SEASONAL INTEGRATION AND COINTEGRATION: MODELLING TOURISM DEMAND IN SINGAPORE

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Abstract Japan has been and still is Singapore's top visitor generating market. We develop a Japanese tourist demand model for Singapore using quarterly data. Based on the Hylleberg *et al*. (1990) procedure, tests for unit roots at various seasonal frequencies as well as the zero frequency are carried out which reveal presence of unit roots at zero frequencies for all series. Unit roots at a biannual cycle are found to be present in tourist arrivals, income and relative price series whereas an annual cycle root is only present in the relative exchange rate series. Using the joint test for seasonal unit roots, we conclude that the series exhibit stationary seasonal patterns thus allowing us to employ deterministic seasonal dummies in the proposed model. A unique cointegrating relation is detected in the model on Japanese tourist demand for Singapore. Empirical results indicate that the Japanese market is highly demand elastic and that the Japanese are not price-conscious travellers. Tourism demand is found to vary in each quarter. The error correction model indicates that the dependent variable will change at a rate of 33.34 percent of the discrepancy between its actual and equilibrium value.

1. INTRODUCTION

World Travel and Tourism Council predicts tourism, along with Information Technology and Telecommunications, as one of the three super industries driving the economy of the next century. The tourism industry, which contributed about 10.9 percent to world gross domestic product and employed about 10.7 percent of the global workforce in 1995 is expected to grow at the rate of 7.9 percent from 1995 to 2000. [see World Tourism Organisation (1995)]

Given the continual expansion of global tourism, the Asia Pacific region will be the fastest growing region to generate and receive this pool of tourists. Singapore should therefore capitalise on locational advantage and respond to this opportunity to increase the country's scale of tourism. With improved transportation facilities, liberalisation of travel regulations and effective management of strategic plans, the catchment area for tourism in Singapore can be further galvanised. Singapore's tourism multipliers have been worked out by Toh and Low (1990).

2. RECENT TRENDS AND THE POTENTIAL OF TOURISM INDUSTRY IN SINGAPORE

Some recent trends on tourism in Singapore are worth observing . Firstly, Asian tourists constituted at least 70 percent of total tourist arrivals in the 1990's while Europeans and North Americans travellers accounted for a poor 7.5 percent and 5 percent respectively. The potential of these two affluent markets with a long good tradition for travelling are yet to be tapped.

Secondly, in terms of destination of international tourists arrivals in East Asia and the Pacific, China has been steadily increasing her market shares from 23.47 percent in 1985 to 27.49 percent in 1993. Over the same period, ASEAN countries such as Malaysian and Thailand appeared to have been able to maintain their market shares of about 9.5 percent and 8.0 percent respectively but Singapore experienced a marginal decline to 8.47 percent in 1993 from 9.01 percent in 1985.

Thirdly, breaking down the aggregate tourist arrival figures reveals a drop of holidaymakers to Singapore, which had long dominated the purpose of visit category, from 55.2 percent in 1990 to 45.3 percent in 1994. The proportion of business travellers to Singapore has risen from 9.6 percent of total arrivals to 18.2 percent over the same period. Such shift in trends could be seen as the result of the recent effort by the Singapore Tourist Promotion Board (STPB) to promote Singapore as the top convention city in Asia. The business segment has greater impact on the Singapore economy compared to holidaymakers since the average *per capita* expenditures in 1994 was S$1043 for business travellers whilst the holidaymakers' average spending was S$798. Thus, the potential of the business traveller market should not be overlooked.

Lastly, Singapore is registering a rapid growth of in-transit travellers. With long-haul holidays getting popular, Singapore is receiving 9.2 percent of total tourist arrivals in 1994 compared to 4.2 percent in 1990 for this category. The continuous efficiency of Changi International airport is once again yielding rewards to the city state.

Focusing on potential sources of top visitor-generating markets of Singapore and quantitatively researching into the travellers characteristic behaviour as well as their seasonal patterns of demand would enable Singapore to be more competitive in attracting tourists. The STPB was designated the task of development and promotion of tourism in Singapore since it was set up in 1964; our proposed project is in response to STPB's new approach to study individual tour markets and undertake promotional strategies of specific targeting adopted in January 1996.

'Tourism Unlimited' is an initiative by STPB that recognises the dynamics of the Asia Pacific region; the main thrust of the strategy is to make use of complementary strengths within the region. The formation of the ASEAN Tourism Association and the setting up of the Indonesia-Singapore Tourism Corporation are just some of the action plans to jointly promote ASEAN as a tourist destination or bilaterally cultivate the dual-destination programme.

Tourist arrivals to Singapore have increased from a mere 91,000 in 1964 to 7.14 million in 1995. Tourist exports contributed about 10 percent to Singapore's gross domestic product over the 1985 -1995 period. Tourism has since become a potential high-growth sector with its activities interwoven into the long term strategic plans of Singapore [see Ministry of Trade and Industry (1991), *The Strategic Economic Plan 1991*, Annex 13). Khan *et al* (1996) argues for an optimal target of 9 million visitors to Singapore by the year 2000, emphasising the quality rather than quantity of visitors in terms of average spending perhead. We call for greater effort to promote business travellers which is in line with the vision statement of Singapore's long term strategic plans as a premier and leading international hub for aviation and convention/exhibition services.

Japan consistently has been the largest visitor-generating country source for Singapore but has shown some indication of becoming a stagnant market in recent years. Japanese arrivals constituted 16.08 percent of total arrivals in 1994 which is in decline compared to 18.25 percent in 1990. Estimated expenditures of Japanese tourists in Singapore has since fallen from S$905.7 million to S$531.1 million over the same period [see Singapore Tourist Promotion Board (1995)]. The potential contribution of Japanese travellers motivates our selection of Japan as a case study.

3. A MODEL OF JAPANESE TOURISM DEMAND FOR SINGAPORE

Tourism demand relates to the study of consumption patterns of tourism products by tourists as well as determining the variables that affect demand patterns. The focus of this section is on the choice of explanatory variables as well as on the derivation and estimation of the Japanese tourism demand model for Singapore.

3.1 MODEL SPECIFICATION

Studies that illustrate tourism demand model are found in Leob (1982), Uysal and Crompton (1984), Gunadhi and Chow (1986), Summary (1987), Var, *et al* (1990), Sheldon (1993), Crouch (1994a & b). Leob (1982) examines three specific determinants of tourism demand in the United States which include real *per capita* income of tourist generating countries, exchange rates and relative prices. These variables are found to be generally significant but the responsiveness of each variable varies. In particular, Leob concludes a positive correlation between international business travel and income. The relative price variable in the demand model appears to be significant indicating the existence of substitution effects.

In another study on tourism demand, Uysal and Crompton (1984) measure tourism demand using tourist arrivals and expenditures. The quantifiable explanatory variables selected are real *per capita* income in tourist generating countries, relative prices and relative exchange rates, transportation costs and promotional expenses. Income, price and exchange rate variables are generally found to be significant. In addition, the authors suggest the importance of distance between tourist-generating countries and a particular destination in explaining the significance of exchange rates. The high price elasticity of demand for tourism indicates the intense competition faced by the tourism sector in that country.

Crouch (1994a, 1994b) did a comprehensive review on tourism demand literature. The log-linear multivariable model estimated by ordinary least squares approach is found to be the most widely used approach. It is found that the models in multiplicative form fit the data better and the coefficients of variables can be conveniently interpreted as demand elasticities. Other advantages in using models of this functional form are the capability to model cause and effects and to provide statistical measures of accuracy and significance. The wide use of time series data enables modelling of trends.

Based on these discussions, the single equation log linear econometric model is used for measuring Japanese tourism demand for Singapore. The common explanatory variables used are the real *per capita* income of Japan, the relative exchange rates and relative prices between Singapore and Japan while the dependent variable is tourist arrivals to Singapore. Since the multiplicative/linear logarithmic model is regarded useful and demand elasticities can be easily derived from the estimated parameters, the Japanese tourists demand model for Singapore can be specified as follows:

$$TA_t = \alpha\, RY_t^{\theta 1}\, RP_t^{\theta 2}\, Ex_t^{\theta 3}\mu_t, \quad t=1,2,....,T \tag{1}$$

where, TA represents annual Japan tourist arrivals,

RY denotes real income of Japan (GDP / RVAD),

RP represents relative price of tourism services in Singapore and is defined as CPI_{st}/CPI_{jt}, where CPI_{st} and CPI_{jt} are consumer price indices of Singapore and Japan respectively,

EX_t is the relative exchange rate, (i.e. Singapore dollar to one unit of yen or S$/yen).

α, θ_1 to θ_3 are the parameters coefficients.

μ_t is the stochastic disturbance term.

Expressing Equation (1) in the linear logarithmic form yields

$$\log(TA_t) = \theta_0 + \theta_1 \log(RY_t) + \theta_2 \log(RP_t) + \theta_3 \log(EX_t) + u_t \tag{2}$$

where $\theta_0 = \log(\alpha)$ is the intercept term, $u_t = \log(\mu_t)$ is the disturbance term which is assumed to be normally distributed with zero mean and constant variance.

In this model the parameter coefficients can be interpreted as elasticities while the signs of parameters should be expected as $\theta_1 > 0$, $\theta_2 < 0$ and $\theta_3 > 0$ from the results.

Seasonality is an integral part in economic and business modelling. Among others Hylleberg (1992), Ghysels (1993), Hendry (1995) placed importance on seasonal cycles from a policy perspective. Hendry (1995) has pointed out that although summer is unlikely to become winter, economic behaviour can change greatly in response to seasons: witness the large switch in electricity consumption to summer months with air conditioning. Seasonality is also a phenomenon for most tourism demand patterns which may be a result of different seasons throughout the year, special events or festivals held in a destination or coincidence with holiday periods. Being related to many industries, seasonality could distort the normal tourism operations. Seasonality can result in underused facilities during periods of low demand or the over-stretching of resources during the peak period to compensate for the off-peak season. Since it is not possible to have a buffer stock for tourism, a destination needs to manage the problem of seasonality which otherwise may result in overcrowding or high prices. These would have negative impacts on the economy.

In order to capture the seasonal effects in the model, Equation 2 can be extended as

$$\log(TA_t) = \theta_0 + \theta_1 \log(RY_t) + \theta_2 \log(RP_t) + \theta_3 \log(EX_t) +$$

$$\theta_4 D_1 + \theta_5 D_2 + \theta_6 D_3 + u_t \tag{3}$$

In this specification, D_1, D_2 and D_3 are seasonal dummies to represent the first, second and third quarters effects of a year respectively; the constant term represents the fourth quarter effect. $D_i = 1$ for quarter *i* and 0 otherwise. The estimated coefficients θ_0, θ_4, θ_5 and θ_6 would reflect any seasonal patterns present in various quarters.

3.2 MODEL ESTIMATION

In modelling time series data, the underlying properties of the data-generating process (dgp) of the series need to be investigated. We need to distinguish between stationary and stochastic components. Non-stationary variables included in the equation can result in spurious regression which will yield a high R^2 and significant t-statistics. This results in making invalid inferences and falsely concluding a relationship to exist between unrelated non-stationary series.

It is important to remove non-stationary components in any series before proceeding with any estimation or testing. Trend-stationary (TS) and difference-stationary (DS) are two possible approaches to achieve stationarity. The former is achieved by adding a deterministic trend into the regression equation or by regressing the variable on time. This process requires the series to be trend stationary which otherwise will result in a misspecified model. The latter is obtained by differencing the original series. If a series becomes stationary after differencing *d* times it is said to be integrated of order *d* i.e. I(*d*). The integrating order of the variable will determine the number of unit roots. Series that become stationary only after differencing may have a linear combination which is stationary without differencing. The system in this case is said to be cointegrated. For the integrated series, the presence of cointegration is required before the ordinary least squares estimates of the static model imparts any meaningful long run equilibrium relationship. This concept has established its importance in econometric specification, estimation and testing.

If cointegration can be determined for the stochastic series, information loss on the long run equilibrium of the model can be captured in the error correction procedure in levels. The error correction mechanisms state that a proportion of the disequilibrium from one period is corrected in the next period. Engle and Granger (1987) establish a two step procedure for estimating cointegrated systems. This estimation requires least squares to be applied to single equations. The first step is to estimate the cointegrated system; the estimated parameters are used in the second step in the error correction form. This two step estimation[1] attempts to reconcile the short run behaviour of a variable with its long-run behaviour. Two distinct kinds of information can be derived from the error-correcting procedure. One would be the estimated parameters of the long run equilibrium relationship whilst the other is the magnitude of the dynamic adjustment coefficients. Taking an example that the static model (Equation 3) is found to be cointegrated in the presence of I(1) series, the residuals from this cointegrated regression is lagged by one period, $\hat{u}_{t-1}$ and substituted in the second step equation as

$$\Delta\log(TA_t) = \theta_0 + \theta_1\Delta\log(RY_t) + \theta_2\Delta\log(RP_t) + \theta_3\Delta\log(EX_t) + \alpha\hat{u}_{t-1}$$
$$\theta_4 D_{1t} + \theta_5 D_{2t} + \theta_6 D_{3t} + \nu_t \qquad (4)$$

where Δ denotes first differences and ν_t is the error term with the usual properties. Equation 4 is a meaningful short-run adjustment equation to estimate. Standard regression techniques are valid since all the terms are stationary after taking first differences. This equation encompasses both short and long run relationships. The coefficient of the error correcting term, α indicates the adjustment towards long-run equilibrium, which is also

[1] Engle and Yoo (1991) propose a third step to the Engle-Granger correcting procedure. It is noted that the estimated parameters in the static first step can be biased in finite samples and the distribution is generally non-normal. The additional correcting step seeks to overcome this problem to ensure normality for the first-stage estimates. A unique cointegrating vector and weak exogeneity of the right hand side variables in the short run ECM are required. The authors assumed the root of interest has a modulus of one which is the root corresponding to a zero frequency peak with no other unit roots present in the system.

known as the speed of adjustment. The parameters θ_1, θ_2 and θ_3 capture the short-run effects in the respective regressors.

The Engle and Granger approach to cointegration is widely used due to the ease of implementation. One defect of the procedure is the possibility that any error from the first step will be introduced to the second step. In addition, the estimation procedure is limited to the use of a single equation. However if the single equation relationship includes more than two regressors, there is a possibility of more than one equilibrium relationship. Johansen and Juselius (1990) adopt a maximum likelihood approach to determine the number of cointegrating relationships for more than two explanatory variables in a single equation. The calculated Johansen's likelihood ratio test statistics are used to test the null hypothesis of at most *r* distinct cointegrating relationships against a general alternative. The critical values used are for the Johansen trace test statistic (λ_{trace}). If multiple relationships are detected, the Engle-Granger two-step estimation approach will not be suitable.

As reported before, seasonal fluctuations should not be ignored or obscured in the modelling analysis since they are an integral part of economic data. The conventional method of modelling with deterministic seasonal dummies is assumed to capture all aspects of seasonality. Stochastic seasonal components, on the other hand do not possess any definite pattern and may drift substantially over time. Thus the application of integration and cointegration on economic time series has been extended beyond the long run or zero frequency to examine the existence of unit roots at different seasonal frequencies. We will follow Hylleberg *et al*. (1990), who developed a framework of tests specific to this area (hereafter referred to as the HEGY test). This test for unit roots at both zero and seasonal frequencies is an extension of the Dickey-Fuller (DF) test in linear unadjusted time series.

A seasonal process is described as one with a spectrum having distinct peaks at seasonal frequencies. The HEGY test distinguishes between roots with modulus one at different frequencies. A seasonal unit root implies that the seasonal pattern is changing and not constant. A satisfactory econometric model should be able to take into account the seasonal variation in order for the model to be compatible with available information. But it is difficult to choose between a model that allows a changing seasonal pattern and a model with a stationary movement around a deterministic pattern. This choice is dependent on the degree of seasonal variation.

Differencing for stationarity for quarterly data takes the form of a polynomial expressed as $(1 - B^4)$. This application of the fourth difference to a quarterly seasonal series to achieve stationarity is one of the transformations advocated by Box and Jenkins (1976). In general, the Box-Jenkins approach to achieve stationarity is to difference non-stationary data repeatedly until the resulting difference series is stationary. Seasonal differencing is commonly used if it is assumed that seasonality is stochastic and integrated. A simple univariate model for a series integrated at all the seasonal and long run (zero) frequencies will be

$$(1 - B^4)x_t = \varepsilon_t, \tag{5}$$

where $\varepsilon_t \sim i.i.d\ (0, \vartheta^2)$ and t = 1, 2, ..., T while B is the lag operator.

A seasonal process is integrated if seasonal unit roots are present in an autoregressive series. The HEGY unit root test is initiated by a specified general autoregressive model parameterised to bring out both long-run and seasonal unit roots. Seasonal differencing operator $(1 - B^4)$ can be factored as

$$(1 - B^4) = (1 - B)(1 + B)(1 - iB)(1 + iB)$$
$$= (1 - B)S(B) \qquad (6)$$

The roots of Equation 6 are 1, -1 and a pair of complex roots. These correspond to a root at zero frequency, bi-annual cycle and annual cycle per year respectively.[2] The series is integrated at the zero frequency if the process contains (1 - B) which means any changes will have permanent effects on $\{x_t\}$ since the series is the sum of all previous changes. The S(B) component on the other hand, provides the long memory parts for series at seasonal frequencies which are asymptotically uncorrelated with the process of unit roots at other frequencies. Seasonal integration is incorporated into the definition of integration at the zero frequency by using the seasonal filter S(B). The term (1 - B) is used to remove zero frequency unit roots and S(B) aims to remove seasonal unit roots. The HEGY test assumes that the series is generated by a stationary general autoregression such that

$$\varphi(B)x_t = \varepsilon_t \qquad (7)$$

where $\varphi(B)$ can possibly be a infinite lag-polynomial and $\varepsilon_t \sim i.i.d.\ (0, \vartheta^2)$.

Roots of $\varphi(B) = 0$ lie outside the unit circle but some roots may be complex pairs with seasonal periodicities. The mathematical manipulation of polynomial $\varphi(B)$ about the 4 unit roots 1, -1, *i* and -*i* yields the following unit roots test model[3]

$$\varphi^*(B)y_{4t} = \pi_1 y_{1t-1} + \pi_2 y_{2t-1} + \pi_3 y_{3t-2} + \pi_4 y_{3t-1} + \varepsilon_t \qquad (8)$$

where,

$$y_{1t} = (1 + B + B^2 + B^3)x_t,$$
$$y_{2t} = -(1 - B + B^2 - B^3)x_t,$$
$$y_{3t} = -(1 - B^2)x_t,$$
$$y_{4t} = (1 - B^4)x_t = \Delta_4 x_t.$$

The term y_{1t} maintains a unit root at zero frequency and removes the seasonal unit roots. y_{2t} removes all other roots and maintains the unit root at the semi-annual frequency. y_{3t} removes all roots at other frequencies and preserves the complex conjugates at annual frequencies.

Equation 8 is estimated by ordinary least squares with additional lags of y_{4t} to whiten the errors. The null for this unit root test is the presence of unit roots against the alternative hypothesis for stationarity. If all π's are different from zero, the series are stationary at all frequencies. The test for a unit root at zero frequency will be a t-test on the

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[2] A quarterly process is integrated at the bi-annual frequency if it contains the component (1 + B), and integrated at the annual cycle if it contains the component $(1 + B^2)$ and integrated at frequency zero if the component (1 - B) is present. Thus one example of a series integrated of order 1 at all frequencies is $\varphi(B)(1 - B^4)x_t = \varepsilon_t$, where the residual is white noise and $\varphi(B)$ is stationary.

[3] The derivation of the HEGY test model will not be explained here. Readers who are interested can refer to Hylleberg *et al.* (1990, pp 222-223). The inclusion of deterministic regressors like the intercept, seasonal dummies, and a trend increases the power against relevant alternatives. Appropriate critical values are given in Hylleberg *et al.* (1990, pp 226).

null of $\pi_1 = 0$. A t-test on $\pi_2 = 0$ will determine the presence of a bi-annual cycle root. A joint F-test of the null hypothesis $\pi_3 = \pi_4 = 0$ will be the test for an annual cycle root. Seasonal unit roots will not be present if both the tests for $\pi_2 = 0$ and the joint test of $\pi_3 = \pi_4 = 0$ reject the null hypothesis. Hylleberg *et al*. (1990) contain the critical values for these unit root and seasonal unit root tests.

The basic test equation can be extended to include a constant (α_0), time trend (t) and deterministic seasonal dummies (D_t). Thus the following equation depicts the test model that handles both deterministic and stationary parts of the series.

$$\varphi^*(B)y_{4t} = \alpha_o + \beta t + \gamma D_t + \pi_1 y_{1t-1} + \pi_2 y_{2t-1} + \pi_3 y_{3t-2} + \pi_4 y_{3t-1} + \varepsilon_t \qquad (9)$$

The distributions of relevant test statistics change with the inclusion of deterministic components. The intercept and trend portions affect the distribution of π_1 since they all have their spectral mass at zero frequency. The remaining three seasonal dummies will not affect the distribution of π_1 once the intercept is included. However the seasonal dummies do affect the distributions of π_2, π_3 and π_4.

The similarity between the HEGY and the DF unit root tests lies in the distributions of critical values and Equation 8 estimated with lagged values of y_4 which is simply an extension of the well-known DF auxiliary regression for a zero frequency unit root.

Canova and Hansen (1995)[4] note that the HEGY test is limited by the low power in moderate sample sizes. Non-rejection of the null hypothesis unfortunately cannot be interpreted as evidence for presence of a seasonal unit root. But, rejecting the null hypothesis implies a strong result that a stationary seasonal pattern is present. Another reservation against this unit root test is that there may be a seasonal unit root which may allow for more variation in the seasonal pattern than is actually observed. When no unit roots are found to be present at the seasonal frequencies but seasonality is believed to be present in the series, deterministic seasonal dummies may be added to the regression model.

Engle *et al*. (1993) interpret cointegration at a long-run frequency as an indication of a 'parallel' movement of non-stationary series in the long run. Similarly, cointegration at a particular seasonal frequency is interpreted as the 'parallel' movement in the corresponding seasonal component of the two series of which both have varying seasonal patterns. If seasonal unit roots are present, potential cointegration may occur at seasonal cycles and/or at zero frequency. Abeysinghe (1994) states that the likelihood of observing spurious relations can be high if the series in the model are seasonally integrated at the same frequency. This possibility increases with sample size. On the other hand, series integrated at different seasonal frequencies do not produce spurious regressions.

Seasonality can be modelled as deterministic or stochastic components. It is often assumed that seasonality is deterministic and fixed so that seasonal dummies can be used. If seasonality is found to be stochastic and integrated, seasonal differencing will be required. If seasonal dummies are used and the series are found to be seasonally integrated,

[4] Canova and Hansen (1995) introduced a Lagrange multiplier (LM) test to complement the HEGY seasonal unit root test. The null hypothesis in this test is no unit roots at seasonal frequencies against the alternative of a unit root at either a single frequency or a set of seasonal frequencies. The LM test in this case is more powerful than the HEGY test. However, this LM test is beyond our scope of our study.

then spurious regression is likely. Thus the Johansen trace test procedure for cointegration is used to determine the presence of cointegration for the model that includes quarterly seasonal dummy variables.

Hylleberg *et al*. (1990) introduce an error-correcting representation which explicitly takes into account the cointegrating restrictions at the zero and seasonal frequencies. If the series have unit roots only at the seasonal frequencies then the series are seasonally cointegrated; if the series have unit roots at zero frequency then the series are cointegrated at zero frequency. Abeysinghe (1994) concludes that seasonal dummies can be utilised in a single regression equation if the explanatory variables are non-seasonal or have stationary seasonal patterns. If either of these two situations is present and the single equation model that includes the deterministic seasonal dummies is found to be cointegrated, then the Engle-Granger approach is used to estimate the model in the presence of unit roots at zero frequency.

4. EMPIRICAL RESULTS AND INTERPRETATION

4.1 DATA SOURCES

Unadjusted quarterly time series data of Japan and Singapore for the variables of the model are abstracted from the Public Access Time Series (PATS) database, Singapore as well as the International Financial Statistics. The period of analysis starts from 1980:1 to 1994:4 and the consumer price indices are calculated using the base year 1990.

The tourism demand depicted in Equation 3 is the long run relationship of variables that we are interested in. If the variables are non-stationary, our regression results will not be efficient. Thus some pre-tests of the underlying properties of variables are performed to check the spurious nature of the regression before estimating the model.

4.2 TESTS FOR UNIT ROOTS

The basic HEGY test auxiliary Equation 8 is estimated by least squares method with the right augmentation to whiten the residuals. Deterministic terms such as the intercept (α_0), trend term (t) and seasonal dummies (SD) are included. The results for the HEGY unit roots test at different frequencies are summarised in Table 1.

Unit roots at zero frequency are found to be present in all the series. Tourist arrivals, relative income and relative price series show unit roots at the bi-annual cycle whereas an annual cycle root is present in the relative exchange rate series. Both the ‘t’ test of $\pi_2 = 0$ and joint test of $\pi_3 = \pi_4 = 0$ should be rejected before concluding that there are stationary seasonal patterns within the series. We can conclude that the three regressors in the model exhibit stationary seasonal patterns. But we cannot reject the null of seasonal unit roots for the tourist arrival series. Unit root at bi-annual cycle is present in all the three different forms of auxiliary equations. However, the HEGY test has the limitations in the power of the test. Not rejecting the null hypothesis cannot be interpreted as evidence for the presence of a seasonal unit root.

Thus we conclude that all the variables exhibit stationary seasonal patterns and deterministic seasonal dummies will be included in the regression model to capture any significant seasonality in each quarter.

4.3 Cointegration Tests

Having determined from the HEGY unit root test that the variables are I(1) at zero frequency and exhibit stationary seasonal patterns, the Engle and Granger (1987) test for cointegration will be used to test for non-cointegrated series against the alternative that the series are cointegrated. In order to have a cointegrating relation in the variables, the residual term of Equation 3 should be stationary. The calculated test statistic is 7.79. At 10 percent of significance, the critical value is 3.73 [Engle and Yoo (1987) pp 157]. Thus we reject the null hypothesis of no-cointegration at 10 percent significance level.

The Johansen trace test determines the number of cointegrating relationships for a single equation with more than two explanatory variables. The calculated likelihood ratio statistic and the critical values are shown in Table 2. Critical values are provided in Johansen and Juselius (1990, Table A3, pp 209). Using 5 percent significance level, the hypothesis that there are at most two cointegrating relationships is rejected. This implies that long run temporal movements of the variables including seasonal dummies are determined by one equilibrium relationship. This conclusion together with the assumption that right hand side variables of Equation 4 are exogenous, means that the single equation approach can yield efficient estimated parameters.

4.4 Error Correction

Given our results above, we now use the two-step error correction proposed by Engle and Granger (1987) for defining a cointegrated system. The first step is the estimation of the cointegrated system. The regression results for the long run static model are as follows:

$$\log(TA_t) = \underset{(4.326)}{4.7965} + \underset{(13.80)}{1.6449}\log(RY_t) + \underset{(4.968)}{4.5042}\log(RP_t) + \underset{(14.67)}{1.4256}\log(EX_t) + \underset{(1.820)}{0.08774}D_1 - \underset{(-1.630)}{0.07859}D_2 + \underset{(3.584)}{0.17220}D_3 \quad (10)$$

R^2(adj) = 0.9165, s.e. = 0.13152, F=123.372, DW=0.85934

(t- values are in the parentheses)

The residual term of the above equation, u_t is lagged by one period and substituted as an explanatory variable in the second step of the Engle-Granger approach. The coefficient of this term shows the speed of adjustment. This short run dynamic relationship obtained as

$$\Delta\log(TA_t) = -\underset{(-5.812)}{0.1468} - \underset{(-0.293)}{0.1508}\Delta\log(RY_t) + \underset{(-1.126)}{1.1654}\Delta\log(RP_t) - \underset{(-0.6090)}{0.3090}\Delta\log(EX_t) - \underset{(-3.329)}{0.3334}\,\hat{u}_{t-1} + \underset{(7.903)}{0.2815}D_1 - \underset{(-0.739)}{0.0259}D_2 + \underset{(12.10)}{0.4278}D_3 \quad (11)$$

R^2(adj) = 0.8250, s.e. = 0.09347, F = 40.067, DW = 2.20152

(t- values are in the parentheses)

The speed of adjustment is calculated as -0.3334. This shows that when the regressors deviate from long-run equilibrium, the dependent variable will change at a rate of 33.34 percent of the deviation to return to equilibrium. The larger the α, the greater the response of dependent variable to previous deviation from the long run equilibrium. The other parameter coefficients simply indicate the short run dynamic relations between the variables. From the results shown in Equation 11, short run changes in the income, price and exchange rates do not seem to have significant effects on tourist arrivals. The other three quarters except the second quarter show significant tourist arrival patterns in the short run.

4.5 ANALYSIS OF EQUILIBRIUM MODEL

The adequacy of the fitted model is determined by the signs of estimated coefficients in accordance with prior expectations, the statistical significance of variables and the coefficient of determination. But the assumption on the normality of the disturbance term, u_t needs to be present before the t and F tests can be valid in finite samples. One test of normality used here for Equation 10 is the chi-square goodness of fit test on the residuals. The calculated χ^2 statistic using 10 groups and 9 degrees of freedom is 13.48 and does not reject the null hypothesis of normality at 10 percent level of significance with critical value of 21.67.

Multicollinearity results in difficulty of separating the effects of certain determinants. This problem has not been satisfactorily addressed as yet since most economic series have some kind of collinearity. We use the correlation matrix to check the pairwise correlations amongst the explanatory variables. The calculated values of the correlation matrix for the income, price and exchange rate variables range from -0.03522 to 0.23800. These values indicate an acceptable level of multicollinearity.

The Bruesch-Pagan test is used to determine the presence of heteroskedasticity in the long run model. The calculated test statistic of 12.94 does not reject the null hypothesis of homoskedasticity at 10 percent with critical value of 76.15.

The Durbin-Watson statistic of Equation 10 indicates the presence of positive autocorrelation. We use the Cochrane-Orcutt Iterative procedure as a remedial measure. The corrected regression yields

$$\log(TA_t) = \underset{(2.877)}{5.1258} + \underset{(8.063)}{1.6017}\log(RY_t) + \underset{(1.968)}{2.0577}\log(RP_t) + \underset{(10.23)}{1.4196}\log(EX_t)$$

$$+ \underset{(3.187)}{0.10065}D_1 - \underset{(-2.518)}{0.088798}D_2 + \underset{(5.746)}{0.17521}D_3 \tag{12}$$

R^2(adj) = 0.9492, s.e. = 0.10922, DWH = 1.4686

(t- values are in the parentheses)

In the corrected model, Durbin h statistic (DWH) is obtained as 1.47 which is less than 5 percent critical value of 1.96. So there is no evidence of autocorrelation in the corrected model.

Since quarterly data sets are used in this study, there is a possibility of obtaining error structures of the form

$$u_t = \rho_4 u_{t-4} + \varepsilon_t \tag{13}$$

We use the Wallis (1972) test for the presence of fourth order autocorrelation. The calculated test statistic is obtained as 1.47. This is marginally inconclusive.

The coefficients of the new regression in Equation 12 did not change much from Equation 10 but the goodness of fit and standard error of estimates have improved. Each of the estimated slope coefficients in the model measures the partial elasticity of tourism demand with respect to each respective variable, holding all other variables constant and taking into account the seasonal effects.

4.6 ECONOMETRIC INTERPRETATION

The regression results can be interpreted as follows. Holding the effects of relative prices and the exchange rate constant, a 1 percent rate of change in real income of Japan induces tourism demand to change by 1.6017 percent after taking into account seasonal effects. Likewise, a 1 percent rate of change in relative price of Singapore results in Japanese arrivals to change by 2.0577 percent in the presence of seasonal effects, ceteris paribus. Lastly, a 1 percent rate of change in the relative exchange rate between the two countries results in a 1.4196 percent change in arrivals after accounting for seasonal effects, *ceteris paribus*.

The signs of the coefficient estimates obtained for both income and exchange rate variables are consistent with a prior expectation. However, an unexpected positive sign for the price coefficient estimate is obtained. From an economic perspective (with all the absolute values of the calculated elasticity coefficients greater than one) we conclude that the tourism demand is income, price and exchange rate elastic.

Deterministic seasonal dummies are included in the model without any transformation. The three quarters explained by the dummies and fourth quarter by the intercept term indicate statistical significance at the 1 percent level (i.e. seasonal factors operating in each quarter of the year are highly significant). The results indicate that the average level of Japanese tourist arrivals in the first quarter increases by about 10.6 percent over the fourth quarter. Arrivals in the second quarter would on average decrease by about 8.4 percent compared to the fourth quarter. Lastly, results indicate that average tourist arrivals in the third quarter increases by 19.1 percent over the fourth quarter. Thus this analysis sheds some light on the average tourist arrival patterns of Japanese travellers. The third quarter receives the largest arrivals whilst demand declines in the second quarter.

5. SOME TENTATIVE REMARKS ON POLICY IMPLICATIONS

We have gained some insight on Japanese tourism demand. We have uncovered various factors which influence the levels of tourism using times series modelling techniques. Deterministic seasonal dummies are used to extract the seasonal components of tourism demand in different quarters. The results reveal differences in the pattern of arrivals in each quarter. All variables are found to be I(1) but cointegrated with one equilibrium relationship. The Engle-Granger two-step approach yields both long and short run relationships of variables without any information loss. The error correction model indicates about a 33.34 percent of the discrepancy between the actual and equilibrium value of the dependent variable.

From the long run equilibrium model, demand from the Japanese market is found to be highly elastic particularly to price changes. A well-performing Japanese economy and an appreciation of yen against the Singapore dollar would probably create a more favourable environment for the Singapore tourism sector. The elasticity of price gives us an idea as to the degree of competition that Singapore faces for this market. The positive sign of the price coefficient may imply that the Japanese is not a price-conscious traveller. This can be explained by the fact that Japan has a higher inflation compared to Singapore such that a price increase here does not deter a Japanese from choosing Singapore as a destination.

However, we should not be mislead by this conclusion of a positive relation between tourism demand and a price increase. If policy makers do not attempt to maintain an optimal balance between price and quality of the Singapore tourism product, an increasing relative price may well be a deterrent for the growth of the Singapore tourism sector. We should interpret the coefficient of the price variable as an indicator of competition such that if we can overcome the stiff competition from alternative destinations, the payoff can be significant.

The fact that exchange rate elasticity is greater than one is another indication of the presence of substitution effects. Since it may not be optimal for Singapore to engage in long term price competition, the emphasis should be on other components of the tourism system (*e.g.* tourist grouping, geographical aspects and tourism activities).

Business travellers are often postulated to be less price sensitive than holiday travellers; this category of arrivals can have significant contributions to the tourism sector. With prices increasing in Singapore, the negative influences on tourism demand from holiday travellers can be cushioned by business arrivals. Singapore has the competitive advantage in attracting business arrivals since they usually consider other factors besides costs such as the efficient transport system or the secure environment that can make doing business in Singapore more efficient and hassle free. However, the existing 'pull' factors of Singapore can lose their effects over time since other countries are also pitching hard for tourism money. If the current situation is not addressed early, the high cost of travelling in Singapore may well result in traffic being diverted to nearby countries. Another growing category of arrivals from Japan is the in-transit arrivals which is another target market for Singapore.

Results of the static seasonal model indicate the importance of the third quarter in contribution to tourism demand. Although seasonal patterns in arrivals is a common phenomenon, the related negative effects should be minimised. The dip in tourism demand in the second quarter will result in inefficient use of resources; we must make sure that enough resources are available to serve the large increase in demand in the third quarter. This imbalance in demand can be addressed systematically using the tourism system. Different categories of travellers can be targeted to alleviate the effects of the low demand period. For example, conventions and exhibitions during off-peak periods can encourage business travellers to Singapore. Besides focusing on the growing pool of business travellers, the holiday travellers should not be ignored. Bringing in popular shows and musicals or introducing festivals (*e.g.* a food festival) is not only a promoting strategy but also can bring in crowds. Thus with the complications arising from seasonal demands, qualities such as a central or strategic location will no longer sell Singapore effectively. Rather, policies or strategies considering the different levels of demand at each quarter or different groups of travellers would be necessary for the sustainability of this sector.

This study is not exhaustive and can be extended to include other aspects of tourism. One possible area of research is on other demand variables excluded from this study due to data limitations. Besides increasing the choice of explanatory variables, the aggregate total arrivals can be disagregated into different categories of travellers such as business, holiday or in-transit arrivals. Distinguishing between purposes of arrival may provide a better view on a particular market since each group is believed to be affected by different variables.

With the scope of tourism expanding rapidly in Singapore, other tourist generating markets should be studied. Some of the major tourist generating countries are ASEAN, Australia, Taiwan and China. Though comparative studies may be another area of research, one should be aware of the comparability of data.

In terms of modelling procedures, the ordinary least squares method used in this study may be limited in its usefulness as a policy tool. Other estimation procedures can be used to study tourism demand and to 'counter-check' the desirability of one model against the other. The decision to use a single equation approach to model tourism demand assumes that the variables are predetermined such that the problem of simultaneity can be ignored in this study.

Tourism will become an increasingly important sector for Singapore. This could well be a 'sunrise' sector which together with manufacturing and financial sectors forms a 'triple engine' of growth for Singapore. Increasing the supply of tourist facilities requires high growth in tourism demand. Facing increasing competition, Singapore needs to adopt strategies that not only call for the expansion of the existing tourist generating markets but also call for diversification into other areas such as the conventions and exhibition or the cruise market. We that this study can initiate future research along similar themes that will serve as a planning guide for this sector in policy formulation.

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TABLE 1

Tests for seasonal unit roots

Variables	**Auxiliary Regression**	**'t':π_1 (zero frequency)**	**'t':π_2 (biannual)**	**'F':$\pi_3 \cap \pi_4$ (annual)**
LTA*	α_0, t	-0.0735	-0.7614	3.0940**
		(-3.21)	(-1.57)	(2.23)
	α_0, SD	-0.1904	-2.3600	6.1749**
		(-2.72)	(-2.69)	(5.50)
	α_0, t, SD	-0.1904	-2.3596	6.1749**
		(-3.37)	(-2.73)	(5.37)
LRY*	α_0, t	-2.0380	-3.3500**	5.6309**
	α_0, SD	-0.8629	-2.1450	7.4204**
	α_0, t, SD	-1.9399	-3.0691**	5.8411**
LRP*	α_0, t	-0.7964	-1.7350**	6.5825**
	α_0, SD	-1.9400	-3.0690**	5.8411**
	α_0, t, SD	-0.8629	-2.1450	7.4204**
LEX*	α_0, t	-1.3680	-3.1940**	4.2937**
	α_0, SD	-1.3600	-3.2560**	4.3042
	α_0, t, SD	-1.3600	-3.2559**	4.3042

Notes: α_0 = intercept; t = trend; SD = seasonal dummy variables.

LTA, LRY, LRP, LEX are the logarithmic transformation of tourist arrivals, income, price and exchange rate variables respectively.

* figures in parentheses are critical values at 10% level of significance. The critical values are only presented for the LTA variable which will be the same for all other variables.

** Significant at 10% level

TABLE 2

Johansen Trace test for Cointegration

r	LR test statistics	5% critical value
0	67.826	53.347
1	32.674	35.068
2	9.024	
3	1.904	

Note: r = number of cointegrating vectors; LR = Likelihood Ratio