

ARMAX Modelling of International Tourism Demand

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EXTENDED ABSTRACT

One of the basic goals of tourism demand modelling is to estimate income and/or price elasticities, which can then be used in developing better informed public and private policies. The focus of econometric studies is to determine the extent to which the data support a particular theory. In reviews of empirical studies on international tourism demand and its determinants, Lim (1999, 2006) argued that the most prominent and frequently used variable in these studies is income of tourist-generating countries, which affects the ability of consumers in these countries to pay for their overseas travel. More specifically, the demand for international travel is positively related to income in the origin market.

Japan has been a dominant economic power and a tourism superpower in the Asia-Pacific region. It has been the largest inbound market for many countries in the region. Figure 1 shows the real GDP and outbound travel of Japan since 1980. The purpose of this paper is to use the ARMAX model to investigate the dynamic relationship between tourism demand and real income of Japan, and to compare the findings with the single-equation model. Extensive discussion of ARMAX modelling and estimation can be found in Franses (1991) and Greene (2000). The ARMAX model is an extension of the Box-Jenkins autoregressive-moving average (ARMA) model with explanatory exogenous variables (X).

Box-Jenkins (1970) models are used to capture the autoregressive moving average of past observations of tourist arrivals from Japan to Taiwan and New Zealand. While it is possible to use the autoregressive (AR) and moving average (MA) processes to capture the current pattern of tourist arrivals from a particular market based on its own past arrivals and the random error from previous periods, other explanatory variables, such as real income in the origin country, have also affected the demand for international travel.

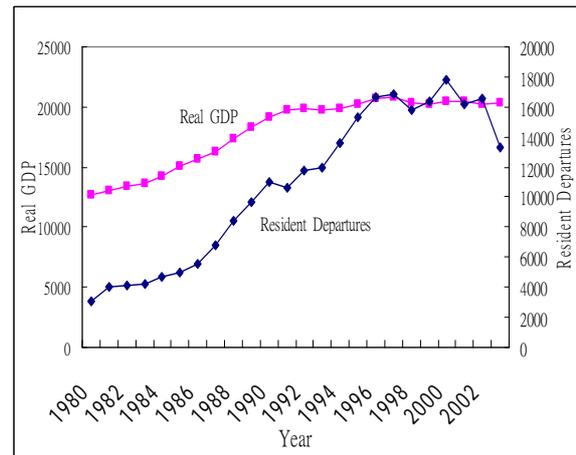


Figure 1. Real GDP (billion JYP) and resident departures ('000) of Japan, 1980-2003.

By including an income variable with a finite lag structure, the ARMAX model is used to estimate the income elasticity of tourism demand by Japan for New Zealand and Taiwan over the period 1980 to 2004. Before specifying the ARMAX model, tests and diagnostics are performed in the estimation of the Box-Jenkins models. By excluding insignificant AR and MA lags, the use of diagnostics and selection criteria would help to determine a more parsimonious model. The latter is subsequently used to undertake ARMAX modelling and estimation of the income elasticity of travel demand.

After discussing the tourism movements from Japan to New Zealand and Taiwan since 1980 and characteristics of international tourists, the methodology and unit root tests for the tourism and income time series are discussed, the estimation of the single equation and ARMAX models is presented, and some concluding remarks are given. The EVIEWS 5 econometric software package is used for the data analysis and empirical estimation.

1. INTRODUCTION

Japanese outbound travel rebounded strongly in 2004 and 2005, after two years of negative growth in 2001 and 2003 (World Tourism Organisation, 2006). Fears of terrorism and diseases related to the events of September 11, 2001 in the USA, SARS and bird flu outbreaks in 2003, have caused negative growth of 9% and 20% in 2001 and 2003, respectively, in Japanese international travel demand (see Figure 2).

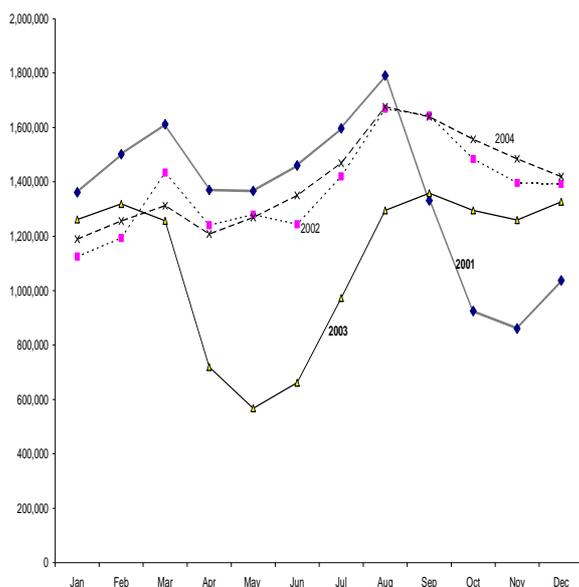


Figure 2. Total short-term resident departures from Japan, 2001-2004

After some discussion of tourism movements from Japan to New Zealand and Taiwan since 1980 and certain characteristics of the tourists in Section 2, the rest of the paper is organised as follows. The methodology and unit root tests for the tourism and income time series are discussed in Sections 3 and 4, respectively. In Section 5, the estimation of the single equation and ARMAX models is presented. Some concluding remarks are given in Section 6. The EViews 5 econometric software package is used for the data analysis and empirical estimation.

2. JAPANESE TOURISM DEMAND FOR NEW ZEALAND AND TAIWAN

Japan is New Zealand's largest Asian tourist source market. Tourist arrivals from Japan had been increasing by more than 14% per annum from 1980 to 1996, after which New Zealand started to experience a decline in the Japanese market (see Figure 3). The 1997/1998 Asian economic and financial crises, continuing economic slowdown in

the Japanese economy since the mid-1990s, SARS and the appreciation of the New Zealand dollar have all contributed significantly to the sharp decline in the Japanese market (NZ Department of Statistics 1980-2004).

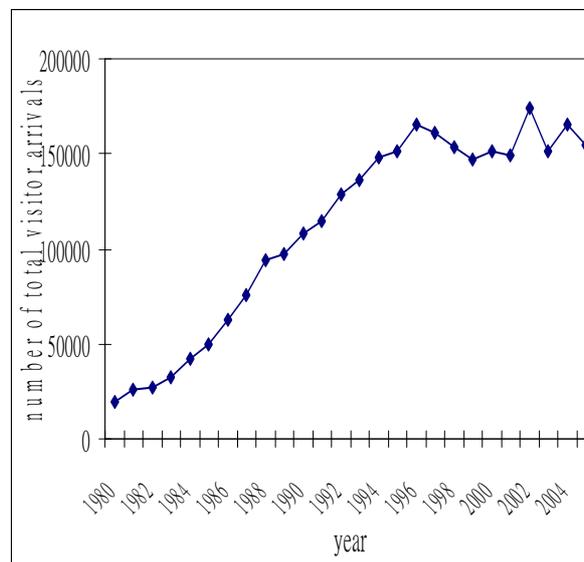


Figure 3. International tourist arrivals from Japan to New Zealand, 1980-2005

Most Japanese tourists regard New Zealand as a holiday destination, as shown in Figure 4. As a long haul destination, it seems that New Zealand is a popular destination for older Japanese tourists, with 37% of all visitors aged 55 years and above. According to the international visitor surveys conducted in 2005, most Japanese visitors were package travellers, and very few were repeat tourists. Auckland (in the North Island), followed by Canterbury and Queenstown (in the South Island), were the most popular regions in New Zealand for Japanese tourists. Not surprisingly, hotels were the dominant type of accommodation used by these visitors.

Market surveys also indicated that shopping and eating out were the most popular activities engaged in by Japanese tourists (Tourism New Zealand 2006). Besides a decline in Japanese tourist arrivals, the increase in the strength of the New Zealand currency has also caused a decrease in tourist spending. Average Japanese tourist expenditures in New Zealand decreased by more than 13% from 2004 to 2005.

Historically, Taiwan was a colony of Japan from 1895 to 1945 prior to the Kuomintang (KMT) Party's flight to Taiwan (from China) to exercise its sovereignty. During that time, only the Japanese language and education were allowed to be spoken

and learned by the island residents. Thus, Taiwan's lifestyle has been heavily influenced by the Japanese culture. For instance, Taiwanese and Japanese enjoy similar leisure activities, such as shopping, dining, and soaking in hot springs all year around.

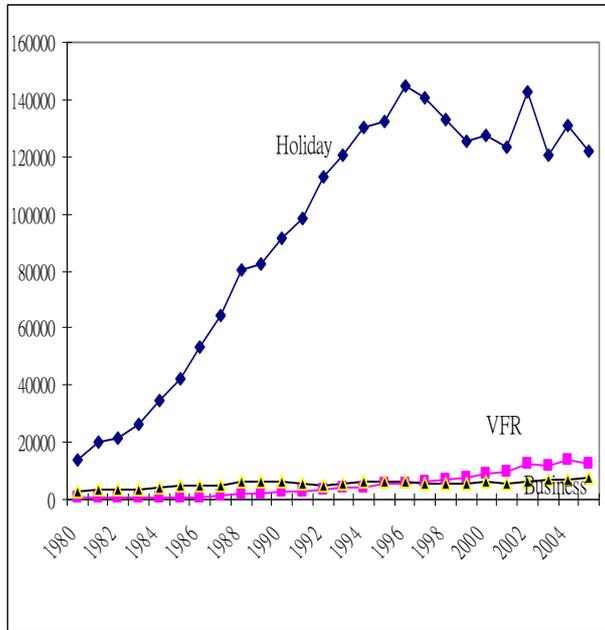


Figure 4. Japanese tourists to New Zealand by trip purpose, 1980-2005

Japan is a significant inbound tourism market for Taiwan in terms of tourist arrivals and tourist average daily expenditure. Japanese tourists, which accounted for over 30% of all international tourists in Taiwan, have been increasing by more than 4% between 1981 and 2005 (Taiwan Tourism Bureau, 2006). Higher tourism or relative prices in Taiwan due to inflation in recent years have not slowed down the flows of tourists from Japan. In particular, the number of Japanese visitors to Taiwan has reached a new record of 1.1 million in 2005, a double-digit growth compared with 2004 (see Figure 5). However, the SARS outbreak in 2003, which was the first pandemic of the 21st Century declared by the World Health Organization (2003), had a far-reaching effect on Japanese inbound arrivals to Taiwan to such levels the country had not experienced since 1986.

Between 2000 and 2005, more than one-third of Japanese tourists to Taiwan were in the 50 and older age group. The share of Japanese male tourists outnumbered their female counterparts by the ratio of approximately 2:1. About 50% of Japanese travelled to Taiwan for pleasure, followed by business (30%), and visiting relatives and friends (3%), as shown in Figure 6. According

to a survey conducted by the Taiwan Tourism Bureau (2006), *Taroko*, *Tienhsiang* (one of the national parks located on the eastern side of Taiwan) and the night markets were the major scenic spots for Japanese tourists. The study also found that cuisine and historical relics were the major attractions for most Japanese tourists. On average, their duration of stay was 5.02 nights, compared with 7.1 nights on average for all inbound visitors.

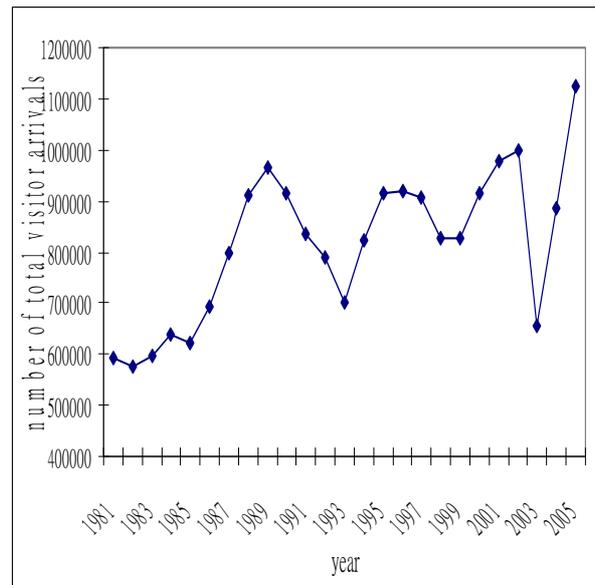


Figure 5. International tourist arrivals from Japan to Taiwan, 1981-2005

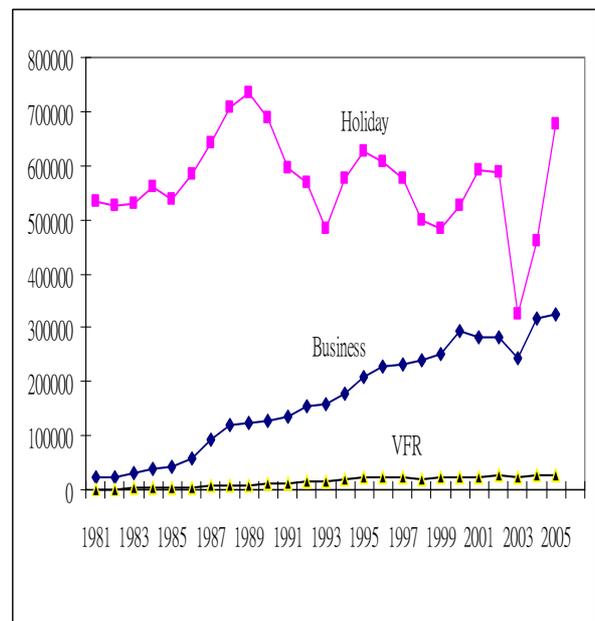


Figure 6. Japanese tourists to Taiwan by trip purpose, 1981-2005

The seasonal patterns of tourist arrivals from Japan to New Zealand and Taiwan are shown in Figure 7. Using the multiplicative ratio-to-moving average technique to estimate the monthly seasonal indices, it is not surprising that there is less seasonal variation for a short-haul destination such as Taiwan. The seasonal range is 0.34 and 0.77 for Taiwan and New Zealand, respectively. Nonetheless, the peak tourism months for the two destinations are February (for New Zealand) and March (for Taiwan). The destinations have overlapping tourism seasons during the period 1979 to 2005, that is, from November to March. While the intra-year movements of Japanese tourists to New Zealand may be related to the climatic conditions at the destination, the same argument would not seem to apply to Taiwan.

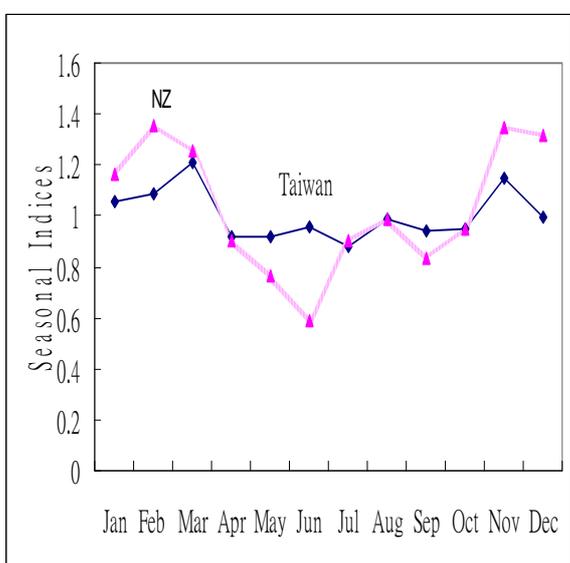


Figure 7. Estimated monthly seasonal indices for inbound tourist arrivals from Japan to New Zealand and Taiwan, 1980-2005

3. METHODOLOGY

The focus of econometric studies is to determine the extent to which the data support a particular theory, namely the demand for international travel is positively related to income of the origin country. We propose to use time series econometric modelling of inbound tourism based on seasonally unadjusted quarterly data for 1980(1) to 2004(2) to obtain estimates of income elasticities of travel to New Zealand and Taiwan by Japanese residents.

Ordinary least squares (OLS) estimation is used to estimate the influence of real income on tourism demand by Japan for New Zealand and Taiwan. More specifically, we will estimate single equation

and ARMAX models by OLS to compare the estimates of the Japanese income elasticity of travel demand for the two destinations. The sensitivity of tourist arrivals from Japan to changes in its real income will also be evaluated. As a guide to model selection, the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) are useful, so that the model with the smallest AIC and SBC values is preferred

We assume a linear model in the variables in which the data on y_1, \dots, y_t have been generated by $y_t = \alpha + \beta x_t + \varepsilon_t$, such that y_t depends linearly on α and β . The other key assumptions of the classical linear regression model include:

- (1) Expected value of disturbance term is zero:
 $E(\varepsilon_t) = 0$;
- (2) Homoskedasticity, or constant variance of the disturbances: $\text{Var}(\varepsilon_t) = \sigma_e^2$ for all t ;
- (3) No serial correlation of the disturbances across periods: $E(\varepsilon_t \varepsilon_s) = 0$ ($t \neq s$);
- (4) Explanatory variables are weakly exogenous, that is, there is zero covariance between ε_t and each explanatory variable: $E(x_t \varepsilon_t) = 0$ for all t ;
- (5) ε_t are normally distributed: $\varepsilon_t \sim N(0, \sigma_e^2)$ for all t ;
- (6) Parameter constancy: α , β and σ (> 0) are fixed unknown numbers.

4. UNIT ROOT TESTS

A graphical analysis of the seasonally unadjusted quarterly data from 1980(1)-2004(2) suggests that the logarithm of tourist arrivals from Japan to New Zealand and Taiwan are likely to be nonstationary (see Figure 8). This result is supported by the correlogram, which displays the estimated autocorrelation and partial autocorrelation functions of the residuals.

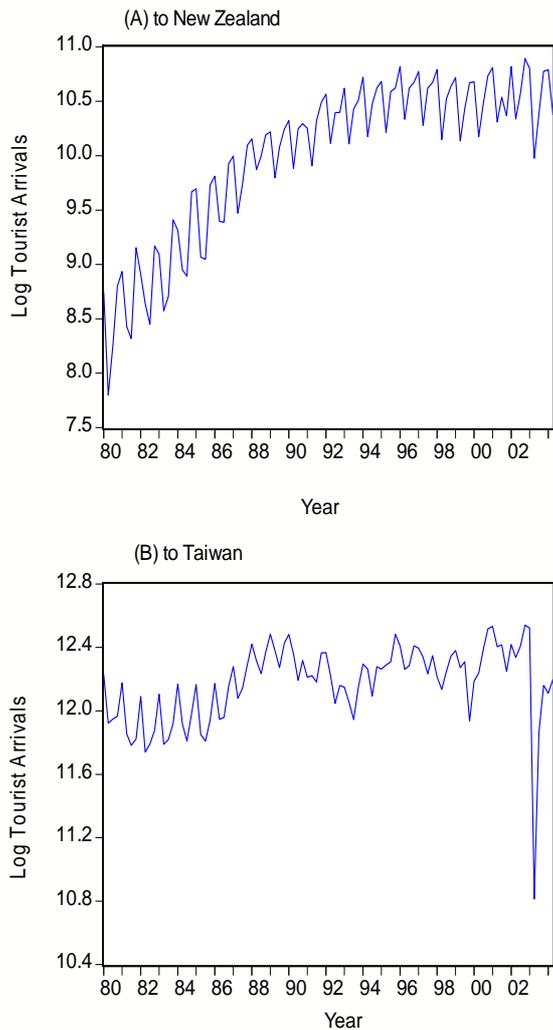


Figure 8. Logarithm of short-term tourist arrivals from Japan, 1980-2004

A tourist arrival series is said to be stationary if the mean, variance and covariance of the series remain constant over time. The unit root test is a formal method of testing the stationarity of a series. Quarterly tourist arrivals (in logarithms) from Japan to New Zealand and Taiwan are tested for unit roots using the Augmented Dickey- Fuller (ADF) test procedure, which is based on the following regression equation:

$$\Delta a_t = \alpha + \beta t + \delta a_{t-1} + \sum_{j=1}^p \psi_j \Delta a_{t-j} + \varepsilon_t$$

where a_t is the logarithm of tourist arrivals to New Zealand or Taiwan from Japan at time t , t is a deterministic trend, ε_t is a disturbance term of the regression which is independent and normally distributed with zero mean and constant variance.

In order to test for unit roots, the hypothesis of interest is:

$$H_0 : \delta = 0$$

$$H_1 : \delta < 0$$

The null hypothesis of a unit root is based on the t-statistic (which has a non-standard distribution) using simulated critical values. The deterministic time trend (t) is retained ($\beta \neq 0$) in the test regression because the ADF t-statistics with and without a trend are substantially different. As quarterly data are used, an initial lag length of 4 is used in the ADF regression to accommodate possible serial correlation in the disturbances. If the fourth lag is insignificant at the 5% level, the lag length is reduced sequentially until a significant lag length is obtained. The third lag is significant for both series.

The ADF test results indicate that the ADF statistics for the tourist arrival series from Japan to New Zealand and Taiwan (-1.36 and -2.67, respectively) are both greater (that is, are less negative) than the critical value of -3.46 at the 5% significance level. Therefore, the null hypothesis of a unit root cannot be rejected, which implies that tourist arrivals from Japan to New Zealand and Taiwan are nonstationary.

Taking the first differences of the logarithm of the tourist arrivals and applying the ADF test procedure to the transformed series, a more negative test statistic (of -4.90 at a significant lag length of 4 for New Zealand and -10.2 at a lag length of 2 for Taiwan) than the critical value of -2.89 are obtained. This suggests that the first difference series are stationary. Individual ADF tests show that the logarithm of tourist arrivals is integrated of order one, $I(1)$, whereas the first difference of the logarithm of the series follow an $I(0)$ process, or is integrated of order zero.

The ADF test procedures are applied to the real GDP of Japan (in logarithms) for the presence of unit roots, and the null hypothesis of a unit root cannot be rejected, which implies that real GDP series of Japan are nonstationary. However, the differenced series is stationary and follows an $I(0)$ process, or is integrated of order zero, whereas the logarithm of real GDP is integrated of order one, $I(1)$. The first difference series for tourist arrivals and real GDP will be used in the empirical modelling in the next section.

5. EMPIRICAL MODELLING OF JAPANESE TOURIST ARRIVALS TO NEW ZEALAND AND TAIWAN

Using a single equation model, the influence of real income on tourism demand by Japan is given as follows:

$$a_t = \alpha + \beta y_t + \phi a_{t-1} + \varepsilon_t$$

where y_t is the log of Japanese real GDP at time t . With the inclusion of seasonal dummy variables, D_{2t} , D_{3t} and D_{4t} in the model as well as a SARS dummy variable for Taiwan, the following estimates are obtained by OLS (with absolute t-ratios in parentheses):

$$(1) \ a_t = 0.03 + 2.39 \hat{y}_t - 0.03 D_{2t} - 0.08 D_{3t} - 0.01 D_{4t}$$

(6.00) (1.35) (4.08)
(12.0) (1.31)

(New Zealand)

$$(2) \ a_t = 0.01 - 0.39 \hat{y}_t - 0.002 D_{2t} - 0.03 D_{3t} - 0.01 D_{4t} + 0.09 DSARS$$

(2.35) (0.27) (0.38)
(4.92) (2.15) (5.43)

(Taiwan)

Deletion of the insignificant seasonal dummy variable for New Zealand does not yield a significant income elasticity of travel demand. The same is also true for Taiwan with the deletion of the insignificant seasonal and SARS dummy variables.

The ARMAX model is an extension of the Box-Jenkins autoregressive-moving average (ARMA) model with explanatory exogenous variables X (Franses 1991). Before the ARMAX model is used to estimate the relationship between income and travel demand by Japan, we need to determine the optimal ARMA models. Using the first difference of the log tourist arrivals from Japan, various ARIMA have been estimated using ordinary least squares.

The models selected yield significant t-statistics at the 5% level of significance for the AR and MA coefficients, with no serial correlation at the 5% level, using the Lagrange multiplier test for serial correlation. ARIMA(3,1,3) and ARIMA(2,1,4) have been identified for New Zealand, and

ARIMA(4,1,4) for Taiwan as the optimal models. Inclusion of three seasonal dummy variables in these models and a SARS dummy for Taiwan, the final ARMAX models are obtained as follows, with the lowest AIC and SBC values (with absolute t-ratios in parentheses):

$$(3) \ a_t = 0.03 + 1.40 \hat{y}_t - 0.02 D_{2t} - 0.07 D_{3t} + (1 + 0.84L - 0.49L^4) \hat{\varepsilon}_t$$

(9.81) (2.37) (3.36)
(12.8) (80.7) (77.2)

(New Zealand Model 1)

$$(4) \ a_t = 0.02 + 2.53 \hat{y}_t - 0.81 \hat{a}_{t-1} - 0.66 \hat{a}_{t-2} - 0.65 \hat{a}_{t-3} - 0.07 D_{t-3}$$

(6.23) (4.14) (10.2)
(7.78) (8.66) (6.10)

(New Zealand Model 2)

$$(5) \ a_t = 0.01 + 1.00 \hat{y}_t - 0.88 \hat{a}_{t-1} - 0.78 \hat{a}_{t-2} - 0.84 \hat{a}_{t-3} - 0.02 D_{t-3} + (1 + 0.95L^4) \hat{\varepsilon}_t$$

(5.07) (4.76) (16.9) (13.0)
(14.6) (5.55) (46.0)

(Taiwan)

The Lagrange multiplier tests, LM(SC), show that the models do not have serial correlation at the 5% level.

6. CONCLUDING REMARKS

In this paper we have estimated single equation and ARMAX models to evaluate the effect of changes in income on Japanese travel demand for New Zealand and Taiwan. The income variable has also been tested and appropriately transformed to obtain stationarity of the data series. Additional variables, namely seasonal and SARS dummy variables, were also included in the estimation of the single equation and ARMAX models. Unlike the single equation model, the ARMAX technique is more appropriate for investigating the dynamic relationship between tourism demand and real income of Japan. The model is developed in two stages, which initially requires that the Box-Jenkins ARIMA models be identified and selected.

The findings of the ARMAX model support the economic theory. In contrast to the single equation models, all the ARMAX models show that the Japanese income elasticities of travel demand are

positive and significant. According to the single equation model for Taiwan, the effects of SARS in 2003 had a significant but positive effect on Japanese inbound travel. The latter is contrary to theory and reality. Only the seasonal effect in quarter 3 is negative and significant in both the single equation and ARMAX models for New Zealand and Taiwan.

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