}(50)$ is the Ljung-Box test statistic for the squared exchange rate changes.

ARCH(50) tests the existence of autoregressive conditional heteroscedasticity of up to 50th order in the 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}^- .

0

0

0

Negative sign bias is the *t*-test of the slope coefficient of the regression of z_t^2 on $S_{t-1}^- \cdot \varepsilon_{t-1}$.

Positive sign bias is the *t*-test of the slope coefficient of the regression of z_t^2 on $S_{t-1}^+ \cdot \varepsilon_{t-1}$.

Joint test is the LM test of joint significance of all three regressors. (In this case, $\varepsilon_t = \Delta s_t - \mu$ and $z_t^2 = (\varepsilon_t / \sqrt{\sigma^2})^2$, where μ and σ^2 are the unconditional mean and variance of the daily changes.) ^(c) The Augmented Dicky–Fuller test statistic is for H₀: $\beta = 0$ in the testing equations below:

With trend and constant:
$$\Delta y_t = \alpha + \gamma \cdot t + \beta \cdot y_{t-1} + \sum_{i=1}^{Lags} \delta_i \Delta y_{t-i} + u_t$$

With constant: $\Delta y_t = \alpha + \beta \cdot y_{t-1} + \sum_{i=1}^{Lags} \delta_i \Delta y_{t-i} + u_t$

Lags of the tests were determined by the number of lagged dependent variables needed to yield white noise residuals in the testing equations at 5% using the Ljung-Box Q test. The MacKinnon (1991) critical value at 1% is -3.9856. \dagger , * and ** denote significance at the 10%, 5% and 1% level, respectively.

Numbers in {...}s are asymptotic *p*-values.

Lags

ARCH(50) test statistics in all cases. Engel and Ng's (1993) sign bias diagnostic tests are reported in the third section.¹ The negative sign bias and joint tests are significant in all cases. In addition, significant positive sign bias is detected in all changes except for the JY/AUD rate. This indicates that an unexpected change in the value of the AUD raised the volatility of the future changes with an unexpected depreciation having a bigger impact than an unexpected appreciation.² Lastly, the Augmented Dickey–Fuller unit root tests confirm that the daily changes of all five exchange rates do not have a unit root. In sum, the daily changes of the AUD exchange rates show leptokurtosis. time-varying conditional heteroscedasticity and asymmetric volatility response to unanticipated changes, and so the modelling of the daily changes should properly address these statistical properties.

The scheduled Australian macro-economic announcements are made by the Australian Bureau of Statistics (ABS) and five announcements are considered: current account deficit, CPI, GDP, unemployment rate and retail sales (Table 2). The CPI and GDP announcements are made every quarter, and the rest are monthly announcements. The five news variables are simply the unexpected component of each announcement as measured by the difference between the actual figures announced and the market participants' expectations proxied by median survey expectations of Money Market Services Australia (MMS).³ That is, they measure the extent to which the announcements contain new information. These news variables are 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.

Econometric modelling of news announcements

The effects of the scheduled economic announcements by the ABS are modelled by investigating the effects of the news on the daily changes of the AUD exchange rates. The daily changes are shown to be leptokurtic and exhibit time-varving heteroscedasticity, and there is evidence of an asymmetric conditional volatility response to unexpected changes. 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 changes (Hsieh, 1989; Baillie and Bollerslev, 1989), and Nelson's (1991) exponential GARCH (EGARCH) modelling approach is useful in addressing the asymmetric effects (Kim, 1996b).⁴ In addition, considering that exchange rates can be viewed as the price of a financial asset (i.e. currency), it may be useful to apply the mean-variance analysis. That is, as the volatility of the AUD increases, foreign holders of the AUD may require an additional incentive in the form of the risk premium in order to continue to hold it. This implies that the mean of the changes of the AUD is dependent on the variance of the changes. Therefore, the model of choice for this paper is EGARCH(1,1) in Mean as shown below:

² 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.

³ The accuracy of the MMS expectations data can be exmined by testing whether they are unbiased predictors of the actual announced figures. The unbiasedness testing involves estimating a test equation of the form:

$$Actual_t = a + b \ Expected_t + e_t$$

¹ 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, we cannot predict the squared standardized residuals (i.e. $z_t^2 = (\varepsilon_t/\sqrt{h_t})^2$, where ε_t and h_t are the residuals and conditional variance of the model, respectively) 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 $\varepsilon_{t-1} < 0$, and 0 otherwise), $S_{t-1}^-\varepsilon_{t-1}$, and $S_{t-1}^+\varepsilon_{t-1}$ (where S_{t-1}^+ takes the value of one when $\varepsilon_{t-1} > 0$, 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 time varying volatility. In this case, $\varepsilon_t = \Delta S_t - \mu$ and $z_t^2 = (\varepsilon_t/\sqrt{\sigma^2})^2$, where μ and σ^2 are the unconditional mean and variance of the changes.

for each announcement variable and testing the null of zero intercept and unit slope coefficient. The test statistics (F-test) are 2.0892 (0.1513), 2.8832 (0.0683), 2.3754 (0.1318), 0.7323 (0.3944) and 0.6565 (0.4209) for the CAD, the CPI, the GDP, the unemployment rate and the retail sales announcements, respectively. Numbers inside the brackets are *p*-values. For all five variables, the null cannot be rejected at least at 5%. This confirms that the MMS expectations data are unbiased predictors of the announced figures and as such, significant deviations of announced figure from the expectations data can be treated as news. Detailed results of these tests are available from the author upon request.

⁴ 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 effect on the future volatility of changes. If $\beta_{\varepsilon 1}$ in Equation 1a is negative, an unexpected depreciation of the AUD increases the future volatility while an unexpected appreciation decreases it; and if $\beta_{\varepsilon 2}$ 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.

	Announcements					
	Current account deficit (CAD)	Consumer price index (CPI)	Gross domestic product (GDP)	Unemployment rate (UE)	Retail sales growth (RET)	
Frequency of announcements	Monthly	Quarterly	Quarterly	Monthly	Monthly	
Source of actual announced figures: ABS Publications	No. 5301, Balance of Payment, Monthly	No. 6401, Consumer Price Index, Quarterly	No. 5206, Quarterly Estimates of National Income and Expenditure	No. 6203, The Labour Force Australia, Monthy	No. 8501, Retail Sales of Goods, Monthly	
Source of market expectations	MMS Australia					
Unit of measurement	\$A billion	% change in CPI from previous quarter	% change in GDP from previous quarter	Unemployment rate, %	% change of gross retail sales from previous month	
Announcement time: AEST (GMT + 10)	11:30 AM	9 AM up to the December quarter 1988, and 11: 30 AM thereafter	Two at 8 AM and three at 7:30 AM early in the sample, and 11:30 AM thereafter	11:30 AM	11: 30 AM	
Date period	July 1985 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	
Total number of announcements within data period	116	39	39	115	79	
Total number of MMS survey	116	39	39	91	64	
Definition of news	Actual figure – (MMS median expectations)					

Table 2. Actual and expected announcements data

MMS surveys approximately 20 to 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.

$$\Delta s_{t} = \alpha_{c} + \sum_{i=MON}^{THU} \alpha_{i} D_{it} + \alpha_{HOL} D_{HOLt} + \sum_{j=CAD}^{RET} \alpha_{j} NEWS_{jt} + \alpha_{h} \sqrt{h_{t}} + \sum_{k=1}^{R} \alpha_{k} \Delta s_{t-k} + \varepsilon_{t} \varepsilon_{t} = z_{t} \sqrt{h_{t}} \sim (0, h_{t}), z_{t} \sim iid(0, 1)$$
(1 a)

$$\ln h_{t} = \beta_{c} + \beta_{\varepsilon 1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\varepsilon 2} \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right)$$
$$+ \beta_{h} \ln h_{t-1} + \sum_{i=MON}^{THU} \beta_{i} D_{it} + \beta_{HOL} D_{HOLt}$$
$$+ \sum_{j=CAD}^{RET} \beta_{j} |NEWS_{jt}| + \beta_{r} r_{t}$$
(1b)

where:

- D_{it} = daily dummy which takes the value of one for day *i* and zero otherwise;
- $D_{HOL,t}$ = holiday dummy which takes the value of one for the days immediately following public holiday and zero otherwise;
- $News_{jt}$ = the five news variables transformed into daily variables by assigning the value of zero for days without the particular news announcement and the magnitude of the news (deviation of actual announcement from the MMS expectations) for announcement days;
 - $h_t =$ conditional variance of daily exchange rate changes;
 - r_t = daily 90-day Australian bank-bill rate;
 - R = the number of significant lags of the dependent variable included in the conditional mean

equation to account for possible serial dependence of the changes in the conditional mean.

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. The log likelihood function is as below:

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

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

Equations 1a and 1b are the conditional mean and variance equations of the daily exchange rate changes, respectively. Testing of the three hypotheses is carried out by examining the sign and the significance of the coefficients of the news 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 changes on the days of their announcements. If the news announcements also have an impact on the volatility of the changes, 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 depend on the equilibrium relationship between the announced economic variable and exchange rates. and market perception regarding the likelihood of monetary and/or exchange rate intervention policy response by the authorities. The focus of this paper, however, is on the news effects on the volatility of exchange rate changes. Estimated coefficients of the news variables will reveal which of the three hypotheses is supported. If there are no news effects on either the conditional mean or variance of the changes, the news coefficients will be insignificantly different from zero and Hypothesis 1 is supported. Hypothesis 2 is relevant if the news variables are significant only in the conditional mean equation. If the news announcements significantly affect the AUD and raise (lower) the conditional volatility of the exchange rate changes, the coefficients in the conditional variance equation will be positive (negative) and significant, then Hypothesis 3 (Hypothesis 4) is supported.

The other explanatory variables included are the seasonal dummies and short-term interest rate (daily 90-

day Australian bank bill rate). The interest rate data were obtained from the RBA. The seasonal dummies are used to account for possible day of the week effect and holiday effect in the daily changes 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. The movements of short-term interest rates may also be useful in modelling the conditional variance. This is because they could be regarded as an indication of the monetary policy stance of the RBA since one of the direct effects of a change in monetary policy stance is on short-term interest rates and subsequently on exchange rates.

III. EMPIRICAL RESULTS

The effects of announcement news

Table 3a reports the maximum likelihood estimation results for the modelling of the five daily exchange rate changes.⁵

Current account deficit news. Of the five news variables, the current account deficit news has a significant effect on all five exchange rates. A one AUD billion unexpected deficit depreciated the AUD against all five currencies by around 0.8% on the days of announcements. This is because unexpected deficits imply higher than expected demand for foreign currencies, among other things, and so current spot exchange rates would depreciate. In addition, the conditional volatility of the AUD is significantly higher on announcement days in response to the CAD news. This clearly supports Hypothesis 3.

Consumer price index news. The CPI news has a significant effect only for the BP/AUD at 5%. 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 (Kim, 1996a). Thus, the estimation over the whole sample neutralized the opposite responses of the exchange rates to the CPI news. Except for the BP/AUD, the conditional volatility of the AUD is significantly higher in response

⁵ The estimations were carried out using RATS version 4.2 on a Pentium PC. The convergence algorithm chosen was that due to Berndt *et al.* (1974).

Table 3. Modelling of the daily exchange rates with economic news

(a) Estimations

	Δ USD/AUD		$\Delta DM/AUD$		Δ JY/AUD	Δ JY/AUD		ΔBP/AUD		Δ SF/AUD	
	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	
α_{C}	-0.0438*	(0.0197)	-0.0414	(0.0346)	0.0008	(0.0356)	-0.0054	(0.0302)	-0.0061	(0.0381)	
$\alpha_{\rm MON}$	0.0206	(0.0172)	0.0016	(0.0245)	0.0105	(0.0269)	0.0316	(0.0228)	-0.0053	(0.0259)	
$\alpha_{\rm TUE}$	0.0412*	(0.0172)	0.0188	(0.0235)	0.0042	(0.0266)	0.0088	(0.0232)	0.0069	(0.0243)	
$\alpha_{\rm WED}$	0.0416*	(0.0166)	-0.0020	(0.0229)	-0.0077	(0.0257)	0.0087	(0.0223)	-0.0101	(0.0236)	
$\alpha_{\rm THU}$	0.0089	(0.0168)	-0.0123	(0.0230)	-0.0543*	(0.0244)	-0.0098	(0.0221)	-0.0153	(0.0236)	
$\alpha_{\rm HOL}$	0.0036	(0.0245)	0.0174	(0.0399)	0.0073	(0.0476)	0.0081	(0.0369)	0.0143	(0.0406)	
αcad	-0.7228**	(0.1252)	-0.9362**	(0.1560)	-0.7450 **	(0.1527)	-0.7455**	(0.1362)	-0.8313**	(0.1813)	
αcpi	-0.1034	(0.2064)	0.2390	(0.2459)	0.1674	(0.2460)	0.4216*	(0.2147)	0.2221	(0.3404)	
$\alpha_{\rm GDP}$	0.1601*	(0.0684)	0.1360†	(0.0801)	0.1550†	(0.0845)	0.1087	(0.0894)	0.1098	(0.1111)	
ΩUEMP	-0.0373	(0.1300)	-0.3543*	(0.1782)	-0.3679^{+}	(0.1907)	-0.4173*	(0.1675)	-0.3811*	(0.1877)	
$\alpha_{\rm RFT}$	-0.0060	(0.0205)	0.0254	(0.0235)	0.0001	(0.0311)	0.0148	(0.0250)	0.0384	(0.0256)	
$\alpha_{\rm h}$	0.0871*	(0.0416)	0.0919	(0.0604)	0.0214	(0.0674)	0.0329	(0.0558)	0.0374	(0.0679)	
$\beta_{\rm c}$	-0.3622**	(0.1258)	-0.2454*	(0.1186)	-0.1990*	(0.0999)	-0.1273	(0.1053)	-0.4005 **	(0.1317)	
$\beta_{\varepsilon 1}$	-0.0915 **	(0.0312)	-0.0519†	(0.0273)	-0.0442*	(0.0213)	-0.0535*	(0.0224)	-0.0450	(0.0306)	
$\beta_{\varepsilon 2}$	0.3732**	(0.0523)	0.2445**	(0.0436)	0.2163**	(0.0357)	0.2120**	(0.0363)	0.2994**	(0.0478)	
$\beta_{\rm h}$	0.8434**	(0.0240)	0.8516**	(0.0306)	0.9185**	(0.0172)	0.9237**	(0.0170)	0.7584**	(0.0456)	
β_{MON}	-0.0050	(0.1684)	0.1472	(0.1693)	0.3370*	(0.1570)	0.0681	(0.1638)	0.1927	(0.1628)	
$\beta_{\rm TUE}$	0.0886	(0.1466)	-0.0375	(0.1497)	0.0618	(0.1402)	0.0879	(0.1489)	-0.0777	(0.1454)	
β_{WED}	-0.0829	(0.1454)	-0.0704	(0.1484)	0.0674	(0.1407)	-0.1308	(0.1444)	-0.1073	(0.1420)	
$\beta_{\rm THU}$	-0.0204	(0.1734)	-0.0629	(0.1744)	-0.1277	(0.1642)	-0.0258	(0.1678)	-0.0851	(0.1706)	
BHOL	-0.2694*	(0.1261)	0.0894	(0.1195)	0.1296	(0.0951)	0.0103	(0.0964)	-0.0003	(0.1445)	
β_{CAD}	2.7229**	(0.4932)	1.9673**	(0.4414)	1.2642**	(0.3710)	1.4181**	(0.3803)	2.3291**	(0.5129)	
β_{CPI}	2.2188**	(0.6260)	1.7137**	(0.6373)	0.9353†	(0.5364)	0.7774	(0.5183)	2.6621**	(0.7448)	
β_{GDP}	0.3503	(0.3215)	0.0358	(0.2334)	-0.0977	(0.2167)	-0.1266	(0.1953)	0.2181	(0.2612)	
β_{UEMP}	1.1554†	(0.5926)	1.3696*	(0.6068)	1.3232**	(0.5000)	1.0864*	(0.4928)	1.5955*	(0.6900)	
$\beta_{\rm RFT}$	-0.1317	(0.1140)	-0.2436*	(0.1161)	-0.1588	(0.0982)	-0.1851 [†]	(0.1011)	-0.1585	(0.1299)	
β_r	0.0127**	(0.0031)	0.0074**	(0.0026)	0.0027†	(0.0014)	0.0035*	(0.0016)	0.0116**	(0.0036)	
d	2.8736**	(0.2166)	2.9983**	(0.2150)	3.8001**	(0.3196)	3.2029**	(0.2401)	3.1786**	(0.2408)	
R	0		0		0		0		4		
ln L	448.7		-180.7		-380.2		-137.8		-251.5		

d is the estimated degrees of freedom parameter of the t-distribution for the standardized residuals.

R is the number of lags of exchange rate changes found to be significant in the conditional mean equation.

ln L is log likelihood.

Table 3. (Continued on page 8)

to the news on the days of announcements. Thus, Hypothesis 3 is supported.

Gross domestic product news. A one percentage point higher than expected GDP growth announcement appreciated the AUD against all five currencies by around 0.13%, however, only the USD/AUD, the DM/AUD and the JY/AUD are significantly affected. This confirms the traditional link between GDP and exchange rates. The effects of the GDP news on the conditional variance is positive for the USD/AUD, the DM/AUD and the SF/ AUD, and negative for the JY/AUD and the BP/AUD. However, none is significant. This might imply that the GDP announcements are seen as containing less information than the others, and so the impact of their announcements, in general, are negligible. Alternatively, market participants have a consensus regarding the equilibrium response to the GDP news and so the GDP news affected the prices of the AUD only. This seems to support Hypothesis 2.

Unemployment rate news. A higher than expected unemployment rate announcement depreciated the AUD against all currencies and the news coefficient is significant in all cases except for the USD/AUD. A one percentage point higher than expected unemployment rate depreciated the AUD against the four currencies by around 0.38%. This is because an unexpectedly higher unemployment rate indicates an unexpected slow down in the economy. The unemployment news also had a significant positive effect on the conditional volatility of the AUD changes on the announcement days. This is compatible with Hypothesis 3.

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(b) Diagnostics

	Δ USD/AUD	$\Delta DM/AUD$	$\Delta JY/AUD$	Δ BP/AUD	Δ SF/AUD
	Summary statistic	cs on z_t			
Mean	-0.0338	-0.0235	-0.0405	-0.0289	-0.0257
Variance	0.8111	0.8670	0.9573	0.9012	0.8964
Skewness	-0.3035	0.0373	-0.7920	-0.2832	-0.3312
Excess kurtosis	8.4606	7.6751	5.2675	5.9230	6.4500
	Tests of white no	ise for $z_t^{(a)}$			
L–B Q(50): $\chi^2(50)$	46.1890	42.2934	50.3000	44.7352	61.8718
	{0.6271}	{0.7724}	{0.4615}	{0.6840}	{0.1210}
L-B $Q^2(50)$: $\chi^2(50)$	55.4499	51.0005	43.0887	46.0614	45.8498
	{0.2768}	{0.4341}	{0.7448}	{0.6321}	{0.6405}
ARCH(50): $\chi^2(50)$	50.5206	54.5607	47.4155	46.1669	49.1901
	{0.4528}	{0.3053}	{0.5777}	{0.6279}	$\{0.5058\}$
	Engel and Ng sig	n bias tests ^(b)			
Sign bias	-1.6150	-0.6583	-0.5931	0.4269	-1.4923
	{0.1064}	{0.5104}	{0.5532}	{0.6695}	{0.1357}
Negative sign bias	0.6364	0.2780	0.2935	0.1372	0.3675
	{0.5245}	{0.7810}	{0.7692}	{0.8908}	{0.7133}
Positive sign bias	-0.0117	-0.0883	-0.1769	0.4145	-0.0110
-	{0.9906}	{0.9296}	{0.8596}	{0.6785}	{0.9912}
Joint test: $\chi^2(3)$	3.6616	0.6988	0.8031	0.9593	3.4963
	{0.3004}	{0.8735}	$\{0.8487\}$	{0.8111}	{0.3212}
	Test for unit root	in the conditional va	triance, H_0 : $\beta_h = 1$		
$\chi^{2}(1)$	42.6387**	23.5181**	22.5828**	20.2155**	28.0932**
	$\{0.0000\}$	$\{0.0000\}$	{0.0000}	$\{0.0000\}$	$\{0.0000\}$
	Joint tests of sign	ificance ^(c)			
H ₀ : $\alpha_i = 0$,	9.9114†	2.1829	8.4303	3.6185	1.2512
for all <i>i</i> , $\chi^2(5)$	{0.0778}	{0.8233}	{0.1341}	{0.6055}	{0.9399}
H ₀ : $\alpha_i = 0$,	39.2756**	45.2805**	31.5766**	42.1437**	28.9518**
for all $j, \chi^2(5)$	{0.0000}	{0.0000}	{0.0000}	$\{0.0000\}$	$\{0.0000\}$
H ₀ : $\alpha_i = \alpha_i = 0$,	50.7089**	47.4523**	40.3578**	45.7382**	29.8452**
for all <i>i</i> and <i>j</i> , $\chi^2(10)$	{0.0000}	{0.0000}	{0.0000}	$\{0.0000\}$	{0.0009}
$\mathbf{H}_0: \ \beta_i = 0,$	5.6297	4.1986	16.2800**	3.2962	7.1943
for all <i>i</i> , $\chi^2(5)$	{0.3439}	{0.5212}	{0.0061}	{0.6544}	{0.2066}
$\mathbf{H}_0: \ \beta_i = 0,$	46.3874**	33.3784**	22.9932**	23.2058**	36.5161**
for all $j, \chi^2(5)$	{0.0000}	{0.0000}	{0.0003}	{0.0003}	$\{0.0000\}$
$\mathbf{H}_0: \ \beta_i = \beta_j = 0,$	53.3047**	35.1699**	34.3227**	25.7911**	41.9163**
for all <i>i</i> and <i>j</i> , $\chi^2(10)$	$\{0.0000\}$	{0.0001}	{0.0002}	{0.0040}	$\{0.0000\}$
H ₀ : $\alpha_i = \alpha_i = \beta_i = \beta_i = 0$,	105.9269**	78.1178**	78.0356**	68.3897**	69.5365**
for all <i>i</i> and <i>j</i> , $\chi^2(20)$	{0.0000}	{0.0000}	$\{0.0000\}$	$\{0.0000\}$	$\{0.0000\}$

^(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 z_t^2 .

ARCH(50) is the Ljung-Box test statistic for z_t . ARCH(50) tests the existence of autoregressive conditional heteroscedasticity of up to 50th order in the z_t . (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 $S_{t-1}^- \cdot \varepsilon_{t-1}$. Positive sign bias is the *t*-test of the slope coefficient of the regression of z_t^2 on $S_{t-1}^+ \cdot \varepsilon_{t-1}$. Joint test is the LM test of joint significance of all three regressors. (c) α_i s and β_i s are the coefficients for the five seasonal dummies and α_j s and β_j s are the coefficients for the five news variables in the conditional mean and variance equations, respectively.

Retail sales growth news. The retail sales announcement news had no effect on the means of the AUD exchange rates changes. The conditional variance fell in response to the news in all cases, however, the news coefficient is significant only for the DM/AUD and the BP/AUD. Apparently the release of the retail sales news had a marginally significant market calming effect on the two exchange rates.⁶ This gives some support to Hypothesis 4.

In sum, the current account deficit, the CPI and the unemployment announcement news significantly raised the conditional volatility on the days of their announcements as shown by the news coefficients which are positive and significant at least at 10% in all estimations, except for the BP/AUD for the CPI news.⁷ Apparently, the surprise announcements of these variables raised the conditional volatility of the changes due to the lack of consensus of the equilibrium adjustments of the AUD or uncertainties regarding policy responses of the RBA. On the other hand, the effects of the GDP and the retail sales news on the conditional volatility are generally insignificant.

Modelling daily changes of the AUD

The modelling of daily changes of the AUD through the EGARCH-M models are shown to be effective. The EGARCH parameters are significant and they show the strong presence of both magnitude and negative asymmetric effects (except for the SF/AUD) of unexpected exchange rate changes on the future volatility of changes, that is, $\beta_{\varepsilon 1}$ is negative and $\beta_{\varepsilon 2}$ 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 for the USD/AUD and the Thursday one for the JY/AUD. The holiday dummy is not significant in any estimation. Also, there are virtually no seasonal effects in the conditional volatilities except for the significant Monday dummy for the JY/AUD and holiday dummy for the USD/AUD. 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 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. It is also shown that the movements of short-term interest rate have a significant positive effect on the conditional volatility. This suggests that the higher the short-term interest rate the higher the conditional volatility of the AUD changes. This may be rationalized by considering that higher interest rates are a symptom of a higher inflation environment and so higher exchange rate volatility reflects higher volatility in the economy at large. It is also shown that higher conditional volatility contributes to a higher risk premium on holding the AUD against all five currencies, however, the coefficient, α_b , is significant only in the USD/AUD changes. Lastly, estimated d is small in all cases which confirms the leptokurtosis of the standardized residuals and thus the usefulness of the adoption of the standardized t-distribution for the residuals.

Diagnostics of the estimations

Table 3b 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 sub-

⁶ This may partly explain the insignificance of the GDP news on the conditional variance. The GDP and the retail sales news announcements convey similar information (private consumption expenditure accounts for slightly over 60% of GDP in the 1980s and 1990s) and the latter is announced more frequently and so the extent to which the former contains new information is lessened.

⁷ The effects of the news on the conditional variance of the changes were also modelled by utilizing news dummy variables in the conditional variance equation that take the value of one for days that include an economic announcement. This approach investigates whether the presence of an economic announcement, regardless of whether or not there is a surprise in the announcement, causes the volatility to change. In general there is no fundamental difference from the results reported in Table 3a and 3b. It is observed that the announcement sof current account deficit, inflation and unemployment figures contributed to higher variance on the days of their announcement regardless of their news content. This implies that, on average, announcements of these figures are seen as important events by the market participants leading to increased activities in the markets around the time of the announcements. Interested readers can obtain the estimation results from the author upon request.

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 exchange rates 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.

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stantially reduced in size compared to the ones reported in Table 1, which indicates that 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 changes are eliminated in the standardized residuals an all cases as can be seen from the insignificant Q test statistics. The ARCH effects are not present in the standardized residuals. In addition, the negative asymmetry of the conditional volatility is also eliminated for all exchange rate changes as shown by the insignificant Engel and Ng sign bias test statistics in all cases. Lastly, tests of joint significance reveals that only the daily dummies are jointly insignificant, in general, while the news variables are highly significant in both the conditional mean and variance equations. In sum, EGARCH-M models address the statistical properties of the daily changes of exchange rates very well.

IV. SUMMARY AND CONCLUSIONS

This paper has examined the effects of the news created by the scheduled releases of Australian macro-economic variables on the first and second moments of daily AUD exchange rate changes. It has been shown that unexpected developments in some variables are shown to have a significant effect on the value of the AUD. The AUD appreciated when higher than expected GDP growth figures were announced, and depreciated in response to unexpectedly high current account deficit and unemployment rate announcements. More importantly, the announcement news also has significant effects on the conditional volatility of the AUD changes. Unexpectedly high current account deficit, inflation and unemployment rate raised the conditional volatility of all five exchange rate changes on the days of their announcements. 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. It is also found that the days of the news release are associated with significantly higher volatility, in general, than other days. This indicates that 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, leading to changes in the price and conditional volatility of the AUD.

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

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