Determinants of Airport Efficiency
A Case Study of A Tourism Receiving Country

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Abstract

This study aims to examine the causal relationship between airport operation (including their capability and efficiency) and regional tourism development in New Zealand for the period of 2010–2016. We first estimate the efficiency of New Zealand's airports using window Slacks-Based Measures Data Envelopment Analysis (window-SBM-DEA), and then examine its relationship to local tourism (proxied by the number of guest arrivals) and airlines capacity (proxied by the total available seat kilometres) using a two-step Tobit regression (2STR) approach. The impacts of factors such as regional characteristics (e.g. GDP, centre status) and external events (e.g. the Global Financial Crisis 2008, the Christchurch earthquake 2011) are also considered. We find that local tourism development can boost up airport efficiency, while the positive impact of airline development on airport performance is not statistically clear. The examination of external factors such as regional GDP or earthquake further suggests that the councils and decision makers can influence regional airports via the development of their regions.

Keywords: two-stage Tobit regression; efficiency; airport; tourism; window-SBM-DEA; New Zealand.

1. Introduction

A significant body of studies has shed light on the relationship between air transportation and tourism, in which there is an interlink between tourism and air transport, and the availability of cheap air transport, including both airlines and airports, can be considered as one driving forces in tourism growth (e.g. Bieger and Wittmer, 2006). It is suggested that tourism can put pressure on airports, which in turn makes the airports to be more efficient, as in Greece (Fragoudaki and Giokas, 2016) or Italy (Percoco, 2010). At the same time, there are evidence that airport operations and quality can influence tourism. For example, Percoco (2010) argued that airline traffic (via an airport) has positive relationship with the local development of 103 Italian provinces. In the same line, Assaf and Josiassen (2011) found that airport density has a negative impact while its services quality has a positive impact on tourism performance of 120 countries located in Africa, the Americas, Asia, Europe, and Oceania for the period of 2005–2008. Consequently, one may argue that an efficient airport could handle more airlines capacity (and more tourist flows), thus regional policy on local airport development can help boost up its tourism. This study contributes to the literature as the first empirical study to examine the causal relationship between airport operation (including their capability and efficiency) and regional tourism development, using New Zealand as a case study.

Due to its geographical and natural characteristics, tourism has become an increasingly important sector of New Zealand's economy in terms of generating export revenue and creating employment opportunities. For example, the total tourism expenditure in New Zealand at the end of March 2015 was $29.8 billion, an increase of 10.3 per cent from previous year (MBIE, 2016). Total international visitor arrivals to New Zealand increased from approximately 2.46 million in 2007 to 3.66 million in 2017 (Statistics New Zealand, 2017) and is expected to reach 4.50 million by 2022 (MBIE, 2016), indicating a growing contribution of tourism to the New Zealand's economy. According to the Ministry of Business, Innovation and Employment, 99 per cent of the visitors, including both international and domestic ones, come by air (MBIE, 2016). This makes New Zealand a unique example to examine the causal relationship between airlines, airports and tourism. Additionally, the fact that each and every region in the country has at least one regional airport suggests that local government can play some roles in promoting its regional air transportation and tourism.

Although there are more than 105 airports in New Zealand (NZTE, 2010), only five received scheduled international services and twenty-six received scheduled domestic services from operators of aircraft of 19 seats or more (MBIE, 2016). Among them, we are able to collect the

data of eleven airports from their published annual reports and financial reports for the period of 2006-2017 with some missing observations. Consequently, an unbalanced panel data with 101 year-based observations, which is still the richest dataset on New Zealand airports, is utilized in this study. Our empirical findings show that airlines capacity in a certain airport (proxied by total available seat kilometres) and its regional tourism (proxied by number of guest arrivals) positively causal impact each other; and the two positively influence the efficiency of the local airport. In addition, external shocks (e.g. the global financial crisis 2008/09 or the Christchurch earthquake 2011) are found to have no significant effect on the above three measures (i.e. airlines capacity, airport efficiency and regional tourism) while internal factors (e.g. regional economic or centre status) have significant impacts on them, but with different directions.

The structure of this paper is as follows: Section 2 provides some background on the New Zealand tourism and aviation industries. Section 3 explains the methodological issue of the study, including the variables, the dataset, and the empirical models. Section 4 presents and discusses on the results and Section 5 concludes.

2. New Zealand tourism and aviation background

Tourism expenditure continuously grows over the year (averagely 4 per cent a year in the 2006-2017 period) and contributes a significant amount in the nation's GDP (see Figure 1); whereas the tourism industry also plays an important role in jobs creation. A recent forecast from the MBIE predicted that, for international visitors alone, their annual spending will reach $15.3 billion NZD in 2023, a 52.1 per cent increase from 2016 (MBIE, 2017).
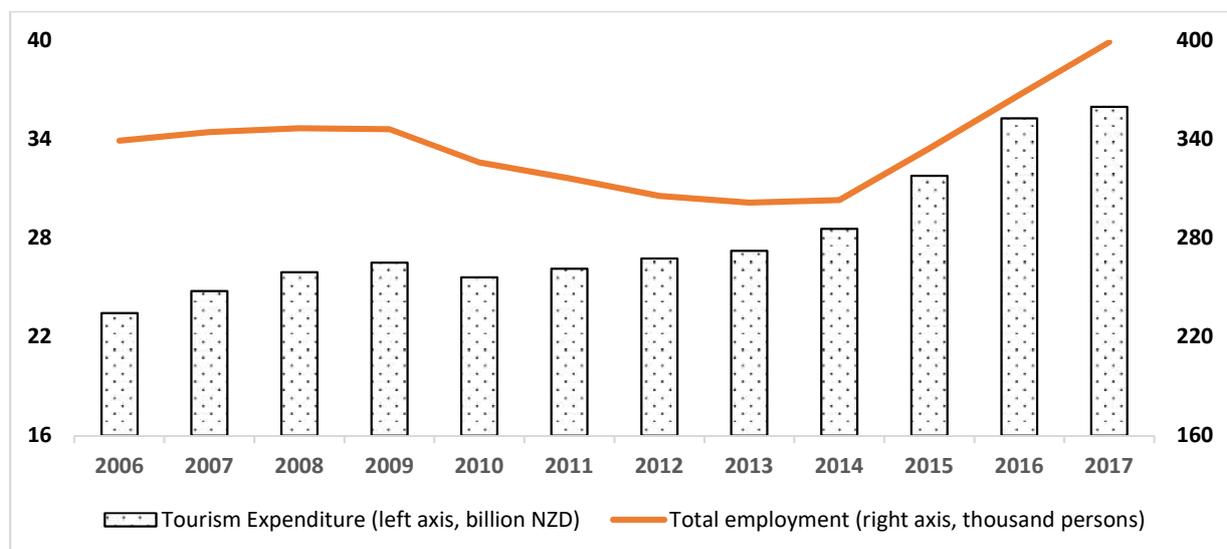
Source: Statistics New Zealand

Figure 1. Tourism employment and expenditure in New Zealand (2006-2017)

Almost all New Zealand tourists, especially international visitors, are carried by air transportation. Air capacity is projected to continue to increase as well, with Australia and Asia (especially China and Japan) as the largest drivers to capacity growth. Figure 2 illustrates how New Zealand is connected to the rest of the world in 2017 via air transportation as well as the trend in direct routes development.
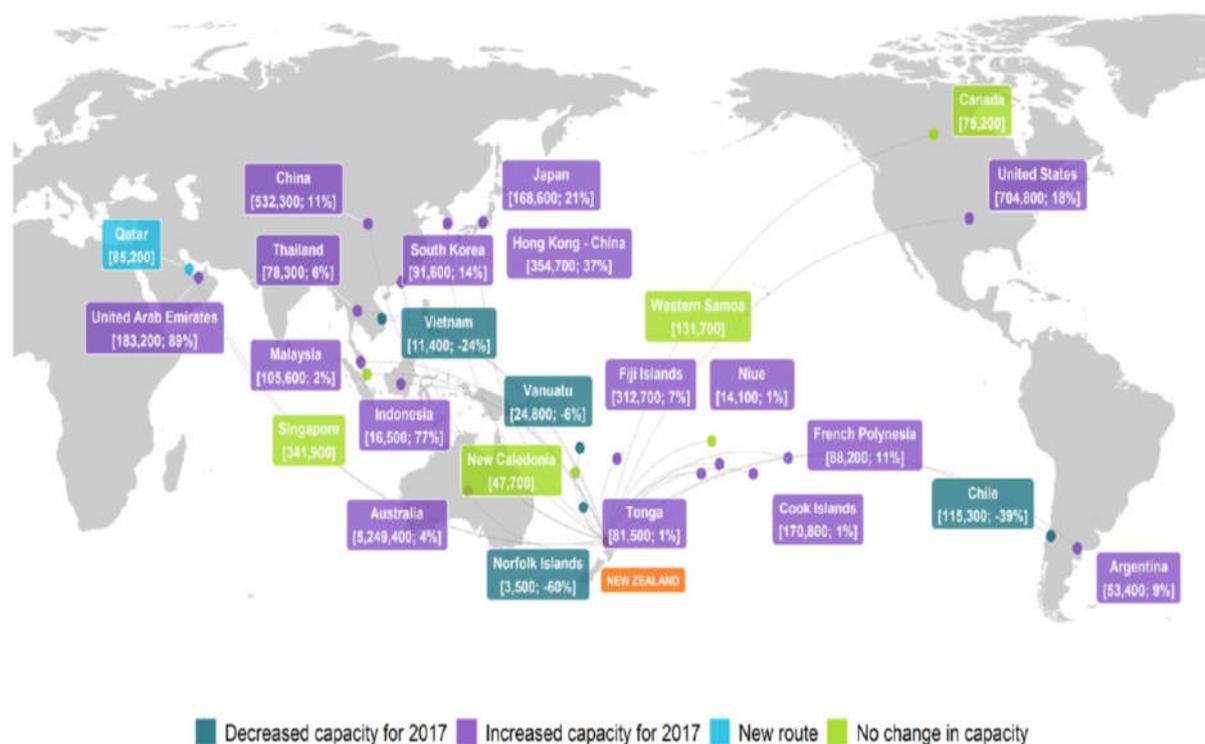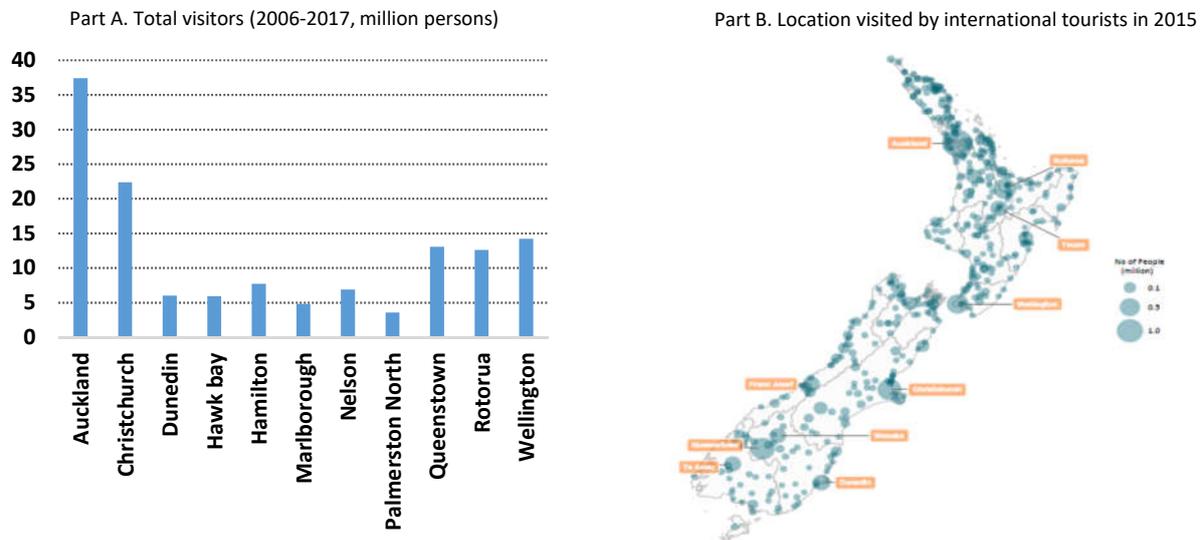

Source: MBIE (2017)

Figure 2. New Zealand's non-stop flights routes in 2017

Visitors cited many reasons to come to New Zealand, including New Zealand's diverse geographic and scenery, Maori culture, easy travelling condition, open and safety for traveller, and even high quality wines, e.g. Marlborough and Hawke's Bay (MBIE, 2016). The largest tourist destination is Auckland (received more than 37 million visitors in the 2006-2017 period), followed by Christchurch (more than 22 million visitors) and Wellington (nearly 15 million) – see Figure 3, Part A. This difference is arguably linked to the regional airport (as well as the airlines involved) and its operations, other transportation modes provided in the region, the attractions of the region (e.g. whether the region is a tourist or business destination), and other factors such as weather or earthquakes. For example, Part B of Figure 3 indicates that

international visitors spending in tourism destinations such as Auckland or Queenstown tend to be higher than those in counterpart regions.

Part A. Total visitors (2006-2017, million persons)

Part B. Location visited by international tourists in 2015

Source: MBIE (2016) and authors' calculation

Figure 3. Distribution of tourists in New Zealand

3. Methodology

This section explains how New Zealand airport efficiency is measured in the first place, and then how they are analysed in a causal relationship with airlines capacity and regional tourism.

3.1. Window Analysis (WA) and Slacks-Based Measure (SBM) in DEA

Data Envelopment Analysis (DEA) was introduced by Charnes *et al.* (1978) to measure the relative efficiency of decision-making-units (DMUs) of a given sample. Specifically, each DMU will be compared with the common frontier built from all DMUs to define the optimal multipliers (or shadow prices) to combine its inputs and outputs so that the ratio between the final outputs and final inputs (or its efficiency score) is maximized. The above problem bears the 'curse of dimensionality' when the total number of inputs and outputs is greater than the number of DMUs (Donoho, 2000); thus a 'rule-of-thumb' is to have a large number of DMUs or observations, at least twice the product of input and output variables (Dyson *et al.*, 2001) or three times the sum of input and output variables (Cooper *et al.*, 2006).

Given our unbalanced panel data with a total of 101 year-based observations (Table 1), traditional DEA models could not analyse the efficiency of New Zealand airports using yearly data for the period of 2006-2008 if using only one input and one output, or for the whole period

of 2006-2017 if using two inputs and two outputs, since we have a maximum of eleven airports (or DMUs). DEA Window Analysis (Charnes *et al.*, 1985) is one solution for this situation: it pools several year-based observations together as a cross-section by treating the same airport in different years independently. We choose a 3-year window since 3 years is considered medium-term with not much changes in the operations of New Zealand airports and is thus appropriate for a common frontier. Consequently, we can increase the sample size from 101 to 264 observations (Table 1), in which the smallest window (i.e. Window 1) consists of 12 DMUs, justifying for a DEA model with 3 inputs and 3 outputs; and the largest window (i.e. Windows 7 and 8) consists of 33 DMUs, justifying for a DEA model with a total of 11 inputs and outputs.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
DEA basic	2	4	6	7	8	9	11	11	11	11	11	10	**101**
DEA Window Analysis													
Window 1	2	4	6										**12**
Window 2		4	6	7									**17**
Window 3			6	7	8								**21**
Window 4				7	8	9							**24**
Window 5					8	9	11						**28**
Window 6						9	11	11					**31**
Window 7							11	11	11				**33**
Window 8								11	11	11			**33**
Window 9									11	11	11		**33**
Window 10										11	11	10	**32**
Total													**264**

Source: Authors' calculation

Table 1. Year-based observations (or DMUs) for DEA Window Analysis

Consider a set of *n* DMUs or airports, with each DMU *j* (*j=1,…,n*) using *k* inputs x_{ij} (*i=1,…,k*) to produce *m* outputs y_{rj} (*r=1,…,m*). In DEA, a DMU is defined as efficient if it lies on the common frontier and has no slack, i.e. no inequalities between the observed values and the frontier (Charnes *et al.*, 1978).[1] Tone (2001) introduced a single scalar called Slacks-Based Measure (SBM) that can accommodate the unit invariant issue of conventional DEA in the form of[2]

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[1] When all slacks equal to zero, one cannot improve the situation further without affecting the (original) inputs/outputs and thus, this is equivalent to the Pareto-Koopmans' efficient or optimal situation.

[2] Notice that it is for the constant-returns-to-scale assumption. The variable-returns-to-scale assumption can be easily assessed by adding the constraint of $\sum_j^n \lambda_j = 1$, $\forall j$ into Equation (1).

$$EF_{j_0} = min_{\lambda, s^-, s^+} \quad \frac{1 - \frac{1}{k} \sum_i^k s_i^- / x_{ij_0}}{1 + \frac{1}{m} \sum_r^m s_r^+ / y_{rj_0}} \tag{1}$$

Subject to

$$\sum_i^k \lambda_j x_{ij} + s_i^- = x_{ij_0}, i = 1, 2, .., k$$

$$\sum_r^m \lambda_j y_{rj} - s_r^+ = y_{rj_0}, r = 1, 2, .., m$$

$$\lambda_j, s_i^-, s_r^+ \geq 0, j = 1, 2, .., n$$

where

EF_{j_0} is the SBM efficiency score of airport j_0 ($EF_{j_0} = 1$ means efficient),

x_{ij_0} is the airport's inputs,

y_{rj_0} is the airport's outputs,

s_i^- is the input slacks,

s_r^+ is the output slacks,

and λ_j is the dual variable of the shadow prices vector associates with each airport.

Specifically, we use three inputs ($EmployeeExpenses$, $OperatingExpenses$ and $LengthOfRunway$) and three outputs ($AeronauticalRevenues$, $NonaeronauticalRevenues$ and $AircraftMovements$) for our SBM DEA model. These variables have been commonly used in previous studies on airport efficiency, including Oum *et al.* (2006), Barros (2008), Tsui *et al.* (2014a), Tsui *et al.* (2014b), Abbott (2015). Since those variables cover both operational and financial aspects of the airport, they are therefore expected to provide an overall assessment on the performance of New Zealand airports.

3.2. Censored regression and the two-step Tobit regression (2STR)

After the New Zealand airports' SBM efficiency scores are estimated, it is important to further examine its determinants as from managerial point of view, knowing where you are (i.e. current efficiency) is not as important as knowing what to do next (i.e. how to improve efficiency).

Since DEA technically analyses the efficiency of the airports in converting inputs into outputs, it does not account for external factors such as the participant of different airlines at the airport (low-cost carrier (LCC)'s involvement), the capacity of airlines involved (total available seat kilometres), the location of the airport (if it belongs to a financial centre or tourism centre), or

airport's ownership. For example, Voltes-Dorta and Pagliari (2012) found that airport cost efficiency worldwide dropped by 5.85 per cent between 2007 and 2009 due to impacts from the Global Financial Crisis (GFC). Meanwhile, Adler and Liebert (2014) revealed that in Australia and Europe, public airports operate less cost efficiently than fully private airports. For New Zealand airports, Tsui *et al.* (2014b) argued that the airport's hub status, its operating hours and ownership have significant impact on efficiency; while Abbott (2015) found scale and ownership are the two important factors for the airport's performance. All of those analyses were done by regressing airports efficiency to the interested external factors.

Second-stage regression after DEA has been done using ordinal least squares (OLS) or Tobit regression, in which the Tobit model is popularly used under the argument that the dependent variable (i.e. efficiency scores, EF) is limited and censored to the interval]0; 1]. A conventional approach for the second-step regression in this study may be done by examining whether airlines capacity (proxied by total available seat kilometres, ASK) and regional tourism (proxied by number of guest arrivals, ARRIVAL) have any impact on airport efficiency, i.e. regressing SBM efficiency scores on ASK, ARRIVAL and other control variables. However, it is argued that tourism growth is positively associated with the development of airlines (Bieger and Wittmer, 2006) as well as other factors such as regional GDP or employment (Fernandes and Pacheco, 2010; Küçükönal and Sedefoğlu, 2017). Consequently, normal Tobit regressions treating ASK and ARRIVAL as (independent) exogenous variables in the second-step may be impacted from the endogeneity bias. We contribute to the literature by proposing a two-step Tobit regression (2STR) to overcome this problem.

Specifically, in the first-step of 2STR, we regress ASK and ARRIVAL on all explanatory variables and get their predicted values ASKF and ARRIVALF, respectively. In the next step, ASKF and ARRIVALF will be used (alongside other explanatory variables) as independent variables of a Tobit regression model to explain airport efficiency EF (instead of the original values ASK and ARRIVAL). Notice that except for dummy variables (e.g. $TouristCentre_i$ or GFC_t), the logarithmic values of all other variables are used instead of original ones. This is to reduce the skewness among variables as well as to overcome the differences in units between them. The 2STR is specified as follows.

First step: Regress ASK and ARRIVAL on all of the explanatory variables to get the predicted values ASKF and ARRIVALF, respectively, using Equations (2) and (3) below.

$$ASK_{it} = \alpha_0 + \beta_1 Accommodation_{it} + \beta_2 InternationalDestinations_{it} \qquad (2)$$
$$+ \beta_3 DomesticDestinations_{it} + \beta_4 RegionalGDP_{it}$$
$$+ \beta_5 FuelPrice_t + \beta_6 TouristCentre_i + \beta_7 FinancialCentre_i$$
$$+ \beta_8 GFC_t + \beta_9 ChristchurchEarthquake_t$$
$$+ \beta_{10} LCCparticipant_{it} + \beta_{11} HubStatus_i + \beta_{12} Year + \varepsilon_{it}$$

$$ARRIVAL_{it} = \alpha_0 + \beta_1 Accommodation_{it} + \beta_2 InternationalDestinations_{it} \qquad (3)$$
$$+ \beta_3 DomesticDestinations_{it} + \beta_4 RegionalGDP_{it}$$
$$+ \beta_5 FuelPrice_t + \beta_6 TouristCentre_i + \beta_7 FinancialCentre_i$$
$$+ \beta_8 GFC_t + \beta_9 ChristchurchEarthquake_t$$
$$+ \beta_{10} LCCparticipant_{it} + \beta_{11} HubStatus_i + \beta_{12} Year + \varepsilon_{it}$$

Second step: Regress EF on the predicted values ASKF and ARRIVALF as well as other explanatory variables using Tobit regression as in Equation (4).

$$EF_{it} = \alpha_0 + \beta_1 ASKF_{it} + \beta_2 ARRIVAL_{it} + \beta_3 Accommodation_{it} \qquad (4)$$
$$+ \beta_4 InternationalDestinations_{it}$$
$$+ \beta_5 DomesticDestinations_{it} + \beta_6 RegionalGDP_{it}$$
$$+ \beta_7 FuelPrice_t + \beta_8 TouristCentre_i + \beta_9 FinancialCentre_i$$
$$+ \beta_{10} GFC_t + \beta_{11} ChristchurchEarthquake_t$$
$$+ \beta_{12} LCCparticipant_{it} + \beta_{13} HubStatus_i$$
$$+ \beta_{14} Privatisation_{it} + \beta_{15} Year + \varepsilon_{it}$$

where

EF_{it} is the (average) SBM DEA Window Analysis efficiency scores of airport i in year t derived from Equation (1);

$ASKF_{it}$ is the logarithmic values of total available seat kilometres of all airlines operating at airport i in year t;

$ARRIVAL_{it}$ is the logarithmic values of total number of guest arrivals in year t to the region where airport i is located; [3]

$Accommodation_{it}$ is the logarithmic values of total number of establishments for guests (e.g. hotels, motels, backpackers) in year t of the region where airport i is located. This variable

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[3] It is unique that every region in New Zealand has at least one airport with scheduled services, as there are 33 scheduled domestic and/or international services airports over twelve regions.

represents the capability of the region to accommodate tourists and is expected to have positive relationships with tourism demand (Sharpley, 2000; Fragoudaki and Giokas, 2016);

$InternationalDestinations_{it}$ is the number of total international destinations that airport i connects to in year t, thus it is expected to have positive relationships with ASK and ARRIVAL;

$DomesticDestinations_{it}$ is the number of domestic destination that airport i connects to in year t, similarly is expected to have positive relationships with ASK and ARRIVAL;

$RegionalGDP_{it}$ is the logarithmic values of total gross domestic products in year t of the region where airport i is located. This variable represents the level of economic development of the region that can boost up air transportation demand (Law, 1992; Prideaux, 2000; Garín-Muñoz, 2009);

$FuelPrice_t$ is the logarithmic values of fuel prices in year t which reflects the cost of airlines as well as air ticket prices and thus negatively impacts ASK and ARRIVAL, respectively (Yeoman *et al.*, 2007; Becken and Lennox, 2012; McConnachie *et al.*, 2013);

$TouristCentre_i$ is a dummy variable which gets value of 1 if the region where airport i is located is defined as a tourist centre thus attracts more tourists, otherwise equals to zero;

$FinancialCentre_i$ is a dummy variable which gets value of 1 if the region where airport i is located is defined as a financial centre thus attracts more business guests, otherwise equals to zero;

GFC_t is a dummy variable which gets value of 1 for the years 2008 and 2009, otherwise equals to zero. This is to capture the negative impact of the global financial crisis on airlines, airports and tourism (Voltes-Dorta and Pagliari, 2012);

$ChristchurchEarthquake_t$ is a dummy variable which gets value of 1 for the year 2011, otherwise equals to zero. This is to capture the negative impact of the earthquake on airlines, airports and tourism (Wang, 2009; An *et al.*, 2010; Tsui *et al.*, 2014b);

$LCCparticipant_{it}$ is a dummy variable which gets value of 1 if there is any low-cost carriers (LCCs) operating at airport i in year t; otherwise equals to zero. The participant of LCCs can bring more customers/tourists to the airport/region and is thus expected to have positive impacts on ASK, ARRIVAL and EF (Alsumairi and Tsui, 2017; Tsui, 2017);

$HubStatus_i$ is a dummy variable which gets the value of 1 for Auckland Airport and Christchurch Airport, the two airports that provide international scheduled services to the customers, otherwise equals to zero. We expect that those hub airports can attract more customers, contribute more to the region (in terms of tourism) and thus outperform the other airports (Green Richard, 2007);

$Privatisation_{it}$ is a dummy variable which gets the value of 1 if airport i is (at least partly) owned by private investors in year t, otherwise equals to zero. We expect that privatised airports perform better than their counterpart (Oum *et al.*, 2006; Adler and Liebert, 2014);

$Year$ is a control variable to capture the fluctuations in ASK, ARRIVAL and EF due to seasonal patterns of air transportation and tourism activities and hence, accounting for any spurious issues;

α_0 is the intercept, β_i is the vector of parameters to be estimated, and ε_{it} is the random errors.

3.3. Data

Data for the DEA Window Analysis regarding 11 New Zealand airports (e.g. $AeronauticalRevenues$, $EmployeeExpenses$) is manually collected from the airports' annual and financial reports. For the 2STR analysis, airports related data (e.g. ASK, $DomesticDestinations$, $Privatisation$) is drawn from the Official Airline Guide (OAG) while regional data (e.g. $ARRIVAL$, $Accommodation$, $RegionalGDP$) is drawn from Statistics New Zealand. It is noted that all dollar values have been deflated using the regional consumer price index provided also by Statistics New Zealand. Table 2 presents the descriptive statistics of the data where high variations (i.e. high standard deviations) are observed in most of the variables. It shows the differences between New Zealand regions in terms of airports' operation, airlines capacity and regional economy and tourism so that it is important to analyse the relationship between the three key variables above.

	Mean	Standard Deviation	Minimum	Maximum
SBM DEA Window Analysis				
$EmployeeExpenses$	2,298,178	2,929,107	24,024	11,367,720
$OperatingEexpenses$	6,490,844	10,264,211	29,507	46,234,000
$LengthOfRunway$	2,227	767	1,347	3,635
$AeronauticalRevenues$	8,148,274	17,081,361	35,533	70,313,000
$NonaeronauticalRevenues$	17,592,424	45,255,824	36,246	176,545,000
$AircraftMovements$	118,811	259,387	17,870	1,608,990
IVTOBIT/3SLS Analysis				

Arrival	1,126,331	884,329	273,204	3,725,545
Accommodations	2,000	1,128	930	4,446
InternationalDestinations	6.545	10.921	0	39
DomesticDestinations	9.109	7.389	3	22
NationalGDP	10.805	0.097	10.576	10.951
RegionalGDP	10.742	0.159	10.494	11.154
FuelPrice	0.758	0.330	0.223	1.117
TouristCentre	0.653	0.478	0	1
FinancialCentre	0.337	0.475	0	1
GFC	0.129	0.337	0	1
Earthquake	0.198	0.400	0	1
LCCparticipant	0.663	0.475	0	1
HubStatus	0.119	0.325	0	1
Privatisation	0.307	0.463	0	1
Year	2012	3.031	2006	2017

Source: Authors' calculation

**Table 2. Descriptive statistics for variables (2006-2017)**

4. Empirical results and Discussions

4.1. Efficiency of New Zealand airports

We first report results from SBM DEA Window Analysis. As discussed in Section 3.1, SBM DEA is applied on 10 windows (each has a 3-years width) so that the number of observations are increased from 101 to 264, which helps improve the discrimination power of DEA. Consequently, an observation may appear in different windows (e.g. the observation of Auckland Airport in 2008 appears in Windows 1, 2 and 3 – see Appendix 1). For those cases, the average values of the efficiency scores for the same airport in the same year among different windows is used to represent the airport's performance in this year. Figure 4 shows the trend in average efficiency scores of the airport sector in New Zealand (Panel A) as well as the average efficiency scores of individual airports in the examined period (Panel B). In particular, New Zealand airports were well performed in 2006[4] but then struggled in 2007-2012, may be due to external shocks. It is a good sign to see some recovery in the recent years, but there are plenty of rooms for improvement as the average efficiency of the sector in 2017 was only less than 0.8 (or 80 per cent). For individual airports, the best performers include Nelson, Wellington, Marlborough, Auckland and Christchurch; the moderate performers include

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[4] Our sample has only two airports for 2006, Auckland and Christchurch, and both were efficient. This result, however, is based on DEA Window Analysis with Window 1 covered the 2006-2008 period (12 observations), thus discrimination is not a problem. Additionally, results are still not changed when the two are excluded, so we have just reported the original findings.

Hawke's Bay and Hamilton; while Queenstown, Palmerston North, Rotorua and Dunedin are considered the worst performers. This finding is inconsistent with Tsui *et al.* (2014b, Table 3) on New Zealand airports because of differences in inputs/outputs selection, period covered and DEA models. In contrast, our findings are closer to the result of Abbott (2015, Table 4) in categorising similar performing groups. Nevertheless, the efficiency differences between New Zealand airports suggests that it is important to determine factors that can contribute to airport efficiency such as airline capacity and regional tourism in the second stage.

Panel A. Average efficiency by year

Panel B. Average efficiency by airport
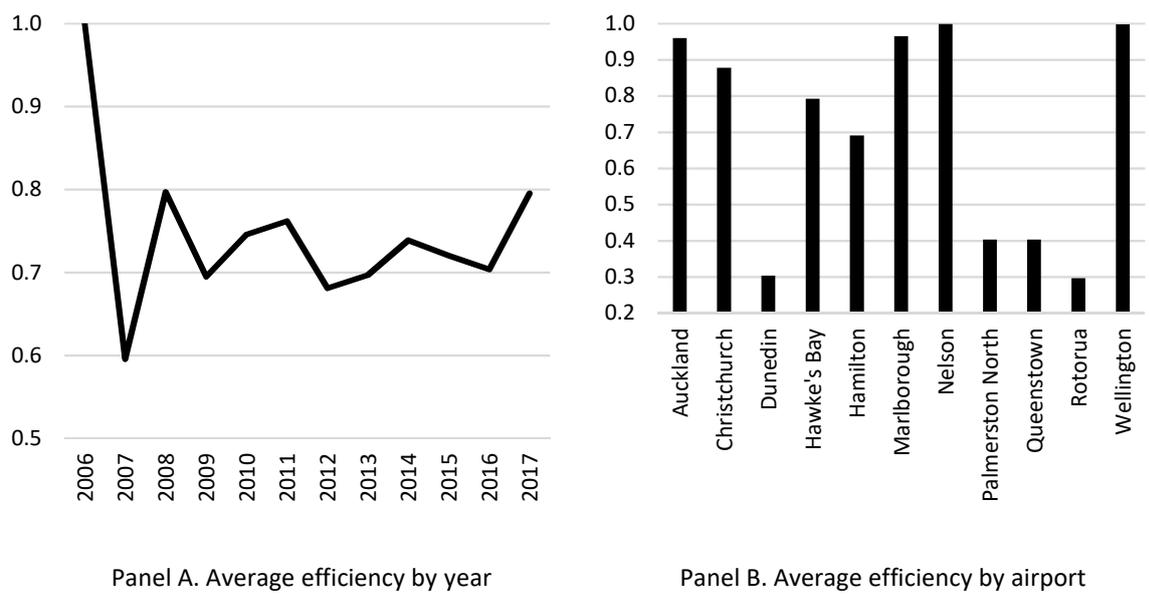
Figure 4. Efficiency of New Zealand airports (2006-2017)

4.2. The relationship between New Zealand airports' efficiency, airlines capacity and its regional tourism

Table 3 presents the estimation results of the 2STR analysis using Equations (2)-(4). Some important results regarding New Zealand airports efficiency, airlines capacity and regional tourism are discussed below.

	Equation (2)		Equation (3)		Equation (4)	
Dependent variables	*ASK*		*ARRIVAL*		*EF*	
Explanatory variables	**Coef.**	**S.E**	**Coef.**	**S.E**	**Coef.**	**S.E**
Intercept	151.932	129.990	-12.314	31.601	-26.818 ***	8.456
ASKF					0.273	0.201
ARRIVALF					1.976 **	0.825
Accommodations	-0.340	0.683	0.713 ***	0.166	-0.795	0.583
InternationalDestinations	0.072 ***	0.023	0.038 ***	0.006	-0.137 ***	0.038
DomesticDestinations	-0.134	0.097	-0.080 ***	0.024	0.213 **	0.090
RegionalGDP	2.189	1.627	-0.152	0.397	0.150	0.279

FuelPrice	-0.078	0.406	-0.089	0.098	0.128	0.095
TouristCentre	-0.684 **	0.295	0.299 ***	0.072	-0.504 **	0.219
FinancialCentre	0.555	1.679	1.666 ***	0.409	-4.367 ***	1.394
GFC	-0.002	0.389	-0.013	0.095	0.033	0.068
ChristchurchEarthquake	-0.263	0.390	-0.007	0.066	0.245 **	0.104
LCCparticipant	0.486 *	0.286	0.249 ***	0.069	-0.819 ***	0.292
HubStatus	3.633 ***	1.085	-0.866 ***	0.264	1.499 **	0.708
Privatisation					1.286 ***	0.452
Year	-0.076	0.071	0.011	0.017		

Notes: *ASKF* and *ARRIVALF* respectively stand for the fitted values of (the logarithmic of) *ASK* and *ARRIVAL* according to Equations (2) and (3); Coef. stands for coefficient; S.E stands for standard error; *, ** and *** denote significance levels at 10%, 5% and 1%, respectively.

As expected, results from equations (2) and (3) shows that Accommodations and (International and Domestic) Destinations have significant impacts on airlines capacity and regional tourism. Particularly, more Accommodations (or the supply of establishments in the region for tourists) helps attract more guest arrivals; and interestingly more international connections to and from the airport helps increase the airlines capacity and tourism while more domestic connections hinders the development of airlines capacity and regional tourism. We argue that airlines and tourism in New Zealand benefit more from international customers rather than from domestic ones and thus, a policy toward international customers should be more focused by airlines and regions. In addition, regions that have financial status tend to attract more attentions from airlines and visitors (including business travellers). Meanwhile, the impact of tourist status is controversial: airlines have less capacity (may be because there is no direct international flights to those destinations, except for Auckland) but the number of guest arrivals to those tourist centres is still higher than their counterpart. It suggests that airlines (and airports) in New Zealand have to face the competition from rental cars (Lohmann and Zahra, 2010) or other modes of surface transportation (Pearce and Sahli, 2007). Whilst the participant of LCCs in an airport shows a positive relationship with airlines capacity and regional tourism, which is in line with Tsui (2017), status of the airport as a hub tells a different story: airlines are attracted more to hub airports but tourists are attracted more by (smaller and) non-hub airports. It is reasonable since tourists often prefer wildlife and nature environment and thus will target remoted destinations like Queenstown or Nelson (see previous discussion in Section 2 above).

Among the three key variables examined, estimation results from Equation (4) indicate that ARRIVALF has a positive and significant impact on EF, whilst ASKF statistically has not (although it is still a positive relationship). It is arguable for the case of ASKF and EF, since

airlines and airports theoretically operate separately from each other and thus, the airlines capacity has no or little impact on the airport efficiency (of using its own resources to cater the customers and get revenues). For the case of ARRIVALF and EF, our findings strengthen the common argument about the linkage between tourism and air transportation, especially airport efficiency, which is well documented in Bieger and Wittmer (2006), Duval (2013) and Küçükönal and Sedefoğlu (2017), among others. For the relationship between airport connectivity and its efficiency, it is suggested that the more international destinations it has, the less efficient the airport will be; however, higher airport efficiency is associated with more domestic destinations. This finding can be understood from the technical efficiency perspective, whereas monitoring a small airport with domestic routes may be easier (and more efficient) than monitoring a big one with both international and domestic routes. It therefore requires New Zealand airports to keep their business strategies balanced: the airports themselves may want to focus more on domestic routes and domestic customers to improve their efficiency, but their partners (airlines and local governments) may be more engaged on expanding their international routes and customers. Similar arguments can apply for the case of tourist centre and financial centre statuses. Given that New Zealand airports are still small in terms of number of annual passengers (see Table 2 above), it is suggested that the way LCCs operate can reduce the airports' efficiency instead of improving it (Červinka, 2017), as evidenced by *LCCparticipant*. Last but not least, we also observed that private airports in new Zealand tend to perform better than public-owned airports, consistent with findings from other studies (Oum *et al.*, 2006; Adler and Liebert, 2014).

5. Conclusion

This study examined the causal relationship between airport operation (including their capability and efficiency) and regional tourism development in New Zealand for the period of 2010–2016. We accounted for the endogeneity issue of airline capacity (proxied by the total available seat kilometres) as well as regional tourism (proxied by the number of region's guest arrivals) on New Zealand airports using a two-step Tobit regression (2STR). The impacts of factors such as regional characteristics (e.g. GDP, centre status) and external events (e.g. the Global Financial Crisis 2008, the Christchurch earthquake 2011) are also considered. Our findings provide evidence to strengthen the argument that local tourism development can boost up airport efficiency, while the positive impact of airline development on airport performance is not statistically clear. The examination of external factors such as regional GDP or

earthquake further suggests that the councils and decision makers can influence regional airports via the development of their regions.

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