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The impacts of airport activities on regional economy - An empirical analysis of New Zealand

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ABSTRACT: This study investigates the impacts of airport activities on regional economies using annual data on 22 regions and airports in New Zealand from 1996 to 2016. Studying all regions of an island country avoids the sample selection bias, and reduces the likelihood of incorrectly capturing the effects of improvements in other transport modes. The use of panel data over an extensive period of time also contributes to a robust identification procedure. In addition to the fixed effects estimation that has been frequently used in the literature, the system generalized methods of moments (GMM) approach and the dynamic common correlated effects (CCE) estimator are applied to account for cross-sectional dependence, cross-regional heterogeneity, and feedback effects. We find that airport activities have a statistically and economically significant impact on a region's economy. This finding is robust across fixed effects, GMM, and CCE estimations, although more significant effects are identified by the less restrictive CCE approach. Our study suggests a positive effect of aviation on regional economies, and supports local/regional policies promoting aviation activities.

KEY WORDS: ***Airport activities; Regional economy; New Zealand; Local/regional policies***

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1. Introduction

It is generally accepted that there is a strong correlation between air traffic and economic growth (Green, 2007), and airport activities and airport infrastructure catalyze local, regional, and national economic development (e.g. Button, Doh, & Yuan, 2010; Cooper, 1990; Green, 2007; Sarkis, 2000). Although the positive effects of aviation on the economy seem intuitive, the identification of such a causal relationship is difficult due to the strong interdependence between the provision of aviation services and regional growth (Blonigen & Cristea, 2015). Button (2010, p. 11) noted that “measuring local economic impact of airport investments is challenging and studies have often over-estimated them.” Compared with the significant body of literature on the relationship between the economic development of major cities and large international hub airports, less research has been conducted on regions with smaller populations and regional airports. Though a few studies have analyzed the impact of regional airports (e.g. Baker, Merkert, & Kamruzzaman, 2015; Button, 2010; Button, Doh, & Yuan, 2010), selecting a subset of airports in a market in a non-random manner may lead to estimation bias. Moreover, airports in the same country may experience different growth patterns that are inter-related. For example, the merger between Delta and Northwest resulted in more flights at Atlanta and Salt Lake City, but fewer flights at Cincinnati and Memphis. Such inter-dependence may exist for airports in different countries. Elwakil, Windle, & Dresner (2013) noted many Canadian travellers cross the border to fly the US low-cost carriers. Similar patterns have been observed in Europe where Ryanair was able to capture passengers from nearby airports in large catchment areas. Furthermore, there is significant heterogeneity among airports, as an aviation network is often consisting of a few large hubs and many small feeder airports. All these factors make sample selection a non-trivial task.

Regional airports are often viewed as a form of strategic infrastructure for regional economies due to the importance of air transport in connecting regions and transporting air passenger and air cargo traffic between destinations (Sarkis, 2000; Baker, Merkert, & Kamruzzaman, 2015). However, airport investments are usually lumpy and costly, and involve substantial risks and time (Oum & Zhang 1990; Xiao, Fu, & Zhang, 2013, 2016; Xiao et al., 2017). Many airports and communities are providing support and incentive programs to airlines in order to promote air services (Fu & Zhang 2010: Zhang, Fu, & Yang, 2010; Blonigen & Cristea, 2015). It is important to correctly identify the impact of airport activities on regional economy so that the right policies on airport investments and airline incentives can be formed (Blonigen & Cristea, 2015).

This study investigates the impact of airport activities on regional economies using annual data on 22 cities and airports in New Zealand from 1996 to 2016. The research design is expected to bring various benefits in empirical estimation: the national data coverage internalizes possible traffic shifting effects and removes subjective selection bias; and, New Zealand is isolated from other countries and air transport also plays a critical role in connecting many of the domestic regions that have limited surface transport services. As a result, the risk of incorrectly attributing the effects of improvements of other transport modes to airport activities during estimation is reduced; our panel dataset spans an extensive period of time which facilitates the identification of the relationship between airport activities and regional economy (Baker, Merkert, & Kamruzzaman, 2015); all airports were built prior to the sample period and thus can be regarded as being exogenous; and, our sample includes all airports with scheduled commercial services in New Zealand, which comprises both small regional airports and major hubs in the aviation system (Abbott, 2015; Kissling, 1998; Tsui, Gilbey, & Balli, 2014). This allows us to examine the influence of airport activities on regional economies of economy for regions of varying size and the New Zealand market as a whole. Finally, the econometric methods used in the study seek to improve upon previous methodologies in the literature, which have been mostly limited to Granger causality and the simple generalized method of moments (GMM) model. In addition to the fixed effects estimation that have been frequently used in the literature, the system generalized methods of moments (GMM) approach and the dynamic common correlated effects (CCE) estimator are applied to account for cross-sectional dependence, cross-regional heterogeneity, and feedback effects.

For the aforementioned considerations, our empirical analysis of New Zealand is expected to offer valuable insights regarding the impact of airport activities on regional economies. Specifically, we find that airport activities have a statistically and economically significant impact on a region's economy. This finding is robust across fixed effects, GMM, and CCE estimations, although more significant effects are identified by the less restrictive CCE model. Our study suggests a positive effect of aviation on regional economy and supports local/regional policies promoting aviation activities.

The remainder of this paper is structured as follows. Section 2 reviews the literature on the relationships between airport activities and regional economic development. Section 3 provides an overview of New Zealand's airport system. Section 4 describes the methodology used and the variables of interest. Section 5 reports and interprets estimation results obtained from alternative models. The last section summarizes the key findings and policy implications.

2. Literature review

A substantial body of literature has investigated various aspects of the impact of airport activities and air transport services on local and regional economic development. For example, recent studies relating to the impact of airport activities and infrastructure (e.g. Allroggen & Malina, 2014; Baker, Merkert, & Kamruzzaman, 2015; Batey, Madden, & Scholefield, 1993; Bilotkach, 2015; Button, Doh, & Yuan, 2010; Cidell, 2014; Cooper, 1990; Florida, Mellander, & Holgersson, 2015; Gibbons & Wu, 2017; Green, 2007; McGraw, 2015; Percoco, 2010; Sheard, 2014; Tsui, Tan, & Shi, 2016; Tveter, 2016; Van den Berg, Van Klink, & Pol, 1996) have suggested that the presence of airport activities (or a well-functioning and well-connected regional airport) is vital to local and regional economic development, employment growth, and the enhancement of social benefits. Table 1 summarizes the airport samples, methodologies, and variables of interest used in previous analyses. For example, Green (2007) used a two-equation model to analyze 83 airports in the United States, and found that the operations of an airport in a metropolitan area is significantly influenced by regional economic development, and meanwhile its presence assists in forecasting population and employment growth. Button, Doh, and Yuan (2010) used the fixed effects and random effects models to analyse the impact of 66 small airports in Virginia on the local economy, and concluded that small airports have the potential to contribute significantly to regional economic development. In Australia, Baker, Merkert, and Kamruzzaman (2015) used the vector error correction (VECM) model to examine the relationship between 88 regional airports and local economic development, and found a strong relationship between small regional airports (local air transportation) and regional economic development. In addition, Bilotkach (2015) used the fixed effects and the GMM models to evaluate the impact of primary airports (classified by air traffic volume and number of destinations) in the U.S. on the key indicators of regional economic development, and concluded that the number of destinations served by non-stop flights had a robust effect on level of employment, number of business establishments, and average wage in the region. These results were consistent with the findings of Sarkis (2000, p. 336), who claimed that "airports are critical, dominant forces in a community's economic development." The provision of efficient, reliable and affordable transport infrastructure has been shown to be essential to economic growth (Badalyan, Herzfeld, & Rajcaniova, 2014; Banister & Berechman, 2001; Duffy-Deno & Eberts, 1991).

Table 1. Studies of the relationship between airports and aviation activities and economic development

Author(s) and date	Sample	Methodology	Estimates
Cooper (1990)	-	Literature review	-
Batey et al. (1993)	1 U.K. airport	Input-output analysis	34 industrial sectors (including air transport)
Van den Berg et al. (1996)	10 European airports	Descriptive analysis	-
Green (2007)	83 U.S. airports	Two-equation model (ordinary least squares (OLS) and instrumental variables (IV) regression)	-Dependent variables: population growth, job growth -Explanatory variables: tax variables, climate variables, human capital variables, industrial structure, unionization variable, average commuting time
Button, Doh, & Yuan (2010)	66 small airports in Virginia (U.S.)	Fixed effects model, random effects model	-Dependent variable: real personal income per capita -Explanatory variables: total passengers, total population, aged population, federal expenditure, local expenditure, total employment, distance to airports (Dulles and Reagan)
Percoco (2010)	36 Italian airports	Tobit model	-Dependent variables: total employment in province, employment in manufacturing sector, employment in service industry -Explanatory variables: total number of passengers, total number of aircraft movements, province population, size of population aged 65 or over, % of population with college degree, total road length, dummy variables (northern and southern provinces, airports), distance between provincial capital and national centroids, number of hotels
Allroggen & Malina (2014)	19 German airports	Limited information maximum likelihood/panel data regression analysis	-Dependent variable: regional output -Explanatory variables: GDP, labour force, capital stock, value of fixed assets through acquisition and production costs, aircraft movements, average road and rail travel time, population, workload unit (WLU) share of airport
Cidell (2014)	25 largest airports in U.S.	Local-level spatial analysis	
Sheard (2014)	Core-based statistical areas in 48 states and District of Columbia, U.S.	System of equations	-Dependent variable: value of planned airport -Explanatory variables: aggregate employment, control factors (geographical, climatic, and demographic), local productivity factors

Baker et al. (2015)	88 Australian airports	VECM model	Total airport passenger movements, real aggregate taxable income
Bilotkach (2015)	All U.S. primary airports	Fixed effects model, dynamic panel data GMM model	-Dependent variables: total employment, total number of establishments, real weekly wages -Explanatory variables: total flights, number of non-stop destinations, population, unemployment rate, mean airfare, airport level HHI index
Florida et al. (2015)	All U.S. airports	Logit regression, bivariate correlation, OLS	-Dependent variables: airport, gross regional product per capita -Explanatory variables: size, technology, human capital, climate, unemployment, Bohemian index
McGraw (2015)	2 small and mid-sized airports in the U.S.	IV approach with three instruments	-Dependent variables: population, employment -Explanatory variables: employment in different sectors, population, earnings, characteristics of geography, transportation, and climate, dummy variables
Tsui et al. (2016)	3 major New Zealand airports	Two-stage least-squares regression analysis	-Dependent variables: property price index -Explanatory variables: airport WLUs, interest rate, rent, national GDP per capita, exchange rate, global financial crisis, Christchurch earthquakes, number of new houses built, material costs, median salary
Tveter (2016)	8 regional Norway airports	Difference in differences	-Population size, lagged employment growth, travel time to nearest airport, industry structure
Gibbons & Wu (2017)	Chinese airports	Panel fixed effects model	-Dependent variables: industrial output, GDP, employment, income, consumption, investment -Explanatory variables: air accessibility (land and air side), control variables

In addition, other recent studies of air transport services, mostly on passenger transport (e.g. Blonigen & Cristea, 2015; Braathen, 2011; Bråthen & Halpern, 2012; Brueckner, 2003; Donzelli, 2010; Graham & Guyer, 2000; Hu, et al., 2015; Mukkala & Tervo, 2013; Özcan, 2013, 2014a; Van de Vijver, Derudder, & Witlox, 2016), have indicated that the provision of air transport activities often has key causal effects on local and regional economic development, income, employment growth, and regional welfare. Similarly, air freight/air cargo traffic has been found to strongly affect local and regional economic development and promote job creation (e.g. Alkaabi & Debbage, 2011; Button, & Yuan, 2013; Kasarda & Green, 2005; Özcan, 2014b; Tan & Tsui, 2016). These recent empirical studies are evidence that airports are centers of economic growth, and that consequently, the growth of airport activities may improve and stimulate economic development in local or regional communities. A strong correlation has been found between air transport activities and economic growth.

Despite these important insights obtained, many previous studies are arguably based on a sample of airports subjectively chosen in the region or country of interest, predominantly in developed economies. Gibbons and Wu (2017) conducted an excellent study of China. However, due to the availability of extensive high-speed rail networks, the effects of improvements in other transport modes may be incidentally captured for estimates using Chinese data. A similar problem may exist for studies carried out for North America and Europe, where road transport consists of a substantial market share of inter-regional traffic. Where new commercial airports are built or converted from military airports (e.g. Western Europe) during the sample period, it is challenging to design a good estimation strategy due to the endogeneity caused by the interdependence between airport activities and economic growth. With an aim to complement these previous investigations, this paper attempts to identify the impact of airport activities on regional economies in New Zealand. The following section provides a brief overview of the airport system in the country.

3. Overview of New Zealand airport system

New Zealand has a well-developed international and regional airport network, with 24 commercial airports offering scheduled international and/or domestic air services (Lyon & Francis, 2016) (see Figure 1). New Zealand is geographically isolated from the rest of the world, with limited surface transport connections between some key regions. The country is thus very dependent on international and domestic air transport (Lyon & Francis, 2006; Balli & Tsui, 2016; Tsui, Tan, & Shi, 2016; Statistics New Zealand, 2016). A unique characteristic of New Zealand's airport system is the presence of only one commercial airport per region across the country (Tsui, 2017), making it easier to define each airport's catchment area. In 2016, six airports offered international air services: Auckland, Christchurch, Dunedin, Nelson, Queenstown, and Wellington. New Zealand airports with regular passenger services vary considerably in size: the largest and busiest airport is Auckland International Airport, followed by Christchurch, Wellington and Queenstown. These airports play a more important role in the air transport system than smaller regional airports because they serve major cities and popular tourist destinations in New Zealand.

Figure 1. New Zealand airport system

In 2016, the top five New Zealand airports as measured by the total number of scheduled airline seats were as follows: Auckland (11.58 million); Christchurch (4.08 million), Wellington (3.83 million), Queenstown (1.11 million), Nelson (0.64 million), and Dunedin (0.60 million). Almost 90% of New Zealand's scheduled airline capacity is represented by Auckland, Christchurch, and Wellington airports. The total annual scheduled seat capacity was less than 0.60 million in 2016. In addition, most New Zealand airports showed the positive compound annual growth rates (CAGR) for scheduled airline seat capacity, ranging from 8.46% to -9.12% (OAG, 2017).

Regarding the airports' international connectivity, Auckland Airport is an international gateway and hub for travelers in Australasia and the Pacific, connecting air passengers and air freight with 39 international destinations in 2016. Christchurch Airport connects passengers and freight with the second largest number of 11 international destinations, followed by Wellington and Queenstown airports, which offer flights to six and four international destinations, respectively. Arguably, Christchurch Airport has become the second international gateway and hub airport serving New Zealand's South Island, benefiting from its ability to attract international airlines (Air New Zealand, Asiana Airlines, China Airlines, China Southern Airlines, Emirates, Fiji Airways, Jetstar, Qantas, Singapore Airlines, Thomson Airways, and Virgin Australia). Auckland and Wellington airports boasts the largest domestic networks (19 destinations each) in 2016, followed by Christchurch Airport (16 destinations), Nelson Airport (seven destinations), Hamilton Airport (six destinations), and Blenheim and Dunedin airports (five destinations). Smaller New Zealand airports have minimal domestic networks: they are connected with only one to four destinations, with primary connections to Auckland, Christchurch, and Wellington airports.

This specific pattern of domestic connectivity reflects the system of hub-and-spoke networks of Air New Zealand, which carries air passengers from smaller regional airports to two main hubs (Auckland and Christchurch airports). The well-developed domestic networks of New Zealand airports enable people from New Zealand's regions and cities to access international connections with ease (New Zealand Ministry of Transport, 2013, 2016).

4. Data definitions and empirical models

Table 2 below defines the variables used in this study and provides data on GDP per capita and unemployment rate. These two quantitative measures succinctly capture the development of New Zealand's regional and local economies that represent the economic output and employment prospects of local population. Airport activity is proxied by the total number of scheduled seats on flights into and out of a given airport, and the total number of available seat kilometers (ASK) on flights into and out of a given airport. These airport activity measures have been used in prior studies (Tsui, Tan, & Shi, 2016; Koo, Tan and Duval, 2013).

Table 3 presents the descriptive statistics associated with the variables of interest. The average of regional GDP per capita and unemployment rate are NZ$38.849.75 and 5.13%, with standard deviations equal to NZ$10,793.36 and 5.13%, respectively. The average of the two key variables of interest (total number of scheduled seats and total ASK) are 855,438 and 1.18E+09, with standard deviations of 1,935,290 and 3.71E+09, respectively. The average number of tourist arrivals is 746,237, and the standard deviation is 748,379. The average regional population and net migration (number of people) are 187,541 and 734, and their standard deviations are 301,257 and 3,435, respectively. Overall, there is substantial heterogeneity across the airports and regions in New Zealand. On the one hand, such a dataset allows us to identify the effects of different types of airports and regions. On the other hand, it is important to use empirical estimation models that are sufficiently flexible in allowing for such cross-regional heterogeneity.

Table 2. Variable definitions and data sources (2001–2016)

Time series and variables	**Definitions**	**Data sources**
Regional GDP per capita$_{it}$	GDP per capita of region *i* at year *t*	Statistics New Zealand
Unemployment rate$_{it}$ (%)	Unemployment in region *i* at year *t*	Statistics New Zealand
Total scheduled seats$_{it}$	Total scheduled airline seats at an airport in region *i* at year *t*	Office of the Auditor-General (OAG)
Total ASK$_{it}$	Total ASK at an airport in region *i* at year *t*	OAG
Tourist arrivals$_{it}$	Number of tourist arrivals to region *i* at year *t*	Statistics New Zealand
Regional population$_{it}$	Size of population of region *i* at year *t*	Statistics New Zealand
Net migration$_{it}$	Number of migrants moving to and from region *i* at year *t*	Statistics New Zealand

Table 3. Descriptive statistics for variables (2001–2016)

Variables	**Observations**	**Mean**	**Standard deviation**	**Maximum**	**Minimum**	**Skewness**	**Kurtosis**
Regional GDP per capita$_{it}$	352	38,849.75	10,793.36	79,289	21,959	1.21	5.19
Regional unemployment rate$_{it}$ (%)	352	5.13	1.58	9	2	0.51	2.31
Total scheduled seats$_{it}$	352	855,438	1,935,290	11,581,404	5672	3.20	13.26
Total available seat kilometres$_{it}$	352	1.18E+09	3.71E+09	2.27E+10	1267336.	3.40	18.18
Tourist arrivals$_{it}$	352	746,237	748,379	3,682,412	84,667	2.00	6.43
Regional population$_{it}$	352	187,541	301,257.20	1,614,300	7990	3.20	13.27
Net migration$_{it}$	352	734.53	3435.78	33,916	-3422	6.40	50.96

We begin by estimating the elasticity between economic growth and airport (air transport) activities based on the following simple panel data model:

(1) $$lnGDP_{it} = \beta lnSeats_{it} + \Delta X_{it} + \gamma_i + \gamma_t + \varepsilon_{it},$$

where $lnGDP_{it}$ represents the logarithm of GDP per capita in region i at year t; $lnSeats_{it}$ represents the logarithm of scheduled airline seats ($lnSeats_{it}$) for region i at year t; γ_i and γ_t constitute a regional fixed effect and a time fixed effect, respectively; and ε_{it} is the error term. The regional fixed effect controls non-parametrically for time-invariant unobservable regional characteristics; the time fixed effect controls non-parametrically for yearly differences in the outcome of interest; and the vector of regional characteristics, X_{it} is a vector of controls for time-varying characteristics that may be correlated with airport (air transport) activities, such as tourism activities. The parameter of interest is represented by β.

Although we present the estimation results using this simple static panel data specification, as applied in many previous empirical studies (a few using air transport data, such as Mahutga et al. (2010) and Khadaroo and Seetanah (2008), their interpretation is subject to the validity of several hypotheses. First, the model does not incorporate temporal dependency (lags) in the dependent variable. Although the coefficients on the lagged dependent variables may not be crucial to researchers' interest, lags shall be introduced to control for the dynamics of the process, following most works on the empirics of economic growth. Second, the model is premised on the potentially unwarranted assumptions of constant time effects and slope coefficients identical across regions.

To address the first point, we allow for dynamics of adjustment in the growth equation above by adding $lnGDP_{i(t-1)}$ as a regressor. However, the estimation of this dynamic model is challenging. Traditional static panel data methods, such as the fixed effects and random effects estimators, become inconsistent due to the violation of the strict exogeneity assumption. The inconsistency of the fixed effects estimator arises from the demeaning process used to eliminate the fixed effect, which results in a negative correlation between the transformed error and the lagged regressor, leading in turn to the failure of the strict exogeneity assumption. The inconsistency of the random effects estimator arises from the non-zero correlation between the fixed effect and the lagged variable, as $lnGDP_{i(t-1)}$ itself depends on the fixed effect.

The dynamic system GMM procedure is commonly used to handle endogeneity issues while including regional fixed effects in a dynamic panel (Arellano & Bond, 1991; Blundell & Bond, 1998). This method is consistent if time effects are constant, error terms are cross-sectionally independent, and slope coefficients are identical across regions. For instance, if time effects within regions are heterogeneous, as per the second point raised above, estimates generated using the dynamic system GMM model will be biased (Pesaran & Smith, 1995). For example, when an increase in airfare induced by oil price shocks may have different effects on the flow of air passengers among regions. This can be an issue in estimation given the significant heterogeneity observed across the regions and airports in New Zealand.

The dynamic common correlated effects (CCE) estimator developed by Chudik and Pesaran (2015) can be used to overcome the two challenges raised above when estimating the dynamic panel GMM model. The estimated equation is given by the following:

(2) $$lnGDP_{it} = \beta lnSeats_{it} + \delta_i lnGDP_{i(t-1)} + \Delta_i X_{it} + \sum_{k=0}^{p_T} \alpha'_{ik} \overline{z_{t-k}} + \gamma_i + \varepsilon_{it},$$

where $\overline{z_{t-k}} = (\overline{lnGDP_{it}}, \overline{lnGDP_{i(t-1)}}, \overline{lnSeats_{it}}, \overline{X_{it}})$ are the cross-sectional averages of the dependent and independent variables, and p_T designates the number of lags in the cross-sectional averages. Note that all parameters are allowed to vary with *i*. This model has the advantage of taking into account the panel time series nature of the data, parameter heterogeneity, cross-sectional dependence, and dynamics.

Following Chudik and Pesaran (2015) and Ditzen (2016), if we define $\pi_i = (\beta_i, \delta_i, \Delta_i)$, the mean group estimates are obtained by:

(3) $$\widehat{\pi_{MG}} = \frac{1}{N} \sum_{i=1}^{N} \widehat{\pi_i},$$

and its asymptotic distribution and nonparametric consistent asymptotic variance-covariance matrix are given by the following:

(4) $$\sqrt{N}(\widehat{\pi_{MG}} - \pi) \rightarrow N(0, \Sigma_{MG}),$$

Where,

(5) $$\Sigma_{MG} = \frac{1}{N-1} \sum_{i=1}^{N} (\widehat{\pi_i} - \widehat{\pi_{MG}})(\widehat{\pi_i} - \widehat{\pi_{MG}}),$$

In the estimations presented below, we use the recursive mean adjustment method to correct for small sample time series bias, as advised by Chudik and Pesaran (2015). We also use regional unemployment rate as an alternative dependent variable and measure of economic well-being. To ensure robustness, the natural logarithm of ASK ($lnASK_{it}$) is used in place of $lnSeats_{it}$ to ascertain the stability of the estimation results.

5. Empirical findings

In this section, the model estimates for the fixed effects and dynamic panel GMM specifications are reported first, followed by those obtained using the dynamic CCE estimator.

Table 4 reports the fixed effects and dynamic panel GMM coefficient estimates. These estimates are generated under different assumptions, all of which are indicated in the table. The top panel of Table 4 displays the estimates yielded by the fixed effects and dynamic GMM models using the natural logarithm of regional GDP per capita (*lnGDP*) in New Zealand. Models (1) to (3) are the fixed effects specifications namely airport and year fixed effects (Model 1), the control variables (Model 2), and an airport-specific time trend (Model 3). Note that the number of scheduled airline seats (*lnSeats*) is the proxy for airport activities. All three models generate statistically significant and positive coefficient estimates of the natural logarithm of *lnSeats* at the 1% significance level, indicating that airport activities have a positive impact on regional GDP per capita in New Zealand. For example, the estimation results of Models (1) to (3) suggest that a 1% increase in the number of scheduled airline seats at an airport leads to a rise of 0.0644–0.7720% in New Zealand's regional GDP per capita, *ceteris paribus*. Model (4) is analogous to Models (1) to (3), but estimated using the dynamic GMM framework. Although the dynamic GMM model does not account for airport-specific time trends, it offers a non-parametric approach to estimation, controls for the dynamic nature of the dependent variable (*lnGDP*), and uses internal instruments (the lagged regressor) to overcome the problem of endogeneity, subject to strict assumptions (Arrelano & Bond, 1991; Blundell & Bond, 1998). *lnSeats* remains statistically significant and positive at the 1% significance level in the dynamic panel GMM model. In addition, its economic significance increases markedly, with an airport activities-to-regional GDP per capita elasticity estimate of 0.7720.

Table 4. Relationship between airport activities and economic well-being (fixed effects and GMM models)

Dependent variables	***lnGDP***							
Explanatory variables	**(1) FE**	**(2) FE**	**(3) FE**	**(4) GMM**	**(5) FE**	**(6) FE**	**(7) FE**	**(8) GMM**
lnSeats	0.0676*** (0.0194)	0.0730*** (0.0201)	0.0644*** (0.0210)	0.7720*** (0.0136)				
lnASK					0.0416*** (0.0127)	0.0400*** (0.0134)	0.0363*** (0.0134)	0.0493*** (0.0112)
Airport fixed effects	√	√	√	√	√	√	√	√
Year fixed effects	√	√	√	√	√	√	√	√
Controls		√	√	√		√	√	√
Airport-specific time trend			√				√	
R^2	0.94	0.93	0.97		0.94	0.93	0.97	
Observations	352	352	352	352	352	352	352	352
Dependent variables	***lnUnemployment***							
Explanatory variables	**(1) FE**	**(2) FE**	**(3) FE**	**(4) GMM**	**(5) FE**	**(6) FE**	**(7) FE**	**(8) GMM**
lnSeats	- 0.0851*** (0.0429)	-0.0671 (0.0533)	0.0291 (0.0672)	-0.0427 (0.0145)				
lnASK					-0.0467* (0.0243)	- 0.0778*** (0.0344)	0.0282 (0.0418)	-0.0488 (0.0138
Airport fixed effects	√	√	√	√	√	√	√	√
Year fixed effects	√	√	√	√	√	√	√	√
Controls		√	√	√		√	√	√
Airport-specific time trend			√				√	
R^2	0.65	0.65	0.76		0.77	0.78	0.83	
Observations	540	499	499	499	440	440	440	440

Models (5) to (8) in the top panel of Table 4 report the estimation results with the natural logarithm of ASK (*lnASK*) as the proxy for (measure of) airport activities in the fixed effects and dynamic GMM models. Clearly, the statistical and economic significance of the estimation results is largely consistent with the results of Models (1) to (4). The coefficient estimate of *lnASK* is found to be statistically significant and positive at the 1% significance level. For example, Models (5) to (8) suggest that a 1% increase in ASK at a New Zealand airport will increase regional GDP per capita by 0.0363–0.0493%.

In the bottom panel of Table 4, the natural logarithm of regional unemployment rate (*lnUnemployment*) is used as the measure of regional well-being in New Zealand. The relationship between airport activities and regional unemployment is slightly more ambiguous than between airport activities and regional GDP per capita. Using *lnSeats* as the regressor of interest, the significant negative coefficient estimate is reported in Model (1). This finding suggests that a 1% increase in the number of an airport's scheduled airline seats reduces regional unemployment in New Zealand by 0.0851%, *ceteris paribus*. Once the control variables and airport-specific time trends have been included in the models, this statistical relationship disappears. Similarly, within the dynamic panel GMM specification, no statistically significant relationship is found between *lnSeats* and *lnGDP*.

In Models (5) to (8), shown in the lower panel of Table 4, *lnASK* is used as a proxy for airport activities. Similar to the results discussed above, a statistically significant and negative relationship between *lnASK* and *lnUnemployment* is revealed in some of the fixed effects model specifications (Models 5 and 6). A 1% increase in ASK at an airport is found to reduce regional unemployment rate by 0.0467–0.0778%. However, once airport-specific time trends have been accounted for in Model (7), no significant relationship can be found between *lnASK* and *lnUnemployment*. Note that the coefficient estimate for *lnASK* is not statistically significant in the dynamic panel GMM model (Model 8).

The results for the dynamic CCE estimator are reported in Table 5. Note that the dynamic CCE model accounts for all of the factors indicated in Table 4, and also allows for parameter heterogeneity, cross-sectional dependence, and the dynamic nature of the dependent variable, as discussed in the section on methodology. In Model (1) as shown in Table 5, *lnGDP* is used as the dependent variable and *lnSeats* as the measure of airport activities. This finding suggests that the airport activities measure is statistically significant and positive at the 1% significance level, and that a 1% increase in the number of scheduled airline seats will result in an average increase of 0.1629% in New Zealand's regional GDP per capita in the same direction. Note that the one period lag of *lnGDP* ($lnGDP_{t-1}$) is found to be statistically significant and positive, indicating a degree of persistence (dynamism) in *lnGDP*.

Table 5. Relationship between airport activities and economic wellbeing (dynamic CCE estimator)

Dependent variables	*lnGDP*		*lnUnemployment*	
Explanatory variables	**Model (1)**	**Model (2)**	**Model (3)**	**Model** (4)
lnSeats	0.1629*** (0.0307)		-0.8156*** (0.1424)	
lnASK		0.1461*** (0.0282)		-0.4863*** (0.1315)
$lnGDP_{t-1}$	0.6614*** (0.0269)			
$lnUnemployment_{t-1}$		0.6142*** (0.0351)	1.0065*** (0.1352)	0.8693*** (0.1935)

Notes: All estimations include a constant region-specific term. Robust standard errors in parentheses. ***, ***, and * represent p < 1%, p < 5%, and p < 10%, respectively.

In addition, Model (2) in Table 5 uses *lnASK* as a proxy for airport activities and regressed against *lnGDP*. Similar to Model (1), its coefficient estimate is statistically and economically significant, with a positive sign. This indicates that a 1% rise in airport ASK results in an increase of 0.1461% in New Zealand's regional GDP per capita on average, *ceteris paribus*. In Models (3) and (4), both measures of airport activities (*lnSeats* and *lnASK*) have a significant negative impact on regional unemployment rate. Specifically, a 1% increase in the number of scheduled airline seats at an airport will result in a 0.8156% reduction in New Zealand's regional unemployment rate on average. Similarly, a 1% increase in an airport's

ASK will result in a decline in regional unemployment rate of 0.4863% on average. Again, Models (3) and (4) generate the statistically significant coefficient estimates of the lagged regional unemployment rate ($lnUnemployment_{t-1}$), reflecting its dynamic nature.

In summary, there is strong evidence that airport activities have an important impact on the economic welfare of New Zealand's regions, as measured by regional GDP per capita and regional unemployment rate. The empirical evidence for the case of regional GDP per capita is strong, with all model estimates suggesting a highly significant positive relationship between airport activities and regional GDP per capita. However, when using unemployment rate as the measure of economic development, the strength of the expected negative relationship varies across the model specifications, with more significant effects identified by the CCE approach. Because the dynamic CCE approach are asymptotically more flexible (e.g. allowing for different slopes for different regions) and robust (e.g. account for cross-sectional dependence and feedback effects), we are inclined to put higher weights on estimates produced by this less restrictive model specification. The dynamic CCE estimator indicates that a statistically and economically significant relationship exists between airport activities and regional unemployment rate, which tends to be stronger than the estimates from other specifications.

6. Summary and conclusion

The findings of this study suggest that a strong causal relationship exists between airport activities and economic well-being in regional economies. Although many prior studies, such as Green (2007), Button, Doh and Yuan (2010), Baker, Merkert and Kamruzzaman (2015) and Bilotkach (2015), have examined the relationship between air transport and economic development, this study uses a dynamic CCE estimator to analyse the New Zealand market, which is expected to produce more robust results that account for panel time series data, parameter heterogeneity, cross-sectional dependence, and dynamics. The analysis of all regions and airports in a geographically isolated country (New Zealand) avoids sample selection bias, and reduces the likelihood of wrongly capturing the effects of improvements in other transport modes. The sampled airports and regional economies vary considerably in size, and the panel data covers a long period. Both these features are expected to contribute to a robust identification.

Importantly, the study's findings, obtained in a New Zealand setting, supplement existing evidence in the air transport literature of airports' significant positive impact on the economic development of their respective regional communities. Consistent estimates are obtained from fixed effect estimation, the GMM approach and the dynamic CCE estimator in this study, which all suggest that airport activities have a statistically and economically significant impact on region economic development, as measured by GDP per capita and regional unemployment rate. Such results are consistent with the findings by the New Zealand Airport Association (2013), which argued that the country's airports and air transportation services have employed more than 12,645 people since 2000, representing 3.2% of New Zealand's labor force. The number of people working for or employed in the airport environment has increased by 49% since 2000.

Results obtained in this study indicates that policy makers and business decision-makers (e.g. local/regional authorities and airport and airline management) should strategically consider investing in and improving airport capacity and air accessibility by providing additional flight routes/increasing flight frequency at local/regional airports. The economic impact of airport activities identified in this study is large enough to warrant a critical assessment of airport capacity and infrastructure improvement by New Zealand policy makers. In particular, the findings suggest that a 1% increase in scheduled airline seat capacity at a local/regional airport will lead to a 0.1461–0.1629% increase in regional GDP per capita and a 0.4863–0.8156% reduction in regional unemployment rate (see Table 5). Note that other factors determining well-being, such as inter-regional business interactions, branding, and trade, may also be influenced by air travel capacity and activity.

The significant effects of airport activities on regional economic output and well-being identified in this study may be partly due to New Zealand's geographical isolation, which makes air transport as a crucial means of connecting passengers and air cargo both domestically and with other countries. On the other hand, it is possible that the contribution of aviation to regional development can be larger than those estimated in this study, as New Zealand doesn't have a lot of high-tech manufacturing activities, which often critically rely on air cargo services to achieve efficient transport and logistics operations.

This study is the first to quantitatively model the relationship between airport activities and the economic development of New Zealand's regional economies. Despite the strong evidence identified, further research should be conducted to identify and capture other benefits associated with airport activities (e.g. business contribution, increased efficacy, and enhanced tourism) to help policy makers to devise and implement better strategic plans for investment in airport infrastructure. As an extension of this study, it may be useful to perform econometric analysis to determine whether the economic impact of airport activities has the same magnitude in larger economies with larger airports (e.g. Auckland, Christchurch, Queenstown, and Wellington) and smaller economies with regional airports (e.g. New Plymouth and Palmerston North). This may provide an interesting point of comparison between larger and smaller regions in New Zealand, and, even more importantly, shed light on the importance of aviation infrastructure to New Zealand's smaller and less developed regions. Finally, future researchers are advised to use more disaggregated data (when available) on individual industries within a local/regional economy, shedding light on the transmission of the benefits of air transport growth and air accessibility for local/regional economies; and to identify which industries (e.g. tourism and air freight) benefit most from a well-planned and developed airport infrastructure and activities. This will prompt local/regional policy makers to raise capital for airport development and negotiate with airlines to provide more flight routes or increase flight frequency for passenger (including tourist) flow and air cargo flow.

References

Abbott, M. (2015). Reform and efficiency of New Zealand's airports. *Utilities Policy*, *36*, 1–9.

Alkaabi, K. A., & Debbage, K. G. (2011). The geography of air freight: Connections to US metropolitan economies. *Journal of Transport Geography*, *19*(6), 1517–1529.

Allroggen, F., & Malina, R. (2014). Do the regional growth effects of air transport differ among airports? *Journal of Air Transport Management*, *37*, 1–4.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, *58*(2), 277–297.

Badalyan, G., Herzfeld, T., & Rajcaniova, M. (2014). *Transport infrastructure and economic growth: Panel data approach for Armenia, Georgia and Turkey*. EAAE Seminar: Growing Success? Agriculture and rural development in an enlarged EU.

Baker, D., Merkert, R., & Kamruzzaman, M. (2015). Regional aviation and economic growth: Cointegration and causality analysis in Australia. *Journal of Transport Geography*, *43*, 140–150.

Balli, F., & Tsui, W. H. K. (2016). Tourism demand spillovers between Australia and New Zealand: Evidence from the partner countries. *Journal of Travel Research*, *55*(6), 804–812.

Banister, D., & Berechman, Y. (2001). Transport investment and the promotion of economic growth. *Journal of Transport Geography*, *9*(3), 209–218.

Batey, P. W., Madden, M., & Scholefield, G. (1993). Socio-economic impact assessment of large-scale projects using input–output analysis: A case study of an airport. *Regional Studies*, *27*(3), 179–191.

Bilotkach, V. (2015). Are airports engines of economic development? A dynamic panel data approach. *Urban Studies*, *52*(9), 1577–1593.

Blonigen, B. A., & Cristea, A. D. (2015). Air service and urban growth: Evidence from a quasi-natural policy experiment. *Journal of Urban Economics*, *86*, 128–146.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, *87*(1), 115–143.

Braathen, S. (2011). *Air transport services in remote regions*. International Transport Forum Discussion Paper No. 2011-13. Retrieved April 14, 2017 from http://hdl.handle.net/10419/68819

Bråthen, S., & Halpern, N. (2012). Air transport service provision and management strategies to improve the economic benefits for remote regions. *Research in Transportation Business & Management*, *4*, 3–12.

Brueckner, J. K. (2003). Airline traffic and urban economic development. *Urban Studies*, *40*(8), 1455–1469.

Button, K. (2010). Economic aspects of regional airport development. In M. N. Postorino (Eds.), *Development of regional airports: Theoretical analyses and case studies* (pp. 11–25). Southampton, U.K.: WIT Press.

Button, K., Doh, S., & Yuan, J. (2010). The role of small airports in economic development. *Journal of Airport Management*, *4*(2), 125–136.

Button, K., & Yuan, J. (2013). Airfreight transport and economic development: An examination of causality. *Urban Studies*, *50*(2), 329–340.

Chudik, A., & Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics*, *188*(2), 393–420.

Cidell, J. (2014). The role of major infrastructure in subregional economic development: an empirical study of airports and cities. *Journal of Economic Geography*, *15*(6), 1125–1144.

Cooper, R. (1990). Airports and economic development: An overview. *Transportation Research Record*, *1274*, 125–133.

Ditzen, J. (2016). *Estimating dynamic common correlated effects in Stata*. The Spatial Economics and Econometrics Centre, Discussion Paper Series No. 8.

Donzelli, M. (2010). The effect of low-cost air transportation on the local economy: Evidence from Southern Italy. *Journal of Air Transport Management*, *16*(3), 121–126.

Duffy-Deno, K. T., & Eberts, R. W. (1991). Public infrastructure and regional economic development: A simultaneous equations approach. *Journal of Urban Economics*, *30*(3), 329–343.

Elwakil, O. S., Windle, R. J., & Dresner, M. E. (2013). Transborder demand leakage and the U.S. – Canadian air passenger market. *Transportation Research - Part E*, *57*, 45–57.

Florida, R., Mellander, C., & Holgersson, T. (2015). Up in the air: The role of airports for regional economic development. *The Annals of Regional Science*, *54*(1), 197–214.

Fu, X., & Zhang, A. (2010). Effects of airport concession revenue sharing on competition and social welfare, *Journal of Transport Economics and Policy*, *44*(2), 119–138.

Gibbons, S., & Wu, W. (2017). *Airports, market access and local economic performance: Evidence from China*. Retrieved from http://eprints.lse.ac.uk/83630/1/sercdp0211.pdf

Graham, B., & Guyer, C. (2000). The role of regional airports and air services in the United Kingdom. *Journal of Transport Geography*, *8*(4), 249–262.

Green, R. K. (2007). Airports and economic development. *Real Estate Economics*, *35*(1), 91–112.

Hu, Y., Xiao, J., Deng, Y., Xiao, Y., & Wang, S. (2015). Domestic air passenger traffic and economic growth in China: Evidence from heterogeneous panel models. *Journal of Air Transport Management*, *42*, 95–100.

Kasarda, J. D., & Green, J. D. (2005). Air cargo as an economic development engine: A note on opportunities and constraints. *Journal of Air Transport Management*, *11*(6), 459–462.

Khadaroo, J., & Seetanah, B. (2008). The role of transport infrastructure in international tourism development: A gravity model approach. *Tourism Management*, *29*(5), 831–840.

Kissling, C. (1998). Liberal aviation agreements–New Zealand. *Journal of Air Transport Management*, *4*(3), 177–180.

Koo, T. T., Tan, D. T., & Duval, D. T. (2013). Direct air transport and demand interaction: A vector error-correction model approach. *Journal of Air Transport Management*, *28*, 14–19.

Lyon, D., & Francis, G. (2006). Managing New Zealand's airports in the face of commercial challenges. *Journal of Air Transport Management*, *12*(5), 220–226.

Lyon, D., & Francis, G. (2016). Current issues in airport management in New Zealand. In D. T. Duval (Eds.), *Air transport in the Asia Pacific* (pp. 53–73). New York, NY: Ashgate Publishing.

Mahutga, M. C., Ma, X., Smith, D. A., & Timberlake, M. (2010). Economic globalisation and the structure of the world city system: The case of airline passenger data. *Urban Studies*, 47(9), 1925–1947.

McGraw, M. J. (2015). *Perhaps the sky's the limit? Airports and employment in local economies*. Retrieved from http://matrix.berkeley.edu/sites/default/files/media_publication/airportspaperJMPv220_HighQ.pdf

Mukkala, K., & Tervo, H. (2013). Air transportation and regional growth: Which way does the causality run? *Environment and Planning A*, *45*(6), 1508–1520.

New Zealand Airport Association. (2013). *Economic and social contribution of New Zealand's airports*. Retrieved from https://www.me.co.nz

New Zealand Ministry of Transport. (2013). *Economic effects of air service liberalisation in New Zealand*. Retrieved from http://www.transport.govt.nz/assets/Uploads/Research/Documents/Covec-Economic-Effects-of-Air-Services-Liberalisation.pdf

New Zealand Ministry of Transport. (2016). *Future domestic air network analysis*. Retrieved August 25, 2017 from http://www.transport.govt.nz/assets/Uploads/About/Documents/Future-Domestic-Airports-Network-Analysis-Report.pdf

OAG (Official Airline Guide). (2017). *Schedule analyzer*. Retrieved August 25, 2017 from https://analytics.oag.com/analyser-client/modules

Oum, T. H., & Zhang, Y., (1990). Airport pricing: Congestion tolls, lumpy investment, and cost recovery. *Journal of Public Economics*, *43*(3), 353–374.

Özcan, I. C. (2013). Air passenger traffic and local employment: Evidence from Turkey. *European Journal of Transport and Infrastructure Research*, *13*(4), 336–356.

Özcan, I. Ç. (2014a). Economic contribution of essential air service flights on small and remote communities. *Journal of Air Transport Management*, *34*, 24–29.

Ozcan, I. C. (2014b). The effect of air cargo traffic on regional job creation in Turkey. *Journal of Transport Literature*, *8*(4), 146–163.

Percoco, M. (2010). Airport activity and local development: Evidence from Italy. *Urban Studies*, *47*(11), 2427–2443.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, *94*(446), 621–634.

Sarkis, J. (2000). An analysis of the operational efficiency of major airports in the United States. *Journal of Operations Management, 18*(3), 335–351.

Sheard, N. (2014). Airports and urban sectoral employment. *Journal of Urban Economics*, *80*, 133–152.

Statistics New Zealand. (2016). *Tourism satellite account: 2016*. Retrieved August 25, 2017 from http://www.stats.govt.nz/browse_for_stats/industry_sectors/Tourism/tourism-satellite-account-2016/summary-results.aspx

Tan, D., & Tsui, K. (2017). Investigating causality in international air freight and business travel: The case of Australia. *Urban Studies*, *54*(5), 1178–1193.

Tsui, K. W. H. (2017). Does a low-cost carrier lead the domestic tourism demand and growth of New Zealand? *Tourism Management*, *60*, 390–403.

Tsui, W. H. K., Gilbey, A., & Balli, H. O. (2014). Estimating airport efficiency of New Zealand airports. *Journal of Air Transport Management*, *35*, 78–86.

Tsui, W. H. K., Tan, D., & Shi, S. (2016). Impacts of airport traffic volumes on house prices of New Zealand's major regions: A panel data approach. *Urban Studies*, 1–18.

Tveter, E. (2016). *Effects of airport accessibility on regional development: Evidence from implementation of regional airports in Norway*. Retrieved from https://www.researchgate.net/publication/311970820

Van den Berg, L., Van Klink, H. A., & Pol, P. M. J. (1996). Airports as centres of economic growth. *Transport Reviews*, *16*(1), 55–65.

Van de Vijver, E., Derudder, B., & Witlox, F. (2016). Air passenger transport and regional development: Cause and effect in Europe. *PROMET—Traffic&Transportation*, *28*(2), 143–154.

Xiao, Y., Fu, X., Oum, T.H., & Yan, J. (2017). Airport capacity investments with real options, *Transportation Research - Part B*, *100*, 93–114.

Xiao, Y., Fu, X., & Zhang, A. (2013). Demand uncertainty and airport capacity choice. *Transportation Research - Part B*, *57*, 91–104.

Xiao, Y., Fu, X., & Zhang, A. (2016). Airport investment with vertical arrangements, *Transportation Research - Part A*, *92*, 298–309.

Zhang A., Fu, X., & Yang, G. (2010), Revenue sharing with multiple airlines and airports. *Transportation Research – Part B, 44*(8-9), 944–959.