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Research Paper

School of Economics and Finance

Inter-regional Spillover Effects in New Zealand International Tourism Demand

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Abstract

This research tests for guest night and volatility spillover effects between tourism regions in explaining international tourism demand in New Zealand. The hypothesis that spillovers are more prevalent with decreasing geographical proximity is also examined. Two multivariate AR-GARCH models are applied to estimate the spillover effects for both New Zealand's North Island and South Island regions. Variance Ratios are then calculated to augment the analysis. The results show that both guest night and volatility spillover effects are important for explaining international tourism demand in New Zealand. Evidence for the geographical proximity hypothesis is mixed from the AR-GARCH models however analysis of the variance ratios supports the hypothesis.

JEL Classification: R12, R58

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1. Introduction

According to the World Tourism Organisation's (UNWTO) 2014 World Tourism Barometer international tourist arrivals grew from 677 million in 2000 to 949 million in 2010 to 1087 million in 2013 and is predicted to grow a further 4-4.5% in 2014. "International tourism continues to grow above expectations, supporting economic growth in both advanced and emerging economies and bringing much needed support to job creation, GDP and the balance of payments of many destinations" says UNWTO Secretary-General, Taleb Rifai ("International Tourism an" 2013). In light of the continuing steady growth of worldwide international tourism it is becoming increasingly important for countries to understand the nature and extent of the economic effects of international tourism. As a result a number of tourism studies have identified and quantified many different economic effects. Studies such as Oh (2005), Kim, Chen & Jang (2006) and Seetanah (2011) examine the impact of tourism on economic growth. Others like Walpole & Goodwin (2000) look at inequalities in the distribution of tourism benefits. While further still applications by Archer & Fletcher (1996), Frechtling & Horvath (1999), West & Gamage (2001), Sugiyarto, Blake & Sinclair (2003), Nayaran (2004), and Akkemik (2012) examine a wide range of economic impacts from growth, employment, value added, exchange rates, balance of payments and prices to spillover and crowding out effects.

New Zealand is a country where international tourism plays an important role in its economy. International tourism contributed $9.8 billion in expenditure to the New Zealand economy in 2013 or 16.1% of total exports making it one of New Zealand's leading export earners (MBIE, 2013a). Annual international visitor arrivals have grown from 1,343,003 year ended March 1995 to 2,749,504 as of January 2014 and as of 2013 was predicted to continue to grow at an compound average annual rate of 2.9% out to 2019 (Statistics New Zealand, 2014a);(MBIE, 2013b). Consequently a number of studies on international tourism demand for New Zealand exist in the literature (e.g. Turner, Kulendran & Pergat, 1995; Turner & Witt, 2001; Chan, Lim & McAleer, 2005; Schiff & Becken, 2011).

The most commonly used measure of international tourism demand is the number of tourist arrivals (Song & Li, 2008). International tourism arrivals much like other macroeconomic variables exhibits considerable volatility over time. Due to the importance of understanding fluctuations for policy making studies of the reasons for volatility in tourism flows have begun to appear in the literature (e.g. Lim & Mcaleer, 2000, 2001, 2002; Chan et al, 2005; Divino & McAleer, 2009; Chang, McAleer & Slottje, 2009; Park & Jei, 2009; Coskun & Ozer, 2011). New Zealand is just as susceptible to tourism variations as any other country. A multitude of factors have been found to cause tourism volatility in New Zealand and elsewhere including the 9/11 terrorist attacks, SARS outbreak, Rugby World Cup, the Canterbury earthquake and the Chilean ash cloud (MBIE, 2013a). Additionally seasonality and other time related factors are strongly linked to tourism demand volatility (Fretchling, 2012).

Another remaining factor important in tourism demand volatility is the existence of tourist flow spillover effects (tourist spillovers). The introduction of tourist spillovers between countries or cities for explaining tourist demand variations has been a recent development in the literature. Spillovers (or conditional variance) were first applied in the finance literature by Engle (1982) and Bollerslev (1986) to analyse volatility in UK and US inflation data using ARCH/GARCH type dynamics. Following an explosion of analyses of conditional variance in the finance literature spillover analyses has spread into the tourism literature as many of the same data properties are shared.

The tourism spillover literature although small has been growing at an increasingly fast pace especially in recent years. A number of differing measures of spillovers appear in the tourism literature. These include measures of tourist arrival, political risk, expenditure, exchange rate and gap spillovers as well as industry and employment spillovers, even a Keynesian multiplier. Varying approaches also exist to capture tourism spillovers. In one of the earlier tourism spillover studies Gooroochurn & Hanley (2005) use a spatial econometric approach to measure tourist expenditure spillovers between Northern Ireland (NI) and the Republic of Ireland (ROI). As reasoning for their analysis it is argued by the authors that joint tourism promotion is only viable if spillovers between regions are present. This argument is carried throughout most of the tourism spillover literature.

Hoti, McAleer & Shareef (2007) use what has become the most common measure of tourism spillovers; tourist arrival spillovers, as well as the more unusual political risk spillovers. By contrast Li & Huang (2008) use the Mundell-Fleming model to analyse tourist economic growth spillovers between cities in the Chinese Pearl River Delta. Shareef & McAleer (2008) continue the use of the tourist arrival measure of spillovers in examining effects from tourist arrivals from five main tourist source countries on the Maldives and Seychelles. This paper takes a different angle than some previous studies by investigating differences in spillovers from tourist source countries. The advantage of this approach is that it allowed for a decomposition of spillovers into that attributable to each source country. A limitation of their approach as noted by the authors was that their results did not indicate which direction variations in tourist arrivals occur due after a shock. Chang, Khamkaew, McAleer & Tansuchat (2011) later rectify this limitation through the use of a newly developed VARMA-AGARCH model in an examination of tourist volatility spillovers between four of the ASEAN nations Thailand, Singapore, Indonesia and Malaysia. Much like Gooroochurn & Hanley (2005) Lazzeretti & Capone (2009) take a spatial econometric approach to spillovers. They apply this method to analysing employment growth rate spillovers between the Italian local tourism systems (filières). One important finding from their study was a tendency for spillover effects to increase with decreasing geographical separation. This implies that with all other conditions held equal filières that are close to localities with higher employment growth rates will tend to have higher development themselves. Conversely filières that are close to localities with lower employment growth will tend to share a lower level of development.

In an entirely different approach Li, Xiao, Zhang, Wu & Wang (2011) build upon a model first proposed by Deng, Wang & Li (2004) known as the gap model. The model is derived from a knowledge spillover model based around the definition of the knowledge gap. In this type of approach the spillover takes its position as the dependent variable in the model with 'gaps' between cities determining the impact of the spillover. The four regressors of the model making up the 'gaps' are the tourism grade scale gap, tourism type difference gap, geographical distance gap and the learning capability gap. Key results from their study were a negative correlation of attract ability grade gap and geographical distance with tourism spillovers and a positive correlation with type difference, learning ability and tourism scale. In another of the diverse spillover approaches Harris (2011) avoids econometrics completely by employing a Keynesian Multiplier in his analysis of different tourism spillover effects in Jamaica. Further use of the spatial econometric approach, this time by Yang & Wong (2012), was in measuring the more standard tourist arrival spillovers as opposed to expenditure spillovers. They examine spillovers between 341 cities in mainland China. Similarly to Lazzertti & Capone (2009) one of the key findings of Yang and Wong's research was the presence of significant spillover effects highlighting the fact that cities surrounded by cities with prosperous tourism markets can receive positive spillover effects in tourism flows.

Other than tourist flows exchange rate spillovers have also be investigated with ARCH type models in the tourism spillover literature. With reference to Taiwanese tourism Chang, Hsu, & McAleer (2013) examine firm performance volatility spillovers from exchange rate changes and look at how firm performance levels influence these spillovers. Significant volatility spillovers in tourism firm stock returns were found due to exchange rate changes. Furthermore firm performance was shown to affect the extent of exchange rate spillovers with large stock return firms receiving spillovers from USA and China exchange rates and small stock return firms receiving spillovers from the Japanese exchange rate. In one of the most recent contributions to the tourism spillover literature Liu, Hong & Li (2013) examine industry and employment spillovers in Chinese tourism to Taiwan. Their methodology uses an industry related spillover model based on a supply and demand equation of the Taiwanese tourism market.

As one can see there are varying measures of spillover effects in tourism and varying methods of capturing these effects as well as many applications for these methods. Much of the tourism spillover research has grown around inter-country volatility spillovers such as that between Ireland and Northern Ireland, between Maldives and Seychelles or between Cyprus and Malta. Also common in these and single country volatility analyses are an examination of volatility spillovers between source country volatilities. Tourism spillover research has even been applied to understanding exchange rates spillover impact on tourism firm performance. In any case there remain opportunities for the expansion of Tourism spillover research. Few studies have ventured an examination of inter-regional spillover effects and this is where my research aims contribute to the literature.

To my knowledge no previous research has sought to identify the importance of inter-regional spillovers in international tourism flows in New Zealand. Nor am I aware of any previous research that has examined the extent to which New Zealand's geographical tourism regions are linked. I aim to be able to contribute to the knowledge of regional distributional effects of shocks to international tourism flows. My research first seeks to identify whether or not inter-regional spillover effects are important in international tourism flows in New Zealand. Next I seek to analyse the distributional impact a tourism shock may have on outlying tourism regions. I will do this through the analysis of inter-regional tourism spillover models.

The use of GARCH models to measure time series volatility is already widespread in empirical finance. The advantage of a mulitvariate GARCH is that it enables the capturing of tourism demand volatility spillovers between source countries or even cities, regions, and small neighbouring countries. The typical approach is that of Chan, Lim & McAleer (2005) who use three multivariate GARCH models to investigate the effect of positive and negative shocks on conditional volatility in tourist arrivals to Australia. Other users of this method include Shareef & McAleer, (2005), (2007), (2008); Hoti, McAleer & Shareef, (2007); Chang, Hsu & McAleer (2013). I intend to use a GARCH approach in the same spirit of the aforementioned earlier users to examine inter-regional spillover effects in New Zealand. The difference in my approach will be the application of this branch of methodology to one country internal inter-regional tourist spillovers rather than the previous inter-country tourist spillover analyses. Also separating my research from others on inter-regional type spillovers will be the analysis of guest night spillovers and volatility spillovers in hotel guest night data rather than the more typical tourist arrival measure.

In the presence of regional tourism linkages Regional Tourism Organisations (here after RTOs) and Tourism Operators can potentially benefit from marketing collaboration and promotion of joint tourism products. One way I aim to make a contribution of value is by identifying those particular regions that stand to make these gains. My first hypothesis is that inter-regional spillover effects will be found to be important for international tourism flows. Secondly, based on the existing literature, I hypothesise that the shocks in international tourism flows will have volatility spillover effects on tourism numbers to those regions nearest the major centre of international tourist entry to New Zealand. Such spillover effects are generally expected to dissipate as the distance away from a major arrival centre increases in what I call the “geographical proximity hypothesis”. It is also my expectation that prominent linkages will exist between major centres and those considered thriving tourist destinations.

Section 2 takes a look at the data used in this analysis and its statistical properties. In section 3 the univariate and multivariate AR-GARCH models as well as the Variance Ratio equations are set out and explained. In Section 4 explained and unexplained inter-regional spillover effects from New Zealands three major centres Auckland, Wellington and Christchurch are estimated using the multivariate AR-GARCH models for both the North Island and South Island. Variance ratios for the proportion of variation in each RTO attributed to a specific volatility spillover are also calculated. Section 5 presents the empirical findings of the spillover models and the variance ratios while section 6 offers some concluding remarks.

2. Data and Descriptive Statistics

For the purposes of this analysis the more commonly used tourist arrival data was overlooked due to its unavailability across all New Zealand regions. The data used is then the number of monthly hotel guest nights recorded in each of New Zealand’s RTOs as taken from the Statistics NZ Accommodation Survey. Each RTO has its own defined geographical boundaries (see figure 1) for which separate international and domestic guest night statistics are collected. Guest nights are recorded for the 32 RTOs and additionally included in the data set are North Island, South Island and national aggregate categories plus a combined Canterbury RTOs category which aggregates data from Canterbury, Hurunui, Mackenzie and Timaru RTOs. A subcategory within the Wellington RTO for Wellington City is also collected in the survey. Statistics are collected over a 14 year period from January 2000 to May 2013 however prior to October 2007 owing to the way in which data was collected only quarterly data is available for some RTOs. The 2007 switch from a quarterly to a monthly survey resulted in a higher response rate of between 65-75% in comparison to a 55-65% response rate before the change. As data figures are imputed for non-respondents this high level of data imputation can affect data quality. This also means data post October 2007 is more robust than earlier data. A number of exclusions from the Statistics New Zealand survey should be noted for example establishments classified as Hosted accommodation (private hotels, bed & breakfasts and farm-stays), establishments that are temporarily closed for more than 14 days in a month, establishments with a GST turnover of less than $30,000, and establishments primarily offering accommodation for a period of a month or more are all excluded from the survey results.

As the focus of this paper is international tourism only the international data was used in the analysis. Additionally as the difference between counts for Wellington City and the Wellington RTO were minimal the Wellington RTO data was used. In the case of the combined Canterbury RTO the disaggregated RTOs were used in an attempt to tease out any effects within the wider Canterbury area. With regards to the time period it was chosen to shorten the analysis from the 2000-2013 to only the 2007-2013 period as necessitated by less frequent data for some RTOs prior to 2007.

Table 1 represents the summary statistics for international hotel guest nights. It shows that the average monthly guest nights vary widely between regions from 227511 (Auckland) down to 2234 (Clutha) with the majority of guest nights being concentrated in the major centres of Auckland, Wellington and Canterbury as well as those popular tourism destinations of Northland, Rotorua and Queenstown. Variation (standard deviation) in guest nights is relatively less dispersed with a range from 56140 (Canterbury) to 1408 (Manawatu). It is also observed that the statistical distributions of international guest nights are almost all negatively skewed (skewed to the left) and exhibit some negative excess kurtosis with values typically around 1-2 meaning the distributions are typically flatter than a normal distribution. Consequently the Jarque & Bera (1980) test statistics show that almost all of the guest night series are not normally distributed. The final four columns of Table 1 report Autocorrelations AC (for logarithmic data) and AC' (for squared data) and their corresponding Ljung & Box (1978) test significances to look for the presence of first and second moment dependencies in the distributions of the hotel guest night data. For all RTOs the AC(1) and AC(4) are highly statistically significant providing strong evidence for the presence of autocorrelation in the logarithmic distribution of guest nights. The AC'(1) and AC'(4) values are also highly significant for all RTOs indicating the presence of strong second moment dependencies (Conditional Heteroskedasticity).

Table 2 gives the statistic and p-value results from the Phillips-Perron (1988) test for a Unit Root in each of the logarithmic RTO's. Most of the RTO's are statistically significant or very close to being significant at the 1% level. Only the Canterbury RTO is not significant at a 5% having a p-value of 0.0974. Despite this one marginal result it seems reasonable to conclude that the underlying generating process for the logarithmic RTO guest night data is stationary (has no unit root).

3. Methodology

A. GARCH Spillover Models

Following the path set forth by Engle (1982) three univariate AR-GARCH and two multivariate AR-GARCH models are applied in the analysis. Initially univariate AR-GARCH models of the logarithmic transformed Hotel Guest Night data for Auckland, Canterbury and Wellington are estimated to obtain residuals (unexpected shock values) for later use. Followed by an examination of both guest night and volatility spillover effects from New Zealand's three major centre RTO's through the formulation of North Island and South Island multivariate AR-GARCH models.

For the univariate models an AR(1) process based on the logarithmic transformed Hotel Guest Night data is used to generate the residual shock (unexpected guest nights) values for the Auckland, Canterbury and Wellington RTO's $\epsilon_{auck,t}$, $\epsilon_{can,t}$ and $\epsilon_{wel,t}$ respectively.

$$G_{auck,t} = c_a + b_a G_{auck,t-1} + \epsilon_{auck,t} \tag{1}$$

$$G_{can,t} = c_c + b_c G_{can,t-1} + \epsilon_{can,t} \tag{2}$$

$$G_{wel,t} = c_w + b_w G_{wel,t-1} + \epsilon_{wel,t} \tag{3}$$

It is assumed that the idiosyncratic shocks $\epsilon_{auck,t}$, $\epsilon_{can,t}$ and $\epsilon_{wel,t}$ are independently and identically distributed. Secondly is the multivariate case where the conditional logarithmic guest nights of the remaining North Island RTO's ($G_{(NI),i,t}$) are modelled as a linear combination of their own history, plus the explained and unexplained (volatility) guest night spillovers from the two major North Island arrival centres Auckland and Wellington.

Accordingly, the guest night spillovers for the North Island are modelled as;

$$G_{(NI),i,t} = \alpha_i + \beta_i G_{i,t-1} + \phi_{a,i} G_{auck,t-1} + \phi_{w,i} G_{wel,t-1} + \theta_{a,i} \varepsilon_{auck,t-1} + \theta_{w,i} \varepsilon_{wel,t-1} + \varepsilon_{i,t} \tag{4}$$

Where α_i is the intercept, β_i is the sensitivity to an RTO's own past guest nights; $\phi_{a,i}$ and $\phi_{w,i}$ are, respectively, the expected guest night spillovers from Auckland and Wellington RTO's; $\theta_{a,i}$ and $\theta_{w,i}$ are the unexpected guest night spillovers from Auckland and Wellington RTO's respectively; and $\varepsilon_{i,t}$ is the error term. The error term is assumed to be distributed $\varepsilon_{i,t} \sim N(0, \sigma_{i,t}^2)$ with the conditional variance following a GARCH(1,1) process,

$$\sigma_{i,t}^2 = \omega_{1,i} + \omega_{2,i} \varepsilon_{i,t-1}^2 + \omega_{3,i} \sigma_{i,t-1}^2. \tag{5}$$

Where $\omega_{1,i}$, $\omega_{2,i}$ and $\omega_{3,i}$ are positive and $\omega_{2,i}$ + $\omega_{3,i}$ is strictly less than 1 in order to satisfy the necessary condition for stability.

The unexpected guest night spillover for the North Island is given by;

$$\epsilon_{i,t} = \theta_{a,i} \varepsilon_{auck,t-1} + \theta_{w,i} \varepsilon_{wel,t-1} + \varepsilon_{i,t}. \tag{6}$$

With the concurrent conditional variance of the unexpected guest night spillover based on the available information set at time t-1 (I_{t-1}) given by;

$$h_{(NI)i,t} = E\left(\epsilon_{i,t}^2 \middle| I_{t-1}\right) = \theta_{a,i,t-1}^2 \sigma_{a,t}^2 + \theta_{w,i,t-1}^2 \sigma_{w,t}^2 + \sigma_{i,t}^2. \tag{7}$$

This equation establishes that the conditional variance of unexpected guest night spillovers for North Island RTO i depends upon the variance of Auckland guest nights, the variance of Wellington guest nights and its own idiosyncratic shocks.

A second multivariate AR-GARCH for the South Island is estimated with the conditional logarithmic guest nights of the South Island RTO's $(G_{(SI),i,t})$ modelled as a linear combination of their own history, along with the expected and unexpected spillovers from all three of New Zealand's major arrival centres Auckland, Wellington and Canterbury.

Subsequently,

$$G_{(SI),i,t} = \alpha_i + \beta_i G_{i,t-1} + \phi_{a,i} G_{auck,t-1} + \phi_{c,i} G_{can,t-1} + \phi_{w,i} G_{wel,t-1} + \theta_{a,i} \varepsilon_{auck,t-1} + \theta_{c,i} \varepsilon_{can,t-1} + \theta_{w,i} \varepsilon_{wel,t-1} + \varepsilon_{i,t.} \tag{8}$$

As in the North Island model α_i is the intercept, β_i is the sensitivity to an RTO's own past guest nights. However to the South Island model the term $\phi_{c,i}$ is added along with $\phi_{a,i}$ and $\phi_{w,i}$ which are, respectively, the expected guest night spillovers from Canterbury, Auckland and Wellington RTO's. Additional to $\theta_{a,i}$ and $\theta_{w,i}$ a third term $\theta_{c,i}$ is included so that each represents the unexpected guest night spillovers from Auckland, Wellington and Canterbury RTO's respectively. Finally $\varepsilon_{i,t}$ is the error term. The error term is assumed to be distributed $\varepsilon_{i,t} \sim N(0, \sigma_{i,t}^2)$ with the conditional variance following a GARCH(1,1) process.

The unexpected shock to South Island guest nights is given by;

$$\epsilon_{i,t} = \theta_{a,i}\varepsilon_{auck,t} + \theta_{c,i}\varepsilon_{can,t} + \theta_{c,i}\varepsilon_{wel,t} + \varepsilon_{i,t}. \tag{9}$$

With the concurrent conditional variance of the unexpected guest night spillover based on the available information set at time t-1 (I_{t-1}) given by;

$$h_{(SI)i,t} = E\left(\epsilon_{i,t}^2 \middle| I_{t-1}\right) = \theta_{a,i,t-1}^2\sigma_{a,t}^2 + \theta_{c,i,t-1}^2\sigma_{c,t}^2 + \theta_{w,i,t-1}^2\sigma_{w,t}^2 + \sigma_{i,t}^2. \tag{10}$$

This equation establishes that the conditional variance of unexpected guest night spillovers for South Island RTO i depends upon the variance of Auckland guest nights, the variance of Canterbury guest nights, the variance of Wellington guest nights and its own idiosyncratic shocks.

B. Variance Ratios

Variance ratios are commonly applied in the finance and economics literature. I follow the general method of variance ratio formulation as used by H.O. Balli, F. Balli & Louis (2011). To measure the contribution of arrival centre shocks to the volatility of unexpected Hotel Guest Nights in each RTO the following variance ratios are computed:

$$VR_{(NI)i,t}^{a} = \frac{\theta_{a,i,t-1}^2\sigma_{a,t}^2}{\theta_{a,i,t-1}^2\sigma_{a,t}^2+\theta_{w,i,t-1}^2\sigma_{w,t}^2+\sigma_{i,t}^2}, \tag{11}$$

$$VR_{(NI)i,t}^{w} = \frac{\theta_{w,i,t-1}^2\sigma_{w,t}^2}{\theta_{a,i,t-1}^2\sigma_{a,t}^2+\theta_{w,i,t-1}^2\sigma_{w,t}^2+\sigma_{i,t}^2}, \tag{12}$$

$$VR_{(SI)i,t}^{a} = \frac{\theta_{a,i,t-1}^2\sigma_{a,t}^2}{\theta_{a,i,t-1}^2\sigma_{a,t}^2+\theta_{c,i,t-1}^2\sigma_{c,t}^2+\theta_{w,i,t-1}^2\sigma_{w,t}^2+\sigma_{i,t}^2}, \tag{13}$$

$$VR_{(SI)i,t}^{c} = \frac{\theta_{c,i,t-1}^2\sigma_{c,t}^2}{\theta_{a,i,t-1}^2\sigma_{a,t}^2+\theta_{c,i,t-1}^2\sigma_{c,t}^2+\theta_{w,i,t-1}^2\sigma_{w,t}^2+\sigma_{i,t}^2}, \tag{14}$$

$$VR^{w}_{(SI)i,t} = \frac{\theta^2_{w,i,t-1}\sigma^2_{w,t}}{\theta^2_{a,i,t-1}\sigma^2_{a,t}+\theta^2_{c,i,t-1}\sigma^2_{c,t}+\theta^2_{w,i,t-1}\sigma^2_{w,t}+\sigma^2_{i,t}} \,. \tag{15}$$

$VR^{a}_{(NI)i,t}$ and $VR^{a}_{(SI)i,t}$ measure the proportion of the variance of unexpected Guest Nights in each North Island (NI) and South Island (SI) RTO that is caused by Auckland Guest Night spillovers. Similarly $VR^{w}_{(NI)i,t}$ and $VR^{w}_{(SI)i,t}$ measure the proportion variance of unexpected Guest Nights in each North Island (NI) and South Island (SI) RTO that is caused by Wellington Guest Night spillovers. Finally $VR^{c}_{(SI)i,t}$ measures the proportion of the variance of unexpected Guest Nights in each South Island RTO that is caused by Canterbury Guest Night spillovers. Variance Ratios provide a useful tool in helping to gauge the power of spillover effects in explaining the unexpected guest nights of each RTO. By conducting simple mean comparisons of the variance ratios the relative importance of each main centre spillover for each RTO can be evaluated.

4. Empirical Analysis

A. North Island Spillover Model

The spillover models are estimated by forming Gaussian likelihood functions and using quasi-maximum likelihood methodology. Estimation was conducted using the Marquardt numerical optimisation algorithm. Parameter estimates are obtained by maximisation of a univariate log-likelihood function. Table 3 gives the results of estimating the North Island Spillover Model for the North Island RTO's Hotel Guest Nights. It shows that the AR(1) terms (represented by the β coefficient) for all RTO's are positive in magnitude and almost all highly statistically significant as one might expect. This shows us that a RTO's own past guest nights are important for predicting its future number of guest nights. Looking at the guest night spillover effects there appears to be no statistically significant effects in the case of explained Wellington guest night spillovers (ϕ_w). One exception is the Coromandel RTO which shows a negative relationship being statistically significant at the 5% level. This is an interesting and as yet unexplained anomaly. It is also interesting to note that the coefficients of those RTO's closest geographically to Wellington tend to have a positive coefficient such as Wairarapa, Wanganui and Horowhenua-Kapiti and those RTO's further north tend to have a negative coefficient such as Waikato, Bay of Plenty, Gisborne and Coromandel. However there are irregularities with the likes of Northland having a positive coefficient and Manawatu having a negative coefficient. For five of the RTO's explained Auckland guest night spillovers (ϕ_a) play a statistically significant role (at least at the 5% level) each with a positive impact. Waikato, Bay of Plenty, Gisborne, Hawkes Bay and Manawatu form this group of five RTO's influenced by explained Auckland guest night spillovers. The first three aforementioned RTO's certainly are closest geographically to Auckland and therefore support the hypothesis that positive spillover effects will be strongest for those RTO's in close proximity to a main arrival centre. Hawkes Bay meanwhile is more central to the North Island geographically and Manawatu is central but slightly biased towards the south. Hawkes Bay's link to Auckland may be due to its easterly location being a final destination for travellers while Manawatu may in fact be a common break point for tourists travelling south via road.

In terms of the volatility spillovers (θ_w and θ_a) nine North Island RTO's have a positive statistically significant relationship with unexplained volatility spillovers from Wellington. The strongest statistical evidence of Wellington volatility spillover effects are for the Coromandel, Hawkes Bay, Northland and Rotorua RTO's. Volatility spillovers from Auckland are positive in nature and statistically significant for the following five RTO's Bay of Plenty, Coromandel, Horowhenua-Kapiti, Ruapehu and Wanganui. For the most part these are in close geographical proximity to the Auckland RTO.

B. South Island Spillover Model

Presented in Table 4 are the mean responses of the South Island Spillover Model for the South Island RTO's Hotel Guest Nights. Much like the North Island Model results the β coefficients for a RTO's own lag are mostly in line with expectations being statistically significant for almost all RTO's. For Central Otago, Clutha, Mackenzie, Nelson-Tasman, Timaru and Wanaka there is a significant negative impact of explained Canterbury guest night spillovers (ϕ_c). Tourist spillovers can be negative with Canterbury being a large region geographically some tourists may be less willing to travel the extra distance to other destinations or perhaps find enough variety of activities in the one region. This could be seen as evidence for the hypothesis that spillover effects will be strongest with close geographical proximity as Timaru, Nelson-Tasman and Mackenzie regions are all close to Canterbury with Central Otago and Clutha being not much further. Those regions where no impact has been seen tend to be at the extremes of the island like Dunedin, Southland and the West Coast which of course while bordering Canterbury requires traversing the Southern Alps to reach by road. Evidence suggests that the expected Auckland guest night spillover has a strong positive and statistically significant impact on the Clutha, Fiordland, Mackenzie, Souhtland and Waitaki RTO's. It is also implied by the model that expected Wellington guest night spillovers have a significant positive effect on the Central Otago, Clutha, Southland, Timaru and Waitaki RTO's. Examination of the volatility spillovers reveals that the Canterbury volatility spillover is strongly statistically significant and positive in all but one of the South Island RTO's. This was a somewhat surprising result as I did not expect to see such a widespread effect from the Canterbury volatility spillover. This may be explained by the Canterbury RTO's central location within the South Island allowing its effects to filter throughout the island. As expected Auckland volatility spillovers appear to be less significant to the South Island RTOs however effects are significant and negative in Clutha, Fiordland, Southland, Timaru and Waitaki. Similarly to the Auckland spillovers, Wellington volatility spillovers play a lesser role in the South Island with an effect being evidenced in only five RTO's. Statistically significant and negative effects are seen in Central Otago, Clutha, Mackenzie, Southland and Timaru. Curiously this time the Wellington volatility spillover effects are negative which is opposite to the positive effects observed from the Wellington explained guest night spillover. This same difference is observed between the Auckland guest night and Auckland volatility spillovers as well.

C. Variance Ratios

In Table 5, the mean percentage variability in North Island RTO Hotel Guest Nights that can be accounted for by unexpected disturbances to Auckland and Wellington Hotel Guest Nights is presented. For the North Island model the effect of Wellington shocks generally exceed that of Auckland shocks which for most RTOs are quite weak. Wellington shocks tend to be in the realm of 10 to 30% accounting for a modest impact on Guest Night volatility. This leaves a large proportion of Guest Night volatility unexplained for each North Island RTO. However one may conclude that volatility spillovers are important for guest night variation with an average of 25% of guest night volatility explained across the North Island RTOs. Bay of Plenty, Kapiti-Horowhenua, Ruapehu and Wanganui RTO's are the most responsive to Auckland shocks with variance ratios of 16%, 14%, 27% and 13% respectively. The fact that the Bay of Plenty and Ruapehu RTO's are the most responsive to Auckland shocks supports the notion that geographically close to shock origin RTO's will experience the most benefit from spillovers however the responsiveness of Kapiti-Horowhenua and Wanganui seem to contravene this rule. There is a wider range of responsiveness to Wellington shocks with the three most responsive RTO's being Manawatu, Rotorua and Waikato with variance ratios of 35% 31% and 33% respectively. On the other end of the scale the least responsive RTO's to Wellington shocks are Bay of Plenty and Ruapehu with variance ratios of 1% and 4% respectively. Manawatu is relatively close geographically to the Wellington RTO possibly explaining the link between the two regions. Meanwhile Rotorua and Waikato are both located in the upper part of the North Island and far closer to Auckland than Wellington begging the question as to the reason for the extent of the link between these two regions and Wellington. Again this is evidence against the geographical proximity hypothesis. Another point that makes itself clear is that for all North Island RTOs the responsiveness to one particular shock seems to dominate the other. In other words none of the RTOs seem to be very responsive to shocks from both Auckland and Wellington but merely one of the two. For example the Bay of Plenty RTO has a variance ratio for Auckland spillovers of 16% where as it is only 1% for Wellington and conversely for Manawatu the Auckland ratio is only 4% but 35% for Wellington. It seems that a shock to either Auckland or Wellington has importance for a particular set of RTOs rather than just those that are in close geographical proximity indicating a greater complexity to regional tourist linkages than initially predicted by mere geography.

Table 6 presents the average percentage variability in the South Island RTO Hotel Guest Nights that is accounted for by unexpected disturbances to Auckland, Wellington and Canterbury Hotel Guest Nights. As expected unexplained variation remains large in most cases but volatility spillovers are clearly very important explaining on average 52% of guest night volatility across the South Island RTOs. In general Canterbury and Wellington shocks seem to be more important than shocks from Auckland in explaining volatility. However Auckland spillovers do appear to be important for some RTOs. Somewhat surprisingly the contribution of Wellington shocks tends to exceed that of Canterbury shocks if only by a small margin. Wellington shocks explain over 19% of guest night variation for almost all South Island RTOs with the two highest spillovers being to Clutha and Nelson-Tasman with 34% and 31% respectively. The high volatility spillover impact from Wellington to Nelson-Tasman supports the geographical proximity notion however the presence of large spillovers for almost all South Island RTOs including those far away from Wellington make this notion difficult to reconcile. Spillovers from Canterbury also appear to be important for most RTOs particularly for Central Otago, Wanaka and Hurunui where the spillovers are as high as 50%, 39% and 28% respectively. What is surprising is that Canterbury spillovers appear to explain virtually zero guest night variation for Marlborough and the West Coast both which border the Canterbury RTO. A possible explanation for this could be due to Marlborough being the South Island's gateway to the North via ferry and the fact that the Southern Alps separate Canterbury and the West Coast. These explanations however are tenuous at best and subsequently the lack of Canterbury spillovers for Marlborough and the West Coast should be treated as evidence against the geographical proximity hypothesis. Auckland spillovers are important for some of the South Island RTOs especially Waitaki, Fiordland, Queenstown, Clutha, Southland and Wanaka with variance ratios of 25%, 19%, 18%, 17%, 14% and 13% respectively. Auckland spillovers appear far less important for the remaining RTOs. On first glance this might seem as more evidence against the geographical proximity hypothesis however one can make sense of this result when Queenstown's role as an airport link and tourist hub is recognised. All of the RTOs in which Auckland spillovers make an important contribution immediately border and surround the Queenstown RTO. It goes to show that thriving tourist destinations with regular flights between destination and major centres may be important in facilitating large volatility spillover effects.

5. Conclusions

For this report I have investigated the presence and extent of international tourism guest night and volatility spillovers between main centres and other RTOs in New Zealand. This was done by employing two multivariate AR-GARCH models and calculating variance ratios to decompose the contribution of each main centre to the volatility spillovers. Spillovers from all of the main centres were found to not necessarily be important for all RTOs. Despite this in the presence of so many expected guest night and volatility spillover effects one can certainly conclude that both expected guest night and volatility spillovers are important for explaining New Zealand's international hotel guest nights. Analysis of the variance ratios also support this conclusion with an average of 52% and 25% and of guest night volatility explained by spillovers across the South Island and North Island RTOs respectively. In light of this result marketing collaboration and joint tourism product promotion appear to be important tools to be considered by the New Zealand Tourism Industry.

Direct evidence for the geographical proximity hypothesis is mixed with many of the guest night and volatility spillovers being present for both those regions close to a main centre and those regions relatively far away. Some evidence was found from the variance ratio analysis for the existence of linkages between major centres and tourism hotspots such as Queenstown. This makes perfect sense with regular flights between major centres and Queenstown forming a well established tourism route. Interestingly there seems to be some evidence that this strong tourist link may be able to facilitate large volatility spillovers between Auckland and RTOs immediately surrounding Queenstown. In an incidental way one can view this as evidence for the geographical proximity hypothesis. If Tourism hotspots can draw tourists into a region then neighbouring regions are likely to receive spillover benefits. Such a result can have important implications for policy making. Governments looking to maximise the benefits of investment in tourism development should pay attention to geography in order to maximise the dispersal of benefits between regions. In an island nation such as New Zealand it would appear better to invest in developing strong inland tourism centres so that the maximum number of neighbouring regions can receive spillover benefits.

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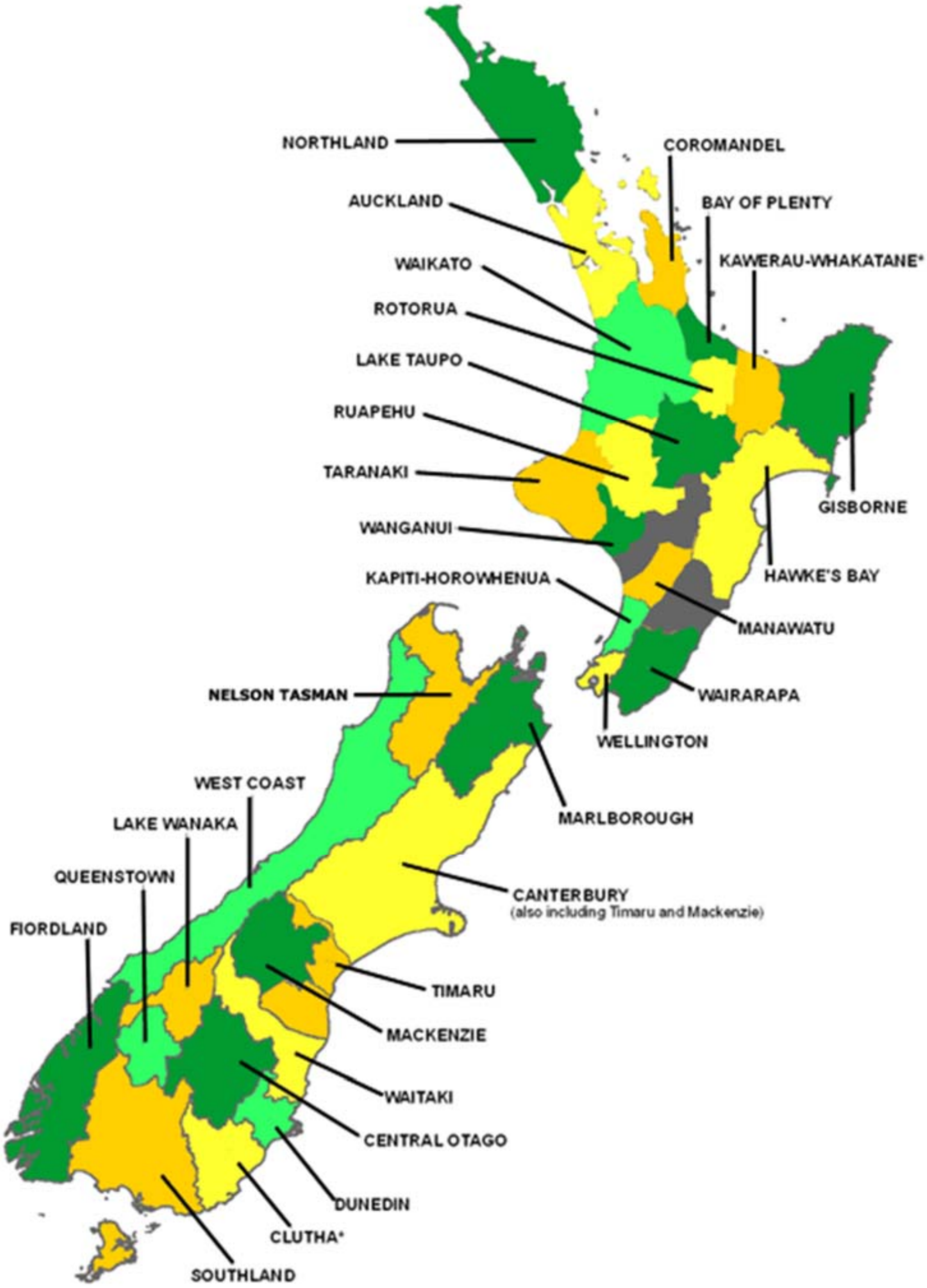
Figure 1. Map of New Zealand RTOs.



Source: RTONZ

Table 1. Descriptive Statistics for International Monthly Hotel Guest Nights.

Descriptive Statistics	Mean	SD	Logarithmic		Skew	Kurt	JB	AC(1)	AC(4)	AC'(1)	AC'(4)
			Mean	SD							
NORTH ISLAND											
AUCKLAND	227511	47137	12.31	0.21	-0.26	2.01	5.17*	0.60***	-0.18***	0.60***	-0.17***
BAY_OF_PLENTY	18191	6951	9.72	0.44	-0.66	2.78	7.46**	0.42***	-0.06***	0.44***	-0.06***
COROMANDEL	18334	11610	9.58	0.72	-0.19	1.67	12.94***	0.85***	-0.39***	0.85***	0.85***
GISBORNE	5081	2967	8.36	0.6	-0.01	1.94	4.66*	0.58***	-0.30***	0.58***	-0.30***
HAWKES_BAY	18481	9928	9.67	0.57	-0.12	1.75	10.87***	0.84***	-0.28***	0.84***	-0.28***
KAPITI_HOROWHENUA	2947	1624	7.84	0.56	-0.09	2.3	2.16	0.55***	-0.14***	0.53***	-0.14***
MANAWATU	4591	1408	8.38	0.32	-0.38	2.59	3.14	0.50***	-0.01***	0.50***	0.00***
NORTHLAND	55514	27512	10.79	0.53	-0.26	2	5.25*	0.59***	-0.30***	-0.30***	-0.30***
ROTORUA	72577	23420	11.14	0.34	-0.19	1.84	10.10***	0.79***	-0.30***	-0.30***	-0.30***
RUAPEHU	10621	4188	9.17	0.49	-0.96	3.29	25.38***	0.64***	-0.02***	-0.02***	-0.02***
TARANAKI	5816	2844	8.55	0.51	-0.19	2.31	4.14	0.79***	-0.17***	-0.17***	-0.17***
TAUPO	24788	11585	10	0.49	-0.11	1.72	11.27***	0.79***	-0.33***	0.80***	-0.34***
WAIKATO	18855	6615	9.78	0.38	-0.43	2.52	6.59**	0.76***	-0.05***	-0.05***	-0.05***
WAIRARAPA	2859	2060	7.71	0.71	0.13	1.93	8.16**	0.79***	-0.38***	0.79***	-0.38***
WANGANUI	3194	1445	7.96	0.49	-0.32	2.04	5.51*	0.58***	-0.27***	0.58***	-0.27***
WELLINGTON	61544	18482	10.98	0.3	-0.05	2.05	6.13**	0.78***	-0.11***	0.78***	-0.11***
WHAKATANE_KAWERAU	2870	2054	7.75	0.66	0.11	2.43	1.56	0.53***	-0.24***	0.51***	-0.23***
SOUTH ISLAND											
CANTERBURY	147358	56140	11.82	0.41	-0.37	2.6	2.99	0.7***	0.11***	0.70***	0.11***
CENTRAL_OTAGO	5560	3392	8.42	0.66	-0.36	2.56	4.77*	0.79***	-0.18***	0.79***	-0.19***
CLUTHA	2234	1520	7.44	0.78	-0.21	1.76	11.49***	0.83***	-0.38***	0.83***	-0.38***
DUNEDIN	27264	12000	10.11	0.48	-0.31	2.01	9.17**	0.80***	-0.30***	0.80***	-0.30***
FIORDLAND	23732	15565	9.8	0.8	-0.32	1.71	13.94***	0.81***	-0.43***	0.82***	-0.43***
HURUNUI	7861	3098	8.89	0.41	-0.13	2.07	3.89	0.48***	-0.24***	0.48***	-0.25***
MACKENZIE	18832	9628	9.7	0.55	-0.27	2.18	4.01	0.49***	-0.17***	0.50***	-0.18***
MARLBOROUGH	23686	12453	9.92	0.59	-0.32	2.11	7.98**	0.85***	-0.31***	0.85***	-0.32***
NELSON_TASMAN	32439	20963	10.14	0.73	-0.22	1.82	10.66***	0.86***	-0.34***	0.86***	-0.35***
QUEENSTOWN	129375	35513	11.73	0.31	-0.98	3.55	27.96***	0.49***	-0.03***	-0.03***	-0.03***
SOUTHLAND	12861	7669	9.26	0.66	-0.2	1.81	10.45***	0.81***	-0.37***	-0.38***	-0.38***
TIMARU	5461	2893	8.47	0.52	-0.09	2.44	1.45	0.54***	-0.20***	-0.20***	-0.20***
WAITAKI	8405	4434	8.87	0.6	-0.37	1.9	7.25**	0.53***	-0.24***	0.53***	-0.24***
WANAKA	26080	10193	10.08	0.44	-0.67	3.09	12.17***	0.58***	0.00***	0.58***	0.00***
WEST_COAST	56226	27718	10.81	0.53	-0.16	1.79	6.50**	0.59***	-0.28***	0.59***	-0.28***

Notes: The first two columns of the table present the mean and standard deviation (SD) for the untransformed monthly international hotel guest night data. The remainder of the table reports summary statistics for the logarithmic transformed monthly international hotel guest nights. The following statistics are included: mean, standard deviation (SD), skewness (Skew), kurtosis (Kurt), Jarque-Bera (JB) statistics, the 1st and 4th autocorrelations for logarithmic data (AC(1) & AC(4)) and the 1st and 4th autocorrelations for the squared data (AC'(1) & AC'(4)). *, **, and *** represent the significance of the Jarque-Bera test statistic and the Ljung & Box (1978) test statistic at the 10%, 5% and 1% levels respectively.

Table 2. Phillips-Perron (PP) Tests for Unit Roots.

RTO	PP Test	PP P-value
NORTH ISLAND		
AUCKLAND	-3.37	0.02**
BAY_OF_PLENTY	-3.35	0.02**
COROMANDEL	-4.52	0.00***
GISBORNE	-3.55	0.01***
HAWKES_BAY	-3.74	0.00***
KAPITI_HOROWHENUA	-3.27	0.02**
MANAWATU	-3.70	0.01***
NORTHLAND	-3.44	0.01**
ROTORUA	-4.16	0.00***
RUAPEHU	-5.09	0.00***
TARANAKI	-5.15	0.00***
TAUPO	-4.26	0.00***
WAIKATO	-4.66	0.00***
WAIRARAPA	-5.42	0.00***
WANGANUI	-3.53	0.01**
WELLINGTON	-5.14	0.00***
WHAKATANE_KAWERAU	-3.43	0.01**
SOUTH ISLAND		
CANTERBURY	-2.60	0.10*
CENTRAL_OTAGO	-5.14	0.00***
CLUTHA	-5.31	0.00***
DUNEDIN	-4.93	0.00***
FIORDLAND	-5.45	0.00***
HURUNUI	-3.57	0.01***
MACKENZIE	-3.50	0.01**
MARLBOROUGH	-3.55	0.01***
NELSON_TASMAN	-3.48	0.01***
QUEENSTOWN	-6.85	0.00***
SOUTHLAND	-5.38	0.00***
TIMARU	-3.33	0.02**
WAITAKI	-3.47	0.01**
WANAKA	-7.48	0.00***
WEST_COAST	-3.43	0.01**

Note: *, **, ***, correspond to the Phillips-Perron test statistic being significant at the 10%, 5% and 1% significance levels respectively. P-values are rounded to the nearest 2dp for simplicity however some p-values are actually below the 1% and 10% threshold for significance at 3dp and consequently differences occur in the number of stars beside some p-values that are reported equal here.

Table 3. North Island Spillover Model. GARCH estimates for the North Island RTO's Hotel Guest Nights.

Parameter:	$\boldsymbol{\beta}$	$\boldsymbol{\phi_a}$	$\boldsymbol{\phi_w}$	$\boldsymbol{\theta_a}$	$\boldsymbol{\theta_w}$
BAY_OF_PLENTY	0.61***	0.45**	-0.09	0.48**	0.08
	(0.08)	(0.20)	(0.24)	(0.22)	(0.16)
COROMANDEL	0.71***	0.64*	-0.77**	0.72***	0.92***
	(0.08)	(0.35)	(0.35)	(0.26)	(0.15)
GISBORNE	0.50***	0.86***	-0.31	0.45	0.50*
	(0.12)	(0.33)	(0.44)	(0.37)	(0.30)
HAWKES_BAY	0.56***	0.80**	-0.41	0.46*	0.69***
	(0.11)	(0.39)	(0.33)	(0.26)	(0.19)
KAPITI_HOROWHENUA	0.63***	-0.28	0.28	0.60**	0.38*
	(0.12)	(0.40)	(0.45)	(0.28)	(0.22)
MANAWATU	0.21*	1.11***	-0.48*	-0.30	0.52**
	(0.12)	(0.29)	(0.25)	(0.31)	(0.25)
NORTHLAND	0.46***	-0.06	0.64	-0.22	0.54***
	(0.12)	(0.40)	(0.54)	(0.26)	(0.21)
ROTORUA	0.60***	-0.06	0.09	0.13	0.53***
	(0.12)	(0.22)	(0.24)	(0.11)	(0.14)
RUAPEHU	0.24**	-0.28	-0.22	1.65***	0.31
	(0.10)	(0.43)	(0.42)	(0.37)	(0.35)
TARANAKI	-0.01	0.51	0.81	-0.20	0.18
	(0.18)	(0.44)	(0.68)	(0.34)	(0.26)
TAUPO	0.54***	-0.32	0.52	0.09	0.46**
	(0.13)	(0.39)	(0.58)	(0.16)	(0.21)
WAIKATO	0.22	0.74***	-0.15	-0.11	0.52**
	(0.15)	(0.25)	(0.26)	(0.21)	(0.21)
WAIRARAPA	0.33**	0.75	0.07	0.37	0.80**
	(0.15)	(0.53)	(0.52)	(0.48)	(0.32)
WANGANUI	0.38***	0.29	0.25	0.63**	0.32
	(0.12)	(0.40)	(0.34)	(0.25)	(0.20)
WHAKATANE_KAWERAU	0.57***	0.68*	-0.40	0.47*	0.54**
	(0.10)	(0.37)	(0.38)	(0.28)	(0.23)

Notes: The mean equation for the multivariate AR-GARCH model of North Island Hotel Guest Nights is specified as follows:

$$G_{(NI),i,t} = \alpha_i + \beta_i G_{i,t-1} + \phi_{a,i} G_{auck,t-1} + \phi_{w,i} G_{wel,t-1} + \theta_{a,i}\varepsilon_{auck,t-1} + \theta_{w,i}\varepsilon_{wel,t-1} + \varepsilon_{i,t}$$

$G_{(NI),i,t}$ is the logarithmic monthly hotel guest nights for each North Island RTO (i). The importance of each RTO's own lag in explaining current guest nights is represented by β_i. ϕ_a and ϕ_w represent the expected guest night spillovers from the Wellington and Auckland RTO's respectively. θ_a and θ_w are the unexpected guest night spillovers from Wellington and Auckland respectively. $\varepsilon_{i,t}$ has a mean of zero and a conditional variance of $\sigma_{i,t}^2 = \omega_{1,i} + \omega_{2,i}\varepsilon_{i,t-1}^2 + \omega_{3,i}\sigma_{i,t-1}^2$. Standard errors are reported in brackets. ***, **, and * represent that the coefficient is statistically significant at the 1%, 5% and 10% significance levels respectively.

Table 4. South Island Spillover Model. GARCH Estimates for the South Island RTO's Hotel Guest Nights.

Parameter:	$\boldsymbol{\beta}$	$\boldsymbol{\phi_a}$	$\boldsymbol{\phi_c}$	$\boldsymbol{\phi_w}$	$\boldsymbol{\theta_a}$	$\boldsymbol{\theta_c}$	$\boldsymbol{\theta_w}$
CENTRAL_OTAGO	0.27***	0.24	-1.06***	4.35***	0.06	2.16***	-3.90***
	(0.09)	(1.02)	(0.15)	(0.73)	(0.68)	(0.23)	(0.71)
CLUTHA	0.43***	1.77***	-0.81***	2.17***	-1.76***	1.96***	-1.43***
	(0.14)	(0.67)	(0.15)	(0.78)	(0.52)	(0.21)	(0.50)
DUNEDIN	0.26	0.78	0.09	0.68	0.09	0.53***	-0.15
	(0.19)	(0.50)	(0.28)	(0.67)	(0.25)	(0.16)	(0.48)
FIORDLAND	0.41***	1.80***	-0.33*	1.18	-1.46***	1.34***	-0.80
	(0.11)	(0.71)	(0.17)	(0.80)	(0.51)	(0.22)	(0.50)
HURUNUI	0.30**	0.87	-0.25*	0.85	-0.19	0.66***	-0.73
	(0.13)	(1.02)	(0.15)	(1.34)	(0.50)	(0.12)	(1.07)
MACKENZIE	0.47***	1.05**	-0.50***	1.10*	-0.46	1.06***	-0.82**
	(0.10)	(0.51)	(0.12)	(0.62)	(0.36)	(0.09)	(0.35)
MARLBOROUGH	0.58***	0.72	-0.06	0.21	-0.12	0.40***	0.08
	(0.16)	(0.55)	(0.12)	(0.47)	(0.32)	(0.12)	(0.31)
NELSON_TASMAN	0.75***	1.04	-0.39***	0.53	-0.54*	0.95***	-0.48
	(0.17)	(0.65)	(0.12)	(0.55)	(0.31)	(0.15)	(0.34)
QUEENSTOWN	0.43***	-0.38	-0.20	0.89	0.84	0.27	-0.56
	(0.14)	(0.65)	(0.25)	(0.87)	(0.73)	(0.32)	(0.67)
SOUTHLAND	0.20**	1.48***	-0.01	1.31**	-1.13***	1.14***	-0.83**
	(0.10)	(0.58)	(0.16)	(0.64)	(0.42)	(0.18)	(0.37)
TIMARU	0.50***	0.88*	-0.42***	1.22**	-0.61***	1.10***	-1.01***
	(0.08)	(0.46)	(0.13)	(0.55)	(0.23)	(0.11)	(0.29)
WAITAKI	-0.05	2.12***	-0.18	1.43**	-1.92***	1.51***	-0.92*
	(0.18)	(0.50)	(0.25)	(0.57)	(0.52)	(0.24)	(0.48)
WANAKA	0.45**	-0.59	-0.66**	2.27	1.27	0.84***	-1.71
	(0.18)	(1.19)	(0.29)	(2.03)	(0.97)	(0.22)	(1.87)
WEST_COAST	0.59***	0.57	-0.04	0.37	-0.47	0.50***	0.00
	(0.15)	(0.72)	(0.16)	(0.68)	(0.33)	(0.09)	(0.46)

Notes: The mean equation for the multivariate AR-GARCH model of South Island Hotel Guest Nights is specified as follows:

$$G_{(SI),i,t} = \alpha_i + \beta_i G_{i,t-1} + \phi_{a,i} G_{auck,t-1} + \phi_{c,i} G_{can,t-1} + \phi_{w,i} G_{wel,t-1} + \theta_{a,i}\varepsilon_{auck,t-1} + \theta_{c,i}\varepsilon_{can,t-1} + \theta_{w,i}\varepsilon_{wel,t-1} + \varepsilon_{i,t}$$

$G_{(SI),i,t}$ is the logarithmic monthly hotel guest nights for each South Island RTO (i). The importance of each RTO's own lag in explaining current guest nights is represented by β_i. ϕ_a , ϕ_c and ϕ_w represent the expected guest night spillovers from the Canterbury, Auckland and Wellington RTO's respectively. θ_a , θ_c and θ_w are the unexpected guest night spillovers from Wellington and Auckland respectively. $\varepsilon_{i,t}$ has a mean of zero and a conditional variance of $\sigma_{i,t}^2 = \omega_{1,i} + \omega_{2,i}\varepsilon_{i,t-1}^2 + \omega_{3,i}\sigma_{i,t-1}^2$. Standard errors are reported in brackets. ***, **, and * represents that the coefficient is statistically significant at the 1%, 5% and 10% significance levels respectively.

Table 5. Variance Ratios for the North Island Spillover Model.

	$\boldsymbol{VR^{a}_{(NI)}}$		$\boldsymbol{VR^{w}_{(NI)}}$	
	Mean	**SD**	**Mean**	**SD**
BAY_OF_PLENTY	0.16	0.21	0.01	0.02
COROMANDEL	0.08	0.13	0.24	0.21
GISBORNE	0.07	0.17	0.12	0.15
HAWKES_BAY	0.06	0.13	0.20	0.18
KAPITI_HOROWHENUA	0.14	0.22	0.10	0.13
MANAWATU	0.04	0.05	0.35	0.30
NORTHLAND	0.02	0.04	0.20	0.24
ROTORUA	0.01	0.02	0.31	0.27
RUAPEHU	0.27	0.25	0.04	0.07
TARANAKI	0.04	0.08	0.09	0.15
TAUPO	0.00	0.00	0.21	0.25
WAIKATO	0.01	0.01	0.33	0.32
WAIRARAPA	0.03	0.06	0.26	0.24
WANGANUI	0.13	0.17	0.10	0.13
WHAKATANE_KAWERAU	0.04	0.07	0.12	0.16

Total Mean 0.25

Notes: The table presents the mean and standard deviation (SD) of Auckland and Wellington hotel guest night variance ratios and the average total spillover (Total Mean) contribution across RTOs for the North Island spillover model. The variance of the unexpected guest nights for a North Island RTO (i) caused by Auckland and Wellington guest night spillovers is formulated as:

$$VR^{a}_{(NI)i,t} = \frac{\theta^{2}_{a,i,t-1}\sigma^{2}_{a,t}}{h_{(NI)i,t}} \text{ and } VR^{w}_{(NI)i,t} = \frac{\theta^{2}_{w,i,t-1}\sigma^{2}_{w,t}}{h_{(NI)i,t}}.$$

Where $h_{(NI)i,t} = \theta^{2}_{a,i,t-1}\sigma^{2}_{a,t} + \theta^{2}_{w,i,t-1}\sigma^{2}_{w,t} + \sigma^{2}_{i,t}$.

Table 6. Variance Ratios for the South Island Spillover Model.

	$VR^{a}_{(SI)}$		$VR^{w}_{(SI)}$		$VR^{c}_{(SI)}$	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
CENTRAL_OTAGO	0.00	0.00	0.25	0.23	0.50	0.30
CLUTHA	0.17	0.16	0.34	0.25	0.20	0.19
DUNEDIN	0.00	0.00	0.23	0.27	0.01	0.03
FIORDLAND	0.19	0.19	0.26	0.23	0.10	0.11
HURUNUI	0.01	0.02	0.23	0.22	0.28	0.26
MACKENZIE	0.04	0.04	0.29	0.23	0.21	0.22
MARLBOROUGH	0.01	0.03	0.19	0.27	0.01	0.02
NELSON_TASMAN	0.07	0.10	0.31	0.25	0.08	0.10
QUEENSTOWN	0.18	0.19	0.06	0.12	0.19	0.21
SOUTHLAND	0.14	0.16	0.28	0.25	0.12	0.11
TIMARU	0.06	0.06	0.29	0.24	0.24	0.23
WAITAKI	0.25	0.21	0.30	0.24	0.13	0.17
WANAKA	0.13	0.13	0.12	0.15	0.39	0.27
WEST_COAST	0.10	0.16	0.16	0.21	0.00	0.00
Total Mean	0.52					

Notes: The table presents the mean and standard deviation (SD) of Auckland, Wellington and Canterbury hotel guest night variance ratios and the average total spillover (Total Mean) contribution across RTOs for the South Island spillover model. The variance of the unexpected guest nights for a South Island RTO (i) caused by Auckland, Wellington and Canterbury guest night spillovers is formulated as:

$$VR^{a}_{(SI)i,t} = \frac{\theta^2_{a,i,t-1}\sigma^2_{a,t}}{h_{(SI)i,t}},\ VR^{w}_{(SI)i,t} = \frac{\theta^2_{w,i,t-1}\sigma^2_{w,t}}{h_{(SI)i,t}} \text{ and } VR^{c}_{(SI)i,t} = \frac{\theta^2_{c,i,t-1}\sigma^2_{c,t}}{h_{(SI)i,t}}.$$

Where $h_{(SI)i,t} = \theta^2_{a,i,t-1}\sigma^2_{a,t} + \theta^2_{w,i,t-1}\sigma^2_{w,t} + \theta^2_{c,i,t-1}\sigma^2_{c,t} + \sigma^2_{i,t}$.