

# WORKING PAPERS IN ECONOMICS

**Modeling Changes in Daily  
\$A Exchange Rates:  
An Application of GARCH\***

by

**Suk-Joong Kim**

**No. 217**

**June 1995**

DEPARTMENT OF ECONOMICS



The University of Sydney  
Australia 2006

**Modeling Changes in Daily  
\$A Exchange Rates:  
An Application of GARCH\***

by

**Suk-Joong Kim**

**No. 217**

**June 1995**

**Abstract**

This paper examines the statistical properties of the logarithmic changes in daily \$A exchange rates. For all five exchange rates considered, changes exhibit volatility clustering and highly significant non-linear serial dependence. GARCH models in various forms were estimated and the results are that there are significant GARCH effects and an unexpected change has asymmetric effects on the future volatility of changes in all five exchange rates. There is some evidence of the day of the week effect in the variance of changes, and the announcements of economic news have a significant effect on changes but the effects on the variance of changes are generally insignificant except in the case of USD/\$A rate. In general, the GARCH modeling of logarithmic changes in daily \$A exchange rates was found to be useful as shown by the significant reductions in the skewness and excess kurtosis and the non-linear serial dependence of the estimated standardised residuals.

\*The author wishes to thank Jeffrey Sheen for helpful comments and suggestions, and Gary Shilson-Josling for providing the survey data used in this paper.

**National Library of Australia Card Number and ISBN 0 86758 884-5**

## CONTENTS

	<b>Page</b>
<b>I. Introduction</b>	<b>1</b>
<b>II. Statistical Properties of Daily Changes of \$A Exchange Rates</b>	<b>2</b>
<b>III. Modeling Daily Exchange Rate Changes</b>	<b>4</b>
<b>IV. Empirical Results</b>	<b>9</b>
IV-A United States Dollar	9
IV-A-1 Estimations	9
IV-A-2 Diagnostics	11
IV-B Deutsche Mark	13
IV-B-1 Estimations	13
IV-B-2 Diagnostics	14
IV-C Japanese Yen	15
IV-C-1 Estimations	15
IV-D British Pound	16
IV-D-1 Estimations	16
IV-D-2 Diagnostics	17
IV-E Swiss Franc	18
IV-E-1 Estimations	18
IV-E-2 Diagnostics	19
<b>V. Summary and Conclusion</b>	<b>19</b>
<b>References</b>	<b>41</b>
<b>Addendum</b>	<b>43</b>

## **I. Introduction**

It is well documented that the distributions of daily exchange rate changes are leptokurtic, that is, the probabilities of observing extreme values are high compared to the normal distribution with the same mean. The salient feature of daily exchange rates is the lack of serial dependence in logarithmic changes but highly significant correlation in squared logarithmic changes which is suggestive of time varying heteroskedasticity. With unconditional homoskedasticity, the coefficients of an econometric model can be estimated efficiently by OLS even in the presence of conditional heteroskedasticity. However, non-linear estimators can be more efficient in the presence of a non-linear dependence in the residuals and so estimation techniques that take into account the non-linear dependence (i.e. conditional heteroskedasticity) have been found useful in modeling changes in daily exchange rates

There have been a number of successful attempts at modeling logarithmic changes in daily exchange rates using Generalised Autoregressive Conditional Heteroskedasticity (GARCH). Engel (1982) show that if the conditional distribution of a series is heteroskedastic, it is possible to observe leptokurtosis in the unconditional distribution of the series even when the conditional distribution is normal. Hsieh (1989) finds that GARCH (1,1) models with the conditional normality assumption account for the excess kurtosis in the rates of changes in daily US Dollar (USD) exchange rates for the period 1974 to 1983. However, he concludes that the non-normal conditional densities applied in that study turned out to be more appropriate. Baillie and Bollerslev (1989) find the GARCH (1,1) models with the standardised  $t$  conditional distribution fit daily USD exchange rate changes for the period 1980 to 1985 quite well. They also find that as the sampling frequency decreases from daily to weekly, bi-weekly and monthly, GARCH effects are weakened, and for the bi-weekly and monthly data, the conditional normality cannot be rejected.

The aim of this paper is to investigate the statistical properties of logarithmic changes in daily Australian Dollar (\$) exchange rates using the GARCH modeling. The rest of the paper is organised as follows: section II reports the statistical properties of daily \$A exchange rates, section III outlines the modeling strategies, section IV discusses the estimation results, and section V summarises the main results and offers conclusion.

## **II. Statistical Properties of Daily Changes of \$A Exchange Rates**

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 \$A. They are daily wholesale closing rates against the United States Dollar (USD), Deutsche Mark (DM), Japanese Yen (JY), British Pound (BP), and Swiss Franc (SF) reported in the Australian Financial Review for the period 2 January 1985 to 3 February 1993, yielding 2022 observations. Changes are measured as  $\Delta S_t = (\ln S_t - \ln S_{t-1}) \times 100$  and thus are continuously compounding rates of return, in foreign currency, of holding \$A. It is well known that exchange rates behave in the same way as other financial prices, that is, as a random walk process (Meese and Rogoff, 1983). Changes in exchange rates are roughly white noise, and provided foreign exchange markets are informationally efficient, they cannot be consistently predicted. Time series plots of each exchange rate changes are shown in graphs 1 to 5. Although the five exchange rate changes appear stationary, volatility clustering is clearly present in all cases, that is, large changes tend to be followed by equally large changes of either sign, and small changes by equally small ones of either sign.

Table 1 displays some statistical properties of the changes in five daily \$A exchange rates. All exchange rate changes show significant skewness and excess kurtosis which are due

to higher peaks and longer tails of the distributions compared to the normal distributions with the same means.

The second section of Table 1 reports the tests of independence and identical distributions (*iid*) for each changes. The first two are Ljung-Box Q tests for the null of white noise (with the lag length equal to the square root of sample size, 45) for changes and squares of changes, respectively. While there is a highly significant serial dependence in squared changes in all cases, linear dependence is generally weak and observable only in the cases of USD, DM, and SF (with the significance at the 5%, 10%, and 5% levels, respectively).

The third *iid* statistic is for the testing of the equality of distributions of changes across the sample. For simplicity, the sample was divided in half and the characteristics of the two distributions compared, and the test statistic under the null of equal distribution is distributed as  $\chi^2$ . The equality of two multinomial distributions is tested as follows: The variable under test is sorted in ascending order of magnitude (not in absolute terms) using the whole sample, and observations are put into  $k$  mutually exclusive and collectively exhaustive groups. The choice of  $k$  should be such that the number of observations in each group is roughly equal and  $k$  should increase with the sample size but at a slower rate (in this study,  $k = n^{1/2}$ ). Denoting the probability of an observation in the subsample one and the subsample two falling into group  $i$  as  $p_{i1}$  and  $p_{i2}$ , the test of equality of two subsample distributions is based on the null  $H_0: p_{i1} = p_{i2}$  for all  $i$ . The test statistic is distributed as  $\chi^2_{(k-1)}$  and values larger than a suitable critical value is evidence against the null (See Hogg and Craig (1978), pp. 320-321). All except BP show a departure from *iid*, USD at 1%, SF at 5%, DM and JY at 10%.

Lastly, both the Phillips-Perron and Dickey-Fuller unit root tests confirm that changes in daily exchange rates are stationary.

In the finance literature it is not uncommon to observe the day of the week effect on the volatility of asset returns, that is, the volatility varies across a week. Essentially, this has to

do with the amount of new information available on each trading day. Mondays usually have more information compared to other week days since the relevant information that may affect underlying asset prices would accumulate over non-trading weekends. This suggests that distributions of exchange rate changes might differ across a week. To test for this possible heterogeneity of distributions, as in Hsieh (1988), the sample is reclassified into five subgroups corresponding to each week day. This is accomplished by collecting all Friday to Monday changes into the Monday group, all Monday to Tuesday changes to the Tuesday group, and so on. Table 2 reports the test results for the equality of the multinomial distributions of pairwise changes. For USD, 5 out of 10 group comparisons show a significant difference at least at 10 %. DM and SF each has one significant group difference at 10 %, and JY and BP have none. Overall, there are only seven significant test statistics out of the total of 50, and so the day of the week effect in the mean of daily exchange rate changes is not significant. That is to say, the violation of *iid* in the whole sample is not due to the different distributional characteristics on different days in a week.

### III. Modeling Daily Exchange Rate Changes

The existence of a highly significant serial dependence in squared changes in daily exchange rate is suggestive of time-varying variance which can be modeled explicitly by Generalised Autoregressive Conditional Heteroskedasticity (GARCH(p,q)) as below:

$$\begin{aligned} \text{Conditional Mean: } \Delta S_t &= \mu + \varepsilon_t, \\ \varepsilon_t &= z_t \sqrt{h_t}; \varepsilon_t \sim (0, h_t), z_t \sim iid(0,1) \\ \text{Conditional Variance: } h_t &= \beta_c + \sum_{i=1}^p \beta_{hi} h_{t-i} + \sum_{j=1}^q \beta_{\varepsilon j} \varepsilon_{t-j}^2 \end{aligned}$$

Bollerslev (1986) shows that p and q can be determined through the usual Box-Jenkins

ARIMA modeling strategy using  $\varepsilon_t^2$  as the series under investigation. Instead of adopting this strategy, it was decided to use a parsimonious GARCH (1,1) model since in recent empirical investigations on exchange rate changes, GARCH (1,1) models were found to be very successful compared to less parsimonious ones (Bollerslev, 1989). However, the non-negativity condition for the conditional variance,  $h_t$ , requires  $\beta_c \geq 0$ ,  $\beta_h > 0$  and  $\beta_\varepsilon > 0$  which is rather restrictive. Also, a very high persistence in volatility has been found for exchange rate changes, that is  $\beta_h + \beta_\varepsilon$  is very close to one. Nelson (1991)'s Exponential GARCH (EGARCH) model (with the conditional variance equation shown below) addresses these problems.

$$\ln h_t = \beta_c + \beta_{\varepsilon 1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\varepsilon 2} \left( \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right) + \beta_h \ln h_{t-1}$$

The coefficients now are not restricted to be positive, and the flexibility of this form is 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  $\beta_{\varepsilon 1}$  is negative, an unexpected depreciation of \$A increases the volatility while an unexpected appreciation decreases it; and if  $\beta_{\varepsilon 2}$  is positive, larger shocks have bigger impact on the volatility regardless of the type of shocks. In addition, the chances of finding an integrated variance are reduced since the stationarity condition for the conditional variance is that  $\beta_h$  be less than one in absolute terms which is less restrictive than requiring  $\beta_h + \beta_\varepsilon$  be less than one in absolute terms.

Another crucial aspect in modeling the conditional variance is to specify correctly the distributional characteristics of the standardised residuals,  $z_t$ . The most common approach would be to assume the conditional normality, although this assumption is frequently violated

in practice. However, Bollerslev and Wooldridge (1992) show that even if the conditional distribution of  $z_t$  is misspecified, provided that the first two moments of the distribution are known, GARCH estimators with the conditional normality assumption are consistent in large samples. Others have tried various non-normal conditional distributions, such as standardised  $t$  (Bollerslev, 1987, Baillie and Bollerslev, 1989, Hsieh, 1989), generalised error distributions (Nelson, 1991), etc., with the  $t$  distribution having some success in modeling changes in daily exchange rates. In this study the standardised  $t$  distribution is used, and the log likelihood function is

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

where  $\Gamma(\cdot)$  denotes gamma function, and  $d$  is the degree of freedom parameter. As  $d$  approaches infinity the  $t$  distribution converges to normal.

In addition to the simple EGARCH parameters, we consider other factors that might influence the conditional variance.

1. Seasonality might be an important consideration since the volatility of daily exchange rate changes might differ across a week. The simplest way of addressing the seasonality issue is to include daily dummies in both the conditional mean and variance equations. Similarly, the inclusion of a holiday dummy may prove helpful since trading days immediately following a public holiday usually have more information available than other weekdays, just as in the case of Monday tradings. Daily dummies take the value of one when the

observation is on the relevant day of the week, and the holiday dummy takes the value of one for any day the market was closed the previous day for any reason other than being a weekend.

2. GARCH effects on exchange rate changes can also be due to an increased volatility of changes following the arrival of new information. Furthermore, if news arrives at uneven intervals of time, the volatility clustering may result. We consider five scheduled announcements of economic variables made by the Australian Bureau of Statistics: they are current account, inflation, GDP, unemployment, and retail sales. The inflation and GDP announcements are made every quarter, and the rest are monthly announcements. The news variables are the percentage differential between the actual announced figures and market expectations, that is, they measure the extent to which the announcements contain new information (see Data Appendix).
3. Movements in short-term interest rates may be useful in modeling the conditional variance. The reasoning is that changes in them could be regarded as an indication of the stance of monetary policy since one of the direct effects of changes in monetary policy is on short-term interest rates and subsequently on exchange rates.
4. 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 exchange rate changes increases, holders of the currency may require additional incentive in the form of the risk premium in order to keep on holding on to the currency. This implies that the mean equation would include, as an additional explanatory variable, the variance of the exchange rate changes in an appropriate form.

All considerations outlined above suggest the conditional mean and conditional variance equations of the form:

$$\Delta S_t = \alpha_c + \sum_{i=MON}^{1HQ} \alpha_i D_{it} + \sum_{j=CAO}^{RET} \alpha_j |NEWS_{jt}| + \alpha_h \sqrt{h_t} + \sum_{k=1}^R \alpha_k \Delta S_{t-k} + \varepsilon_t$$

$$\ln h_t = \beta_c + \sum_{i=MON}^{1HQ} \beta_i D_{it} + \sum_{j=CAO}^{RET} \beta_j |NEWS_{jt}| + \beta_{e1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{e2} \left( \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right) + \beta_h \ln h_{t-1} + \beta_r r_t$$

where R is the number of significant lagged dependent variable in the conditional mean equation. This constitutes the central model in this study. The model without the seasonal dummies and news variables is labelled Model 1, the one that includes the seasonal dummies but without the news variables is Model 2, and the central model is model 3.

Instead of including the economic news variables in the conditional variance equation in magnitudes, we can incorporate news dummies that take the value of one for observations that include an economic announcement. This approach investigates whether or not the presence of an announcement caused the volatility to change. This is Model 4.

Models 1 to 4 allow for the possibility of positive and negative shocks having different effects on the conditional variance. Alternatively, Glosten, Jagannathan and Runkle (1993), hereafter GJR, model this difference explicitly by replacing  $\beta_{e2} \left( \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right)$  above by  $\beta_{e3} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} S^-$ , where  $S^-$  is a dummy variable that takes the value of 1 when  $\varepsilon_t < 0$ , and 0 otherwise. In this form,  $\beta_{e3}$  is expected to be negative if a negative (positive) shock increases (decreases) the volatility of changes. Model 5 uses the news variables in magnitudes, while model 6 includes the news dummies in the conditional variance equation using the GJR method. The six models for each exchange rate change are estimated using maximum likelihood<sup>1</sup>.

<sup>1</sup> In additions to the estimations reported, all combinations of EGARCH (p,q) up to (2,2) were tried without making a significant difference to the results obtained for EGARCH (1,1).

## IV. Empirical Results

### IV-A United States Dollar

#### IV-A-1 Estimations

Table 3-a reports the USD estimations of the exponential GARCH in mean (EGARCH-M) models discussed in the previous section. In the conditional mean equation, the constant is significant only in model 1 and only at the 10 % significance level. Of the five seasonal dummies included in models 2 to 6, only the Wednesday dummy is significant in all models at 5 %, and the positive sign implies that \$A appreciated, on average, on Wednesdays by about 0.07 %. The coefficients for the current account and inflation news are statistically significant at least at 5 % in all models that include the news variables. The magnitudes of the two news coefficients are virtually the same across the models. The negative coefficient for the current account news implies a depreciation of \$A whenever there is a higher than expected current account deficit, and the positive coefficient for the inflation news implies an appreciation of \$A whenever there is a higher than expected inflation<sup>2</sup>. In models 3 and 4, good GDP news also caused a significant appreciation. In all models the coefficient for the EGARCH-M term,  $\alpha_h$ , is insignificant.

In the conditional variance equation, all the basic EGARCH coefficients are highly

<sup>2</sup> This confirms the findings of Karfakis and Kim (1995) and Kim (1994) where an unexpected current account deficit caused a depreciation of \$A and a rise in both short and long term domestic interest rates, and an unexpected inflation caused the interest rates to rise but depreciated \$A before April 1988 and appreciated it afterwards.

significant except for  $\beta_{e1}$  which is significant only at 10% in models 3 and 4, and at 5% in models 1, 2 and at 1% in models 5, 6. In models 1 to 4,  $\beta_{e1}$  is negative which suggests that an unexpected depreciation of \$A raised the volatility while an unexpected appreciation lowered it. In models 5 and 6, the asymmetry requires  $\beta_{e3}$  be negative which is what is observed. The negative asymmetric effect of changes is explained by the so called 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 in 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 would cause greater uncertainty than an unexpected appreciation in the sense that a depreciation might be due to an unexpected deterioration of the terms of trade and this would lead to an upward pressure on inflation and nominal interest rates which would add to uncertainties regarding the stability of economic variables.

The coefficient for the autoregressive term,  $\beta_h$ , is close to one in all models which implies a high persistence in the volatility.

None of the seasonal dummies has a significant effect on the conditional variance except for the one for Mondays which is positive and significant at 10% in models 2, 4 and 6, and at 5% in models 3 and 5. The positive sign indicates that the volatility of the \$A changes is higher on Mondays, on average, which may be due to the accumulation of information over the weekends.

The current account and inflation news had significant influences on the conditional variance. The former is significant at 1% in models 3 and 5, and at 10% in models 4 and 5, while the latter is significant at 5% in models 3 to 6. Both the news coefficients are positive which indicates that an unexpected current account deficit and an unexpected inflation raised the volatility of USD/\$A changes. In addition, the two news coefficients are significant and have the same sign in models 4 and 6 as in models 3 and 5 meaning that the volatility

increased, on average, on the days of announcement of the two variables. This suggests that unexpectedly high announcements of the current account deficit and inflation caused the volatility to rise while unexpected low ones had little effect. If this was the case, when the types of news (good or bad) were not distinguished, the overall effect of the economic news announcements would be dominated by the bad news, that is, a rise in the volatility. The other three news variables failed to have a significant effect on the volatility.

In all six models, the coefficient for the short-term interest rate,  $\beta_r$ , is significant at least at 5%. The positive sign suggests that a rise in the rate is associated with a rise in the exchange rate volatility. Finally,  $d$  is around 3.8 and is significantly different from zero (and from infinity) which suggests the presence of high excess kurtosis in the conditional distribution of the residuals.

#### IV-A-2 Diagnostics

Table 3-b shows the diagnostics for the USD/\$A estimations. The first three sections of the table deal with the statistical properties of the standardised residual  $z_t$ . In comparison to the summary statistics reported in Table 1, the excess kurtosis is almost halved, however, there is only a slight reduction in the skewness in all models. The means and variances are very close to zero and one, respectively.

The statistics for the Q tests of serial correlation for both linear and squared standardised residuals are substantially reduced in size, however, there still is a significant serial correlation in the squared standardised residuals. This is essentially caused by an outlier, which is the observation on 4 February 1985, and with this observation omitted the Q statistic is now insignificant in all models with the exception of model 1 where it is significant at 10%. The Q statistic for the stability of the distribution is substantially lower compared to that in

Table 1 in all models, however it is still significant at 1% in model 2 and at 5% in the other models.

Engel and Ng (1993) propose a set of diagnostic tests based on the idea of a news impact curve. The basic idea is that if a model is specified correctly we cannot predict the squared standardised residuals 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 variable using the usual  $t$  tests. In addition, the joint test includes all three regressors and is an LM test. Only the positive sign bias test is failed in models 3 and 6, however, the  $t$  statistic is marginally significant only at 10%.

The tests for a unit root in the conditional variance reveal that, although  $\beta_h$  is very close to one, it is statistically significantly different from one in all models. This implies that although the shocks to the conditional variance are highly persistent, the conditional variance itself is not integrated. However, the usual problems associated with the unit root testing may be present and so the results should be interpreted with caution. The joint tests of significance show that only the news variables are jointly significant in the conditional mean equation, and both the news variables and the seasonal dummies are jointly significant in the conditional variance equation. This confirms that model 1 is inadequate.

In sum, the daily USD/\$A exchange rate changes are well accounted for by the EGARCH-M models. There are strong GARCH effects, and the volatility is persistent but not integrated. There is no strong seasonal pattern in the volatility, and the current account deficit and the inflation news significantly affected both the conditional mean and the conditional variance of the exchange rate changes. In addition, the short-term interest rate also influenced

volatility, and the conditional  $t$  distribution for the standardised residuals seems to work well.

## IV-B Deutsche Mark

### IV-B-1 Estimations

Table 4-a reports the estimations for the DM/\$A rate changes. None of the seasonal dummies is statistically significant, nor is the constant term in all models. Of the five news variables, the current account deficit and inflation news have the coefficients that are significant at 1 % in models 3 to 6. The negative and positive signs for the two news coefficients indicate that a 1% higher than expected current account deficit and inflation announcements depreciated and appreciated SA by about 0.01% and 1.13%, respectively. In addition, in models 4 and 6 the unemployment news also had a significant negative impact on the exchange rate. An unexpected unemployment depreciated the DM/\$A rate. The EGARCH-M term is not significant.

In the conditional variance part of the estimations,  $\beta_h$  is highly significant but is smaller than one in all models (see the fourth section of Table 4-b);  $\beta_{e2}$  is significant at 1 % in the relevant models;  $\beta_{e1}$  is negative in the non-GJR models (1,2,3 and 4) and is marginally significant at 10 % in model 4. In the GJR models (5 and 6),  $\beta_{e2}$  is significant at 1% and has a negative sign in both models. The asymmetric effects of changes are present in all models, however, they are significant only in the GJR models and model 4.

In models other than model 1, the Tuesday and holiday dummies are significant at 10 % and 5%, respectively. The negative and positive coefficients for the dummies imply that, on average, the volatility of DM/\$A changes decreased on Tuesdays and increased on the days following a public holiday.

The news effect on the conditional variance is generally insignificant, only the

unemployment news coefficient is significant and positive at 10 % in models 3 and 5. The coefficient becomes negative in models 4 and 6 but is insignificant. The short-term interest rate has no explanatory power and  $d$  is around 5.5 which explains the significant excess kurtosis in the standardised residuals.

#### IV-B-2 Diagnostics

The skewness is reduced slightly in models 3 and 5, and slightly higher in the others, and excess kurtosis is reduced slightly in all models. There is no evidence that the standardised residuals are serially correlated in linear and squared form, and they are identically distributed in all models except for model 1 where the test statistic is significant at 10 %. The negative sign bias test is failed in all models, however, none of the other tests including the joint test is failed. The hypothesis of an integrated variance is rejected at any meaningful significance level.

The tests of significance of additional variables included in the models show that only the news variables are jointly significant in the conditional mean equation, and only the seasonal dummies are jointly significant in the conditional variance equation, however, all additional variables are jointly significant, rejecting model 1 as an appropriate model.

In sum, EGARCH-M models describe the changes in DM/\$A exchange rate quite well. The diagnostics of the estimations show no fundamental model inadequacy, additional variables in both the conditional mean and the conditional variance equations turned out to be useful, and there is no evidence of the variance being integrated.

### IV-C Japanese Yen

#### IV-C-1 Estimations

Table 5-a reports the JY/\$A estimations. Only the current account and inflation news variables are significant in the conditional mean equation. As in the previous two exchange rate estimations, an unexpected current account deficit depreciated JY/\$A exchange rate and an unexpected inflation appreciated it on the days of their announcements.

The constant in the conditional variance equation is significant only in models 1, 5 and 6, and  $\beta_{\epsilon}$ 's are significant at 1 % in all models and their signs are such that the negative asymmetric effects are present. That is,  $\beta_{\epsilon 1}$  is negative and  $\beta_{\epsilon 2}$  is positive in the non-GJR models; and  $\beta_{\epsilon 1}$  is positive and  $\beta_{\epsilon 3}$  is negative in the GJR models. The coefficient for the autoregressive term for the conditional variance is around 0.85 and is highly significant in all models. Among the seasonal dummies included, only the holiday dummy is significant and positive at 5 % which implies the volatility of the JY/\$A changes increased on the days following a public holiday. No news variable is able to explain the volatility and the short-term interest rate also has no explanatory power.

#### IV-C-2 Diagnostics

The skewness of the standardised residuals is reduced slightly and the excess kurtosis is more than halved in all models, however they are still significantly different from zero. Although there is no evidence of linear and non-linear serial dependence, there is a departure from the assumption of identical distribution in models 3, 4 and 5. The sign bias test is failed in all models, and the negative sign bias is also significant at 10 % in model 1. Nevertheless, the joint test statistic is not significant in any model. As in the previous exchange rate

estimations, there is no evidence of an integrated variance, and the seasonal dummies and the news variables in the conditional mean and conditional variance equations are jointly significant thereby rejecting model 1, however, only the additional variables in the conditional mean equation are jointly significant.

The daily JY/\$A exchange rate changes are well modeled by the EGARCH-M approach. All the EGARCH parameters are significant and there is no evidence of variance integration. In general, the additional explanatory variables are not successful in explaining the volatility of changes.

#### **IV-D British Pound**

##### **IV-D-1 Estimations**

Table 6-a reports the estimations for the BP/\$A exchange rate changes. The Tuesday dummy in the conditional mean equation is significant at 5 % in all models, and the negative sign suggests that, on average, \$A depreciated against BP on Tuesdays. The current account deficit and inflation news significantly affected the exchange rate on the days of their announcements. An unexpected current account deficit depreciated the exchange rate and an unexpected inflation appreciated it. The constant and the EGARCH-M term are not significant in any model.

In the conditional variance equation, the constant is insignificant in all models, and the negative asymmetric effect is present in all models but significant only in models 5 and 6. The autoregressive term for the variance is very close to one but not statistically so. The only significant seasonal dummy is the holiday dummy and is significant at 10 % in model 2 and at 5 % in the other models. There is no real evidence that the economic news have any

significant effect on the volatility of changes. None of the news coefficients is significant with the exception of the unemployment news in models 4 and 6, however it is significant only at 10 %. The negative sign for the news coefficient implies that, on average, the volatility of changes is decreased on the days of announcement of unemployment figures, however, the actual news variable itself is not significant. This may be explained by considering the notion that markets have in mind a clear strategic response to the news and so following an unemployment surprise market participants reacted in the predictable fashion so as to reduce the uncertainty associated with the news. The short-term interest rate had no effect on the volatility and the degree of freedom parameter for the  $t$ -distribution is around 4.8 which is an evidence against the normality assumption.

##### **IV-D-2 Diagnostics**

Table 6-b shows the diagnostics for the BP/\$A estimations. The excess kurtosis is reduced in size, however, there is an increase in the skewness compared to the one in Table 1 in all models. The statistics for the tests of linear and non linear serial correlation are significantly reduced, however, there is still some evidence of serial dependence in the squared standardised residuals which turned out to be due to an outlier. The omission of the outlier, which is the observation for 16 August 1990, removed completely the non-linear serial dependence in all models. The distributions of the standardised residuals are *iid*. There is an evidence of remaining negative sign bias as shown by the significant test statistic in all models, which cause the joint test to fail in models other than 3 and 5. The additional variables included are jointly significant in the conditional mean equation, however, they are not significant in the conditional variance equation.

In sum, although the excess kurtosis of the exchange rate changes is substantially reduced and the non-linear serial dependence of  $z_t$  eliminated (with the outlier taken out), there is an evidence of model misspecification in models other than 3 and 5 in the form of failed joint test of Engel and Ng. Thus, although EGARCH-M explains a substantial portion of the conditional variance, the models 1, 2, 4 and 6 may not be adequate.

#### **IV-E Swiss Franc**

##### **IV-E-1 Estimations**

Table 7-a reports the estimations for the SF/\$A exchange rate changes. In the conditional equation, only the current account and inflation news variables are significant. They have the same sign as before, and so the same interpretations would follow.

In the conditional variance equation, the constant term is significant at 10 % in models 2, 3 and 4. All the relevant variables for the negative asymmetric effects are significant at least at 5 % in all models. The coefficient for the autoregressive term is highly significant and close to one. The Tuesday, Thursday and holiday dummies are significant in all models, and their signs suggest the volatility of changes tends to fall on Tuesdays and Thursdays, while it tends to rise on days following a public holiday. The unemployment news is significant at 5 % in models 3 and 5 with the positive sign implying an increase in volatility whenever there is an unexpected unemployment. As in the other exchange rates, there is no significant interest rate effect and the estimated degree of freedom for the  $t$  distribution explains the significant excess kurtosis in the standardised residuals.

##### **IV-E-2 Diagnostics**

Table 7-b reports the diagnostics for the estimations. The skewness is slightly higher and the excess kurtosis is halved compared to the ones in Table 1. The distributions of the standardised residuals are *iid*. However, there is some evidence of serial dependence in the squared series, the  $Q^2$  statistic is significant at 10 % in models 2, 3 and 5, and at 5 % in models 4 and 6. The sign bias, negative sign bias and joint test are significant at least at 5 % in all models. This might be an evidence of model misspecification.

The news variables are jointly significant in the conditional mean equation but insignificant in the conditional variance equation, and the reverse is the case for the seasonal dummies. All the additional variables included in the conditional mean and variance equations are jointly significant in the relevant models.

The SF/\$A exchange rate estimations show some evidence of model misspecification judging by the significant asymmetric effects and non-linear serial correlation still present in the standardised residuals.

#### **V. Summary and Conclusion**

This paper examined the statistical properties of the logarithmic changes in daily \$A exchange rates against five currencies. All five exchange rate changes show highly significant non-linear dependence and exhibit volatility clustering. Using the EGARCH-M modeling strategy with the conditional  $t$  distribution for the standardised residuals, all five exchange rate changes were modeled with generally successful results.

The excess kurtosis is substantially reduced in the estimated standardised residuals but

is still statistically significant in the estimated models for all five exchange rate changes, providing a justification for using a non-normal conditional distribution. The highly significant serial dependence in the squared changes, which is suggestive of GARCH effects, is significantly reduced in all cases and is eliminated in all exchange rates other than SF/\$A rate. The tests of identical distributions are still significant in the standardised residuals in all models of the USD/\$A exchange rate estimations, and in some models of JY/\$A estimations.

The Engel and Ng diagnostic tests reveal that only the SF/\$A rate fails the joint test in all models and the UK/\$A estimations have some failed joint tests. Other exchange rates show no evidence of overall model misspecification.

The coefficient for the autoregressive term of the conditional variance is highly significant and very close to one but the conditional variance is not integrated in all models of five exchange rate estimations. The negative asymmetric effects of unexpected changes in exchange rates on the changes of future volatility are present and significant in all the rates except for the non-GJR models in the DM and BP estimations. The asymmetry observed indicates that an unexpected depreciation of \$A caused the volatility of exchange rate changes to rise while an unexpected appreciation had the opposite effect.

The seasonal dummies turned out to have an insignificant effect on exchange rate changes. This is not surprising considering the results in Table 2 which show virtually indistinguishable distributional characteristics amongst different days of a week. On the other hand, some news variables have a significant effect. The current account deficit and inflation news are significant in all the conditional mean equations; an unexpected current account deficit depreciated \$A against five currencies, and an unexpected inflation appreciated it. In addition, an unexpected rise in GDP appreciated the USD/\$A exchange rate.

The EGARCH-M term is not significant in any exchange rate estimations and dropping it does not produce any notable change. Thus, the volatility of changes does not affect the changes in all five exchange rates. The short-term interest rate included in the

conditional mean equations show significance only in the USD estimations, however dropping the term in the other exchange rate estimations does not produce any noticeable change.

With the exception of the USD exchange rate, all changes are more volatile on the days immediately following a public holiday. This confirms that markets have more information on those days compared to other days of week. In addition, some daily dummies have significant coefficients in the conditional variance equations; the volatility of USD changes increased on Mondays, that of DM changes decreased on Tuesdays, and that of SF changes decreased on Tuesdays and Thursdays.

The news variables included in the conditional variance equation show generally insignificant results. The current account deficit and inflation news significantly increased the volatility of USD changes while the unemployment news increased the volatilities of DM and SF changes. Other news variables simply can not explain the movements of the conditional variance of changes. There is also some evidence that the conditional variance responds to economic announcements regardless of their news contents as shown by the significant news dummies in model 4 and 6. The USD exhibits an increased volatility on the days of the current account and inflation announcements, and the BP shows a fall in the volatility on days of the unemployment announcement.

In sum, daily changes in the five \$A exchange rates exhibit volatility clustering and these non-constant conditional variances are modeled relatively well by the EGARCH-M models with the exception of SF estimations which show some evidence of model misspecification. In addition, there is an evidence of the day of the week effect in the conditional variances and some economic announcement news had a significant influence.

## **Data Appendix**

### 1. \$A Exchange Rates:

The daily \$A dollar exchange rates used in this study are daily wholesale closing rates as reported in the Australian Financial Review. \$A is measured in the foreign price term so that an increase in the rates is an appreciation of \$A. The sample period is from 2 January to 3 February 1993, yielding 2022 observations.

### 2. News variables:

#### (a) Economic announcements

The scheduled announcements of economic variables are the relevant Australian Bureau of Statistics (ABS) publications which are usually embargoed until 11.30 am on the day of announcement.

The Current Account Deficit figures are announced monthly in the Publication No. 5301, Balance of Payment. The figures are in AS billions and the publications are embargoed until 11.30 am on the day of the announcement. The sample includes 90 announcements from the July 1985 figure that was announced on 13 August to the December 1992 that was announced on 2 February 1993.

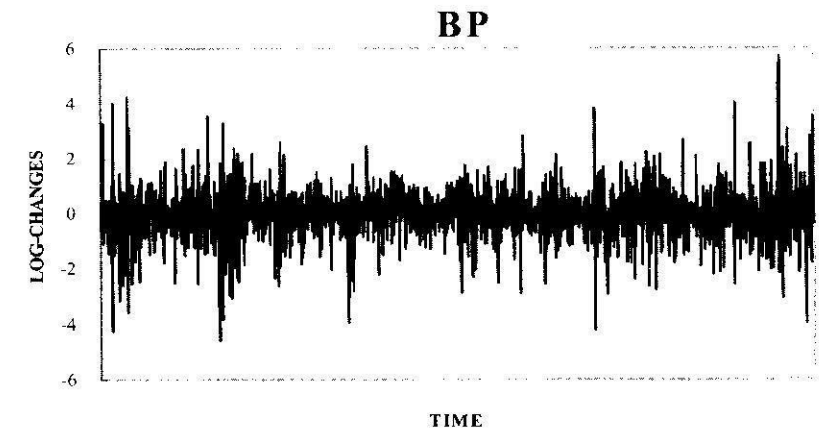
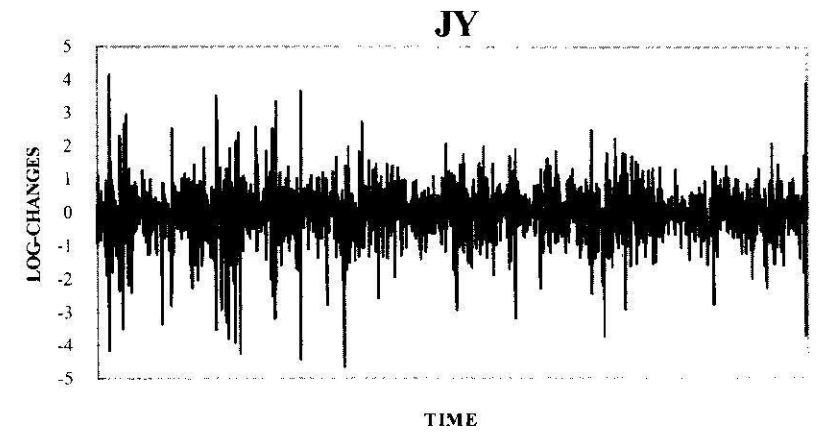
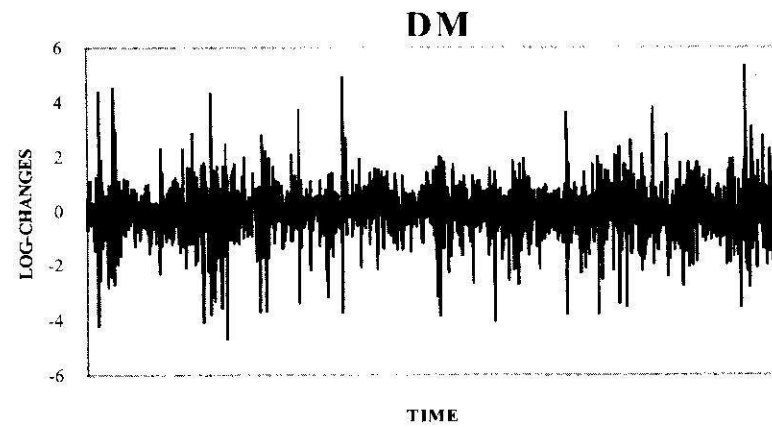
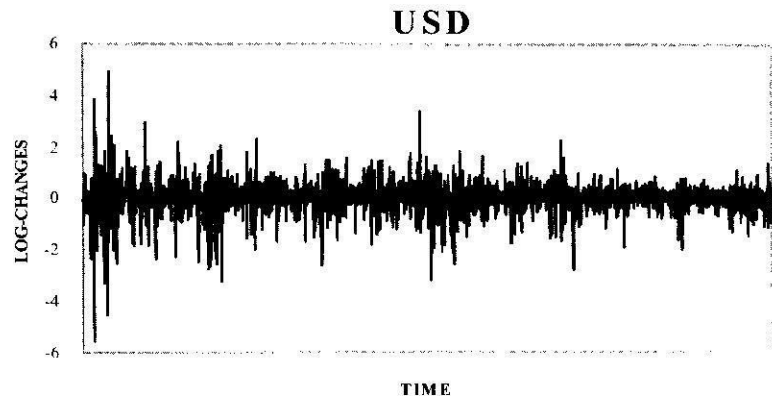
The inflation announcements are the quarterly percentage change in the weighted average prices of all goods and services in eight capital cities and are reported in the ABS Publication Call No. 6401, Consumer Price Index, Quarterly. There are 31 announcements

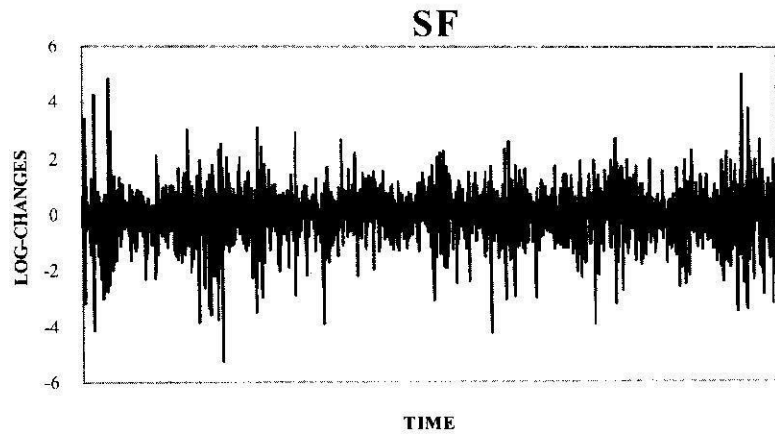
beginning from the June quarter 1985 which was announced on 25 July 1985, ending with the December quarter 1992 which was announced on 28 January 1993. The announcements were made at 9.00 am up to the December quarter 1988 announcements and 11.30 am afterwards.

The GDP announcements are the quarterly release of the ABS Publication No. 5206, Quarterly Estimates of National Income and Expenditure. The figures are the percentage change in the Estimates of Main Aggregates at constant prices. With the exception of five announcements, all announcements were made at 11.30 am. There are 30 announcements, the first one is the June quarter 1985 figures which was released on 20 August 1985 and the last one is the September quarter 1992 figures which was released on 1 December 1992.

The unemployment announcements are the monthly announcements of the proportion of persons unemployed in Australia reported in the ABS Publication No. 6203, The Labour Force Australia, Monthly. There are 87 announcements made in our sample beginning from the August 1985 figures released on 2 October 1985 and ending with the November 1992 figures released on 24 December 1992. All announcements were made at 11.30 am.

Lastly, the retail sales announcements are the percentage change in the monthly retail sale of goods measure at the current prices as reported in the table 1 of the ABS Publication No. 8501, Retail Sales of Goods, Monthly. There are 50 announcements made in our sample, the first one is the figures for August 1988 which was released on 7 November 1988 and the last one is for October 1992 which was released on 9 December 1992. All announcements were made at 11.30 am.

**Graphs: Time Series Plots of Daily SA Exchange Rate Changes**



## Tables

Table 1:  
Statistical Properties of the Daily Exchange Rate Changes

	USD	DM	JY	BP	SF
Summary Statistics					
Mean	-0.0093	-0.0414	-0.0441	-0.0203	-0.0357
Variance	0.4718	0.9395	0.7051	0.8731	0.9636
Skewness	-0.5878	-0.2005	-0.5773	-0.0135	-0.3107
Excess Kurtosis	7.2282	3.2135	3.9371	3.5183	2.4113
Minimum	-5.5263	-4.6837	-4.6554	-4.5931	-5.2414
Maximum	4.9558	5.3227	4.1460	5.7102	4.9997
Test of <i>iid</i> <sup>(a)</sup>					
Q(45) : $\chi^2(45)$	63.4394 *	60.0739 †	54.9840	50.1767	62.3045 *
	{0.0362}	{0.0657}	{0.1463}	{0.2757}	{0.0446}
Q <sup>2</sup> (45) : $\chi^2(45)$	844.8672 **	278.4618 **	300.1300 **	493.7376 **	355.7298 **
	{0.0000}	{0.0000}	{0.0000}	{0.0000}	{0.0000}
Q(k=44) : $\chi^2(43)$	143.0516 **	55.2571 †	55.8828 †	41.9423	61.6240 *
	{0.0000}	{0.0996}	{0.0899}	{0.5171}	{0.0325}
Unit Root Test <sup>(b)</sup>					
ADF	-43.7042 **	-43.9744 **	-43.3676 **	-43.8067 **	-43.5609 **
Lag	0	0	0	0	0
P-P Z(t)	-43.7016 **	-44.6279 **	-42.0490 **	-43.8520 **	-43.6174 **

Notes: The changes in daily exchange rates are defined as  $\Delta S_t = (\ln S_t - \ln S_{t-1}) \times 100$

- (a) Q(45) is the Box-Ljung test statistic for serial correlation up to 45th order for exchange rate changes.  
 Q<sup>2</sup>(45) is the Box-Ljung test statistic for squared exchange rate changes.  
 Q(k=44) is for testing the equality of distributions of exchange rate changes.

- (b) ADF denotes Augmented Dicky-Fuller test, and P-P Z(t) denotes Phillips-Perron Z test for unit root.

† means significance at the 10% level

\* means significance at the 5% level

\*\* means significance at the 1% level

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

Table 2:

Tests of Equality of Distribution of Daily Exchange Rate Changes Across a Week

	USD	DM	JY	BP	SF
Monday vs. Tuesday	37.28571 † {0.0704}	31.9524 {0.1947}	28.21693 {0.3479}	19.97892 {0.7926}	21.07994 {0.7378}
Monday vs. Wednesday	22.50739 {0.6606}	37.3810 † {0.0690}	21.15344 {0.7340}	25.54487 {0.4883}	26.58201 {0.4315}
Monday vs. Thursday	28.50916 {0.3339}	32.5026 {0.1770}	19.95238 {0.7938}	23.61905 {0.5977}	28.18482 {0.3494}
Monday vs. Friday	43.14999 * {0.0186}	30.4598 {0.2490}	29.66667 {0.2817}	27.90169 {0.3633}	24.98358 {0.5199}
Tuesday vs. Wednesday	54.81348 ** {0.0008}	28.5661 {0.3312}	18.78836 {0.8452}	20.40182 {0.7721}	36.80952 † {0.0778}
Tuesday vs. Thursday	58.8583 ** {0.0002}	21.0741 {0.7381}	19.67725 {0.8066}	21.72528 {0.7036}	27.57072 {0.3799}
Tuesday vs. Friday	27.60837 {0.3780}	16.9538 {0.9105}	30.32804 {0.2542}	32.33968 {0.1821}	19.2184 {0.8271}
Wednesday vs. Thursday	24.01734 {0.5750}	33.6667 {0.1436}	17.8232 {0.8821}	22.01058 {0.6881}	26.2963 {0.4469}
Wednesday vs. Friday	31.77249 {0.2008}	33.5979 {0.1455}	31.07608 {0.2254}	31.24078 {0.2194}	18.28042 {0.8653}
Thursday vs. Friday	40.85185 * {0.0321}	18.2963 {0.8647}	32.86773 {0.1660}	31.31486 {0.2168}	22.28042 {0.6733}

Notes: The pairwise test of equality of distribution of changes across a week is the test of equality of two multinomial distributions. There are 391 observations in each weekday group, and so the test statistic is distributed as  $\chi^2_{(k-1)}$ , where  $k \approx (391 \times 2)^{1/2}$ .

Asymptotic p-values are in {...}'s.

Table 3-a: USD

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
$\alpha_c$	0.0627 † (0.0355)		0.0391 (0.0380)		0.0427 (0.0367)		0.0347 (0.0366)		0.0425 (0.0367)		0.0368 (0.0367)	
$\alpha_{MON}$			0.0238 (0.0318)		0.0314 (0.0315)		0.0257 (0.0314)		0.0308 (0.0315)		0.0262 (0.0314)	
$\alpha_{TUE}$			0.0387 (0.0322)		0.0394 (0.0320)		0.0377 (0.0320)		0.0392 (0.0320)		0.0377 (0.0320)	
$\alpha_{WED}$			0.0713 * (0.0312)		0.0751 * (0.0308)		0.0707 * (0.0309)		0.0750 * (0.0308)		0.0717 * (0.0309)	
$\alpha_{THU}$			-0.0039 (0.0309)		0.0016 (0.0307)		-0.0010 (0.0306)		0.0015 (0.0307)		-0.0011 (0.0306)	
$\alpha_{FRI}$			0.0199 (0.0530)		0.0272 (0.0528)		0.0225 (0.0530)		0.0274 (0.0528)		0.0222 (0.0530)	
$\alpha_{CAD}$					-0.0101 ** (0.0019)		-0.0096 ** (0.0015)		-0.0101 ** (0.0019)		-0.0096 ** (0.0015)	
$\alpha_{CHI}$					0.6198 * (0.2591)		0.7661 ** (0.2372)		0.6202 * (0.2592)		0.7680 ** (0.2382)	
$\alpha_{JDP}$					0.1494 * (0.0750)		0.1396 (0.0932)		0.1494 * (0.0750)		0.1369 (0.0933)	
$\alpha_{UIMP}$					-0.0135 (0.0397)		-0.0100 (0.0206)		-0.0128 (0.0385)		-0.0103 (0.0206)	
$\alpha_{RET}$					-0.0039 (0.0380)		-0.0047 (0.0357)		-0.0018 (0.0379)		-0.0009 (0.0357)	
$\alpha_h$	-0.0586 (0.0618)		-0.0653 (0.0616)		-0.0769 (0.0606)		-0.0589 (0.0600)		-0.0764 (0.0607)		-0.0634 (0.0603)	
$\beta_c$	-0.1284 ** (0.0496)		-0.2741 * (0.1173)		-0.3518 ** (0.1204)		-0.2958 * (0.1210)		-0.6174 ** (0.1259)		-0.5720 ** (0.1274)	
$\beta_{E1}$	-0.0479 * (0.0239)		-0.0477 * (0.0241)		-0.0476 † (0.0254)		-0.0458 † (0.0255)		0.2854 ** (0.0565)		0.2934 ** (0.0570)	
$\beta_{E2}$	0.3093 ** (0.0436)		0.3150 ** (0.0441)		0.3328 ** (0.0457)		0.3344 ** (0.0462)					
$\beta_{E3}$									-0.6659 ** (0.0915)		-0.6805 ** (0.0935)	
$\beta_h$	0.9224 ** (0.0177)		0.9228 ** (0.0176)		0.9080 ** (0.0189)		0.9122 ** (0.0191)		0.9081 ** (0.0189)		0.9096 ** (0.0195)	
$\beta_{MON}$			0.3629 † (0.1854)		0.3745 * (0.1853)		0.3554 † (0.1871)		0.3745 * (0.1853)		0.3557 † (0.1871)	
$\beta_{TUE}$			0.1916 (0.1579)		0.2111 (0.1579)		0.1974 (0.1593)		0.2114 (0.1579)		0.1945 (0.1593)	
$\beta_{WED}$			0.1147 (0.1532)		0.0983 (0.1537)		0.0676 (0.1544)		0.0983 (0.1536)		0.0669 (0.1544)	
$\beta_{THU}$			0.0836 (0.1764)		0.1347 (0.1776)		0.1085 (0.1796)		0.1351 (0.1776)		0.1107 (0.1798)	
$\beta_{FRI}$			0.0374 (0.1296)		0.0704 (0.1346)		0.0394 (0.1356)		0.0706 (0.1346)		0.0424 (0.1368)	
$\beta_{CAD}$					0.0122 ** (0.0042)		0.2652 † (0.1506)		0.0122 ** (0.0042)		0.2696 † (0.1510)	
$\beta_{CHI}$					1.1889 * (0.5674)		0.4609 * (0.2194)		1.1880 * (0.5676)		0.4682 * (0.2209)	
$\beta_{JDP}$					-0.1541 (0.2559)		0.1185 (0.2159)		-0.1546 (0.2560)		0.1289 (0.2175)	
$\beta_{UIMP}$					0.0596 (0.0873)		-0.0448 (0.1495)		0.0597 (0.0869)		-0.0406 (0.1502)	
$\beta_{RET}$					-0.0613 (0.1049)		-0.2639 (0.1753)		-0.0621 (0.1046)		-0.2634 (0.1764)	
$\beta_t$	0.0066 * (0.0026)		0.0062 * (0.0026)		0.0085 ** (0.0029)		0.0065 * (0.0029)		0.0085 ** (0.0029)		0.0067 * (0.0029)	
d	3.7599 ** (0.3986)		3.7667 ** (0.4007)		3.8861 ** (0.4101)		3.8020 ** (0.3999)		3.8846 ** (0.4101)		3.8002 ** (0.3993)	
R	4		4		4		4		4		4	
Ln L	-574.5		-568.0		-548.5		-550.0		-548.5		-550.1	

Notes: d is the estimated degrees of freedom parameter of the t distribution for the standardised 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.

Model 1: Conditional Mean and Conditional Variance Equations

$$\Delta S_t = \alpha_c + \alpha_h \sqrt{h_t} + \sum_{k=1}^R \alpha_k \Delta S_{t-k} + \varepsilon_t$$

$$\ln h_t = \beta_c + \beta_{\varepsilon 1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\varepsilon 2} \left( \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right) + \beta_h \ln h_{t-1} + \beta_r r_t$$

Model 2: Conditional Mean and Conditional Variance Equations

$$\Delta S_t = \alpha_c + \sum_{i=MON}^{THU} \alpha_i D_{it} + \alpha_h \sqrt{h_t} + \sum_{k=1}^R \alpha_k \Delta S_{t-k} + \varepsilon_t$$

$$\ln h_t = \beta_c + \sum_{i=MON}^{THU} \beta_i D_{it} + \beta_{\varepsilon 1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\varepsilon 2} \left( \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right) + \beta_h \ln h_{t-1} + \beta_r r_t$$

Model 3, 4, 5 and 6: Conditional Mean Equation

$$\Delta S_t = \alpha_c + \sum_{i=MON}^{THU} \alpha_i D_{it} + \sum_{j=CAD}^{RET} \alpha_j |NEWS_{jt}| + \alpha_h \sqrt{h_t} + \sum_{k=1}^R \Delta S_{t-k} + \varepsilon_t$$

Model 3: Conditional Variance Equation

$$\ln h_t = \beta_c + \sum_{i=MON}^{THU} \beta_i D_{it} + \sum_{j=CAD}^{RET} \beta_j |NEWS_{jt}| + \beta_{\varepsilon 1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\varepsilon 2} \left( \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right) + \beta_h \ln h_{t-1} + \beta_r r_t$$

Model 4: Conditional Variance Equation

$$\ln h_t = \beta_c + \sum_{i=MON}^{THU} \beta_i D_{it} + \sum_{j=CAD}^{RET} \beta_j NEWS_{jt} + \beta_{\varepsilon 1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\varepsilon 2} \left( \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right) + \beta_h \ln h_{t-1} + \beta_r r_t$$

Model 5: Conditional Variance Equation

$$\ln h_t = \beta_c + \sum_{i=MON}^{THU} \beta_i D_{it} + \sum_{j=CAD}^{RET} \beta_j |NEWS_{jt}| + \beta_{\varepsilon 1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\varepsilon 2} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} S^- + \beta_h \ln h_{t-1} + \beta_r r_t$$

Model 6: Conditional Variance Equation

$$\ln h_t = \beta_c + \sum_{i=MON}^{THU} \beta_i D_{it} + \sum_{j=CAD}^{RET} \beta_j NEWS_{jt} + \beta_{\varepsilon 1} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \beta_{\varepsilon 2} \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} S^- + \beta_h \ln h_{t-1} + \beta_r r_t$$

Table 3-b: USD Diagnostics

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Summary Statistics on $Z_t$						
Mean	-0.0455	-0.0426	0.0456	-0.0449	-0.0454	-0.0442
Variance	0.9195	0.9213	0.9392	0.9321	0.9391	0.9326
Skewness	-0.4987	-0.4511	-0.5335	-0.4673	-0.5341	-0.4695
Excess Kurtosis	3.2225	3.2608	3.7296	3.8251	3.7294	3.8658
Tests for iid of $Z_t^{(a)}$						
Q(45): $\chi^2(45)$	43.0223 {0.5561}	42.4027 {0.5826}	42.1390 {0.5939}	42.9682 {0.5584}	42.1651 {0.5927}	43.1914 {0.5488}
Q <sup>2</sup> (45): $\chi^2(45)$ (Full Sample)	94.0859 ** {0.0000}	91.0678 ** {0.0001}	100.5051 ** {0.0000}	93.3376 ** {0.0000}	100.3971 ** {0.0000}	94.1049 ** {0.0000}
Q <sup>2</sup> (45): $\chi^2(45)$ (With an outlier omitted)	58.0396 † {0.0919}	56.9418 {0.1092}	55.3088 {0.1395}	54.0604 {0.1668}	55.2495 {0.1408}	54.1944 {0.1637}
Q <sup>2</sup> (k=44): $\chi^2(43)$	64.9429 * {0.0169}	84.0982 ** {0.0002}	63.9034 * {0.0209}	60.5098 * {0.0416}	61.5034 * {0.0333}	63.1034 * {0.0245}
Engel and Ng Sign Bias Tests <sup>(b)</sup>						
Sign Bias	1.0853 {0.2779}	0.8265 {0.4086}	0.4762 {0.6340}	0.5670 {0.5708}	0.4442 {0.6570}	0.4463 {0.6554}
Negative Sign Bias	-1.3813 {0.1673}	-1.4547 {0.1459}	-0.7952 {0.4266}	-0.9775 {0.3284}	-0.7945 {0.4270}	-0.9021 {0.3671}
Positive Sign Bias	-1.6438 {0.1004}	-1.6039 {0.1089}	-1.6781 † {0.0935}	-1.6429 {0.1006}	-1.6813 † {0.0929}	-1.6525 † {0.0986}
Joint Test: $\chi^2(3)$	3.6490 {0.1185}	4.0199 {0.2593}	3.5361 {0.3161}	3.5260 {0.3174}	3.6147 {0.3062}	3.6812 {0.2980}
Test for Unit Root in the Conditional Variance, $H_0: \nu_h = 1$						
$\chi^2(1)$	19.3340 ** {0.0000}	19.2769 ** {0.0000}	23.7032 ** {0.0000}	21.1658 ** {0.0000}	23.6148 ** {0.0000}	21.5753 ** {0.0000}
Joint Tests of Significance <sup>(c)</sup>						
$H_0: m_i = 0,$ for all i, $\chi^2(5)$		7.6277 0.1780	8.0271 0.1547	7.2823 0.2005	8.0151 0.1554	7.4432 0.1897
$H_0: m_j = 0,$ for all j, $\chi^2(5)$			37.8909 ** 0.0000	53.8493 ** 0.0000	37.9495 ** 0.0000	53.6700 ** 0.0000
$H_0: m_i = m_j = 0,$ for all i and j, $\chi^2(10)$			48.4026 ** 0.0000	63.8532 ** 0.0000	48.4409 ** 0.0000	63.7449 ** 0.0000
$H_0: \nu_i = 0,$ for all i, $\chi^2(5)$		6.0990 0.2967	6.0727 0.2992	5.8522 0.3209	6.0690 0.2996	5.7989 0.3263
$H_0: \nu_j = 0,$ for all j, $\chi^2(5)$			13.7795 * 0.0171	10.2761 * 0.0678	13.7873 * 0.0170	10.4354 † 0.0638
$H_0: \nu_i = \nu_j = 0,$ for all i and j, $\chi^2(10)$			19.3768 * 0.0357	16.4019 † 0.0887	19.3842 0.0356	16.4767 † 0.0868
$H_0: m_i = m_j = \nu_i = \nu_j = 0,$ for all i and j, $\chi^2(20)$			62.4738 ** 0.0000	77.6126 ** 0.0000	62.4764 ** 0.0000	77.5734 ** 0.0000

Table 4-b: DM Diagnostics

Notes:

- (a)  $Q(45)$  is the Box-Ljung test statistic for serial correlation upto 45th order for  $z_t$ .  
 $Q^2(45)$  is the Box-Ljung test statistic for  $z_t^2$  with full sample, and with an outlier omitted.  
 $Q(k=44)$  is for testing the equality of distributions of  $z_t$ .
- (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  $s_{t-1}^- \varepsilon_{t-1}$ .  
 Positive sign bias is the t-test of the slope coefficient of the regression of  $z_t^2$  on  $s_{t-1}^- \varepsilon_{t-1}$ .  
 Joint test is the LM test of joint significance of all three regressors.
- (c)  $m_i$ 's and  $v_i$ 's are the coefficients for the five seasonal dummies and  $m_j$ 's and  $v_j$ 's are the coefficients for the five news variables in the conditional mean and variance equations, respectively.

Table 4-a: DM

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
$\alpha_C$	0.0571	(0.0797)			0.0351	(0.0849)	0.0605	(0.0835)	0.0322	(0.0837)	0.0605	(0.0835)
$\alpha_{MON}$			-0.0074	(0.0571)	0.0090	(0.0573)	0.0026	(0.0571)	0.0090	(0.0573)	0.0045	(0.0572)
$\alpha_{TUE}$			-0.0600	(0.0543)	-0.0616	(0.0539)	-0.0624	(0.0543)	-0.0616	(0.0539)	-0.0625	(0.0542)
$\alpha_{WED}$			0.0761	(0.0546)	0.0710	(0.0544)	0.0714	(0.0543)	0.0710	(0.0544)	0.0719	(0.0542)
$\alpha_{THU}$			0.0128	(0.0530)	0.0093	(0.0528)	0.0141	(0.0532)	0.0093	(0.0528)	0.0140	(0.0531)
$\alpha_{FRI}$			-0.0972	(0.1038)	-0.0897	(0.1049)	-0.0957	(0.1037)	-0.0897	(0.1049)	-0.0886	(0.1050)
$\alpha_{CAD}$					-0.0105	** (0.0028)	-0.0101	** (0.0022)	-0.0105	** (0.0028)	-0.0101	** (0.0022)
$\alpha_{CPI}$					1.1288	** (0.4086)	1.1744	** (0.4024)	1.1280	** (0.4087)	1.1732	** (0.4013)
$\alpha_{GDP}$					0.0916	(0.1665)	0.1016	(0.1928)	0.0916	(0.1665)	0.1007	(0.1974)
$\alpha_{UNEMP}$					-0.0902	(0.0856)	-0.0806	* (0.0358)	-0.0903	(0.0856)	-0.0827	* (0.0350)
$\alpha_{RET}$					-0.0040	(0.0831)	-0.0036	(0.0801)	-0.0040	(0.0831)	-0.0029	(0.0795)
$\alpha_h$			-0.076	(0.0914)	-0.0559	(0.0905)	-0.0879	(0.0896)	-0.0554	(0.0893)	-0.0879	(0.0896)
$\beta_C$	0.0289	(0.0298)	0.1490	(0.1059)	0.1108	(0.1082)	0.1464	(0.1076)	-0.1373	(0.1109)	-0.1106	(0.1112)
$\beta_{s1}$	-0.0316	(0.0214)	-0.0351	(0.0222)	-0.0339	(0.0233)	-0.0385	† (0.0230)	0.2770	** (0.0478)	0.2775	** (0.0496)
$\beta_{E2}$	0.2825	** (0.0371)	0.2907	** (0.0385)	0.3108	** (0.0396)	0.3021	** (0.0393)				
$\beta_{E3}$									-0.6218	** (0.0791)	-0.6329	** (0.0819)
$\beta_h$	0.9096	** (0.0215)	0.9026	** (0.0217)	0.8879	** (0.0235)	0.8943	** (0.0225)	0.8878	** (0.0235)	0.8843	** (0.0247)
$\beta_{MON}$			0.0042	(0.1798)	0.0288	(0.1714)	0.0188	(0.1720)	0.0289	(0.1714)	0.0339	(0.1722)
$\beta_{TUE}$			-0.2501	† (0.1508)	-0.2638	† (0.1511)	-0.2630	† (0.1528)	-0.2638	† (0.1511)	-0.2665	† (0.1524)
$\beta_{WED}$			-0.1954	(0.1461)	-0.2054	(0.1467)	-0.2207	(0.1475)	-0.2055	(0.1467)	-0.2138	(0.1471)
$\beta_{THU}$			-0.1888	(0.1708)	-0.1478	(0.1727)	-0.1558	(0.1732)	-0.1477	(0.1727)	-0.1484	(0.1735)
$\beta_{HOL}$			0.2973	** (0.1258)	0.3386	* (0.1325)	0.3294	* (0.1295)	0.3386	* (0.1325)	0.3439	* (0.1351)
$\beta_{CAD}$					0.0064	(0.0044)	0.0251	(0.1460)	0.0064	(0.0044)	0.0381	(0.1483)
$\beta_{CPI}$					0.3071	(0.6224)	0.1210	(0.2229)	0.3075	(0.6226)	0.1216	(0.2298)
$\beta_{GDP}$					0.0137	(0.2439)	0.2353	(0.2086)	0.0139	(0.2440)	0.2591	(0.2164)
$\beta_{UNEMP}$					0.1172	† (0.0662)	-0.0805	(0.1414)	0.1173	† (0.0662)	-0.0788	(0.1439)
$\beta_{RET}$					0.0254	(0.1031)	-0.0259	(0.1667)	0.0253	(0.1033)	-0.0294	(0.1708)
$\beta_r$	-0.0022	(0.0021)	-0.0025	(0.0023)	-0.0015	(0.0026)	-0.0029	(0.0024)	-0.0015	(0.0026)	-0.0031	(0.0026)
$d$	5.3522	** (0.6429)	5.5336	** (0.7039)	5.6091	** (0.7125)	5.5354	** (0.7117)	5.6093	** (0.7125)	5.5497	** (0.7159)
$R$	0		0		0		0		0		0	
Ln L	-1459.2		-1449.7		-1436.2		-1438.4		-1436.2		-1438.4	

Notes: See the notes for Table 3-a.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Summary Statistics on $Z_t$						
Mean	-0.0307	-0.0289	-0.0268	-0.0295	-0.0268	-0.0288
Variance	0.9909	0.9901	0.9932	0.9904	0.9932	0.9904
Skewness	-0.2187	-0.2173	-0.1962	-0.2460	-0.1962	-0.2458
Excess Kurtosis	2.5794	2.3260	2.3971	2.2938	2.3970	2.2872
Tests for iid of $Z_t^{(a)}$						
$Q(45): \chi^2(45)$	48.9028 {0.3192}	48.9532 {0.3174}	51.2881 {0.2408}	51.3174 {0.2399}	51.2881 {0.2408}	51.6239 {0.2308}
$Q^2(45): \chi^2(45)$	46.9537 {0.3924}	50.3355 {0.2706}	50.3670 {0.2695}	53.7059 {0.1752}	50.3620 {0.2696}	52.6001 {0.2034}
$Q^2(k=44): \chi^2(43)$	56.1171 <sup>†</sup> {0.0865}	46.9036 {0.3155}	49.8342 {0.2200}	36.7490 {0.7379}	49.8342 {0.2200}	37.6185 {0.7032}
Engel and Ng Sign Bias Tests <sup>(b)</sup>						
Sign Bias	0.7335 {0.4633}	0.7573 {0.4489}	0.5669 {0.5708}	0.7275 {0.4670}	0.5667 {0.5710}	0.6615 {0.5084}
Negative Sign Bias	-2.2342 <sup>*</sup> {0.0256}	-2.2536 <sup>*</sup> {0.0243}	-1.8870 <sup>†</sup> {0.0593}	-2.1907 <sup>*</sup> {0.0286}	-1.8859 <sup>†</sup> {0.0595}	-2.0193 <sup>*</sup> {0.0436}
Positive Sign Bias	-0.1759 {0.8604}	-0.2216 {0.8246}	-0.1322 {0.8948}	-0.1697 {0.8653}	-0.1326 {0.8945}	-0.2414 {0.8092}
Joint Test: $\chi^2(3)$	5.6520 {0.1298}	5.6964 {0.1274}	4.1188 {0.2489}	5.4338 {0.1427}	4.1147 {0.2493}	4.5854 {0.2048}
Test for Unit Root in the Conditional Variance, $H_0: V_h = 1$						
$\chi^2(1)$	17.6616** {0.0000}	20.1621** {0.0000}	22.7947** {0.0000}	22.0633** {0.0000}	22.7953** {0.0000}	22.0154** {0.0000}
Joint Tests of Significance <sup>(c)</sup>						
$H_0: m_i = 0,$ for all $i, \chi^2(5)$		7.7604 0.1699	7.2276 0.2043	7.5380 0.1836	7.2263 0.2043	7.4405 0.1899
$H_0: m_j = 0,$ for all $j, \chi^2(5)$			23.0284**	35.1129**	23.0139**	35.0151**
$H_0: m_i = m_j = 0,$ for all $i$ and $j, \chi^2(10)$			0.0003	0.0000	0.0003	0.0000
$H_0: v_i = 0,$ for all $i, \chi^2(5)$		31.8844**	44.8370**	31.8684**	44.6034**	44.6034**
$H_0: v_j = 0,$ for all $j, \chi^2(5)$		10.6574 <sup>†</sup>	12.5283 <sup>*</sup>	12.5781 <sup>*</sup>	12.5295 <sup>*</sup>	12.8702 <sup>*</sup>
$H_0: v_i = v_j = 0,$ for all $i$ and $j, \chi^2(10)$		0.0586	0.0282	0.0277	0.0282	0.0246
$H_0: m_i = m_j = v_i = v_j = 0,$ for all $i$ and $j, \chi^2(20)$			5.2597	1.8995	5.2600	2.0620
			0.3850	0.8629	0.3850	0.8405
			16.9647 <sup>†</sup>	14.0807	16.9662 <sup>†</sup>	14.5433
			0.0751	0.1693	0.0751	0.1496
			51.2505**	62.6968**	51.2322**	63.0764**
			0.0001	0.0000	0.0001	0.0000

Notes: (a), (b) and (c): See the notes for Table 3-b.

Table 5-a: JY

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
$\alpha_c$	0.0689	(0.0598)	0.0753	(0.0668)	0.0878	(0.0660)	0.0856	(0.0662)	0.0911	(0.0663)	0.0875	(0.0663)
$\alpha_{MON}$			-0.0112	(0.0470)	-0.0024	(0.0471)	-0.0057	(0.0471)	-0.0033	(0.0473)	-0.0060	(0.0472)
$\alpha_{TUE}$			-0.0487	(0.0456)	-0.0498	(0.0456)	-0.0483	(0.0458)	-0.0502	(0.0456)	-0.0490	(0.0457)
$\alpha_{WED}$			0.0244	(0.0444)	0.0176	(0.0443)	0.0187	(0.0444)	0.0166	(0.0443)	0.0181	(0.0443)
$\alpha_{THU}$			-0.0299	(0.0446)	-0.0282	(0.0445)	-0.0264	(0.0447)	-0.0291	(0.0446)	-0.0273	(0.0447)
$\alpha_{HOL}$			0.0565	(0.0828)	0.0706	(0.0835)	0.0707	(0.0832)	0.0782	(0.0845)	0.0762	(0.0840)
$\alpha_{CAD}$					-0.0074	** (0.0023)	-0.0072	** (0.0019)	-0.0075	** (0.0024)	-0.0072	** (0.0019)
$\alpha_{CPI}$					1.0400	** (0.3593)	1.1430	** (0.3047)	1.0222	** (0.3618)	1.1383	** (0.3037)
$\alpha_{GDP}$					0.1485	(0.1058)	0.1433	(0.1208)	0.1434	(0.1096)	0.1435	(0.1224)
$\alpha_{UEMP}$					-0.0345	(0.0606)	-0.0366	(0.0440)	-0.0399	(0.0618)	-0.0347	(0.0422)
$\alpha_{RET}$					-0.0220	(0.0506)	-0.0234	(0.0511)	-0.0218	(0.0512)	-0.0232	(0.0515)
$\alpha_h$	-0.089	(0.0819)	-0.0806	(0.0820)	-0.1001	(0.0809)	-0.0983	(0.0810)	-0.1040	(0.0813)	-0.1004	(0.0813)
$\beta_c$	-0.0784	† (0.0422)	-0.0529	(0.1100)	-0.0758	(0.1127)	-0.0528	(0.1117)	-0.4131	** (0.1189)	-0.3752	** (0.1178)
$\beta_{c1}$	-0.0724	** (0.0240)	-0.0765	** (0.0255)	-0.0786	** (0.0268)	-0.0784	** (0.0265)	0.3197	** (0.0581)	0.3078	** (0.0588)
$\beta_{c2}$	0.3342	** (0.0422)	0.3640	** (0.0446)	0.3819	** (0.0462)	0.3757	** (0.0466)				
$\beta_{e1}$									-0.8012	** (0.0952)	-0.7766	** (0.0956)
$\beta_h$	0.8832	** (0.0236)	0.8627	** (0.0261)	0.8489	** (0.0275)	0.8562	** (0.0266)	0.8338	** (0.0297)	0.8464	** (0.0283)
$\beta_{MON}$			0.0660	(0.1687)	0.0504	(0.1687)	0.0438	(0.1694)	0.0572	(0.1677)	0.0500	(0.1688)
$\beta_{TUE}$			-0.2080	(0.1475)	-0.2244	(0.1477)	-0.2197	(0.1482)	-0.2301	(0.1465)	-0.2246	(0.1472)
$\beta_{WED}$			-0.0762	(0.1477)	-0.1285	(0.1478)	-0.1395	(0.1481)	-0.1263	(0.1466)	-0.1372	(0.1472)
$\beta_{THU}$			-0.0390	(0.1708)	-0.0136	(0.1714)	-0.0159	(0.1717)	-0.0068	(0.1703)	-0.0105	(0.1710)
$\beta_{HOL}$			0.3387	† (0.1527)	0.3899	† (0.1578)	0.3717	† (0.1547)	0.4112	† (0.1635)	0.3859	† (0.1595)
$\beta_{CAD}$					0.0056	(0.0048)	0.0216	(0.1545)	0.0059	(0.0049)	0.0281	(0.1569)
$\beta_{CPI}$					1.1094	(0.7489)	0.3384	(0.2266)	1.1612	(0.7763)	0.3469	(0.2319)
$\beta_{GDP}$					0.0097	(0.2830)	0.2532	(0.2534)	0.0420	(0.2911)	0.2662	(0.2390)
$\beta_{UEMP}$					0.0166	(0.0809)	-0.0259	(0.1540)	0.0144	(0.0844)	-0.0196	(0.1567)
$\beta_{RET}$					-0.0446	(0.1068)	-0.1043	(0.1710)	-0.0355	(0.1094)	-0.0881	(0.1738)
$\beta_T$	0.0031	(0.0027)	0.0035	(0.0030)	0.0046	(0.0034)	0.0036	(0.0032)	0.0051	(0.0036)	0.0039	(0.0034)
d	4.9240	** (0.6736)	5.0909	** (0.7052)	5.1115	** (0.7046)	5.1814	** (0.7396)	5.1431	** (0.7081)	5.2006	** (0.7415)
R	0		0		0		0		0		0	
Ln L	-1111.7		-1105.8		-1092.0		-1092.7		-1092.0		-1092.7	

Notes: See the notes for Table 3-a.

Table 5-b: JY Diagnostics

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Summary Statistics on $Z_t$					
Mean	-0.0442	-0.0461	-0.0466	-0.0461	-0.0464	-0.0458
Variance	0.9613	0.9670	0.9704	0.9693	0.9716	0.9701
Skewness	-0.4585	-0.4811	-0.5168	-0.5043	-0.5192	-0.5056
Excess Kurtosis	1.6388	1.6455	1.7494	1.5777	1.7717	1.5936
Tests for $h(d)$ of $Z_t^{(a)}$						
$Q(45): \chi^2(45)$	37.1387 {0.7913}	37.5447 {0.7772}	38.0686 {0.7582}	38.3156 {0.7491}	37.7917 {0.7683}	38.1588 {0.7549}
$Q^2(45): \chi^2(45)$	42.3286 {0.5858}	45.6394 {0.4454}	47.4271 {0.3739}	48.0445 {0.3505}	47.9459 {0.3542}	48.6045 {0.3299}
$Q^2(k=44): \chi^2(43)$	42.6785 {0.4851}	50.5994 {0.1986}	64.6040 {0.0181}	57.5296 {0.0683}	62.5171 {0.0274}	47.3933 {0.2981}
Engel and Ng Sign Bias Tests <sup>(b)</sup>						
Sign Bias	2.3053 {0.0213}	2.2279 {0.0260}	1.8533 {0.0640}	2.0261 {0.0429}	1.7411 {0.0818}	1.9005 {0.0575}
Negative Sign Bias	-1.8192 {0.0690}	-1.5925 {0.1114}	-1.3258 {0.1851}	-1.5573 {0.1196}	-1.0823 {0.2793}	-1.3702 {0.1708}
Positive Sign Bias	-1.0180 {0.3088}	-1.0418 {0.2976}	-1.0191 {0.3083}	-1.0499 {0.2939}	-1.0391 {0.2989}	-1.0602 {0.2892}
Joint Test: $\chi^2(3)$	5.8216 {0.1206}	5.1773 {0.1593}	3.5289 {0.3170}	4.3410 {0.2269}	3.0381 {0.3858}	3.7168 {0.2937}
Test for Unit Root in the Conditional Variance, $H_0: \nu_h = 1$						
$\chi^2(1)$	24.4472 {0.0000}	27.6465 {0.0000}	30.1613 {0.0000}	29.2345 {0.0000}	31.4116 {0.0000}	29.3661 {0.0000}
Joint Tests of Significance <sup>(c)</sup>						
$H_0: m_i = 0$ for all $i, \chi^2(5)$		3.3653	3.1812	3.0453	3.2758	3.1615
$H_0: m_i = 0$ for all $j, \chi^2(5)$		0.6439	0.6721	0.6930	0.6576	0.6751
$H_0: m_i = m_j = 0$ for all $i$ and $j, \chi^2(10)$			20.8987**	31.2859**	20.2933**	31.3090**
$H_0: \nu_i = 0$ for all $i, \chi^2(5)$			0.0008	0.0000	0.0011	0.0000
$H_0: \nu_i = \nu_j = 0$ for all $i$ and $j, \chi^2(10)$			24.1811**	34.3757**	23.6427**	34.5240**
$H_0: \nu_i = 0$ for all $i, \chi^2(5)$		7.7187	9.7898 <sup>†</sup>	9.5289 <sup>†</sup>	10.3189 <sup>†</sup>	9.8759 <sup>†</sup>
$H_0: \nu_i = 0$ for all $j, \chi^2(5)$		0.1724	0.0814	0.0897	0.0667	0.0788
$H_0: \nu_i = \nu_j = 0$ for all $i$ and $j, \chi^2(10)$			3.7104	3.7607	3.7427	3.6964
$H_0: m_i = m_j = \nu_i = \nu_j = 0$ for all $i$ and $j, \chi^2(20)$			0.5918	0.5844	0.5870	0.5939
			12.5770	13.0339	13.0822	13.3000
			0.2483	0.2218	0.2191	0.2074
			35.1890 <sup>*</sup>	46.7495**	35.2859 <sup>*</sup>	47.2833**
			0.0191	0.0006	0.0186	0.0005

Notes: (a), (b) and (c): See the notes for Table 3-b.

Table 6-a: BP

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
$\alpha_C$	-0.0158	(0.0700)	0.0147	(0.0758)	0.0261	(0.0755)	0.0057	(0.0740)	0.0262	(0.0755)	0.0072	(0.0744)
$\alpha_{MON}$			-0.0064	(0.0526)	0.0053	(0.0525)	-0.0023	(0.0522)	0.0054	(0.0525)	-0.0005	(0.0522)
$\alpha_{TUE}$			-0.1226 *	(0.0514)	-0.1161 *	(0.0511)	-0.1251 *	(0.0513)	-0.1161 *	(0.0511)	-0.1227 *	(0.0512)
$\alpha_{WED}$			-0.0011	(0.0512)	-0.0029	(0.0509)	-0.0090	(0.0512)	-0.0028	(0.0509)	-0.0089	(0.0511)
$\alpha_{THU}$			-0.0307	(0.0503)	-0.0292	(0.0503)	-0.0324	(0.0504)	-0.0291	(0.0503)	-0.0270	(0.0503)
$\alpha_{FRI}$			-0.0851	(0.0863)	-0.0840	(0.0878)	-0.0858	(0.0870)	-0.0838	(0.0878)	-0.0862	(0.0872)
$\alpha_{CAD}$					-0.0109 **	(0.0025)	-0.0107 **	(0.0021)	0.0109 **	(0.0025)	0.0107 **	(0.0021)
$\alpha_{CPI}$					0.9046 *	(0.3532)	0.8696 *	(0.3510)	0.9048 *	(0.3532)	0.8948 *	(0.3538)
$\alpha_{GDP}$					0.0358	(0.1531)	0.0342	(0.1596)	0.0357	(0.1531)	0.0298	(0.1632)
$\alpha_{UEMP}$					-0.0676	(0.0956)	-0.0671	(0.0504)	-0.0676	(0.0956)	-0.0669	(0.0497)
$\alpha_{RET}$					-0.0120	(0.0716)	-0.0107	(0.0748)	-0.0120	(0.0716)	-0.0120	(0.0743)
$\alpha_h$	0.0179	(0.0836)	0.0267	(0.0813)	0.0088	(0.0813)	0.0377	(0.0798)	0.0087	(0.0813)	0.0346	(0.0801)
$\beta_C$	0.0257	(0.0189)	0.0710	(0.0984)	0.0452	(0.1032)	0.0611	(0.0988)	-0.1553	(0.1067)	-0.1190	(0.1034)
$\beta_{C-1}$	-0.0192	(0.0182)	-0.0210	(0.0184)	-0.0228	(0.0208)	-0.0249	(0.0186)	0.2285 **	(0.0422)	0.2058 **	(0.0399)
$\beta_{C-2}$	0.2145 **	(0.0311)	0.2099 **	(0.0307)	0.2508 **	(0.0350)	0.2105 **	(0.0308)				
$\beta_{C-3}$									-0.5026 **	(0.0701)	-0.4599 **	(0.0660)
$\beta_h$	0.9552 **	(0.0129)	0.9567 **	(0.0126)	0.9362 **	(0.0165)	0.9545 **	(0.0127)	0.9359 **	(0.0166)	0.9465 **	(0.0143)
$\beta_{MON}$			-0.0020	(0.1693)	0.0243	(0.1738)	0.0315	(0.1679)	0.0245	(0.1739)	0.0299	(0.1705)
$\beta_{TUE}$			-0.0639	(0.1512)	-0.0664	(0.1527)	-0.0423	(0.1525)	-0.0664	(0.1527)	-0.0495	(0.1528)
$\beta_{WED}$			-0.1735	(0.1455)	-0.1931	(0.1487)	-0.1818	(0.1467)	-0.1932	(0.1487)	-0.1905	(0.1476)
$\beta_{THU}$			-0.0092	(0.1634)	0.0143	(0.1686)	0.0033	(0.1647)	0.0145	(0.1687)	0.0066	(0.1669)
$\beta_{FRI}$			0.1911 *	(0.1088)	0.2452 *	(0.1243)	0.2267 *	(0.1102)	0.2456 *	(0.1244)	0.2355 *	(0.1163)
$\beta_{CAD}$					0.0063	(0.0042)	0.0751	(0.1378)	0.0063	(0.0042)	0.0885	(0.1396)
$\beta_{CPI}$					0.2914	(0.5414)	0.1795	(0.1837)	0.2920	(0.5421)	0.1960	(0.1906)
$\beta_{GDP}$					0.0243	(0.2239)	0.1514	(0.1811)	0.0247	(0.2242)	0.1857	(0.1884)
$\beta_{UEMP}$					0.0734	(0.0576)	-0.2590 †	(0.1396)	0.0736	(0.0576)	-0.2542 †	(0.1423)
$\beta_{RET}$					0.0061	(0.0952)	0.0312	(0.1418)	0.0060	(0.0953)	0.0251	(0.1492)
$\beta_r$	-0.0016	(0.0013)	-0.0017	(0.0013)	-0.0013	(0.0018)	-0.0019	(0.0014)	-0.0013	(0.0018)	-0.0021	(0.0016)
$d$	4.7914 **	(0.5749)	4.7323 **	(0.5678)	4.7961 **	(0.5723)	4.8324 **	(0.5791)	4.7966 **	(0.5725)	4.8446 **	(0.5826)
$R$	0		0		0		0		0		0	
$\ln L$	-1358.7		-1350.8		-1339.3		-1338.7		-1339.3		-1338.7	

Notes: See the notes for Table 3-a.

Table 6-b: BP Diagnostics

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Summary Statistics on $Z_t$						
Mean	-0.0241	-0.0279	-0.0273	-0.0288	-0.0273	-0.0296
Variance	0.9749	0.9748	0.9784	0.9804	0.9784	0.9795
Skewness	-0.1455	-0.1458	-0.1541	-0.2132	-0.1542	-0.2162
Excess Kurtosis	2.3836	2.5171	2.5422	2.5864	2.5412	2.5562
Tests for iid of $Z_t^{(a)}$						
$Q(45) : \chi^2(45)$	29.0696	29.2963	32.0343	30.7817	32.0555	31.5236
	{0.9685}	{0.9662}	{0.9270}	{0.9476}	{0.9266}	{0.9359}
$Q^2(45) : \chi^2(45)$	68.0335 *	69.6452 *	64.3125 *	62.6440 *	64.2403 *	59.5797 †
(Full Sample)	{0.0149}	{0.0107}	{0.0308}	{0.0419}	{0.0312}	{0.0714}
$Q^3(45) : \chi^2(45)$	51.6393	50.2762	49.8297	44.4589	49.8169	43.9700
(With an outlier omitted)	{0.2304}	{0.2724}	{0.2872}	{0.4948}	{0.2876}	{0.5155}
$Q^2(k=44) : \chi^2(43)$	46.0577	34.8127	40.0180	49.4233	42.7828	43.6842
	{0.3469}	{0.8086}	{0.6014}	{0.2321}	{0.4806}	{0.4423}
Engel and Ng Sign Bias Tests <sup>(b)</sup>						
Sign Bias	-0.0534	1.0831	1.0994	0.7768	1.0992	0.8611
	{0.9574}	{0.2789}	{0.2717}	{0.4374}	{0.2718}	{0.3893}
Negative Sign Bias	-2.4726 *	-2.6255 **	-1.8611 *	-2.2918 *	-1.8557 *	-2.0864 *
	{0.0135}	{0.0087}	{0.0629}	{0.0220}	{0.0636}	{0.0371}
Positive Sign Bias	0.7936	0.7718	0.5740	0.7641	0.5699	0.6015
	{0.4275}	{0.4403}	{0.5660}	{0.4449}	{0.5476}	{0.5476}
Joint Test: $\chi^2(3)$	10.6373 *	10.1586 *	5.6984	7.9649 *	5.6621	6.3913 †
	{0.0139}	{0.0173}	{0.1272}	{0.0467}	{0.1293}	{0.0941}
Test for Unit Root in the Conditional Variance, $H_0: v_h = 1$						
$\chi^2(1)$	12.0776 **	11.8756 **	14.9572 **	12.7482 **	14.9871 **	13.9560 **
	{0.0005}	{0.0006}	{0.0001}	{0.0004}	{0.0001}	{0.0002}
Joint Tests of Significance <sup>(c)</sup>						
$H_0: m_i = 0,$		9.9583 †	9.4186 †	10.0960 †	9.4111 †	9.9212 †
for all $i, \chi^2(5)$		0.0764	0.0935	0.0726	0.0937	0.0775
$H_0: m_j = 0,$			26.3320 **	34.6716 **	26.3362 **	34.9955 **
for all $j, \chi^2(5)$			0.0001	0.0001	0.0001	0.0000
$H_0: m_i = m_j = 0,$			35.2339 **	44.2693 **	35.2298 **	44.2935 **
for all $i$ and $j, \chi^2(10)$			0.0001	0.0000	0.0001	0.0000
$H_0: v_i = 0,$		5.0117	6.5382	6.5990	6.5440	6.6767
for all $i, \chi^2(5)$		0.4145	0.2573	0.2522	0.2568	0.2458
$H_0: v_j = 0,$			4.4269	4.4146	4.4347	4.5758
for all $j, \chi^2(5)$			0.4897	0.4914	0.4887	0.4698
$H_0: v_i = v_j = 0,$			10.2136	10.3557	10.2249	10.5602
for all $i$ and $j, \chi^2(10)$			0.4220	0.4099	0.4210	0.3928
$H_0: m_i = m_j = v_i = v_j = 0,$			43.6278 **	54.7403 **	43.6294 **	54.9870 **
for all $i$ and $j, \chi^2(20)$			0.0017	0.0000	0.0017	0.0000

Notes: (a), (b) and (c): See the notes for Table 3-b.

Table 7-a: SF

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.	Coeff	S.E.
$\alpha_C$	0.0560	(0.0942)	0.0516	(0.0998)	0.0565	(0.0960)	0.0262	(0.0970)	0.0568	(0.0960)	0.0250	(0.0970)
$\alpha_{MON}$			-0.0060	(0.0609)	-0.0045	(0.0605)	-0.0090	(0.0606)	-0.0043	(0.0605)	-0.0070	(0.0606)
$\alpha_{TUE}$			-0.0644	(0.0584)	-0.0754	(0.0582)	-0.0720	(0.0579)	-0.0753	(0.0582)	-0.0720	(0.0579)
$\alpha_{WED}$			0.0465	(0.0593)	0.0311	(0.0591)	0.0312	(0.0588)	0.0311	(0.0591)	0.0311	(0.0588)
$\alpha_{THU}$			-0.0052	(0.0566)	-0.0156	(0.0561)	-0.0082	(0.0563)	-0.0150	(0.0561)	-0.0083	(0.0563)
$\alpha_{HOL}$			-0.1024	(0.1044)	-0.1103	(0.1047)	-0.1027	(0.1055)	-0.1099	(0.1048)	-0.1025	(0.1056)
$\alpha_{AD}$					-0.0110	** (0.0027)	-0.0107	** (0.0022)	-0.0110	** (0.0027)	-0.0107	** (0.0022)
$\alpha_{PI}$					1.1857	* (0.4810)	1.2647	** (0.4361)	1.1821	* (0.4832)	1.2652	** (0.4361)
$\alpha_{GDP}$					0.0101	(0.1771)	0.0206	(0.2168)	0.0096	(0.1771)	0.0113	(0.2188)
$\alpha_{UEMP}$					-0.0488	(0.1224)	-0.0586	(0.0394)	-0.0471	(0.1235)	-0.0587	(0.0393)
$\alpha_{REI}$					-0.0348	(0.1063)	-0.0047	(0.0868)	-0.0338	(0.1062)	-0.0062	(0.0870)
$\alpha_h$	-0.064	(0.1049)	-0.0498	(0.1035)	-0.0502	(0.1007)	-0.0192	(0.1013)	-0.0507	(0.1008)	-0.0178	(0.1014)
$\beta_C$	0.0177	(0.0185)	0.1818	† (0.1017)	0.1447	† (0.1000)	0.1815	† (0.1045)	-0.0098	(0.1000)	-0.0105	(0.1047)
$\beta_{E1}$	-0.0373	* (0.0168)	-0.0446	* (0.0188)	-0.0459	* (0.0182)	-0.0538	* (0.0214)	0.1474	** (0.0407)	0.1869	** (0.0474)
$\beta_{E2}$	0.1871	** (0.0311)	0.2153	** (0.0342)	0.1919	** (0.0325)	0.2393	** (0.0380)				
$\beta_{E3}$									-0.3868	** (0.0655)	-0.4814	** (0.0762)
$\beta_h$	0.9485	** (0.0151)	0.9300	** (0.0178)	0.9358	** (0.0157)	0.9109	** (0.0210)	0.9350	** (0.0158)	0.9094	** (0.0211)
$\beta_{MON}$			-0.0470	(0.1665)	-0.0428	(0.1647)	-0.0385	(0.1691)	-0.0416	(0.1650)	-0.0377	(0.1691)
$\beta_{TUE}$			-0.3353	* (0.1449)	-0.3518	* (0.1448)	-0.3656	* (0.1468)	-0.3527	* (0.1449)	-0.3667	* (0.1468)
$\beta_{WED}$			-0.1518	(0.1418)	-0.1513	(0.1430)	-0.1565	(0.1444)	-0.1510	(0.1432)	-0.1561	(0.1444)
$\beta_{THU}$			-0.2990	* (0.1602)	-0.2876	* (0.1606)	-0.2913	† (0.1649)	-0.2870	* (0.1609)	-0.2912	† (0.1649)
$\beta_{HOL}$			0.2395	* (0.1081)	0.2691	* (0.1049)	0.3163	** (0.1186)	0.2708	** (0.1055)	0.3180	** (0.1189)
$\beta_{CAD}$					0.0038	(0.0037)	-0.0392	(0.1362)	0.0038	(0.0038)	-0.0391	(0.1363)
$\beta_{PI}$					0.5005	(0.5107)	0.1092	(0.2045)	0.4971	(0.5135)	0.1096	(0.2050)
$\beta_{GDP}$					-0.0119	(0.2026)	0.3172	(0.1978)	-0.0088	(0.2034)	0.3186	(0.1984)
$\beta_{UEMP}$					0.1286	* (0.0569)	-0.1056	(0.1335)	0.1285	* (0.0573)	-0.1045	(0.1337)
$\beta_{REI}$					0.1236	(0.0908)	0.0917	(0.1508)	0.1240	(0.0912)	0.0910	(0.1512)
$\beta_d$	-0.0014	(0.0013)	-0.0018	(0.0016)	-0.0001	(0.0015)	-0.0021	(0.0019)	-0.0001	(0.0016)	-0.0022	(0.0019)
$\beta_r$	6.8199	** (1.0432)	7.1399	** (1.2015)	7.2038	** (1.2007)	7.1855	** (1.2343)	7.2056	** (1.1991)	7.1819	** (1.2344)
$\beta$	0		0		0		0		0		0	
$\beta_{Ln L}$	-1529.8		-1521.5		-1506.6		-1509.8		-1506.6		-1509.8	

Notes: See the notes for Table 3-a.

Table 7-b: SF Diagnostics

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Summary Statistics on Z					
Mean	-0.0337	-0.0332	-0.0307	-0.0318	-0.0308	-0.0322
Variance	0.9958	0.9939	0.9968	0.9939	0.9969	0.9938
Skewness	-0.4103	-0.3744	-0.3733	-0.3740	-0.3730	-0.3740
Excess Kurtosis	1.4990	1.2807	1.3627	1.2428	1.3618	1.2431
Tests for iid of $Z_t^{(a)}$						
$Q(45): \chi^2(45)$	42.4192 {0.5819}	43.7442 {0.5252}	46.4094 {0.4140}	49.1494 {0.3105}	46.4795 {0.4112}	49.2159 {0.3082}
$Q^*(45): \chi^2(45)$	55.8883 {0.1281}	61.3571 {0.0527}	59.4098 {0.0735}	62.1866 {0.0455}	59.3140 {0.0747}	62.2240 {0.0452}
$Q^*(k=44): \chi^2(43)$	53.7571 {0.1259}	39.1625 {0.6384}	41.8727 {0.5201}	42.9352 {0.4741}	40.3075 {0.5887}	41.5439 {0.5345}
Engel and Ng Sign Bias Tests <sup>(b)</sup>						
Sign Bias	2.5106 {0.0211}	2.4390 {0.0148}	2.1993 {0.0280}	2.1920 {0.0285}	2.1739 {0.0298}	2.1684 {0.0302}
Negative Sign Bias	-3.3705 {0.0008}	-3.0872 {0.0020}	-2.9338 {0.0034}	-2.5872 {0.0097}	-2.9088 {0.0037}	-2.5693 {0.0103}
Positive Sign Bias	-0.4291 {0.6679}	-0.4826 {0.6295}	-0.2266 {0.8208}	-0.5570 {0.5776}	-0.2289 {0.8190}	-0.5610 {0.5748}
Joint Test: $\chi^2(3)$	13.7784 {0.0032}	11.7928 {0.0081}	11.0676 {0.0114}	8.3850 {0.0387}	10.8474 {0.0126}	8.2234 {0.0416}
Test for Unit Root in the Conditional Variance, $H_0: \nu_h = 1$						
$\chi^2(1)$	11.6695 {0.0006}	15.5009 {0.0001}	16.8365 {0.0000}	18.0780 {0.0000}	16.8220 {0.0000}	18.1673 {0.0000}
Joint Tests of Significance <sup>(c)</sup>						
$H_0: m_i = 0,$ for all i, $\chi^2(5)$		5.1270 0.4006	5.2519 0.3859	4.8694 0.4320	5.2338 0.3880	4.8665 0.4324
$H_0: m_j = 0,$ for all j, $\chi^2(5)$			23.1236 0.0003	33.3208 0.0000	22.9754 0.0003	33.3287 0.0000
$H_0: m_i = m_j = 0,$ for all i and j, $\chi^2(10)$			29.0154 0.0012	39.4632 0.0000	28.8462 0.0013	39.4551 0.0000
$H_0: \nu_i = 0,$ for all i, $\chi^2(5)$		11.8958 0.0362	13.5727 0.0186	14.1128 0.0149	13.5891 0.0184	14.1726 0.0145
$H_0: \nu_j = 0,$ for all j, $\chi^2(5)$			8.0391 0.1541	3.9686 0.5540	7.9327 0.1600	3.9539 0.5561
$H_0: \nu_i = \nu_j = 0,$ for all i and j, $\chi^2(10)$			19.2851 0.0368	17.4924 0.0642	19.2289 0.0375	17.5392 0.0633
$H_0: m_i = m_j = \nu_i = \nu_j = 0,$ for all i and j, $\chi^2(20)$			47.7943 0.0005	58.4635 0.0000	47.5924 0.0005	58.5070 0.0000

Notes: (a), (b) and (c): See the notes for Table 3-b.

## References

- Baillie, Richard T. and Bollerslev, Tim (1989), "The Message in Daily Exchange Rates: A Conditional-Variance Tale", *Journal of Business and Economic Statistics*, July, Vol. 7, No. 3, pp. 297-305.
- Bollerslev, Tim (1986), "Generalized Autoregressive Conditional Heteroskedasticity", *Journal of Econometrics*, Vol. 31, pp. 307-327.
- \_\_\_\_\_ (1987), "A Conditionally Heteroskedastic Time Series Model for Speculative Prices and Rates of Return", *Review of Economics and Statistics*, Vol. 69, pp. 542-547.
- Ederington, Louis H. and Lee, Jae Ha (1993), "How Markets Process Information: News Releases and Volatility", *Journal of Finance*, September, Vol. XLVIII, No. 4, pp. 1161-1191.
- Engle, Robert F. (1982), "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation", *Econometrica*, July, Vol. 50, No. 4, pp. 987-1007.
- Engle, Robert E. and Ng, Victor K. (1993), "Measuring and Testing the Impact of News on Volatility", *Journal of Finance*, September, Vol. XLVIII, No. 5, pp. 1749-1778.
- Glosten, Lawrence R., Jagannathan, Ravi, and Runkle, David E. (1993), "On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks", *Journal of Finance*, December, Vol. XLVIII, No. 5, pp. 1779-1801.
- Hogg, Robert. V. And Craig, Allen T. (1978) *Introduction to Mathematical Statistics*. Macmillan, New York
- Hsieh, David A. (1988), "The Statistical Properties of Daily Foreign Exchange Rates: 1974-1983", *Journal of International Economics*, Vol. 24, pp. 129-145.
- \_\_\_\_\_ (1989), "Modeling Heteroscedasticity in Daily Foreign-Exchange Rates", *Journal of Business and Economic Statistics*, July, Vol. 7, No. 3, pp. 307-317.
- Karfakis, Costas and Kim, Suk-Joong (1995), "Exchange Rates, Interest Rates and Current Account News: Some Evidence from Australia", *The Journal of International Money and Finance*, August, Vol. 14, No. 4.
- Kim, Suk-Joong (1994) "Inflation News in Australia: Its Effects on Exchange Rates and Interest Rates", *Working Papers in Economics*, No. 210, October, Department of Economics, The University of Sydney.
- Meese, Richard and Rogoff, Kenneth (1983) "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of sample?", *Journal of International Economics*, Vol 14, pp. 3-24.

**Working Papers  
in Economics**

- 170 B. Fritsch Energy and Environment in Terms of Evolutionary Economies; January 1992
- 171 W.P. Hogan Financial Deregulation: Fact and Fantasy; January 1992
- 172 P.T. Vipraio An Evolutionary Approach to International Expansion: A Study for an Italian Region; January 1992
- 173 C. Rose Equilibrium and Adverse Selection; February 1992
- 174 D.J. Wright Incentives, Protection and Time Consistency; April 1992
- 175 A.J. Phipps, J. Sheen & C. Wilkins The Slowdown in Australian Productivity Growth: Some Aggregated and Disaggregated Evidence; April 1992
- 176 J.B. Towe Aspects of the Japanese Equity Investment in Australia; June 1992
- 177 P.D. Groenewegen Alfred Marshall and the Labour Commission 1891-1894; July 1992
- 178 D.J. Wright Television Advertising Regulation and Programme Quality; August 1992
- 179 S. Ziss Moral Hazard with Cost and Revenue Signals; December 1992
- 180 C. Rose The Distributional Approach to Exchange Rate Target Zones; December 1992
- 181 W.P. Hogan Markets for Illicit Drugs; January 1993
- 182 E. Jones The Macroeconomic Fetish in Anglo-American Economies; January 1993
- 183 F. Gill Statistics in the Social Sciences A Mixed Blessing? March 1993
- 184 Y. Varoufakis & S. Hargreaves-Heap The Simultaneous Evolution of Social Roles and of Cooperation; April 1993
- 185 C. Karfakis & D.M. Moschos The Information Content of the Yield Curve in Australia; April 1993
- 186 C. Karfakis & A. Parikh Uncovered Interest Parity Hypothesis for Major Currencies; May 1993
- 187 C. Karfakis & A.J. Phipps Do Movements in the Forward Discount on the Australian Dollar Predict Movements in Domestic Interest Rates? Evidence from a Time Series Analysis of Covered Interest Parity in Australia in the late 1980s; May 1993
- 188 J.B. Towe Citation Analysis of Publications on the Australian Tariff Debate, 1946-1991; August 1993
- 189 C. Karfakis & S-J Kim Exchange Rates, Interest Rates and Current Account News: Some Evidence from Australia; September 1993
- 190 A.J. Phipps & J.R. Sheen Unionisation, Industrial Relations and Labour Productivity Growth in Australia: A Pooled Time-Series/Cross-Section Analysis of TFP Growth; September 1993
- 191 W.P. Hogan Market Value Accounting in the Financial Sector; November 1993
- 192 Y. Varoufakis & W. Kafourous The Transferability of Property Rights and the Scope of Industrial Relations' Legislation: Some Lessons from the NSW Road Transport Industry; November 1993
- 193 P.D. Groenewegen Jacob Viner and the History of Economic Thought; January 1994
- 194 D. Dutta & A. Hussain A Model of Share-Cropping with Interlinked Markets in a Dual Agrarian Economy; March 1994

- 195 P.E. Korsvold Hedging Efficiency of Forward and Option Currency Contracts; March 1994
- 196 J. Yates Housing and Taxation: An Overview; March 1994
- 197 P.D. Groenewegen Keynes and Marshall: Methodology, Society and Politics; March 1994
- 198 D.J. Wright Strategic Trade Policy and Signalling with Unobservable Costs; April 1994
- 199 J. Yates Private Finance for Social Housing in Australia; April 1994
- 200 L. Haddad The Disjunction Between Decision-Making and Information Flows: The Case of the Former Planned Economies; April 1994
- 201 P.D. Groenewegen & S. King Women as Producers of Economic Articles: A Statistical Assessment of the Nature and the Extent of Female Participation in Five British and North American Journals 1900-39; June 1994
- 202 P.D. Groenewegen The French Connection: Some Case Studies of French Influences on British Economics in the Eighteenth Century; June 1994
- 203 F. Gill Inequality and the Wheel of Fortune: Systemic Causes of Economic Deprivation; July 1994
- 204 M. Smith The Monetary Thought of Thomas Tooke; July 1994
- 205 A. Aspromourgos Keynes on the Australian Wages System; July 1994
- 206 W. Kafourous & Y. Varoufakis Bargaining and Strikes: From an Equilibrium to an Evolutionary Framework; July 1994
- 207 A. Oswald & I. Walker Rethinking Labor Supply: Contract Theory and Unions; July 1994
- 208 J.B. Towe & D.J. Wright The Research Output of Australian Econometrics and Economics Department: 1988-93; July 1994
- 209 F. Gill & C. Rose Discontinuous Payoff Functions under Incomplete Information; August 1994
- 210 S-J Kim Inflation News in Australia: Its Effects on Exchange Rates and Interest Rates; October 1994
- 211 Y. Varoufakis Moral Rhetoric in the Face of Strategic Weakness: Modern Clues for an Ancient Puzzle; November 1994
- 212 E. Jones Bureaucratic Politics and Economic Policy: The Evolution of Trade Policy in the 1970s and 1980s; December 1994
- 213 R. Hataiseree & A.J. Phipps The Relationship Between Money and Income in Thailand: Some Evidence for the 1980s Using a Cointegration Approach; January 1995
- 214 G. White Classical Competition, Keynesian Adjustment and Composite Dynamics: A Critical Perspective; February 1995
- 215 C. Karfakis & A.J. Phipps Treasury Note and Bank Bill Rates, the Risk Premium and Australian Monetary Policy; February 1995
- 216 P.D. Groenewegen The Post 1945 Internationalization of Economics The Australian Experience; April 1995
- 217 S-J Kim Modeling Changes in Daily \$A Exchange Rates: An Application of GARCH; June 1995

**Copies are available upon request from:**

Department of Economics  
The University of Sydney  
N.S.W. 2006, Australia

## Working Papers in Economics Published Elsewhere

- 2 I.G. Sharpe & R.G. Walker *Journal of Accounting Research*, 13(2), Autumn 1975
- 3 N.V. Lam *Journal of the Developing Economies*, 17(1), March 1979
- 4 V.B. Hall & M.L. King *New Zealand Economic Papers*, 10, 1976
- 5 A.J. Phipps *Economic Record*, 53(143), September 1977
- 6 N.V. Lam *Journal of Development Studies*, 14(1), October 1977
- 7 I.G. Sharpe *Australian Journal of Management*, April 1976
- 9 W.P. Hogan *Economic Papers*, 55, The Economic Society of Australia and New Zealand, October 1977
- 12 I.G. Sharpe & P.A. Volker *Economics Letters*, 2, 1979
- 13 I.G. Sharpe & P.A. Volker *Kredit und Kapital*, 12(1), 1979
- 14 W.P. Hogan *Some Calculations in Stability and Inflation*, A.R. Bergström et al (eds.), J. Wiley & Sons, 1978
- 15 F. Gill *Australian Economic Papers*, 19(35), December 1980
- 18 I.G. Sharpe *Journal of Banking and Finance*, 3(1), April 1978
- 21 R.L. Brown *Australian Journal of Management*, 3(1), April 1978
- 23 I.G. Sharpe & P.A. Volker *The Australian Monetary System in the 1970s*, M. Porter (ed.), Supplement to Economic Board 1978
- 24 V.B. Hall *Economic Record*, 56(152), March 1980
- 25 I.G. Sharpe & P.A. Volker *Australian Journal of Management*, October 1979
- 27 W.P. Hogan *Malayan Economic Review*, 24(1), April 1979
- 28 P. Saunders *Australian Economic Papers*, 19(34), June 1980
- 29 W.P. Hogan *Economics Letters*, 6 (1980), 7 (1981)
- I.G. Sharpe & P.A. Volker *Australian Economic Papers*, 18(33), December 1979
- 30 W.P. Hogan *Keynesian Theory, Planning Models, and Quantitative Economics*, G. Gandolfo and F. Marzano (eds.), 1987
- 32 R.W. Bailey, V.B. Hall & P.C.B. Phillips *Australian Economic Papers*, 21(39), December 1982
- 38 U.R. Kohli *Journal of the Operational Research Society* (33) 1982
- 39 G. Mills *Canadian Journal of Economics*, 15(2), May 1982
- 41 U.R. Kohli *Applied Economics*, 15, February 1983
- 42 W.J. Merrilees *Australian Economic Papers*, 20(37), December 1981
- 43 P. Saunders *Canadian Journal of Economics*, 15(3), August 1982
- 45 W.J. Merrilees *Journal of Industrial Economics*, 31, March 1983
- 46 W.J. Merrilees *Review of Economic Studies*, 50(160), January 1983
- 49 U.R. Kohli *Economic Record*, 57(159), December 1981
- 50 P. Saunders *AFSI, Commissioned Studies and Selected Papers*, AGPS, IV 1982
- 53 J. Yates *Economic Record*, 58(161), June 1982
- 54 J. Yates *Seventh Australian Transport Research Forum-Papers*, Hobart 1982
- 55 G. Mills *Economic Record*, 60(168), March 1984
- 56 V.B. Hall & P. Saunders

- 57 P. Saunders *Economic Record*, 59(166), September 1983
- 58 F. Gill *Économie Appliquée*, 37(3-4), 1984
- 59 G. Mills & W. Coleman *Journal of Transport Economics and Policy*, 16(3), September 1982
- 60 J. Yates *Economic Papers*, Special Edition, April 1983
- 61 S.S. Joson *Australian Economic Papers*, 24(44), June 1985
- 62 R.T. Ross *Australian Quarterly*, 56(3), Spring 1984
- 63 W.J. Merrilees *Economic Record*, 59(166), September 1983
- 65 A.J. Phipps *Australian Economic Papers*, 22(41), December 1983
- 67 V.B. Hall *Economics Letters*, 12, 1983
- 69 V.B. Hall *Energy Economics*, 8(2), April 1986
- 70 F. Gill *Australian Quarterly*, 59(2), Winter 1987
- 71 W.J. Merrilees *Australian Economic Papers*, 23(43), December 1984
- 73 C.G.F. Simkin *Singapore Economic Review*, 29(1), April 1984
- 74 J. Yates *Australian Quarterly*, 56(2), Winter 1984
- 77 V.B. Hall *Economics Letters*, 20, 1986
- 78 S.S. Joson *Journal of Policy Modeling*, 8(2), Summer 1986
- 79 R.T. Ross *Economic Record*, 62(178), September 1986
- 81 R.T. Ross *Australian Bulletin of Labour*, 11(4), September 1985
- 82 P.D. Groenewegen *History of Political Economy*, 20(4), Winter 1988 and *Scottish Journal of Political Economy*, 37(1) 1990
- E.M.A. Gross, W.P. Hogan & I.G. Sharpe *Australian Economic Papers*, 27(50), June 1988
- 84 E.M.A. Gross, W.P. Hogan & I.G. Sharpe *Australian Bulletin of Labour*, 16(4), December 1990
- 85 F. Gill *Company and Securities Law Journal*, 6(1), February 1988
- 94 W.P. Hogan *Urban Studies*, 26, 1989
- 95 J. Yates *The Economic and Social Review*, 20(3), April 1989
- 96 B.W. Ross *Australia's Greatest Asset: Human Resources in the Nineteenth and Twentieth Centuries*, D. Pope (ed.), Federation Press, 1988
- 97 F. Gill *Australian Economic Papers*, 31(58), June 1992
- 98 A.J. Phipps *Australian Bulletin of Labour*, 15(1), December 1988
- 99 R.T. Ross *Hetsa Bulletin*, (11), Winter 1989
- 100 L. Haddad *Public Sector Economics - A Reader*, P. Hare (ed.), Basil Blackwell, 1988
- 101 J. Piggott *Journal of Macroeconomics*, 13(1), Winter 1991
- 102 J. Carlson & D. Findlay *Journal of Economics and Business*, 44(1), February 1992
- 102 J. Carlson & D. Findlay *Decentralization, Local Government and Markets: Towards a Post-Welfare Agenda*, R.J. Bennet (ed.) Oxford University Press, 1990
- 104 P.D. Groenewegen *Prometheus*, 6(2), December 1988
- 107 B.W. Ross *Rivista di diritto valutario e di economia internazionale*, 35(2), June 1988
- 108 S.S. Joson *NeoClassical Economic Theory 1870 to 1930*, K. Hennings and W. Samuels (eds.), Boston Kluwer-Nighoff, 1990
- 112 P. Groenewegen *Energy Economics*, 12(4) October 1990
- 113 V.B. Hall, T.P. Truong & V.A. Nguyen

- 114 V.B. Hall *Australian Economic Review*, (87) 1989(3)  
T.P. Truong  
& V.A. Nguyen
- 115 F. Gill *Australian Journal of Social Issues*, 25(2), May 1990
- 116 G. Kingston *Economics Letters*, 15 (1989)
- 117 V.B. Hall & *Pacific and Asian Journal of Energy*, 2(2), December 1988  
D.R. Mills
- 118 W.P. Hogan *Abacus*, 25(2), September 1989
- 120 P. Groenewegen *Flattening the Tax Rate Scale: Alternative Scenarios & Methodologies*, (eds.) J.G. Head and R. Krever, 1990  
*Economic Analysis and Policy*, 19(1), March 1989
- 122 W.P. Hogan & I.G. Sharpe
- 123 G. Mills *Journal of Transport Economics and Policy*, 23, May 1989
- 126 F. Gill *The Australian Quarterly*, 61(4), 1989
- 128 S. Lahiri & *The Economic Journal*, 100(400), 1990  
J. Sheen
- 130 J. Sheen *Journal of Economic Dynamics and Control*, 16, 1992
- 135 Y. Varoufakis *Économie Appliquée*, 45(1), 1992
- 136 L. Ermini *The Economic Record*, 69(204), March 1993
- 138 D. Wright *Journal of International Economics*, 35, (1/2) 1993
- 139 D. Wright *Australian Economic Papers*, 32, 1993
- 141 P. Groenewegen *Australian Economic Papers*, 31, 1992
- 143 C. Karfakis *Applied Economics*, 23, 1991
- 144 C. Karfakis & *Journal of Money, Credit and Banking*, 22.(3), 1990  
D. Moschos
- 147 J. Yates *Housing Studies*, 7, (2), April 1992
- 158 W.P. Hogan *Economic Papers*, 10(1), March 1991
- 159 P. Groenewegen *Local Government and Market Decentralisation: Experiences in Industrialised, Developing and Former Eastern Block Countries*, R. J. Bennett (ed.) UN University Press, 1994
- 160 C. Karfakis *Applied Financial Economics*, 1(3), September 1991
- 162 Y. Varoufakis *Erkenntnis*, 38, 1993
- 163 Y. Varoufakis *Science and Society*, 56(4), 1993
- 173 C. Rose *The Rand Journal of Economics*, 24(4), Winter 1993
- 177 P. Groenewegen *European Journal of the History of Economic Thought*, 1(2) Spring 1994
- 178 D. J. Wright *Economic Record*, 70(211), December 1994
- 187 C. Karfakis & *Australian Economic Papers*, 33(62), June 1994  
A. J. Phipps
- 189 C. Karfakis & *Journal of International Money and Finance*, 14(4)  
S.J Kim August 1995
- 190 A.J. Phipps & *Labour Economics and Productivity*, 6(1), March 1994  
J.R. Sheen
- 193 P. Groenewegen *Contributions to Political Economy*, 13, 1994
- 199 J. Yates *Housing Policy Debate*, 5(2), 1994
- 202 P. Groenewegen *Dix-Huitieme Siecle* (26), 1994
- 203 F. Gill *Australian Economic Papers*, 33(62), June 1994
- 208 J.B. Towe & *Economic Record*, 71(212), March 1995  
D.J. Wright