Forecasting International Tourist Flows to Macau

Haiyan Song*

School of Hotel and Tourism Management

The Hong Kong Polytechnic University

Hung Hom, Kowloon

Hong Kong SAR

Tel: + 852 2766 6372

Fax: +852 2362 9362

Email: hmsong@polyu.edu.hk

Stephen F. Witt

School of Management

University of Surrey

Guildford GU2 7XH, UK

and

Institute for Tourism Studies

Macau SAR, P. R. China

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Abstract

The vector autoregressive (VAR) modelling technique is used to forecast tourist flows to Macau from eight major origin countries/regions over the period 2003 to 2008. The existing literature shows that the VAR model is capable of producing accurate medium to long term forecasts, and also separate forecasts of the explanatory variables are not required. A further justification for using the VAR technique is that it permits an impulse response analysis to be performed in order to examine the ways in which the demand for Macau tourism responds to the 'shocks' in the economic variables within the VAR system. The implications of this analysis are discussed. The forecasts generated by the VAR models suggest that Macau will face increasing tourism demand by residents from mainland China. Since the needs of Chinese tourists tend to be different from those from other origin countries/regions, especially Western countries, the business sectors in Macau need to pay considerable attention to catering for the needs of Chinese tourists.

1. Introduction

Tourism demand is the foundation on which all tourism-related business decisions ultimately rest. Practitioners are interested in tourism forecasting for the following reasons. First, companies such as airlines, ferry operators, tour operators, hotels, casinos, other recreation facilities providers, and shop owners are interested in the demand for their products by tourists. The success of many businesses depends largely or totally on the state of tourism demand, and ultimate management failure is quite often due to the failure to meet market demand. Because of the key role of demand as a determinant of business profitability, estimates of expected future demand constitute a very important element in all planning activities. It is clear that accurate forecasts of tourism demand are essential for efficient planning by tourism-related businesses, particularly given the perishability of the tourism product. Empty airline, ferry, bus and restaurant seats, and unused hire cars, hotel rooms, rental apartments, cruise ship rooms, holiday tour packages and tourist entertainment facilities cannot be stockpiled – once the potential sale is lost it is lost forever. Secondly, tourism forecasting is important because tourism investment, especially investment in destination infrastructures, such as airports, highways and rail-links, requires long-term financial commitments from public finances and the expected net returns on the investment would not be achieved if insufficient tourism demand materialises to fully utilize the designed capacities of the investment projects. The prediction of long-term demand for tourism related infrastructures often forms an important part of project appraisals. Thirdly, governments' macroeconomic policies depend largely on the relative importance of individual sectors within the economy. Hence, accurate forecasts of the demand situation in the tourism sector of the economy will help governments in formulating and implementing appropriate medium-long term tourism strategies.

A review of the existing literature shows that there have been no published studies in academic journals concerning the forecasting of Macau tourism. One of the reasons for this is that Macau has not been regarded as a traditional and popular destination by Western tourists. Indeed many European and North Americans do not even know where Macau is, let alone consider choosing Macau as a holiday destination. Macau is located on the southeast coast of China to the west of the Pearl River Delta. Bordering Guangdong Province, it is 60km from Hong Kong and 145km from the city of Guangzhou. Macau has been increasing in size as a result of the land reclamation that has taken place around its coastline. It covers an area of 26.8km^2, including the peninsula of Macau and the two islands of Taipa and Coloane which are linked by a six-lane highway 2.20km long. The size of Macau's local population is 444,000 and the population density is over 16,000/km^2.

Given such as a densely populated small area, the flows of tourists to Macau have been impressive. Over the last few years, an average of 20,000 passengers have entered Macau via the Outer Harbour ferry terminal each day and around 50,000 people have crossed the Border Gate Checkpoint at the border with mainland China. Macau attracts a large number of tourists from China - about 40% of total tourist arrivals in 2002 were from China. This share is likely to increase in the future due to the introduction of the individual traveller's scheme in August 2003 and rapidly rising incomes in China.

Tourism and gaming is the leading industry in Macau and makes a major contribution to the growth of the economy (Macau Government Tourist Office, 2003). The very strong role that gaming plays in attracting tourists to Macau is likely to be considerably enhanced with the introduction in the near future of mega projects that are planned by three international gaming concessionaires. Macau also has a rich architectural and cultural heritage resulting from its former Portuguese colonial rule, and strenuous efforts are being made to enhance and preserve historic sites and buildings. It also has many other attractions, such as the annual Grand Prix and museums. The cuisine of Macau is unique in the sense that it combines Western and Chinese. Traditional Portuguese and Chinese dishes, as well as spicy recipes from Africa and India, in addition to the large variety of wines, many from Portugal, make the region a fine dining destination too.

The revenue generated by the tourism industry exceeded the income from visible exports for the first time in 1992 and the tourism sector has been growing fast since then. Now the tourism sector employs 30% of the total working population and generates 40% of the total revenue in Macau. Given the importance of the tourism industry to Macau, it is essential to generate accurate forecasts of the future trends in tourist flows from the major origin countries/regions. The forecasting horizon considered in this study is 2003 Quarter 3 to 2008 Quarter 1.

The forecasting method selected for this study is the vector autoregressive (VAR) modelling technique. The major contribution to the literature in this paper is the innovative use of impulse response analysis in a tourism context, which is facilitated by using the VAR approach. This analysis examines the ways in which tourism demand responds to ‘shocks’ in the economic variables within the VAR system.

The rest of the paper is organised as follows. Section 2 reviews recent publications in the area of tourism modelling and forecasting, which will provide the rationale for using the chosen research methodology for this study. Section 3 discusses the forecasting methodology. Section 4 presents the empirical results, while the last section summarises the conclusions.

2. Literature Review

The importance of tourism forecasting in tourism planning and tourism policy formulation has been widely documented in such studies as Artus (1972), Loeb (1982), Frechtling (1996) and Wong and Song (2003). International originations, such as Pacific Asia Travel Association (PATA) and World Travel and Tourism Council (WTTC) together with Oxford Econometrics (OE) regularly publish forecasts of tourism demand for various countries (see, for example, Turner and Witt, 2003, 2004). The Australia Tourism Forecasting Council and Hong Kong Tourism Board, for example, have also been providing forecasts of tourist arrivals for their respective governments for both long-term and short-term planning and policymaking purposes.

Tourism forecasts may be generated by either quantitative approaches or qualitative approaches (Frechtling, 2001). The focus in this study is on quantitative forecasting methods, specifically, econometric approaches. Studies published between the 1960s and early 1990s mainly followed the traditional regression approach in that the models were specified in static form with very limited diagnostic statistics being reported. Static regression models suffer from a number of problems including structural instability, forecasting failure and spurious regression as pointed out by Witt and Song (2000). In the mid 1990s, dynamic specifications such as the autoregressive distributed lag model (ADLM) and error correction model (ECM) began to appear in the tourism literature. Kim and Song (1998), Kulendran (1996), Kulendran and King (1997), Seddighi and Shearing (1997), Syriopoulos (1995), and

Vogt and Wittayakorn (1998) were among the first few authors who applied the cointegration and error correction techniques to tourism forecasting. The monograph by Song and Witt (2000) was the first book that systematically introduced a number of modern econometric techniques to tourism demand analysis. Over the last few years there has been a surge in the application of modern econometric approaches to tourism demand modelling and forecasting. Such studies include De Mello et al (2002), Dritsakis (2003), Huybers (2003), Kulendran and Witt (2001, 2003), Lim and McAleer (2001, 2002), Morley (2000), Papatheodorou (2001), Song *et al* (2000, 2003a, b), and Webber (2001).

Total tourist arrivals is the most frequently used measure of tourism demand, followed by tourist expenditure. In his literature survey, Li (2004) pointed out that amongst the 45 selected studies published since 1990, 37 of them used tourist arrivals as the dependent variable while only 6 employed tourist expenditure as the dependent variable.

Lim (1997) argued that discretionary income, defined as the income remaining after spending on necessities in the country of origin, should be used as the appropriate measure of income in the demand model. However, this is a subjective variable and the data cannot be easily obtained in practice. Therefore, alternative measures of income have to be used as a proxy for tourists' discretionary income. Among these alternatives, real personal disposable income (PDI) is the best proxy to be included in the demand models that relate to holiday or visiting friends and relatives (VFR) travel (Kulendran and Witt, 2001; Song *et al*, 2000; Syriopoulos, 1995). National disposable income (NDI), gross domestic product (GDP), gross national product (GNP), and gross national income (GNI), all in real terms, have also been used in many of the empirical studies. These variables are more suitable for the study of business travel or the combination of business and leisure travel when these two types of data are not separable (Song and Witt, 2000). Other possible proxies include real private consumption expenditure (Song *et al*, 2003b) and the industrial production index (González and Moral, 1995). Although most studies have found that income is the most important factor that influences the demand for international tourism, this finding has not always been conclusive. For example, the income variable was found to be insignificant in some of the error correction models in Kulendran and King (1997), Kim and Song (1998), and Song *et al* (2003b), and the insignificant income variable tends to be associated with the models related to the demand for international tourism by residents from Japan and Germany. One possible reason is that there are measurement errors in the data, and this is particularly true for the German income data as a result of reunification.

The own price of tourism is another variable that has been found to have an important role to play in determining the demand for international tourism. In theory this variable should contain two components: the cost of living for tourists at the destination and the travel cost to the destination. However, due to difficulties in obtaining data, travel costs have been omitted in most of the studies with Witt and Witt (1991,1992), Dritsakis (2003) and Lim and McAleer (2001, 2002) being some of the exceptions. The cost of living in the destination is normally measured by the destination consumer price index (CPI) relative to the origin CPI. Another factor that contributes to the cost of living in the destination is the exchange rate between the origin country and destination country currencies, as a higher exchange rate in favour of the origin country's currency would result in more tourists visiting the destination from that origin country. Qiu and Zhang (1995) and Witt and Witt (1992) used the exchange rate between the destination and origin as well as a separate CPI variable to account for the cost of tourism, while the majority of the published studies, especially the most recent ones, have employed an exchange rate adjusted relative price index between the destination and origin as the own price variable.

In addition to the relative price between the destination and origin, substitute prices in alternative destinations have also proved to be important determinants in some studies. There are two forms of substitute prices that have been used: one allows for the substitution between the destination and a number of competing destinations separately (Kim and Song, 1998, and Song *et al*, 2000), and the other calculates the cost of tourism in the destination under consideration relative to a weighted average cost of living in various competing destinations, and this index is also adjusted by relevant exchange rates. The weight is the relative market share (arrivals or expenditures) of each competing destination (Song and Witt, 2003). The second form is used more often in empirical studies, as fewer variables are incorporated in the model and so more degrees of freedom are available for model estimation.

Marketing is also potentially an important factor that influences tourism demand. The inclusion of this variable in the demand model with micro data is expected to generate significant results. However, in macro studies, the unavailability of marketing expenditure data across different origin countries has constrained its inclusion in demand models. A few studies have incorporated this variable in their demand analyses (Crouch *et al*,1992, Ledesma-Rodriguez *et al,* 2001 and Witt and Martin, 1987).

In the studies by Lim and McAleer (2001, 2002), Kulendran and King (1997), and Song *et al* (2000, 2003a,b), the lagged dependent variable has been found to be an important factor that influences the demand for tourism, and its statistical significance suggests that consumer habitual behaviour and 'word-of-mouth' effects should be properly considered in demand forecasting models. The exclusion of this variable in the modelling process can result in unreliable forecasts.

In order to account for the impacts of one-off events and tourists' taste changes on the demand for tourism, dummy and time trend variables have been used in some of the studies. As far as one-off events are concerned, the impacts of the two oil crises in the 1970s are examined in most of the empirical studies, as well as the Gulf War in the early 1990s, and the global economic recession in the mid 1980s. Other regional events and origin/destination-specific events have also been included in some of the studies covering areas that have been affected. As for the trend variable, a deterministic linear trend has been used in some of the studies, especially in the studies prior to the 1990s. Twenty five out of 100 papers reviewed in Lim (1997) incorporated the trend variable in the model specification. However, the time trend tends to be highly correlated with the income variable and this can cause serious multicollinearity problems in model estimation. As a result most of the recent studies have avoided including the deterministic trend in the model specification. Li (2004) discovered that in the 45 selected papers published after 1990, only 6 of them considered this variable in the model specification.

The main focus so far has been on single equation tourism demand models in which an endogenous tourism demand variable is related to a number of exogenous variables. The single equation approach depends heavily on the assumption that the explanatory variables are exogenous. If this assumption is violated, a researcher would have to model the economic relationships using a system of simultaneous equations method. The popularity of simultaneous equations approaches dates back to the 1950s and 1960s within the context of structural macroeconomic models which were used for policy simulation and forecasting. In estimating these structural models, restrictions were often imposed in order to obtain identified equations. Sims (1980) argued that many of the restrictions imposed on the parameters in the structural equations were 'incredible' relative to the data generating process, and hence he suggested that it would be better to use models that do not depend on the imposition of incorrect prior information. Following this argument, Sims developed a vector autoregressive (VAR) model in which all the variables apart from the deterministic variables such as trend, intercept and dummy variables, are modelled purely as dynamic processes, that is, the VAR model treats all variables as endogenous.

More importantly, the VAR technique has been closely associated with some of the recent developments in multivariate cointegration analysis, such as the Johansen (1988) cointegration method. Although there has been increasing interest in using the VAR technique in macroeconomic modelling and forecasting, relatively little effort has been made to use this method to forecast tourism demand. Exceptions are Song *et al* (2003b), Witt *et al* (2003), Witt *et al* (2004) and Wong *et al* (2003).

3. Forecasting Methodology

The Model

In this paper the VAR model is used to forecast the demand for Macau tourism by tourists from eight major origin countries/regions. These eight origins comprise: China, Hong Kong, Taiwan, Japan, Korea, Philippines, UK and USA. Tourist arrivals from these eight countries/regions accounted for 98 percent of the total arrivals to Macau and the arrivals data were collected by nationality because no consistent data by residency was available. One reason why this approach is selected is that it has been shown in empirical studies that the VAR model can generate relatively accurate medium and long term forecasts of tourism demand (Witt *et al* 2003 and 2004). Another advantage of this approach is that the VAR model does not require the generation of forecasts for the explanatory variables before the forecasts of the dependent variable can be obtained. In addition, an impulse response analysis can be carried out, which can provide useful information for policymaking purposes.

As mentioned earlier, tourism demand in this project is measured by tourist arrivals from the major origin countries/regions. The economic conditions that are relevant for holiday visits include tourism prices in Macau, the availability of and tourism prices for competing (substitute) destinations, and incomes of tourists in their home countries/regions. The lagged dependent variable that reflects word-of-mouth effects and consumer habit persistence is automatically included in the VAR specification. Marketing may be another useful variable to predict tourism demand, but due to data unavailability this variable was excluded from our study.

The tourism demand function takes the form

$$Q_i = f(P_i, P_{is}, X_i, \varepsilon_i) \tag{1}$$

where Q_i is the quantity of the tourism product demanded in Macau by tourists from country/region i;

P_i is the cost of living for tourists in Macau relative to cost the cost of living at home;

P_{is} is the cost of living for tourists in substitute destinations relative to the cost of living in Macau;

X_i is the level of income in origin country/region i; and

ε_i is the disturbance term that captures all other factors which may influence the quantity of the tourism product demanded in Macau by tourists from origin country/region i.

Equation (1) is a theoretical model of tourism demand, which is simply a statement that indicates that there is a relationship between the variables under consideration. However, in practice, we need to specify the mathematical form of the tourism demand function. In this study, the tourism demand model is specified as a log-log demand function, in common with most previous tourism demand models.

Tourism demand is measured by the number of arrivals from a particular origin country/region in Macau. The data are quarterly covering the period 1992 Quarter 1 to 2003 Quarter 2, and were supplied by the Macau Statistical Office. The cost of living for tourists in Macau relative to the origin country/region is measured by the consumer price index (CPI) in Macau divided by the consumer price index in the origin and adjusted by the appropriate exchange rates. The consumer price indexes and exchange rates are from the International Monetary Fund's Statistical Database and the base year of the CPIs is 2000. Martin and Witt (1987) provided the justification for the use of this variable to represent tourists' cost of living in the destination country. Numerous researchers have used this variable in their empirical studies of tourism demand (see, for example, Kulendran and King, 1997, Song, *et al*, 2000, Song and Witt, 2000, Witt and Witt, 1992, Song, *et al*, 2003a,b). The substitute price for the VAR model for all origin countries/regions except Hong Kong is measured by the relative consumer price index of Hong Kong to that of Macau adjusted by the appropriate exchange rate. For the Hong Kong VAR model, the substitute price is measured by the consumer price index in China relative to that in Macau adjusted by the appropriate exchange rate. Initially, a weighted average living cost index was calculated using the CPIs, exchange rates and the market shares of tourist arrivals among a number of substitute destinations including, China, Hong Kong, Japan, Singapore and Taiwan; however, a preliminary regression analysis suggested that this index was not relevant for the demand for Macau tourism. This could be due to the fact that the selected countries/regions might not be good representatives of the substitute destinations. The income level in the origin country/region is measured by the GDP indices in the origin country/region in real terms. The data on these variables are obtained from the International Monetary Fund (IMF) for all countries/regions except Taiwan. The data for Taiwan are obtained from Taiwan's official statistics.

The VAR model is a system equation in which all variables are treated as endogenous. The current values of the variables are regressed against lagged values of all the variables in the system. If we use the following vector to represent the variable set in the system: $Y_t = (Q_{it}, P_{it}, P_{ist}, X_{it})$, then a general VAR(p), where p is the lag length of the VAR, can be written as:

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + ... + \Pi_p Y_{t-p} + U_t \,;\, U_t \sim IID(0, \Sigma) \qquad (2)$$

For illustration purpose, we assume the lag length is 1, then Equation (2) becomes

$$Y_t = \Pi_1 Y_{t-1} + U_t \qquad (2.a)$$

The intercept vector in (2) and (2a) is omitted for simplicity, but it is included in the VAR systems when they are estimated in this study. The above equation is known as Sims' general (unrestricted) VAR model, in which the current values of all the variables are regressed against all the lagged values of the same set of variables in the system. U_t is a vector of regression errors that are assumed to be contemporaneously correlated but not autocorrelated. This indicates that each equation in the system can be individually estimated by OLS. Although the use of the seemingly unrelated regression estimator (SURE) introduced by Zellner (1962) is an alternative, it does not add much efficiency to the estimation procedure.

If a VAR model has m equations, there will be $m + pm^2$ coefficients that need to be estimated (including the constant term in each equation). This suggests that an unrestricted VAR model is likely to be over-parameterised. A practical problem with estimating a VAR(p) model is that it is desirable to include as much information as possible for the purposes of forecasting and policy analysis, but degrees of freedom quickly run out as more variables are introduced. Therefore, the process of lag length selection is very important for the specification of a VAR model. If the lag length of p is too small, the model cannot represent correctly the data generating process (DGP); if, on the other hand, p is too large, lack of degrees of freedom can be a problem and OLS estimation is unreliable. We use the likelihood ratio (LR) statistic and the Aikake Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) (Song and Witt, 2000, pp 93-94) to determine the lag length of the VAR model, and in most cases 4 lags are included in the forecasting models.

Impulse Response Analysis

By repeatedly substituting the lagged variables into themselves based upon Equation (2a), the following equation is obtained:

$$Y_t = \sum_{i=0}^{\infty} \Pi_1^i U_{t-i} \qquad (3)$$

Equation (3) is called a *vector moving average* (VMA) process since the vector of the dependent variables is represented by an infinite sum of lagged random errors weighted by an exponentially diminishing matrix of coefficients. This equation shows that the vector (Y_{it}) can be expressed by sequences of 'shocks' measured by the residual errors. It also indicates the impact of the unitary changes in the error terms on the dependent variables. However, the error terms for any period tend to be correlated; the impact of each shock cannot be exactly separated from the error terms from different equations within the system. To overcome this problem the error terms need to be orthogonalised. There are a number of ways in which the error terms can be orthogonalised (for a detailed explanation about how to orthogonalise the error U_{t-i} see, for example, Song and Witt, 2000, pp 95-96, and Hamilton, 1994, pp 318-322). After orthogonalisation, Equation (3) becomes

$$Y_t = \sum_{i=0}^{\infty} \phi_i U'_{t-i} \quad (4)$$

where U'_t and the ϕ_i matrices are termed the *impulse response functions* since they represent the behaviour of the time series Y_{it} in response to the shocks U'_t.

The results of the impulse response analysis can be of use to practitioners because they demonstrate for how long the shocks are likely to have an effect and with what intensity.

Forecasting

It is straightforward to generate the forecasts for all the exogenous variables in the VAR framework, as all explanatory variables are pre-determined.

For one-period-ahead forecasts, since $Y_{t+1} = \Pi_1 Y_t + U_t$, the forecasts can be generated by taking the conditional expectation of Y_{t+1}, that is $\hat{Y}_{t+1} = E_t(Y_{t+1}) = \Pi_1 Y_t$. The forecasting error is $Y_{t+1} - \hat{Y}_{t+1} = U_{t+1}$. In the same way, two-periods-ahead forecasts can be generated from $\hat{Y}_{t+2} = \Pi_1^2 Y_t$, and the forecasting error now becomes $U_{t+2} + \Pi_1 U_{t+1}$. More generally, the n-periods-ahead forecast is:

$$\hat{Y}_{t+n} = \Pi_1^n Y_t \quad (5)$$

In fact the forecasts can also be generated from the VMA process of (3). From Equation (4), we have:

$$Y_{t+n} = \sum_{i=0}^{\infty} \phi_i U'_{t+n-i} \quad (6)$$

Based on (6) the one-period-ahead forecast $\hat{Y}_{t+1} = E(\sum_{i=0}^{\infty}\phi_i U'_{t+1-i})$ and the corresponding one-period-ahead forecast error is $Y_{t+1} - \hat{Y}_{t+1} = \phi_0 U'_{t+1}$. Following the same procedure, we could obtain the *n*-periods-ahead forecasts:

$$Y_{t+n} - \hat{Y}_{t+n} = \sum_{i=0}^{n-1}\phi_i U'_{t+n-i} \qquad (7)$$

In this study both the impulse response analysis and the forecasting exercise were conducted using Econometric Views (E-Views) 4.0, an econometric forecasting software program.

4. Empirical Results

The VAR model was estimated for each of the origin countries/regions over the period 1993 Quarter 1-2003 Quarter 2. In estimating the VAR models a number of dummy variables were also included to capture the influences of seasonality and one-off events. These one-off event dummies include the opening of the new Macau International Airport in 1995, which is thought to have had an important influence on the long-haul and Taiwanese markets, a dummy to account for the SARS epidemic in early 2003, a 1997 financial crisis dummy, a hand-over dummy to reflect the effect of the handover of Macau to China and seasonal dummies to reflect the seasonality in the data. The independent travelling policy for the residents in China introduced in September 2003 was not considered due to insufficient information being available to the researchers at the time. However, this effect will be looked at when more data become available in the near future.

The estimation of the VAR models for each origin country/region generated a large number of parameters, as 32 equations (four equations for each origin) were estimated in total. Although there are four equations in each of the eight VAR models, interest centres on the ones where the demand for tourism is the dependent variable. The estimation results of the VAR models are omitted as the focus of this paper is on forecasting. However, the diagnostic statistics for each of the tourism demand equations are provided in Table 1.

Insert Table 1 here

The results show that the tourism demand models fit the data well according to the adjusted R-Squared values and the F-Statistics. The following impulse response analysis and forecasting are carried out based on these eight tourism demand equations (one for each origin).

Empirical Results from the Impulse Response Analysis: The responses of the tourism demand variables to the 'shocks' in each of the explanatory variables can be plotted as diagrams. For illustration purposes, we only present the impulse response functions for the Korea and Hong Kong models. These demonstrate the impulse response relationships between the dependent variables and the shocks in the other variables. Similar results were also found in all the other models.

The shocks in this study are measured by the Cholesky one standard deviation innovations (Hamilton, 1994, p 322). Figures 1 and 2 show the ways in which tourism demand responds to the shocks occurring in each of the variables including the tourism demand variable itself over a 16 quarters (four years) period. In the case of Korea, a shock in the demand variable itself (see the top left panel in Figure 1) will have a relatively larger impact on the current level of tourism demand and this impact will gradually die off and disappear after 12 periods (three years). The top right panel of Figure 1 shows that tourism demand responds positively to the shock in GDP and the momentum of this impact takes about four years to disappear, suggesting that GDP is an important factor that influences the demand for tourism. The shock in own price has a negative impact on demand and the impact of the shock lasts for about four years before dying off, while the response of demand to the shock in substitute prices is positive and the influence of the shock also tends to last about four years.

The conclusions are more or less the same for the Hong Kong VAR model with the one exception that the response of the dependent variable to the shock in the own price variable appears to have the ‘wrong’ sign. However, the magnitude of the response of the demand variable to the shock in the own price variable is relatively small, suggesting a negligible impact.

Insert Figures 1 and 2 here

The implication of the impulse response analysis is that the tourism authority in Macau needs to realise that the influence of any shocks in the economic variables in the VAR system tend to last for about three to four years, although the magnitudes of these impacts are likely to be fairly small. For example, it is known that the SARS epidemic in early 2003 had a very large negative impact on tourist arrivals from Hong Kong to Macau. If we treat the influence of SARS as a shock to the demand variable, the impact of this shock tends to have a relatively large impact on the demand for tourism within four quarters since the shock first started and a recovery will occur from quarter 6 onwards, but the impact is likely to last for about four years before it completely disappears (with reference to the top right panel in Figure 2).

The Forecasts for 2003 Quarter 3 − 2008 Quarter 1: The quarterly forecasts generated by the VAR models over the period 2003 Quarter 3 − 2008 Quarter 1 for the three main source markets, China, Hong Kong and Taiwan, are presented in diagrammatic form (Figures 3-5)[1] while the forecasts of tourist arrivals from all eight origin countries/regions are given in Table 2.

Insert Figures 3-5 here

Insert Table 2 here

[1] Tourist arrivals from 1992 Quarter 1 to 2003 Quarter 2 on Figures 3-5 are actual arrivals.

The forecasts presented are the baseline forecasts generated by the VAR models. No adjustments have been made to the forecasts. In particular, the forecasts of tourist arrivals in Macau from China have not been modified to reflect the introduction of the individual traveller scheme. It is as yet too early to judge the impact of the scheme. To some extent those visitors coming to Macau as individual travellers are replacing those coming on group tours, and to some extent they represent an extra source of tourists. But tourist arrival numbers from China have been rising rapidly recently in response to strong economic growth and a general lessening of travel restrictions, and the individual traveller scheme may well be merely a continuation of this general process. As a result it may not be necessary to adjust the forecasts.

China

It can be seen that the strong growth in tourism demand from 1998 until 2003 Quarter 1 is expected to continue throughout the forecast period, with tourist arrivals rising from 1.33 million in 2003 Quarter 1 to 2.91 million in 2008 Quarter 1. The forecast market share of tourists from China was 40% in 2003 Quarter 3, but this share is likely to increase to 62.9% in 2008 Quarter 1. This result has important implications for Macau. It is clear that the main market for Macau tourism in the next five years will be mainland China. Any investment in the tourism sector will have to cater the needs of tourists from mainland China.

Hong Kong

The decline in tourism demand over the period 1992-1999 was reversed in 2000 and reached a new peak in 2002 Quarter 3, although still below 1995 levels, before dropping again. It is forecast that an initial rise in tourist arrivals occurred in 2003 Quarter 3, followed by a steady decline, with arrivals decreasing slightly from 1.19 million in 2003 Quarter 1 to 1.14 million in 2008 Quarter 1. The market share for Hong Kong is expected to drop from 43% in 2003 Quarter 3 to 24.6% in 2008 Quarter 1.

Taiwan

Tourist arrivals in Macau from Taiwan increased dramatically with the opening of the airport in 1995, and continued on a strong upward trend until 2002. A full recovery from the massive reduction in tourism demand in 2003 Quarter 2 as a result of the SARS crisis is expected to have taken place in 2003 Quarter 3 with growth continuing until mid 2005. Thereafter a steady reduction in tourist arrivals is forecast, but overall growth over the forecast period is reasonably strong, rising from 311,000 in 2003 Quarter 1 to 460,000 in 2008 Quarter 1. The forecast market share for Taiwan in 2003 Quarter 3 was 13%, but the share is likely to drop to just 9.9% in 2008 Quarter 1.

The Rest

Tourist arrivals from the other five origin countries considered only represent about 1% of total arrivals. Therefore, the significance of the demand for Macau tourism by tourists from these countries is much less than the three main origins. Tourist arrivals from Japan are expected to fluctuate around the 35,000 mark over the forecasting period, while arrivals from Korea are expected to increase from 20,000 in 2003 Quarter 3 to 30,200 in 2008 Quarter 1. Arrivals from the Philippines are likely to increase, with some quite large fluctuations, from 13,800 to 21,100 over the same forecasting period. Tourist arrivals from the UK and USA show a similar zigzag pattern with relatively constant projections over the sample period.

The forecast for total arrivals in Macau from the eight major origin markets for 2007 is 17.9 million.

5. Summary and Concluding Remarks

This study forecasts tourist flows to Macau from the eight major tourism origin countries/regions, namely, China, Hong Kong, Taiwan, Japan, Korea, Philippines, UK and USA. The forecasting model is selected based on a review of recent published studies in the area of tourism forecasting. According to the published studies, the VAR model is capable of producing accurate medium to long term tourism forecasts. The use of VAR in forecasting tourism demand also has the following two conceptual advantages. First, the VAR modelling approach is a theory based approach. Therefore, it permits policy simulation via the impulse response analysis. Secondly, the VAR approach is a system approach, which relaxes the exogenous assumption of the explanatory variables. Since each of the variables in the system is treated as endogenous, the modelling procedure is simplified considerably. In the traditional single equation modelling approach, one has to test for exogeneity of the explanatory variables. If the test does not suggest that the explanatory variables are exogenous, different estimation approaches, such as the instrumental variables approach or simultaneous equations approach, would have to be employed and this can complicate the modelling procedure considerably. The main limitation of the VAR modeling approach is its consumption of degrees of freedom in the model estimation. Given the fact that the size of the sample in this study is relatively small, the findings of the empirical analysis should be treated with caution. A future extension of the study could be to use the Bayesian VAR (BVAR) approach in order to to reduce the number of parameters that need to be estimated. In addition, this study does not compare the forecasting performance of the VAR with that of other econometric models, which forms a base for further investigation.

Given the advantages of the VAR model for this study, the demand for Macau tourism by tourists from the eight origin countries/regions was modelled using this approach. The sample used in model estimation covers the period 1993 Quarter 1-2003 Quarter 2. Following the recommendations from the existing literature the model structure (lag length) was determined by the LR statistic and the AIC and SBC criteria. In total 32 equations were estimated, but only eight of them are of specific interest. Based on the estimated VAR models, an impulse response analysis was carried out to examine the impacts of ‘shocks’ in each of the variables on the demand for tourism. The evidence shows that tourism demand generally responds with ‘correct’ signs to these shocks, but the magnitudes of the responses are relatively small. The results also suggest that the influences of the shocks on tourism demand tend to last for about 3-4 years.

The forecasting results show that the growth of tourist arrivals from China is expected to be the strongest among the eight origin countries/regions. Tourist arrivals from Hong Kong are expected to decline during the forecasting period, and this is likely to be caused by the increasing competition from China. Another major market, Taiwan, shows an increasing trend accompanied by some large fluctuations, but there is a decline at the end of the period. It is possible that the expected opening of the new Las Vegas style casinos/theme hotels may reverse the declines in Hong Kong and Taiwan arrivals. The forecasts for the other five origin countries show that the demand for Macau tourism by residents from these origin countries are likely to increase over the forecasting period, but the scale of increase is much smaller than that of China.

This study suggests that Macau will face increasing tourism demand by residents from mainland China. Since the needs of Chinese tourists tend to be different from those from other origin countries/regions, especially Western countries, the business sectors in Macau need to pay considerable attention to catering for the needs of Chinese tourists. Although some of the Chinese tourists are seasoned gamblers, a relatively large proportion of the independent travellers are likely to be cultural, leisure and shopping tourists. Therefore, the provision of facilities for these travellers will be a key to successfully attracting more high class tourists from mainland China to Macau.

References

Artus, J. R. (1972). An econometric analysis of international travel. *IMF Staff Papers,* 19, 579-614.

Crouch, G. I., Schultz, L. and Valerio, P. (1992). Marketing international tourism to Australia: a regression analysis. *Tourism Management,* 13, 196-208.

De Mello, M., A. Pack and M. T. Sinclair (2002). A system of equations model of UK tourism demand in neighbouring countries. *Applied Economics*, 34, 509-521.

Dritsakis, N. (2004). Cointegration analysis of German and British tourism demand for Greece. *Tourism Management* (forthcoming).

Frechtling, D. (1996). Practical Tourism Forecasting. Butterworth Heinemann: Oxford.

Frechtling, D. (2001). Forecasting Tourism Demand, Methods and Strategies, Butterworth Heinemann: Oxford.

González, P. and P. Moral (1995). An analysis of the international tourism demand in Spain. *International Journal of Forecasting* 11, 233-251.

Hamilton, J. D. (1994). *Time Series Analysis*. Princeton University Press: Princeton.

Huybers, T. (2003). Modelling short-break holiday destination choices. *Tourism Economics*, 9, 389-405.

Johansen, S. (1988). A statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12, 231-254.

Kim, S. and H. Song (1998). Analysis of tourism demand in South Korea: a cointegration and error correction approach. *Tourism Analysis*, 3, 25-41.

Kulendran, N. (1996). Modelling quarterly tourism flows to Australia. *Tourism Economics*, 2, 203-222.

Kulendran, N. and M. King (1997). Forecasting international quarterly tourism flows using error correction and time series models. *International Journal of Forecasting*, 13, 319-327.

Kulendran, N. and S. F. Witt (2001). Cointegration versus least squares regression. *Annals of Tourism Research*, 28, 291-311.

Kulendran, N. and S. F. Witt (2003). Forecasting the demand for international business tourism. *Journal of Travel Research*, 41, 265-271.

Ledesma-Rodríguez, F. J., M. Navarro-Ibánez and J. V. Pérez-Rodríguez (2001). Panel data and tourism: a case study of Tenerife. *Tourism Economics*, 7, 75-88.

Loeb, P. (1982). International Travel in the United States: an economic evaluation. *Annals of Tourism Research* 9, 42-55.

Li, G. (2004). *Tourism Forecasting – An Almost Ideal Demand System Approach*. Unpublished PhD Thesis, University of Surrey.

Li, G, H. Song and S. F. Witt (2004). Modelling tourism demand: a linear dynamic

AIDS approach. *Journal of Travel Research* 43.

Lim, C. (1997). Review of international tourism demand models. *Annals of Tourism Research*, 24: 835-849.

Lim, C. and M. McAleer (2001). Cointegration analysis of quarterly tourism demand by Hong Kong and Singapore for Australia. *Applied Economics*, 33, 1599-1619.

Lim, C. and M. McAleer (2002). A cointegration analysis of tourism demand by Malaysia for Australia. *Mathematics and Computers in Simulation* 59, 197-205.

Macau Government Tourist Office (2003), *Macau Travel and Tourism Statistics 2002*, Macau SAR, Macau Government Tourist Office.

Martin, C. A. and S. F. Witt (1987). Tourism demand forecasting models: choice of appropriate variable to represent tourists' cost of living. *Tourism Management*, 8, 233-246.

Papatheodorou, A. (2001). Why people travel to different places. *Annals of Tourism Research,* 28, 164-179.

Qiu, H. and J. Zhang (1995). Determinants of tourist arrivals and expenditures in Canada. *Journal of Travel Research*, 34, 43-49.

Seddighi, H. R. and D. F. Shearing (1997). The demand for tourism in North East England with special reference to Northumbria: an empirical analysis. *Tourism Management*, 18, 499-511.

Sims, C. (1980). Macroeconomics and reality. *Econometrica*, 48,1-48.

Song, H., P. Romilly and X. Liu (2000). An empirical study of outbound tourism demand in the U.K. *Applied Economics*, 32, 611-624.

Song, H. and S. F. Witt (2000). *Tourism Demand Modelling and Forecasting: Modern Econometric Approaches*. Pergamon: Oxford.

Song, H. and S. F. Witt (2003). Tourism forecasting: the general-to-specific approach. *Journal of Travel Research,* 42, 65-74.

Song, H. and K. F. Wong (2003). Tourism demand modelling: a time varying parameter approach. *Journal of Travel Research*, 42, 57-64.

Song, H., K. F. Wong, and K. Chon (2003a). Modelling and forecasting the demand for Hong Kong tourism. *International Journal of Hospitality Management*, 22, 435-451.

Song, H., S. F. Witt and T. C. Jensen (2003b). Tourism forecasting: accuracy of alternative econometric models. *International Journal of Forecasting*, 19: 123-141.

Syriopoulos, T. (1995). A dynamic model of demand for Mediterranean tourism. *International Review of Applied Economics*, 9, 318-336.

Turner, L. W. and S. F. Witt (2003). Pacific Asia Tourism Forecasts 2003-2005, PATA: Bangkok.

Turner, L. W. and S. F. Witt (2004). Pacific Asia Tourism Forecasts 2004-2006, PATA: Bangkok.

Vogt, M. G. and C. Wittayakorn (1998). Determinants of the demand for Thailand's exports of tourism. *Applied Economics*, 30, 711-715.

Webber, A. (2001). Exchange rate volatility and cointegration in tourism demand. *Journal of Travel Research*, 39, 398-405.

Witt, S. F. and C. A. Martin (1987). International tourism demand models – inclusion of marketing variables. *Tourism Management*, 8, 33-40.

Witt, S. F. and H. Song (2000). Forecasting future tourism flows, in Medlik, S and A. Lockwood (eds,) *Tourism and Hospitality in the 21st Century*. Butterworth-Heinemann, Oxford,106-118.

Witt, S. F. and C. A. Witt (1992). *Modeling and Forecasting Demand in Tourism*. Academic Press: London.

Witt, S. F. and C. A. Witt (1995). Forecasting tourism demand: a review of empirical research. *International Journal of Forecasting*, 11, 447-475.

Witt, S. F., H. Song and P. Louvieris (2003). Statistical testing in forecasting model selection. *Journal of Travel Research* 42, 151-158.

Witt, S. F., H. Song and S. Wanhill (2004). Forecasting tourism generated Employment: the case of Denmark. *Tourism Economics* 10, 167-176.

Wong, K. F. and H. Song (2002). Tourism Forecasting and Marketing. Haworth Press: New York.

Wong, K. F., H. Song and K. Chon (2003). Tourism forecasting: a Bayesian VAR approach. Working Paper, School of Hotel and Tourism Management, The Hong Kong Polytechnic University.

Zellner, A. (1962). An efficient method for estimating seemingly unrelated regressions and tests for aggregate bias. *Journal of the American Statistical Association* 57,348-368.

Table 1 Diagnostic Statistics of the Estimated Tourism Demand Equations

Statistics	China	HK	Taiwan	Japan	Korea	Philippines	UK	USA
$\overline{R}^2$	0.95	0.82	0.97	0.92	0.78	0.81	0.64	0.86
F-Stat.	48.38	10.10	60.53	25.17	8.26	9.18	4.43	13.24
S.E.	0.22	0.06	0.12	0.13	0.23	0.07	0.23	0.06
LL	17.77	70.56	47.55	41.03	15.56	62.09	17.58	73.92
AIC	0.11	-2.48	-1.15	-0.93	0.27	-2.22	0.26	-2.58
SBC	0.83	-1.59	-0.15	-0.09	1.14	-1.35	1.23	-1.70

Notes: S.E. is the standard error of regression; LL is the log likelihood value, AIC is Akaike Information Criterion; and SBC is Schwarz Bayesian Criterion

Table 2 Forecasts of Tourist Arrivals to Macau from Eight Major Origin Countries/Regions

Year	China	Hong Kong	Taiwan	Japan	Korea	Philippines	UK	USA	Total
2003Q3	1311182	1429768	421304.6	36187.52	19958.82	13803.40	19305.19	18684.67	3270194
2003Q4	1423587	1342205	447319.3	31919.19	17617.30	13909.25	15734.07	22880.17	3315171
2004Q1	1493296	1378019	429833.0	30185.78	17008.21	14771.94	12872.56	18406.55	3394393
2004Q2	1682383	1297854	517065.8	31039.35	10491.64	18031.61	14781.08	19761.48	3591408
2004Q3	1750636	1343426	544115.0	35446.51	12048.36	15050.62	16733.00	18402.06	3735858
2004Q4	1792701	1250803	549042.8	33586.25	11321.48	15289.76	14918.12	22346.56	3690009
2005Q1	1776455	1272597	507813.0	33578.04	12143.44	16539.79	13660.50	18659.85	3651447
2005Q2	1947207	1220136	550726.7	39250.05	27887.92	14261.04	13493.71	17153.27	3830116
2005Q3	2010125	1245186	567606.6	39444.22	26029.72	11431.34	20488.29	16973.25	3937284
2005Q4	2074193	1173409	537552.1	40244.10	27432.78	12448.54	14194.69	21360.12	3900834
2006Q1	2082936	1197172	506754.5	36817.75	24697.61	15027.99	17644.72	18136.47	3899187
2006Q2	2282179	1169901	525124.6	33426.74	20562.44	21213.90	21924.49	19596.49	4093929
2006Q3	2373975	1197527	545018.4	34243.64	21722.39	19638.99	29643.27	18720.79	4240489
2006Q4	2454233	1142376	514358.6	35510.35	15215.58	20601.41	25599.71	22693.93	4230589
2007Q1	2470850	1157448	487850.1	33533.85	19312.92	21899.71	21279.8	18681.97	4230856
2007Q2	2687844	1140203	495512.3	32148.49	40902.77	18283.63	20288.79	17191.66	4452375
2007Q3	2791492	1165152	510232.6	41905.48	39440.89	14735.64	26999.35	17137.05	4607095
2007Q4	2884877	1125477	482498.8	41633.05	32527.89	16994.94	15879.51	21705.89	4621594
2008Q1	2912358	1141562	460222.8	35488.40	30161.93	21112.89	16436.19	18569.73	4635912

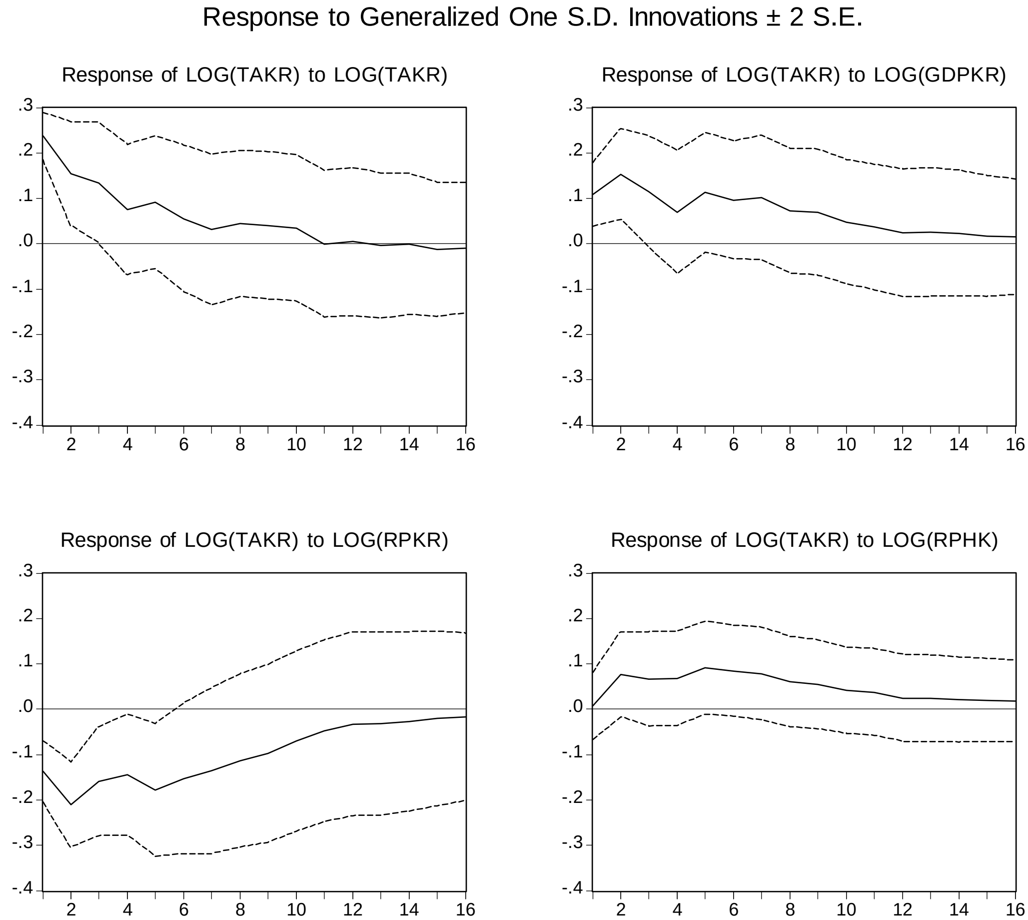

Figure 1 Impulse Response Functions of the Korea VAR Model[2]

[2] TAKR, GDPKR, RPKR and RPHK are tourist arrivals from Korea, GDP of Korea, the cost of living in Macau relative to the cost of living in Korea, and the cost of living in Macau relative to the cost of living in Hong Kong, respectively.

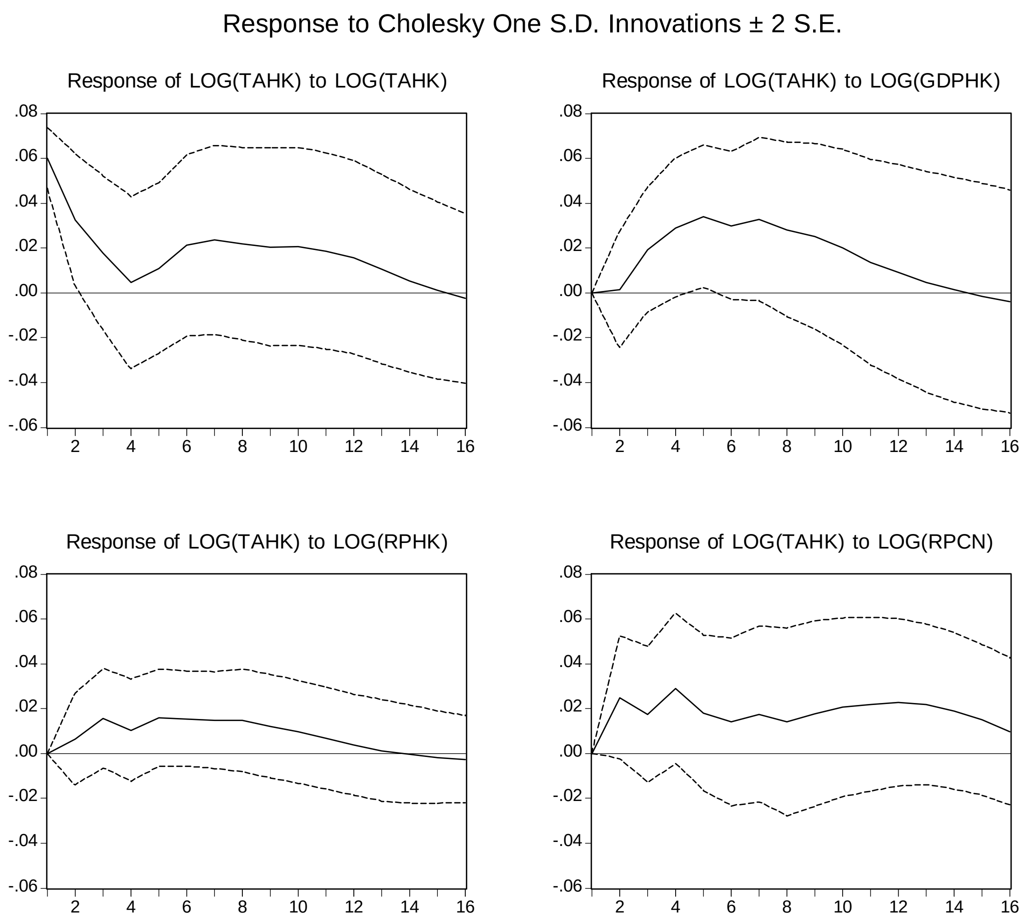

Figure 2 Impulse Response Functions of the Hong Kong VAR Model[3]

[3] TAHK, GDPHK, RPHK and RPCN are tourist arrivals from Hong Kong, Hong Kong GDP , the cost of living in Macau relative to the cost of living in Hong Kong and the cost of living in Macau relative to the cost of living in China, respectively

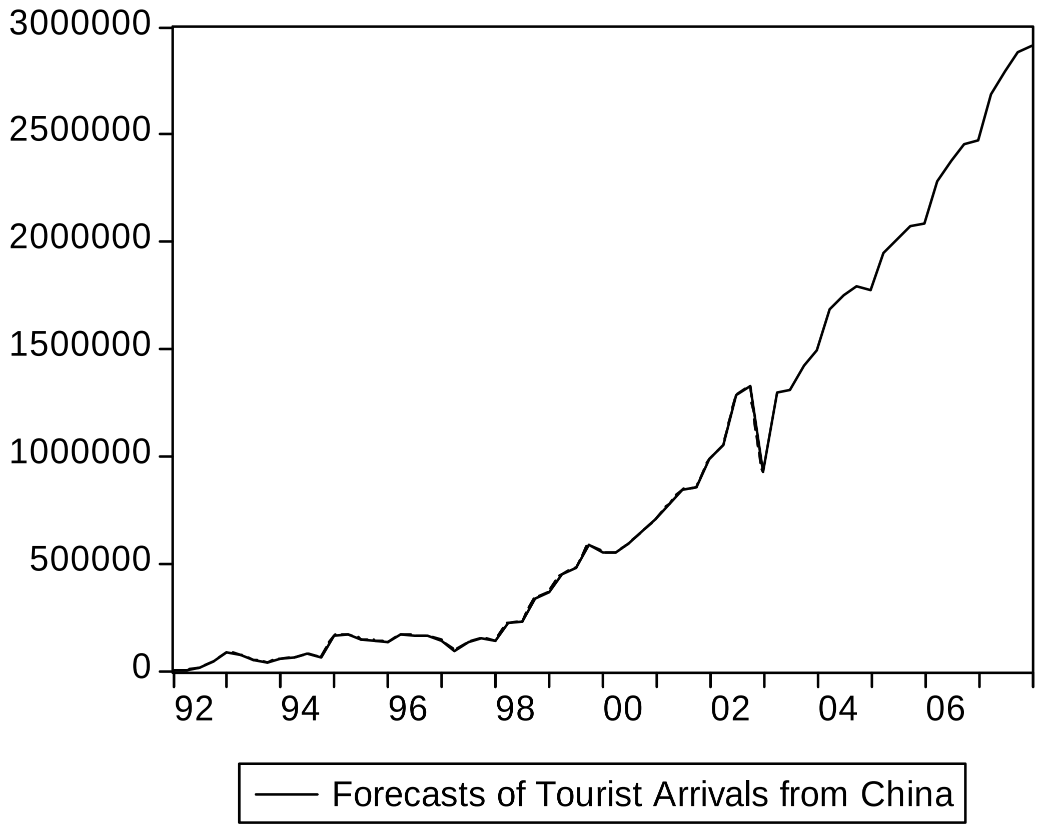

Figure 3 **Forecasts of Tourist Arrivals from China**

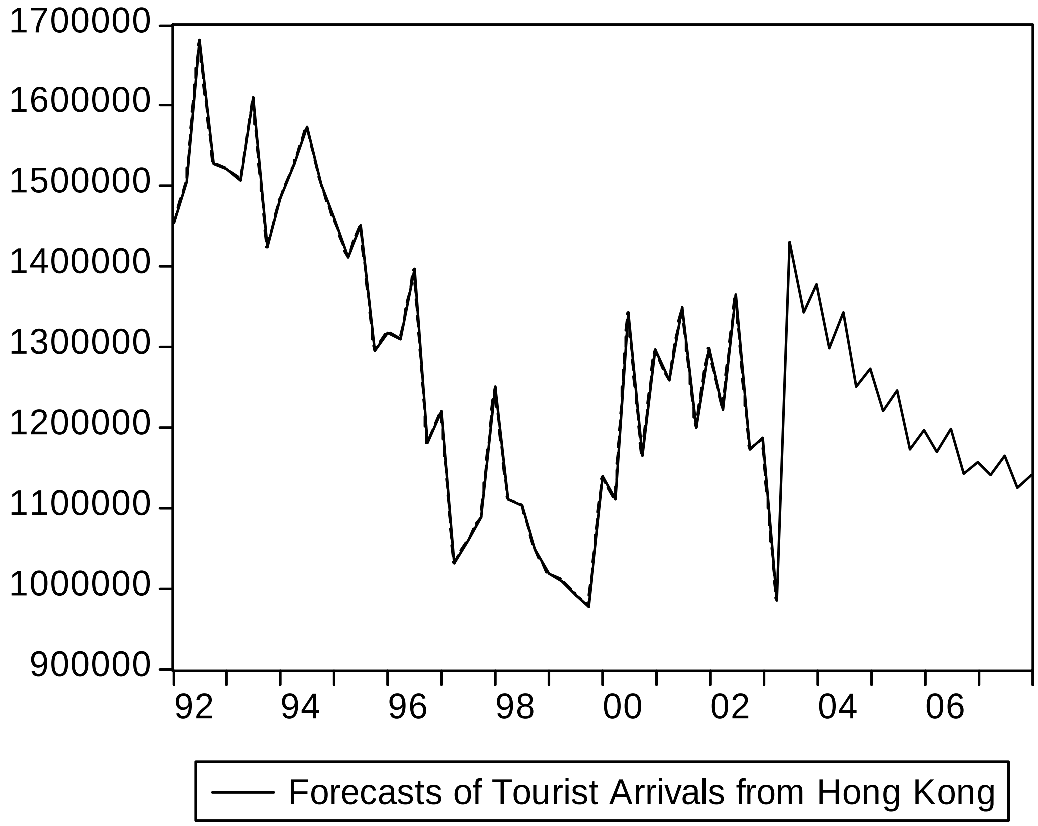

Figure 4 **Forecasts of Tourist Arrivals from Hong Kong**

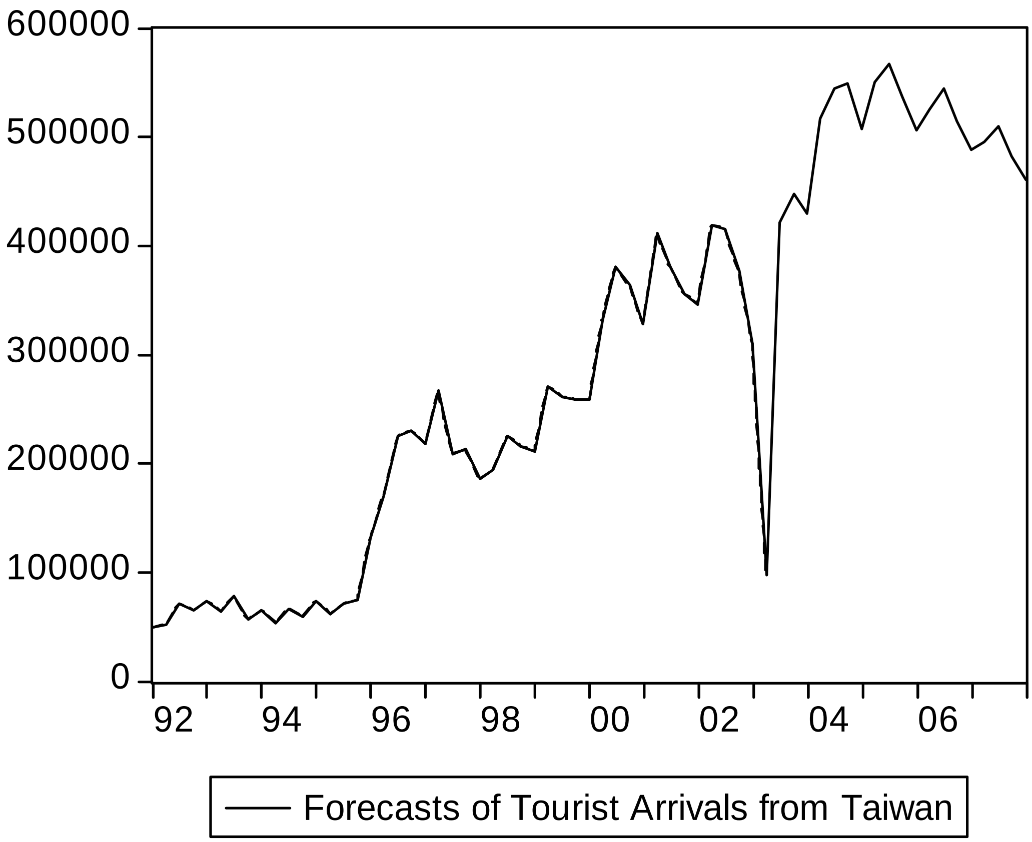

Figure 5 **Forecasts of Tourist Arrivals from Taiwan**