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AN EXAMINATION OF THE EFFECTS OF EXCHANGE RATES ON AUSTRALIA'S INBOUND TOURISM GROWTH: A MULTIVARIATE CONDITIONAL VOLATILITY APPROACH

Ghialy Yap *

The appreciation of the Australian dollar has been a concern as Australia has become less competitive compared to neighbouring countries. This paper investigates to what extent exchange rates could adversely affect Australia's inbound tourism and whether volatility in exchange rates could increase the uncertainty in international tourist arrivals to Australia. The study is based on nine countries of origin, namely China, India, Japan, Malaysia, New Zealand, Singapore, South Korea, the UK and the USA for the period January 1991 to January 2011. It uses multivariate conditional volatility regressions to model the time-varying conditional variances of international tourism growth and exchange rates. Empirical findings show that tourists from Malaysia and New Zealand are relatively more sensitive to currency shocks than the others. Nevertheless, tourists' memories of the shocks could diminish in the long-run, suggesting that the sudden appreciation of the Australian dollar will not have long-term negative impacts on Australia's inbound tourism.

Keywords: *inbound tourism, Australia, exchange rates, volatility spill-over, news shocks*

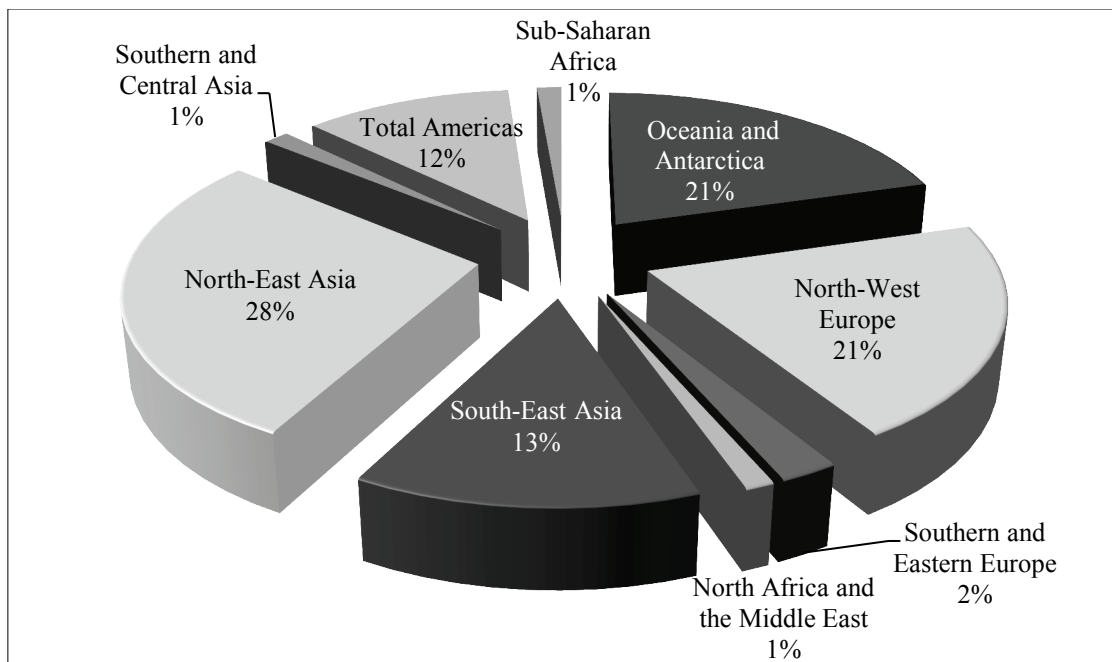
I. INTRODUCTION

Australia is a unique destination and very large continent which consists of a single and safe country with a stable democratic government. This country is famous for its beautiful natural heritage which ranges from deserts to the wet temperate Tasmania Wilderness and from huge ephemeral inland lakes to the vast coral areas of the Great Barrier Reef. These experiences are complemented by some of the world's liveable cities such as Melbourne and Sydney, as well as offering traditional Aboriginal culture and multiculturalism through impressive arts festivals.

International tourists from North-East Asia accounted for 28% of the total tourist arrivals to Australia, followed by Oceania and Antarctica (21%) and North-West Europe (21%) between 1991 and 2010 (See Figure 1). In terms of individual countries, the top ten tourists' origin countries are New Zealand, Japan, Hong Kong, Singapore, Malaysia, South Korea, China, the USA, the UK and Germany (Figure 2). Furthermore, international tourists who spent the most money in Australia in the year ended 30 September 2010 were the visitors from China (AUD2.5 billion), the UK (AUD1.9 billion), New Zealand (AUD1.5 billion) and the USA (AUD1.2 billion).

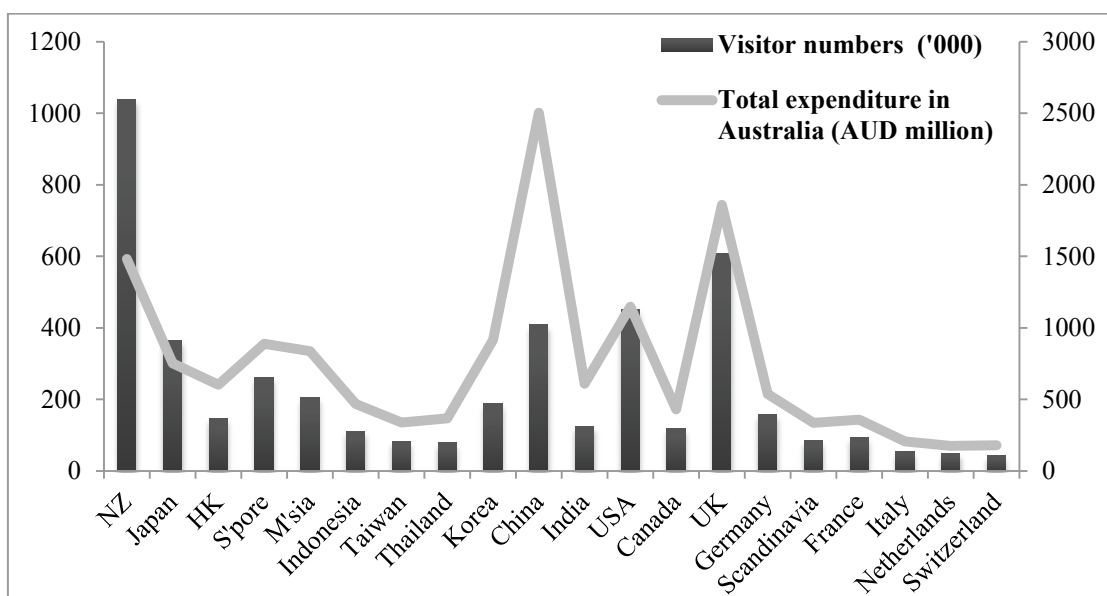
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**FIGURE 1: AVERAGE COMPOSITION OF TOURIST ARRIVALS TO AUSTRALIA
BY CONTINENT (JANUARY 1991 to OCTOBER 2010)**



NOTE: *Oceania and Antarctica countries* are Fiji, New Caledonia, New Zealand, Papua New Guinea and Vanuatu. *North-West European countries* are Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Netherlands, the UK, Norway, Switzerland and Sweden. *Southern and Eastern European countries* are Greece, Italy, Poland, Russia Federation and Spain. *North and Sub-Sahara African and Middle East countries* are Israel, South Africa and United Arab Emirates. *South-East Asian countries* are Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam. *North-East Asian countries* are Hong Kong, China, Japan, Korea and Taiwan. *Southern and Central Asian countries* are India and Sri Lanka. *American continent* consists of Brazil, Canada, Mexico and the USA.

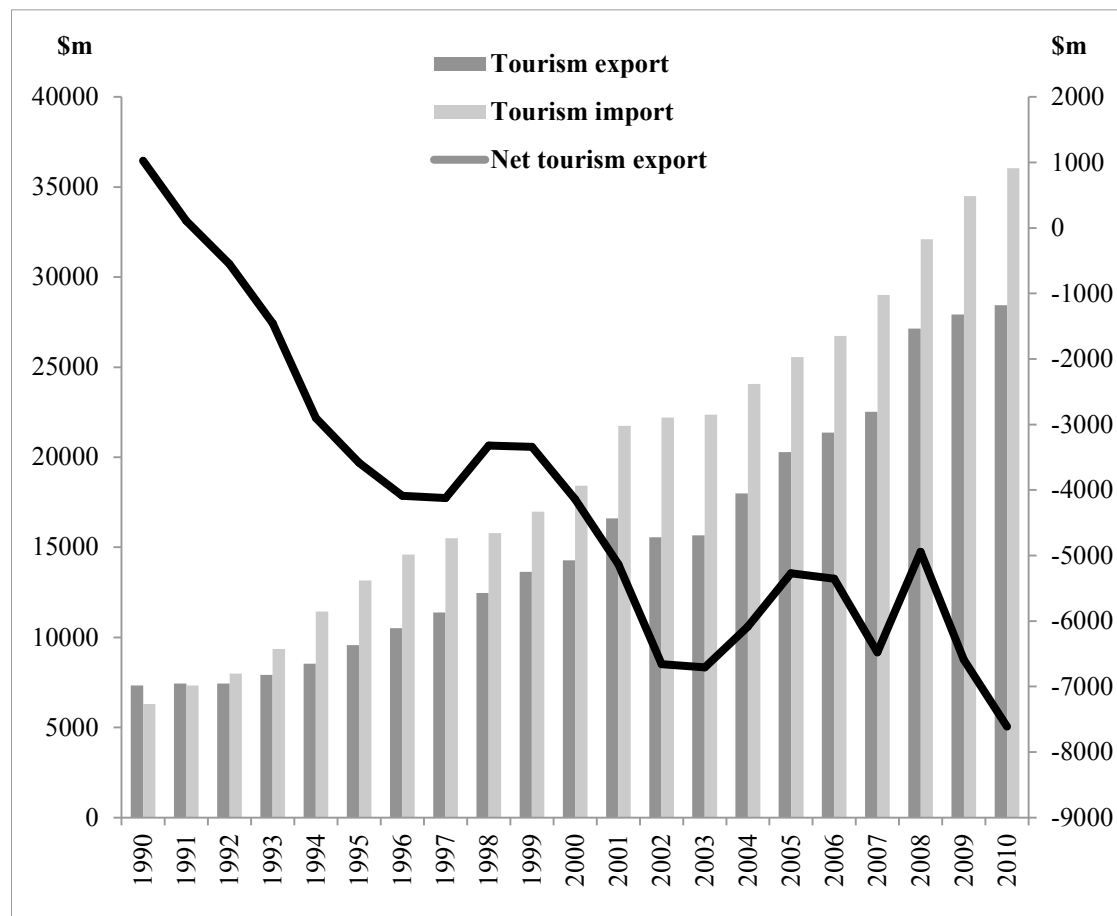
**FIGURE 2: SELECTED INTERNATIONAL VISITOR ARRIVALS TO
AUSTRALIA AND THEIR EXPENDITURE IN AUSTRALIA
FOR THE YEAR ENDED 30 SEPTEMBER 2010**



SOURCE: International Visitors in Australia, September 2010

Nevertheless, in recent years, tourism policy-makers in Australia have expressed concerns about the country's tourism industry. According to the Australian Bureau of Statistics (ABS), Australia experienced a deficit of AUD5 billion in the tourism balance of trade in 2009-10 (ABS, 2010). In that financial year, the ABS recorded approximately 5.6 million short-term international visitors entering to Australia and average spending per international tourist of AUD4,865 (ABS, 2010). Furthermore, they spent a total of AUD28 billion on the Australian produced goods and services. The Tourism Forecasting Committee (TFC) also predicted that by the year 2020, outbound Australian visitors would grow up to 10.2 million a year while international visitor arrivals to Australia would reach only 8.5 million (RET, 2010). Figure 3 reveals that tourism exports have been underperforming compared to tourism imports since the 1990s. Moreover, the net tourism exports (tourism export minus tourism import) shows a declining trend, with Australia facing more tourism trade deficits. This may be a concern because tourism imports (approximately AUD33 billion in 2010) exceeded tourism exports (about AUD23 billion in 2010).

**FIGURE 3: INTERNATIONAL TRADE IN TOURISM IN AUSTRALIA
AS AT THE FINANCIAL YEARS 1990 to 2010**



SOURCE: ABS, Cat. No. 5302.0

NOTE: The data obtained from the ABS are tourism related services derived from total travel services (which include business, personal and education related travels) as well as total costs of passenger transportation services (which include agency fees and commissions for air transport). Net tourism export is total tourism export minus total tourism import. The 2010 data are calculated quarterly from March to September upon the availability of the data at the time when the data were collected.

The aftermath of global financial crises, including various European economic crises, and the appreciation of the Australian dollar may have affected the tourism trade balance. Specifically, the rising uncertainty in economic conditions in several European countries, Japan and the USA may have negatively impacted inbound tourism in Australia. The recent Eurozone debt crises have forced most European governments to cut spending, increase taxes and thus depressing the overall economic growth in the region. Similarly, the long-term sluggishness of Japan's economy has been evident in the country's gross domestic product which declined 25% in mid-2008 and 5% in the first quarter of 2009 (Anonymous, 2010b). In addition, the US economy is still struggling to increase consumer confidence as it recovers from a deep recession (Anonymous, 2010c). As the inbound tourists from Japan, the UK and the USA are among the main components of the international tourists to Australia, the rising concerns about economic situations (and possibly slow economic growth in the future) in these developed countries could indirectly cause negative impacts on the demand for international travel to Australia. Furthermore, Australia has been enjoying a significant mining boom which leads to strong growth in mineral exports and appreciation of the Australian dollar. In 2011, the Australian dollar reached parity with the US dollar and the sterling pound is at a 25-year low against the dollar (Anonymous, 2010a). Hence, the surge in the Australian dollar value may cause the loss of competitiveness as a destination for international tourists, and encourage Australians to travel overseas.

Nevertheless, while some tourist markets are in the stage of decline, there are several growth markets (see Table 1). India, Malaysia and Singapore are among the best performing tourist markets for Australia. Despite the global financial crisis which occurred between 2008 and 2009, these countries showed a strong growth in tourist numbers (i.e. 22% for India, 7.3% for Malaysia, and 2.2% for Singapore in 2008). The Chinese economy demonstrated strong growth in 2007 but the number of Chinese tourists to Australia fell 1.5% in 2008, possibly due to the fall of the country's business performance during the global financial crisis. As for the UK and the US markets, the tourists from these countries increased significantly in 2009 despite the countries experiencing recession during the crisis (see Table 1).

**TABLE 1: PERCENTAGE GROWTH IN TOURIST ARRIVALS FOR
SELECTED TOURIST MARKETS (2007-2009)**

Year	Mainland China	India	Japan	Malaysia	New Zealand	Singapore	South Korea	UK	USA
2007	14.76	14.10	-11.91	5.26	5.73	3.36	-2.99	-4.84	1.18
2008*	-1.51	21.57	-20.38	7.25	-2.46	2.23	-14.56	-3.07	-2.29
2009*	2.23	7.67	-22.45	24.87	0.13	5.80	-16.48	0.18	6.60

SOURCE: Overseas Arrivals and Departures, Australia (ABS, Cat. No. 3401.0)

NOTE: The percentage growth rate in tourist arrivals to Australia is measured as follows:

$G_{i,t} = \left(\frac{TA_{i,t} - TA_{i,t-1}}{TA_{i,t-1}} \right) \times 100$, where $TA_{i,t}$ = total tourist arrivals from country i at year t and $TA_{i,t-1}$ = total tourist arrivals from country i from previous year ($t-1$). The total tourist arrivals series used in this paper are based on seasonally adjusted data.

* indicates the years where the global financial crisis occurred.

Notwithstanding Australia having witnessed an increasing trend of tourist arrivals from certain countries such as China, Malaysia and Singapore since 2007, the visitor volumes from these emerging markets are insufficient to have much effect on total inbound numbers into Australia (Richardson, 2010). In particular, the traditional large-source markets such as Japan, New Zealand, the UK and the USA are mostly saturated or in decline as well as unlikely to have high future growth. Given such evidence, would the appreciation of the Australian dollar be one of the main causes for the decline in tourist numbers for some countries? Furthermore, particularly after the global financial crises, could the volatility in exchange rates raise uncertainties in tourism business in Australia?

The research examines whether changes in exchange rates could affect the fluctuation of tourist arrival data. It employs conditional volatility models because they can compute time-varying variations in international tourism demand. In addition, the models are useful for investigating the effects of exchange rate shocks on the fluctuations in Australia's international tourism demand. The results could provide in-depth information about the degree of volatility in each tourism market segment and such findings could assist tourism stakeholders to develop forecasting models more accurately.

II. RELEVANT LITERATURE

Conditional volatility model

Research on modelling uncertainty in tourism demand has expanded since 2005. The main intention is to measure how the variations in tourism demand can be affected by shocks. Tourists are generally sensitive to news such as the unexpected changes in international and domestic policies, issues relating to safety and health, large-scale mega events as well as volatile exchange rates (Kim and Wong, 2006). When news spreads through mass media sources, it becomes a shock to the public and causes fluctuations in demand for travel. Researchers seek to identify the types of tourist markets that are highly responsive to news shocks and often use conditional volatility models (Bartolome, McAleer, Ramos and Rey-Maqueira, 2009; Chan, Lim and McAleer, 2005; Chang and McAleer, 2010; Chang, McAleer and Slottje, 2009; Coshall, 2009; Divino and McAleer, 2009, 2010; Glosten, Jagannathan and Runkle, 1993; Hoti, McAleer and Shareef, 2005, 2007; Kim and Wong, 2006; Shareef and McAleer, 2005, 2007). The models that are used commonly are the generalised autoregressive conditional heteroscedasticity (GARCH) (Bollerslev, 1986), exponential GARCH (Nelson, 1990) and asymmetric GARCH (thereafter named as GJR) (Glosten *et al.*, 1993).

In the tourism literature, conditional volatility models were first introduced by Chan, Lim and McAleer (2005). They employed several multivariate conditional volatility models, namely CCC-MGARCH, symmetric vector ARMA-GARCH (VARMA-GARCH) and asymmetric vector ARMA-ARCH (VARMA-AGARCH) models. The benefits of using multivariate version are threefold. First, the models can determine whether there is volatility spill-over from one investigated country to another. As pointed out by Hoti, McAleer and Shareef (2007), shocks in one country could affect the tourism demand volatility in another country, depending on the degree of correlations in demand uncertainty between countries. Such information may be

useful for tourism policy-makers to determine whether it is ideal to diversify their marketing investment portfolios. Second, it measures time-varying conditional correlations between two countries' tourism demand volatility. Lastly, the multivariate models follow a univariate conditional volatility process which can measure the short-run and long-run persistence of shocks to tourism growth.

The usefulness of multivariate conditional volatility models became more evident when Hoti, McAleer and Shareef (2007) investigated whether shocks in tourism growth of a country could be influenced by other factors such as country risk. These authors employed VARMA-GARCH and VARMA-AGARCH models to model international tourism and country risk spill-overs for Cyprus and Malta.

Despite the advantage of using these multivariate models, the study on the effects of economic factors on tourism demand volatility is downplayed in the literature. Although modelling of second moment data (volatility) has been introduced in the literature recently, there are still many tourism empirical studies focusing on first moment (mean) estimations (Smeral, 2009, 2010; Song and Lin, 2010; Wang, 2009). Nevertheless, modelling second moments is still important because such research is able to quantify the likely impact of shock to volatile tourist markets and hence assist with relevant policy formulation either before or at the moment of a shock (Coshall, 2009).

Exchange rates

Tourism policy-makers need to understand how tourists react to price changes before and during their stays in a destination. However, it is difficult to obtain accurate tourist prices. While some tourism researchers recommended using consumer price indices to measure relative prices between tourist origin country and destination, others suggested using exchange rates as a proxy for tourist prices (Rossello, Aguilo and Riera, 2005; Wang, 2009). The possible assumption is that most tourists are more aware of exchange rates and therefore, they may make travel decisions based on the movement of currencies (Witt and Martin, 1987). Because of this assumption, exchange rates have become one of the determinants used to model international tourism demand.

Nonetheless, the study on the effects of exchange rate volatility on tourism demand is largely ignored in the literature. Thus far, only two empirical papers have attempted such research. In the early 2000s, Webber (2001) investigated the long-run impacts of exchange rate volatility on Australian demand for Asian tourism. The author emphasised that exchange rate volatility could affect tourism since expenditure at the holiday destination is a substantial expense. In his findings, the variations in exchange rates were found to be a significant determinant of long-run tourism demand in 50% of the countries studied (Webber, 2001). Subsequently, Chang and McAleer (2009 and 2012) adopted various conditional volatility models to examine the existence of volatility persistence of international tourist arrivals to Taiwan as well as exchange rates. They discovered that the volatility persistence was high for both tourist arrival and exchange rate data, particularly when the global financial crisis occurred. Based on the results, the authors asserted that it is of important for estimating the dynamic effects of world prices and exchange rates and their respective volatilities on international tourist arrivals to Taiwan.

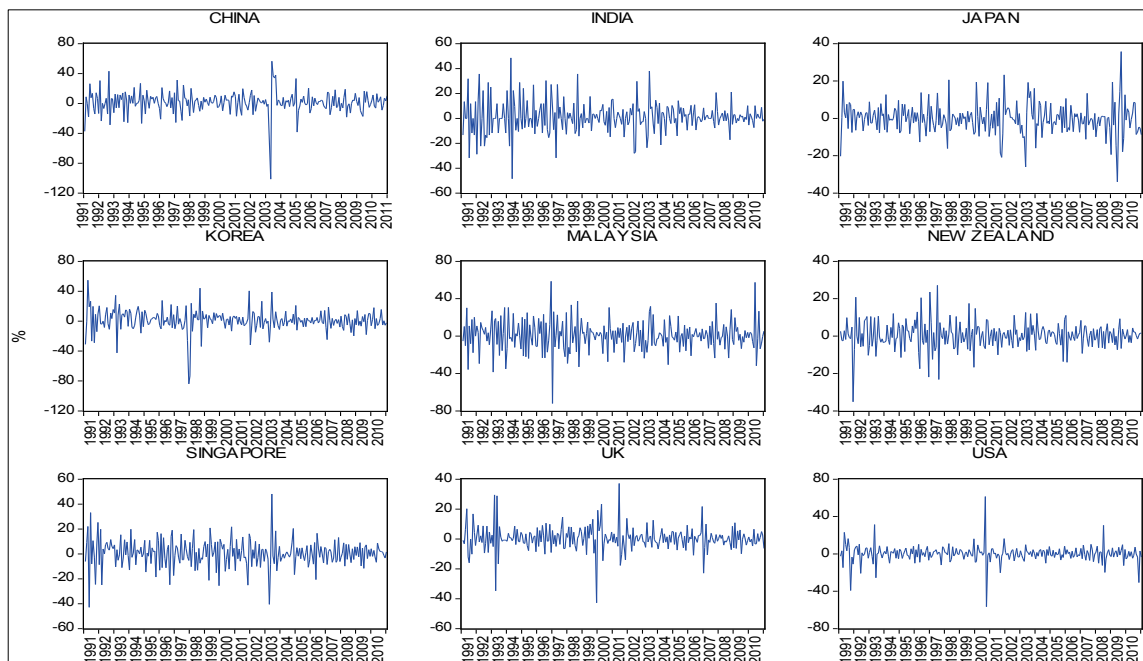
Inspired by the Chang and McAleer studies, this research explores whether volatility in exchange rates can influence the movement of international tourist arrivals to Australia. No such study carried out in the context of Australian tourism has been identified.

III. DESCRIPTION OF DATA

This study estimates the multivariate conditional volatility models using monthly inbound tourism growth rate and exchange rate returns data. The monthly tourist data consist of nine countries of origin, namely China, India, Japan, Malaysia, New Zealand, Singapore, South Korea, the UK and the USA. They are the monthly de-seasonalized data on short-term visitor arrivals to Australia (visitors who stayed less than one year in the country) and are freely available from the Australian Bureau of Statistics websites (www.abs.gov.au). Furthermore, the exchange rate data used for the Chinese yuan, Indian rupees, Japanese yen, Malaysian ringgit, New Zealand dollar, Singapore dollar, Korean won, pound sterling and US dollar are based on the monthly average of the currencies per Australian dollar. The exchange rates were extracted from the *International Financial Statistics* which are published by the International Monetary Fund. The data are based on the periods from January 1991 to January 2011.

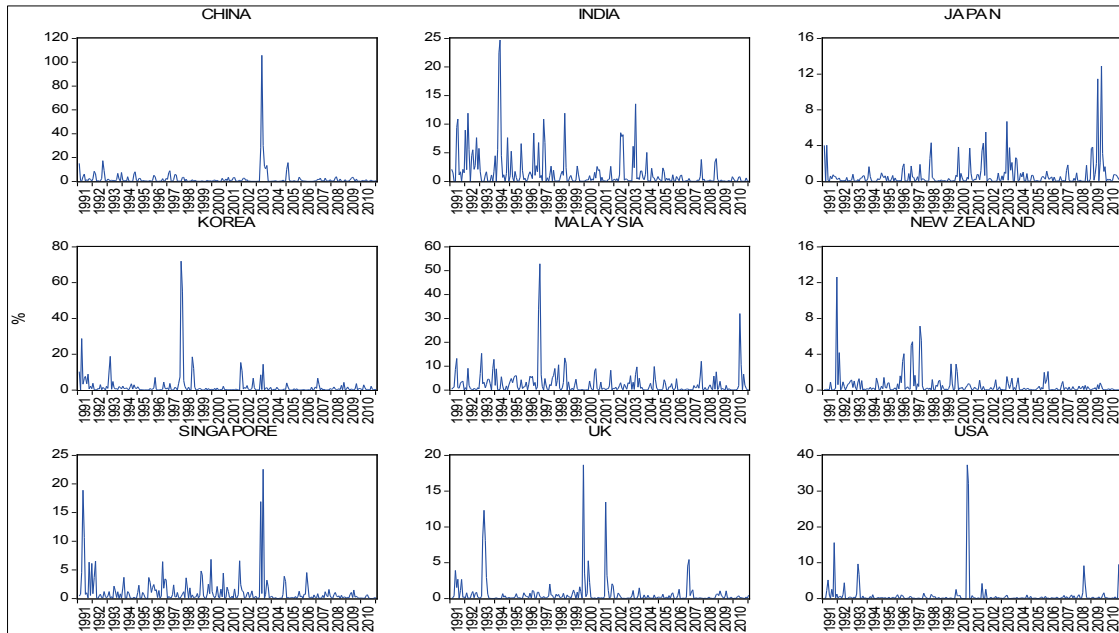
Figures 4 and 5 present the percentage change and the volatility for nine tourist countries of origin, respectively. In Figure 4, the variations in international tourism growth rate range are relatively large when compared to the exchange rate data in Figure 6. Furthermore, Figures 4 and 5 show that some of these countries are susceptible to unexpected shocks. For instance, the number of tourists from China, Japan and Singapore dropped significantly in mid-2003 due to the outbreak of the SARS virus. Similarly, during the Asian financial crises, the number of tourists from both South Korea and Malaysia declined by approximately 80%. Moreover, after the global financial crisis in 2008, there was a significant fluctuation in the number of Japanese tourists in Australia. In conclusion, this suggests that there is evidence of outliers and extreme observations in international tourist arrivals data.

FIGURE 4: PERCENTAGE GROWTH IN INBOUND TOURISM



SOURCE: Own calculation

FIGURE 5: VOLATILITY OF INBOUND TOURISM GROWTH



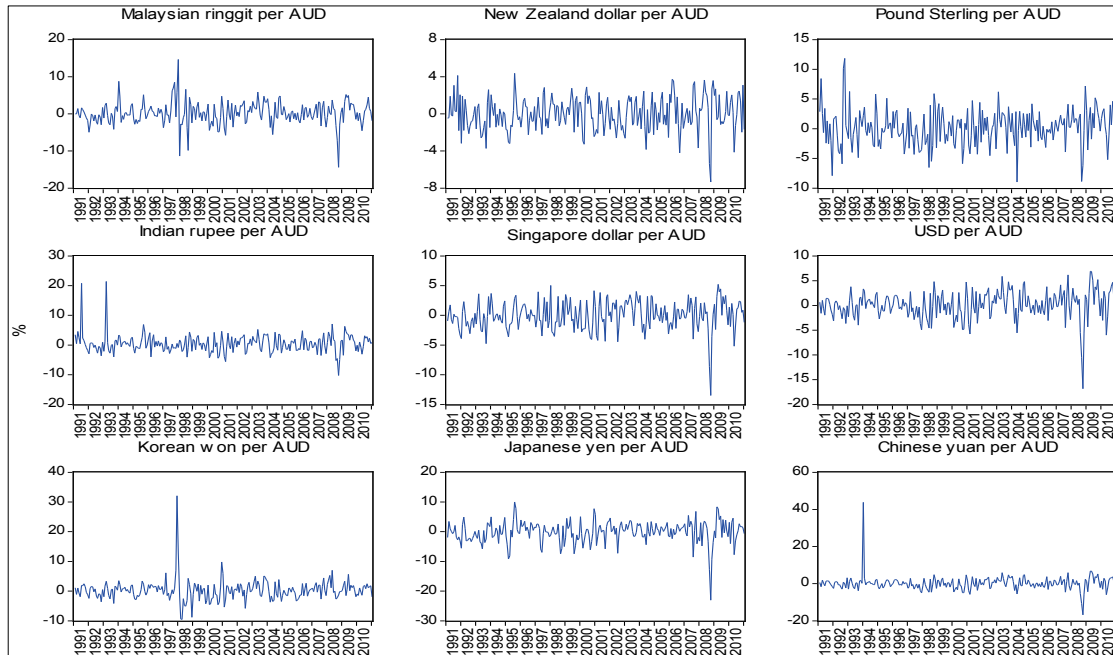
SOURCE: Own calculation.

NOTE: Volatility is calculated based on the square of each logarithm differenced value deviates from a mean.

Similarly, Figures 6 and 7 reveal that exchange rate returns display several extreme values. For example, during the Asian financial crises in 1998, the Korean won and Malaysian ringgit depreciated by more than 30% and 10% respectively, against the Australian dollar. In addition, when the global financial crisis hit in 2008, the Australian dollar rates fell by nearly 20% against the Chinese yuan, Japanese yen and the US dollar.

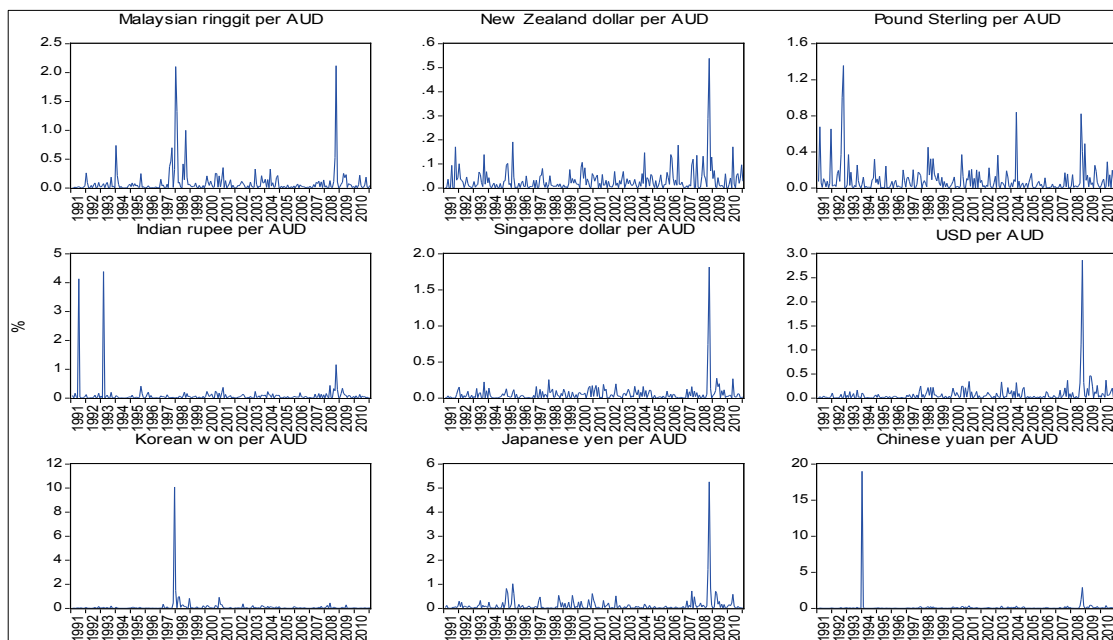
In 1994, the Australian dollar appreciated more than 40% against the Chinese yuan, as the yuan was effectively devalued when the official and swap rates were unified in that year (www.chinability.com/Rmb.htm). Moreover, the volatilities in the Singaporean and New Zealand dollars are evident in Figure 7, but the magnitudes for both exchange rates are rather small.

FIGURE 6: PERCENTAGE CHANGE IN EXCHANGE RATES



Source: Own calculation

FIGURE 7: VOLATILITY OF EXCHANGE RATE RETURNS



SOURCE: Own calculation

NOTE: Volatility is calculated based on the square of each logarithm differenced value from a mean.

In general, almost all data on tourism growth and exchange rate returns contain some outlier and/or extreme observations due to the occurrence of unexpected events such as the 1997-1998 Asian financial crises and the 2008 global financial crisis. Furthermore, based on Figures 5 and 7, there is some evidence of volatility clustering.

IV. MULTIVARIATE CONDITIONAL VOLATILITY AND CONDITIONAL CORRELATION FOR INTERNATIONAL TOURISM GROWTH RATE AND EXCHANGE RATES

This paper extends the research conducted by Chan, Lim and McAleer (2005) in two ways. First, this study develops conditional mean and conditional variance for monthly tourist arrivals from nine major countries of origin. Second, instead of focusing on the effects of shocks, this study explores whether the volatility in exchange rates could have significant effects on the uncertainty in international tourism in Australia.

In the economics and finance literature, multivariate conditional volatility models are used in risk management. The advantage of such models is that they take account of the volatility dependence effects between assets returns (Bauwens, Laurent and Rombouts, 2006). Thus, they allow a sensitivity analysis between asset returns and assess portfolio diversification (Yap, 2005). Adopting the methodology from the literature, this research models the monthly international tourism growth rates and changes in exchange rates for nine countries from January 1991 to January 2011. The international tourism growth rate is defined as the difference between current period and one-period lagged of logarithm inbound tourist data. Mathematically, it can be written as $\Delta \ln(y_t) = \ln(y_t) - \ln(y_{t-1})$, where y_t = international tourism at time t . Similarly, changes in exchange rates are the difference between current period and one-period lagged of logarithm exchange rate series, which can be written as $\Delta \ln(ER_t) = \ln(ER_t) - \ln(ER_{t-1})$. The main purpose of using logarithm differenced data is that they are tested stationary and do not contain unit root issues¹. Furthermore, when the data are employed for regression analyses, the coefficients can be expressed as elasticities (Lim, 2006).

VARMA-GARCH and VARMA-AGARCH models

To illustrate the conditional volatility models, it starts with a vector autoregressive moving average (VARMA) model, as given below:

$$\Phi(L)(y_t - \mu) = \Psi(L)\varepsilon_t, \quad t = 1, \dots, n$$

Where $\Phi(L)$ is vector autoregressive (AR) model with p lags and mathematically, it is written as $\Phi(L) = I - \Phi_1 L - \dots - \Phi_p L^p$; $\Psi(L)$ is vector moving average (MA) model with q lags and mathematically, it is written as $\Psi(L) = I + \Psi_1 L + \dots + \Psi_q L^q$; μ = a constant and ε_t = mean equation residuals. The conditional mean equation follows an ARIMA(1,1) process. Mathematically, the ARIMA equation is written as: $z_{it} = \delta_{1i} + \delta_{2i}z_{it-1} + \varepsilon_{it} + \gamma_i \varepsilon_{it-1}$, where z_{it} is the tourism growth data, δ_{1i} is the constant; δ_{2i} and γ_i are the coefficients of the AR(1) and MA(1) processes, respectively; ε_{it} is the

¹ The logarithm international tourist arrivals and exchange rate series have been tested using various unit root tests. The results reveal that most of the data contain the order of integration of one, I(1). In other words, the logarithm data are non-stationary but they become stationary after logarithm differencing. Therefore, this suggests that logarithm differenced data should be employed. Due to space limitation, the unit root test results are not disclosed in this paper but they can be obtained upon request.

error term which follows a white noise process. The necessary and sufficient condition for the equation to be stationary are that $\delta_{2i} < 1$ and $\gamma_i < 1$.

To capture the time-varying variance, the residuals are specified as:

$$\varepsilon_t = D_t \eta_t, \quad \eta_t \sim iid(0, \Gamma_t) \quad (1)$$

Where Γ_t = conditional correlation matrix, η_t = standardized error terms which contain a sequence of independent and identical distributed (i.i.d.) random vectors, m = number of variables, D_t = a multivariate conditional volatility model which is specified as:

$$D_t = diag(\sqrt{h_{it}}), \quad i = 1, \dots, m. \quad (2)$$

h_{it} is a conditional variance model for each variable i . For each variable, a univariate GARCH model is expressed as:

$$h_{it} = \omega_i + \sum_{j=1}^r \alpha_i \varepsilon_{it-j}^2 + \sum_{j=1}^s \beta_i h_{it-j}, \quad i = 1, \dots, m, \quad (3)$$

where ω_i = unconditional variance, α_i = the short-run coefficient of lagged shocks (ε_{it-1}^2), β_i = the coefficient of GARCH effects which capture the effects of shocks in the long-run. To take account of negative new shock effects, equation (3) can be re-written as:

$$h_{it} = \omega_i + \left(\sum_{j=1}^r \alpha_{ir} + \sum_{j=1}^r \gamma_{ir} I(\eta_{it-r}) \right) \varepsilon_{it-r}^2 + \sum_{j=1}^s \beta_i h_{it-j} \quad (4)$$

$$I(\eta_{it}) = \begin{cases} 1, & \varepsilon_{it} < 0 \\ 0, & \varepsilon_{it} \geq 0 \end{cases}$$

where

$I(\eta_{it})$ is a dummy variable where any negative shock will be indicated as one while zero otherwise.

Nevertheless, equation (2) may be inappropriate to assume that independent conditional variance exists across the variables (Ling and McAleer, 2003). To explain the relationship between the volatility across different variables, h_{it} should incorporate the interdependence of conditional variances across all variables. In other words, h_{it} should include all past information of ε_{it} and ε_{jt} , where $i \neq j$, in the multivariate GARCH model. Hence, Ling and McAleer (2003) developed VARMA-GARCH model, as follows:

$$H_t = W + \sum_{i=1}^r A_i \vec{\varepsilon}_{t-i} + \sum_{j=1}^s B_j H_{t-j} \quad (5)$$

where $H_t = (h_{1t}, \dots, h_{mt})'$, $\tilde{\varepsilon} = (\varepsilon_{1t}^2, \dots, \varepsilon_{mt}^2)'$, and W , A_i for $i = 1, \dots, r$ and B_j for $j = 1, \dots, s$ are $m \times m$ matrices. The usefulness of the equation (5) is that it explains how the volatility of a variable can be influenced by its own as well as the shocks from other variables.

Moreover, VARMA-AGARCH model is developed to accommodate asymmetric behaviour (McAleer, Hoti, and Chan, 2009), which is written as:

$$H_t = W + \sum_{i=1}^r A_i \tilde{\varepsilon}_{t-i} + \sum_{i=1}^r C_i I_{t-i} \tilde{\varepsilon}_{t-i} + \sum_{j=1}^s B_j H_{t-j} \quad (6)$$

where $H_t = (h_{1t}, \dots, h_{mt})'$, $\tilde{\varepsilon}_t = (\varepsilon_{1t}^2, \dots, \varepsilon_{mt}^2)'$, $C = m \times m$ matrices and $I_t = \text{diag}(I_{1t}, \dots, I_{mt})$ where $I_{it} = I(\eta_{it})$.

This study uses a bivariate regression approach where the VARMA-GARCH and VARMA-GARCH estimations were based only on one tourist origin and its currency. Chan, Lim and McAleer (2005) and Hoti, McAleer and Riaz (2007) employed multivariate conditional volatility models to explore the volatility spill-over effects among the investigated countries of origin. One of their research goals was to examine whether the tourist markets were diversifiable. However, the current study could not use their suggested methodology because when all variables were included at the preliminary stage of the research, most estimation outputs failed to generate estimations which could be due to insufficient number of observations. Furthermore, the main intention of this research is to explore whether the variations in a country's currency could affect the fluctuations in tourist arrivals to Australia. As most international tourists may travel using their own countries' currencies, the changes in these currencies may have significant effects on their travel decisions.

Constant conditional correlation GARCH models

A constant conditional correlation (CCC) can be further developed by assuming that conditional variances across the variables are independent and exhibit symmetrical behaviour (Bollerslev, 1990). In other words, for each multivariate GARCH model above, CCC is valid given that the standardized shocks (η_t) is a sequence of i.i.d. random vectors.

The conditional correlation matrix of CCC is $\Gamma = E(\eta_t \eta_t')$ where $\Gamma = \{\rho_{ij}\}$ and

$$\Gamma = \begin{pmatrix} 1 & \rho_{12} & \cdots & \rho_{1m} \\ \rho_{21} & 1 & \cdots & \rho_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{m1} & \rho_{m2} & \cdots & 1 \end{pmatrix}$$

in which $\rho_{ij} = \rho_{ji}$ for $i, j = 1, \dots, m$. From equation (1), $\varepsilon_t \varepsilon_t' = D_t \eta_t \eta_t' D_t = (\text{diag } Q_t)^{1/2}$ and $E(\varepsilon_t \varepsilon_t' / I_{t-1}) = D_t \Gamma D_t = Q$, where Q_t is the conditional covariance matrix. The matrix is defined as $\Gamma = D_t^{-1} Q_t D_t^{-1}$ and each conditional correlation coefficient is estimated from the standardised residuals in equations (1) and (2) (McAleer, 2005).

For this study, CCC is used to examine the relationships between conditional shocks to exchange rates and inbound tourism growth. The main purpose of this estimation is to determine whether Australia's tourist markets are strongly responsive to the sudden changes (shocks) in exchange rates. If the estimated correlation has a positive value, this indicates that the shocks to exchange rates and inbound tourism growth are positively correlated. Conversely, if the estimated correlation has a negative value, this implies that the exchange rate shocks do not cause the shocks of inbound tourism growth.

V. EMPIRICAL RESULTS

This study employs VARMA-GARCH and VARMA-AGARCH models to examine whether exchange rates can influence the volatility in international tourist arrivals to Australia. Nine countries of origin and their exchange rates were used to conduct this research. In this paper, the estimates of conditional mean and volatility equations were generated using the algorithm of Berndt, Hall, Hall and Hausman (1974) in the Eviews 7 econometric software package. Furthermore, the reporting standard errors are based on the Bollerslev and Wooldridge (1992) robust standard errors.

Tables 2 and 3 present the results of VARMA-GARCH and VARMA-AGARCH regressions for each country of origin, respectively. Referring to the coefficients in the conditional mean equation, the lagged dependent variable was found to be statistically significant for South Korea and US tourist arrivals data. The AR(1) coefficient (δ_{2i}) signs for these countries are positive, indicating that the tourists have the tendency of repeating their visits to Australia. Particularly for the US tourists, there was 0.38% increase in the average monthly tourist arrival growth data². As for the MA(1) coefficient (γ_i), the estimations for all countries (except Japan and the UK) are statistically significant at the 1% level. This means that these countries are susceptible to unexpected shocks. As for the China data, the MA coefficient is statistically significant in the VARMA-AGARCH results but not in the VARMA-GARCH results despite having the same MA(1) sign in each model.

² The conditional mean equation is estimated based on double log model and hence, the coefficients can be interpreted as elasticity. As the data used in this study are rate of change of tourist arrivals and rate of change of exchange rates, the coefficient interpretation is slightly different from other empirical study. For simplicity, let us assume that a conditional mean equation is written as: $\Delta y_t = a_0 + a_1 \Delta x_t + e_t$, where : Δy_t = the rate of change of y (logarithm difference of y), Δx_t = the rate of change of x (logarithm difference of x), e_t = error terms, a_0 = constant and a_1 = equation slope or coefficient . The explanation of a_1 is that when the rate of change of x (Δx_t) increases by 1%, the rate of change of y (Δy_t) is estimated to increase by a_1 %. It measures the percentage change in the rate of change of y (the dependent variable).

TABLE 2: RESULTS OF VARMA-GARCH REGRESSION

Variable	Country of Origin								
	China	India	Japan	Malaysia	New Zealand	Singapore	South Korea	UK	USA
Conditional mean equation									
δ_{1i}	0.018*** (0.005)	0.011*** (0.002)	0.001 (0.003)	0.009*** (0.002)	0.002 (0.001)	0.005*** (0.002)	0.019*** (0.004)	0.007*** (0.002)	0.003*** (0.001)
δ_{2i}	-0.114 (0.113)	0.084 (0.120)	-0.085 (0.172)	-0.034 (0.089)	0.056 (0.090)	0.044 (0.103)	0.330* (0.176)	-0.222 (0.137)	0.282*** (0.072)
γ_i	-0.171 (0.115)	-0.729*** (0.070)	-0.128 (0.130)	-0.710*** (0.060)	-0.714*** (0.025)	-0.642*** (0.073)	-0.518*** (0.071)	-0.239 (0.171)	-0.802*** (0.046)
Conditional variance equation									
ω_i	0.014** (0.006)	0.0003 (0.0004)	0.001*** (0.000)	0.005*** (0.001)	0.003*** (0.001)	0.004** (0.002)	0.009*** (0.000)	0.006*** (0.000)	0.008** (0.003)
α_i	0.284 (0.313)	0.194** (0.093)	0.350** (0.146)	0.074 (0.053)	0.478** (0.192)	0.101 (0.089)	0.498 (0.346)	0.083 (0.062)	0.324** (0.159)
β_i	0.118 (0.288)	0.766*** (0.091)	0.301* (0.163)	0.746*** (0.052)	-0.050* (0.029)	0.535*** (0.181)	0.118 (0.101)	0.530*** (0.091)	-0.119 (0.089)
ε_{t-1}^2 (ERorigin)	-0.078*** (0.023)	-0.251** (0.107)	-0.182 (0.181)	6.257*** (1.702)	0.940 (0.624)	0.021 (0.259)	-1.255*** (0.132)	-0.451 (0.360)	-0.235*** (0.067)
h_{t-1}^2 (ERorigin)	-1.857 (1.386)	0.583 (0.836)	0.747 (0.649)	-7.484*** (1.143)	-4.427*** (0.911)	-1.962*** (0.758)	-1.104** (0.510)	-0.946* (0.538)	-1.377** (0.612)

NOTE: The conditional mean equation is written as: $z_{it} = \delta_{1i} + \delta_{2i}z_{it-1} + \varepsilon_{it} + \gamma_i\varepsilon_{it-1}$, where z_{it} is international tourism growth data, δ_{1i} is the constant; δ_{2i} and γ_i are the coefficients of the AR(1) and MA(1) processes, respectively; ε_{it} is the error term which follows a white noise process. The conditional variance equation is based on multivariate conditional volatility model which is expressed as $H_t = W + A\vec{\varepsilon}_{t-1} + BH_{t-1}$, where H_t is vector of volatility of tourism growth, W is the constant variance and $\vec{\varepsilon}_{t-1}$ is the one-lagged vector error terms which is based on $\vec{\varepsilon}_t = (\varepsilon_{1t}^2, \dots, \varepsilon_{mt}^2)'$. ***, ** and * denote significance at the critical levels of 1%, 5% and 10%, respectively. Figures in brackets are the Bollerslev –Wooldridge robust standard errors. ε_{t-1}^2 (ERorigin) denotes one-lagged shocks of an origin country's currency against Australian dollar. For instance, in the China column, the ε_{t-1}^2 (ERorigin) refers as one-period lagged shocks of yuan against Australian dollar. ε_{t-1}^2 (US\$ per A\$) denotes one-lagged shocks of US dollar against Australian dollar. The coefficients of h_{t-1}^2 (ERorigin) and h_{t-1}^2 (US\$ per A\$) are the volatility of an origin country's currency and US dollar against Australian dollar, respectively.

TABLE 3: RESULTS OF VARMA-AGARCH REGRESSION

Variable	Country of Origin								
	China	India	Japan	Malaysia	New Zealand	Singapore	South Korea	UK	USA
Conditional mean equation									
δ_{1i}	0.014*** (0.005)	0.011*** (0.002)	-0.002 (0.003)	0.008*** (0.002)	0.002** (0.001)	0.005*** (0.002)	0.020*** (0.005)	0.007*** (0.002)	0.004*** (0.001)
δ_{2i}	-0.161 (0.141)	0.072 (0.102)	-0.090 (0.171)	-0.104 (0.091)	0.003 (0.074)	0.037 (0.104)	0.314 (0.202)	-0.205 (0.135)	0.383*** (0.088)
γ_i	-0.255*** (0.078)	-0.709*** (0.076)	-0.154 (0.135)	-0.679*** (0.059)	-0.712*** (0.026)	-0.640*** (0.074)	-0.50*** (0.092)	-0.256 (0.162)	-0.828*** (0.051)
Conditional variance equation									
ω_i	0.012*** (0.000)	0.004* (0.002)	0.001 (0.001)	0.005*** (0.001)	0.003*** (0.001)	0.004** (0.002)	0.010*** (0.002)	0.006*** (0.000)	0.009*** (0.003)
α_i	-0.031 (0.056)	0.058 (0.081)	0.166 (0.101)	0.032 (0.048)	0.90*** (0.342)	0.068 (0.139)	0.452* (0.250)	0.095 (0.104)	0.351* (0.207)
$I(\eta_{it})$	0.455 (0.467)	0.599** (0.238)	0.491* (0.278)	0.129 (0.152)	-0.642** (0.306)	0.042 (0.152)	0.051 (0.596)	-0.108 (0.111)	-0.130 (0.284)
β_i	0.212 (0.690)	0.235* (0.122)	0.298 (0.279)	0.714*** (0.086)	-0.070** (0.032)	0.531*** (0.188)	0.093 (0.101)	0.518*** (0.097)	-0.164 (0.153)
ε_{t-1}^2 (ERorigin)	-0.099 (2.260)	-0.207* (0.116)	-0.210*** (0.069)	6.348*** (1.679)	0.790* (0.437)	-0.029 (0.259)	-1.329*** (0.291)	-0.411 (0.366)	-0.227*** (0.069)
h_{t-1}^2 (ERorigin)	-1.388 (5.143)	1.419 (2.577)	0.566 (0.686)	-7.253*** (1.041)	-4.082*** (0.839)	-2.005*** (0.755)	-1.081*** (0.207)	-0.942* (0.551)	-1.557** (0.623)

NOTE: The conditional mean equation is written as: $z_{it} = \delta_{1i} + \delta_{2i}z_{it-1} + \varepsilon_{it} + \gamma_i\varepsilon_{it-1}$, where y_{it} is international tourism growth data, δ_{1i} is the constant; δ_{2i} and γ_i are the coefficients of the AR(1) and MA(1) processes, respectively; ε_{it} is the white noise error term. The conditional variance equation is based on multivariate conditional volatility model as follows: $H_t = W + (A + CI(\eta_{t-1}))\bar{\varepsilon}_{t-1} + BH_{t-1}$, where H_t is vector of volatility of tourism growth, W is the constant variance, $C = m \times m$ matrices, $I(\eta_t) = \text{diag}(I(\eta_{it}))$, and $\bar{\varepsilon}_{t-1}$ is the one-lagged vector error terms which is based on $\bar{\varepsilon}_t = (\varepsilon_{1t}^2, \dots, \varepsilon_{mt}^2)'$. ***, ** and * denote significance at the critical levels of 1%, 5% and 10%, respectively.

Figures in brackets are the Bollerslev –Wooldridge robust standard errors. ε_{t-1}^2 (ERorigin) denotes one-period lagged shocks of an origin country's currency against Australian dollar. ε_{t-1}^2 (US\$ per A\$) denotes one-lagged shocks of US dollar against Australian dollar. The coefficients of h_{t-1}^2 (ERorigin) and h_{t-1}^2 (US\$ per A\$) are the volatility of an origin country's currency and US dollar against Australian dollar, respectively.

The conditional variance equations provide some evidence showing that the volatility of international tourist arrivals is vulnerable to unexpected shocks. The values of α_i in Table 2 are positive and statistically significant for countries such as India, Japan, New Zealand and the USA. This implies that when a news shock occurs, these tourist growth rates become considerably more volatile than for the other countries. However, Table 3 shows rather different results. Apparently, only the volatilities of tourist arrivals growth rates from New Zealand, South Korea and the USA are prone to the effects of news shocks. In addition, the asymmetric effects are statistically significant for the India, Japan and New Zealand.

Table 2 also suggests that previous volatility of tourist growth data can influence its current volatility. The coefficient of h_{it-1} are found statistically significant for India, Japan, Malaysia, New Zealand, Singapore and the UK. Similarly, Table 3 reveals the same outcomes for these countries except Japan. Both VARMA-GARCH and VARMA-AGARCH exhibit quite similar results for h_{it-1} . Most results reveal a

positive sign for h_{it-1} (except New Zealand), implying that an increase in previous volatility of tourist growth rate can lead to a rise in its current volatility. In fact, India and Malaysia have the highest magnitude of more than +0.7. Hence, this indicates that these tourists may have a long memory for shock events. Nevertheless, the coefficient for New Zealand case is between -0.5 and -0.7, indicating that these tourists' memories of news shocks could be diminished in the long-run.

The spill-over effects from exchange rates and tourist arrivals growth are evident in Tables 2 and 3. Referring to the $\varepsilon_{t-1}^2(\text{ERorigin})$, the coefficients are statistically significant for tourist arrivals from all countries except Singapore and the UK. The tables present two distinct findings. On one hand, the coefficient signs for China, India, Japan, South Korea and the USA are negative, showing that tourists from these countries are less sensitive to the sudden appreciation of the dollar. There could be two possible explanations: (1) Most of the tourists from Asia may visit Australia by tours and hence, major travel expenses such as accommodation and tickets to tourist destinations have included in their tour package. Hence, these tourists may not be susceptible to the fluctuation in exchange rates; (2) Majority of tourists from the USA tend to hold a working holiday visa while staying in Australia. Therefore, they might not be easily affected by the changes in exchange rates as they could earn money while working in Australia and spend the money on travelling. However, the $\varepsilon_{t-1}^2(\text{ERorigin})$ signs for Malaysia and New Zealand are positive, implying that an unexpected news shock on these countries' currencies could cause an increase in the volatility of these tourist arrivals to Australia. Put it differently, a surge in the Australian dollar value could raise the uncertainty of these tourists wanting to visit Australia. Perhaps, the reason could be that these tourists have a tendency to arrange Australia trips by themselves, and consequently, they are rather sensitive to exchange rate shocks.

In regard to the $h_{t-1}^2(\text{ERorigin})$, the empirical results reveal that most currencies have significant impacts on the volatility of tourist arrivals to Australia, except the Chinese yuan, Indian rupee and Japanese yen. In fact, the coefficient signs for most cases are negative, signifying that the persistence of currency shocks will gradually decay in the long run. The magnitude of the coefficient for the Malaysia case is the highest among the rest. Notwithstanding the Malaysian tourists are sensitive to a sudden appreciation of the Australian dollar, they may not have a long-run memory for the event. This similar situation occurs to the New Zealand tourists.

Table 4 presents the constant conditional correlation between inbound tourism growth and exchange rates. The results show that most of the correlations are negative and the values are rather small. For example, the correlation between the US dollar and the US tourists is negative and is the lowest (ranging from -0.001 to -0.004). Hence, a sudden change in the exchange rates would not significantly affect the growth in US visitors in Australia. Moreover, positive conditional correlations are evident in three cases: (1) yuan and Chinese tourists (0.035); (2) rupee and Indian tourists (0.015); and (3) ringgit and Malaysian tourists (0.023). This shows that when there is a news shock to these currencies, it would increase the uncertainty of these Asian tourists visiting to Australia. In addition, the conditional correlations between yen and these visitors are -0.004 for VARMA-GARCH and 0.005 for VARMA-AGARCH, and hence, such findings could not make a solid conclusion about the relationship. In general, all correlation values in the table are small, indicating that the relationships between exchange rates and inbound tourist growth are rather weak.

**TABLE 4: CONSTANT CONDITIONAL CORRELATION BETWEEN
INBOUND TOURISM GROWTH AND EXCHANGE RATES**

Conditional shocks between a country's currency and the inbound tourists from the country	Conditional correlation	
	VARMA-GARCH	VARMA-AGARCH
Yuan ↔ Chinese tourists	0.035	0.032
Rupee ↔ Indian tourists	0.015	0.01
Yen ↔ Japanese tourists	-0.004	0.005
Ringgit ↔ Malaysian tourists	0.023	0.023
NZD ↔ New Zealand tourists	-0.061	-0.049
SGD ↔ Singaporean tourists	-0.064	-0.052
Won ↔ Korean tourists	-0.056	-0.019
Pound sterling ↔ UK tourists	-0.012	-0.023
USD ↔ US tourists	-0.004	-0.001

NOTE: NZD refers to New Zealand dollar; SGD stands for Singapore dollar; USD stands for US dollar. The correlation coefficients are calculated based on the estimation of equations (5) and (6).

VI. POLICY IMPLICATIONS

The results provide vital information for planning marketing strategies. Despite the Australian dollar rising dramatically against most world trading currencies, the number of inbound tourists from China, India, Japan, Singapore, South Korea, and the USA to Australia may not be significantly affected. As shown in Table 5, when there are sudden changes in the countries' currencies, the volatility of these tourist numbers will decline. Hence, this suggests that tourism stakeholders should invest more resources in promoting Australia's tourism in Asian countries and the USA. As the low-cost carriers from Asia have emerged, Tourism Australia could work closely with the carriers to encourage more Asian tourists to visit Australia. One of the recent activities was that Australia and China have planned to enhance aviation capacity between these two countries by up to 50% from 14,000 to 18,500 seats (Creedy, 2011). Perhaps, Australian tourism operators and hoteliers could offer more discounts on tour packages and accommodation to maintain competitiveness and to attract more Asian tourists into the country. Moreover, as for the US tourist market, Australian policy-makers could ease the holiday working visa policy for the US tourists and encourage them to stay longer while travelling in Australia.

TABLE 5: THE EFFECTS OF PAST SHOCKS, CURRENCIES SHOCKS AND VOLATILITIES ON VOLATILITY IN INTERNATIONAL TOURIST ARRIVAL GROWTH

	Volatility of tourism growth for each origin								
	China	India	Japan	Malaysia	New Zealand	Singapore	South Korea	UK	USA
Shock spillover effects:									
1. One-period lagged tourism growth shocks	<i>X</i>	+	+	<i>X</i>	+	<i>X</i>	+	<i>X</i>	+
2. One-period lagged currency shocks	-	-	-	+	+	<i>X</i>	-	<i>X</i>	-
3. Asymmetric effect	<i>X</i>	+	+	<i>X</i>	-	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>
Volatility spillover effects:									
1. One-period lagged tourism growth volatility	<i>X</i>	+	-	+	-	+	<i>X</i>	+	<i>X</i>
2. One-period lagged currency volatility	<i>X</i>	<i>X</i>	<i>X</i>	-	-	-	-	-	-

NOTE: The summary is based on the results in Tables 2 and 3. + and – denote positive and negative effects, respectively. *X* denotes no spillover effects.

This study also suggests that when the Australian dollar appreciates, the tourist numbers from Malaysia and New Zealand become more volatile. From Table 5, one-period lagged currency shocks have positive effects on the volatility of Malaysian and New Zealand tourists in Australia. Therefore, any news shock of the currencies may increase the uncertainty in these tourist arrivals to Australia. Even though a strong Australian dollars could rise uncertainties in these tourist markets, Tourism Australia may need to expand more tourism products which could provide good value of money. Nevertheless, this requires long-term planning, particularly in developing tourism infrastructure.

Lastly, Table 5 reveals that one-period lagged tourism growth shocks can increase the volatilities in tourist arrivals from India, Japan, New Zealand, South Korea and the USA, implying that these tourists could be sensitive to the unexpected changes in exchange rates. However, for cases like India, Malaysia, Singapore and the UK, the previous tourism growth volatility has positive impacts on its current volatility. This suggests that the visitors from these countries may have long-term memories to the changes. Therefore, perhaps Australian tourism policy-makers should introduce some discounts or travel promotions to inbound tourists and make Australia to become more price competitive in the global travel markets.

VII. CONCLUSIONS

The tourism industry in Australia has been challenged by the rising value of the Australian dollar and because of that, the industry is facing a wide deficit in tourism trade. One of the potential causes is a decline in tourism export (inbound tourism).

This paper examined whether the volatility of exchange rate impacts on the fluctuations in the international tourism growth rate. The main purpose was to measure the degree of uncertainty between international tourism growth and exchange rates. The research employed nine countries of origin for tourists coming to Australia (China, India, Japan, Malaysia, New Zealand, Singapore, South Korea, the UK and the USA) from January 1991 to January 2011 while the exchange rate data used were based on the monthly average value of each foreign currency against the Australian dollar.

Spill-over effects from currency shocks to the volatility in tourist arrivals to Australia were evident in this research. Several tourist markets such as Malaysia and New Zealand reacted strongly to the shocks while others responded passively. However, the results found that the tourists' memories of the shocks could diminish in the long-run. Furthermore, based on the findings of constant conditional correlations, the relationships between the currency shocks and inbound tourism growth were rather weak. This suggests that the appreciation of the Australian dollar would not have significant long-term impacts on the tourists' decisions to travel to Australia. Therefore, during this mining boom period where the Australian dollar value is very high, tourism stakeholders should invest more resources in promoting Australian tourism in Asian countries, the UK and the USA.

Notwithstanding the current results provided useful information for tourism policy-makers, they should be treated with caution. There are three limitations of this study which require further investigation. First, income is one of the most important explanatory variables for international tourism demand (Lim, 2006). However, this research omitted this variable as its monthly series is publicly not available. Second, the data used in this research were based on monthly tourist arrival data. In fact, the tourism literature has suggested using high frequency data such as weekly and daily series in tourism empirical research. These data has several advantages, especially as it can lead to a considerably higher sample size, enable a more accurate prediction of uncertainty in tourism tax revenue and can capture day-of-the-week effects through differential pricing strategies in the tourism industry (Divino and McAleer, 2010; McAleer *et al.*, 2009). In conclusion, perhaps in the future, this study can be replicated when higher frequency data (i.e. daily series) become available.

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