Do airport activities affect regional economies? Regional analysis of New Zealand's airport system

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Abstract

This study investigates the impacts of airport activities on regional economies using annual data on all regions and 22 airports in New Zealand from 2001 to 2016. The use of panel data over an extensive period enables robust identification. In addition to fixed effects (FE) estimation, which is frequently used in the literature, the system generalized method of moments (GMM) approach and the dynamic common correlated effects (CCE) estimator are used to account for cross-sectional dependence, cross-regional heterogeneity, and feedback effects. We find that airport activities have significant impacts on a region's economy. This finding is robust across the FE, GMM, and CCE estimations. Our study shows clear evidence that aviation activities positively affect regional economies, and that it is beneficial for policy makers and airport owners in a region to promote aviation activities.

Keywords: 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 that airport activities and airport infrastructure catalyze local, regional, and national economic development (e.g., Adler et al., 2014; Button et al., 2010; Cooper, 1990; Fu et al., 2010; Green, 2007; Sarkis, 2000). Although the positive effects of aviation on the economy seem intuitive, the identification of such a causal relationship is difficult because of 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 (e.g., Button et al., 1999; Sellner & Nagl, 2010), less research has been conducted on regions with smaller populations and regional airports. A few studies have analyzed the impact of regional airports (e.g., Baker et al., 2015; Baltaci et al., 2015; Button, 2010; Button et al., 2010), but selecting a subset of airports in a market in a non-random manner may lead to sampling and estimation bias. Moreover, airports in the same country may experience different but inter-related growth patterns. 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 et al. (2013) noted that many Canadian travelers cross the border to take advantage of lower fares offered by low-cost US carriers. Similar patterns have been observed in Europe, where Ryanair was able to capture passengers from nearby airports in large catchment areas. Furthermore, airports are highly heterogeneous, as an aviation network often consists of a few large hubs and many small feeder or regional airports. All of these factors make sample selection a non-trivial task.

Regional airports are often viewed as a type of strategic infrastructure for regional economies because of the importance of air transport in connecting regions and transporting air passengers and air cargo traffic (Baker et al., 2015; Sarkis, 2000). However, airport investments are usually lumpy and costly, involving substantial risks and time (Oum & Zhang 1990; Xiao et al., 2013, 2016, 2017). Many airports and communities provide support and incentive programs to airlines to promote air services (Fu & Zhang, 2010; Zhang et al., 2010; Fu et al., 2011). It is important to correctly identify the impact of airport activities on regional economies so that the most effective policies on airport investments and airline incentives can be implemented (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 2001 to 2016. The research design is expected to provide various benefits in the empirical estimation. The national data coverage internalizes possible traffic-shifting effects and removes subjective selection bias. New Zealand is isolated from other countries, and air transport plays a critical role in connecting many domestic regions that have limited surface transport services; therefore, the risk of incorrectly attributing the effects of improvements of other transport modes to airport activities in the estimation is reduced. Our panel dataset spans an extensive period, thus facilitating the identification of the relationship between airport activities and regional economies (Baker et al., 2015). All of the airports were built prior to the sample period, and thus any complicating effects of airport capital investments on the local economy will be minimal.[5] Finally, our sample includes all airports with scheduled commercial international and domestic services in New Zealand, which comprises both small regional airports and major hubs in New Zealand's airport system (Abbott, 2015; Kissling, 1998; Tsui et al., 2014). This allows us to examine the influence of airport activities on regional economies of varying size and on the New Zealand market as a whole.

Furthermore, the econometric methods used in the study seek to improve upon previous methodologies in the literature. Many previous studies have used Granger causality tests (e.g., Fernandes and Pacheco, 2010), regression discontinuity (e.g., Campante and Yanagizawa-Drott, 2018), fixed-effects estimation (e.g., Mahutga et al., 2010), natural experiments (e.g., Blonigen and Cristea, 2015), and instrumental variables (Sheard, 2014). Our study complements these previous studies in that in addition to the FE estimation, which has been frequently used in the literature, the system GMM approach and the dynamic CCE estimator are applied to account for cross-sectional dependence, cross-regional heterogeneity, and feedback effects. Our study is among the first to apply the dynamic common correlated effects (CCE) model while using instrumental variables to estimate the relationship between aviation activities and economic development. As explained, airports in the same country may experience different but inter-related growth patterns, and there is often significant heterogeneity between airports. When proposing CCE estimators, Pesaran (2006) stated, "*We also allow for individual specific errors to be serially correlated and heteroscedastic, and we do not require the individual-specific regressors to be identically and/or independently distributed over the cross-section units, which is particularly relevant to the analysis of cross-country panels*." Our sample includes all airports in New Zealand, which are of different sizes and types. Applying multiple estimators (i.e., FE, GMM, and CCE) to a well-chosen dataset collected over an extended period enhances the validity and robustness of the estimation results.

Our empirical analysis of New Zealand offers valuable insights into the impact of airport activities on regional economies and regional economic wellbeing, as measured by regional gross domestic product (GDP) per capita and regional unemployment rates. We find that in New Zealand, airport activities have a significant effect on a region's economy. For example, we find that on average, a 1% increase in an airport's total available seat kilometers (ASK) results in an increase of 0.38% in New Zealand's regional GDP per capita, *ceteris paribus*. Our findings are robust across the FE, GMM, and CCE estimations, although more significant effects are identified by the less restrictive CCE model. This evidence suggests that the aviation industry has a positive effect on the regional economy and supports local/regional policies that promote aviation activities.

[5] 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, capital investments, and economic growth.

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 on and interprets the 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 effects of airport activities and air transport services on local and regional economic development. For example, recent studies on the impact of airport activities and infrastructure (e.g., Allroggen & Malina, 2014; Cidell, 2014; McGraw, 2017; Percoco, 2010; Tsui et al., 2016; Van den Berg et al., 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 and the enhancement of social benefits. Moreover, air transport has been found to have significant effects on employment growth and job creation (e.g., Appold & Kasarda, 2013; Button et al., 1999; Neal, 2012).

For example, Green (2007) used a two-equation model to analyze 83 selected airports in the United States and found that the operations of an airport in a metropolitan area are significantly influenced by regional economic development, and that the presence of an airport facilitates accurate forecasting of population and employment growth. Button et al. (2010) used the FE and random effects (RE) models to analyze the impact of 66 small airports in Virginia on the local economy and concluded that small airports can contribute significantly to regional economic development. In Australia, Baker et al. (2015) used the vector error correction (VECM) model to examine the relationship between 88 regional airports and local economic development, and they found a strong relationship between small regional airports (local air transportation) and regional economic development. Bilotkach (2015) used the FE and 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 robust effects on the level of employment, number of business establishments, and average wage in the region. Sheard (2014) found that airport size has a positive impact on the employment share of tradable services. These results were consistent with the findings of Sarkis (2000, p. 336), who concluded 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 et al., 2014; Banister & Berechman, 2001; Duffy-Deno & Eberts, 1991).

Other recent studies of air transport services, primarily passenger transport (e.g., Blonigen & Cristea, 2015; Braathen, 2011; Brathen & Halpern, 2012; Brueckner, 2003; Donzelli, 2010; Hakim & Merkert, 2016; Hu et al., 2015; Van de Vijver et al., 2016; Yao & Yang, 2012), 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. For example, Yao and Yang (2015) used an augmented production function to reveal that air transport is positively related to economic growth, industrial structure, population density and openness but negatively related to ground transportation in China. Many studies obtained similar findings, and the most popular empirical approach for identification has been Granger causality tests. Fernandes and Pacheco (2010) used the Granger causality test to examine the relationship between economic growth (i.e., GDP) and domestic air passenger transport, and they found a uni-directional Granger causal relationship from economic growth to domestic air transport demand in Brazil. Similarly, Mukkala and Tervo (2013) used Granger noncausality analysis to analyze the correlation between air traffic and economic growth in Europe. They found causality from air traffic to regional growth in peripheral regions, although it was less evident in core regions. The Granger causality approach was also used in the studies by Kulendran and Wilson (2000) and Van De Vijver et al. (2014), which identified one-way and two-way causality relationships between air travel and trade volumes.

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; Özcan, 2014; Tan & Tsui, 2016). Recently, Brugnoli et al. (2018) used the augmented gravity model to study the impact of aviation on regional trade in Italy and suggested that efficient air transport services can boost regional development by enabling access to the work marketing, facilitating integration, and labor mobility and by fostering local industries. 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 their important insights, many previous studies are based on samples of airports chosen in the region or country of interest, predominantly in developed economies. In terms of less developed countries, Yao and Yang (2015) and Gibbons and Wu (2019) conducted two empirical studies of China. However, because of China's extensive high-speed rail networks, special efforts had to be made so that the effects of improvements in other transport modes would not be incidentally captured in the estimates. A similar problem may exist in studies carried out for North America and Europe, where road transport accounts for a substantial market share of inter-regional traffic.

In summary, although many studies have investigated the relationship between aviation services and regional economies, there remain some limitations in data selection and identification, such as the assumption of homogeneous effects of airport activity on regions and the challenge of endogeneity. Given the critical importance of this issue, this paper aims to complement the literature with an empirical analysis using alternative estimation procedures. In addition to our study's aforementioned advantages in data and methods, its alternative estimation procedures yield consistent findings for New Zealand's airport system, in which there is only one commercial airport per city or region. Our analysis providessupporting evidence that complements the general understanding of airport activity and economic development and contributes to policy formation for the regions of New Zealand. The following section provides a brief overview of the airport system in New Zealand and detailed descriptions of our empirical research.

3. Overview of New Zealand airport system

New Zealand airports have been at the forefront of commercialization and privatization (Lyon & Francis, 2006; 2016). New Zealand's airport system has undergone a series of changes in its operation. First, the introduction of elements of commercialization in the 1960s (under the Airport Authorities Act, 1966), the partial privatization of airports (Forsyth, 2002), and the deregulation of airports paved the way for the creation of companies to own and operate the airports (corporatization) and later for the sale of their shares to private investors (privatization) (Abbott, 2015). Many local authorities have undertaken such corporatization, and today, only the smallest of New Zealand's airports are still operated by local government authorities. Under this decentralized commercialized model, airport owners (e.g., regional governments or airport companies) make decisions on airport activities.

Auckland Airport is publicly listed on the New Zealand stock market, with shares owned by local governments, institutional investors, and the public.[6] Christchurch Airport is a limited liability company that is registered with the New Zealand Companies Office, with 75% of its shares owned by Christchurch City Council and the remaining owned by the New Zealand government. Wellington Airport is partly owned by local government, and the majority of its shares are held by Infratil, a publicly listed infrastructure company. Smaller regional airports exhibit a variety of ownership structures, and most airports still maintain some local government ownership. For example, Palmerston North Airport has been a limited liability company since 2016, and all the shares are owned by the Palmerston North City Council (See Lyon and Francis (2006; 2016) for details on the ownership structure of New Zealand airports). Hamilton, Nelson, and Tauranga airports are owned and operated by local governments and city councils. One exception is Milford Sound Airport, a small tourism-oriented airport that is fully owned and controlled by New Zealand's central government.

New Zealand's unique model of airport ownership and airport operations has numerous positive aspects. One is that New Zealand provides a fairly stable regulatory context that allows individual airports to become integral parts of the nation's air transport system (Lyon & Francis, 2016). In addition, since the commercialization policy was initiated, there have been significant developments in the capabilities of New Zealand's airport system, notably in terms of infrastructure, capacity, and revenue streams (non-aeronautical revenues). The central government still retains some control over airport activities through regulation. For example, Auckland, Christchurch, and Wellington airports have been subject to so-called "reserve regulation," in which the central government reserves the right to introduce price-cap

[6] 22.15% of the shares of Auckland Airport are held by the Auckland City Council, and the New Zealand Superannuation Fund and the New Zealand Accident Compensation Commission are major shareholders. We are grateful to an anonymous referee for drawing our attention to the special features of New Zealand's airport system.

regulations if these airports are considered to be abusing their market power.[7] Another positive aspect is that airlines have a degree of influence over airports' capital expenditure (Airport Authorities Act, 1966). However, the New Zealand airport system is not without problems. One key challenge to regional airports is remaining financially viable with limited traffic volume due to New Zealand's small regional aviation markets; in addition, regional airports face pressure to increase air services to achieve regional social and economic objectives (Lyon, 2011; Lyon & Francis, 2016).

New Zealand is geographically isolated from the rest of the world, with limited surface transport connections between some key regions. The country is thus highly dependent on international and domestic air transport (Lyon & Francis, 2006; Tsui et al., 2016; Statistics New Zealand, 2016). New Zealand has a well-developed international and regional airport network, with 24 commercial airports offering scheduled international or domestic air services. A unique characteristic of New Zealand's airport system is the presence of only one commercial airport per region across the country (Tsui, 2017), which makes it easier to define each airport's catchment area. In this paper, we adopt Statistics New Zealand's definitions of administrative regions (which are governed by regional councils) and key large cities.[8] This also makes it easier to consistently obtain other regional data. The locations of all of New Zealand's commercial airports and corresponding regions are shown in Figure 1. 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 airports. These airports play more important roles in the air transport system than the smaller regional airports because they serve major cities and popular tourist destinations.

In 2016, the top five New Zealand airports as measured by the total number of scheduled airline seats were 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 handled by the Auckland, Christchurch, and Wellington airports. Most New Zealand airports showed positive compound annual growth rates (CAGR) for scheduled airline seat capacity, ranging from 8.46% to 9.12% (OAG, 2017).

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 international destinations, 11, followed by Wellington and Queenstown airports, which offer flights to 6 and 4 international destinations, respectively. Christchurch Airport, serving New Zealand's South Island, has thus become the second-largest international gateway and hub

[7] A similar "light-handed regulation/threat of regulation" system is used in Australia (Yang & Fu, 2015).
[8] The definition of region in this study follows that used by Statistics New Zealand. There are 15 regions in New Zealand, including Northland, Auckland, Waikato, Bay of Plenty, Gisborne, Hawke's Bay, Taranaki, Manawatu-Wanganui, Wellington, West Coast, Canterbury, Otago, Southland, Marlborough, and Tasman/Nelson (Statistics New Zealand, 2016a).

airport, and it has benefitted 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 boasted the largest domestic networks (19 destinations each) in 2016, followed by Christchurch Airport (16), Nelson Airport (7), Hamilton Airport (6), and Blenheim and Dunedin airports (5). Smaller New Zealand airports have minimal domestic networks: they are mostly connected with only one to four destinations, with primary connections to Auckland, Christchurch, and Wellington airports.

This pattern of domestic connectivity reflects the hub-and-spoke network system of Air New Zealand, which carries air passengers from smaller regional airports to two main hubs (Auckland and Christchurch airports). New Zealand airports' well-developed domestic networks enable people from New Zealand's regions and cities to access international connections with ease (New Zealand Ministry of Transport, 2013, 2016). It should be noted that New Zealand's domestic aviation market has long been dominated by Air New Zealand, which is a monopolistic provider of scheduled air services at many domestic airports in New Zealand.[9] The low-cost carrier Jetstar (a wholly owned subsidy of Qantas) began its low-cost services for key cities (e.g., Auckland, Christchurch, Dunedin, Queenstown, and Wellington) in 2009 and has offered budget services to Napier, Nelson, New Plymouth, and Palmerston North since late 2015. The entry of Jetstar introduced competition into New Zealand's domestic aviation market and trans-Tasman routes (Wang et al., 2020). However, domestic competition may have been reduced when the New Zealand Commerce Commission allowed Air New Zealand to codeshare with Qantas. Shortly after the code sharing agreement between Air New Zealand and Qantas from 14 October 2018, Jetstar announced its withdrawal from several regional routes from November 2019 onward. This withdrawal reduced the number of Jetstar's domestic routes in New Zealand from nine to five. Arguably, this policy removed a key competitor and increased the entry barrier for other airlines to serve or set up in New Zealand's domestic aviation market, as any entrant would face competition with Air New Zealand, Qantas, and Jetstar (Air New Zealand, 2018).

4. Data definitions and empirical models

Table 1 defines the variables used in this study and provides data on the GDP per capita and unemployment rate. These two quantitative measures succinctly capture the development of New Zealand's regional and local economies and represent the economic output and employment prospects of the 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) of flights into and out of a given airport. These airport activity measures

[9] The New Zealand government is currently the major shareholder of Air New Zealand. controlling 52% of its shares. Thus, the government obtains financial benefits if Air New Zealand's profitability improves. However, although the New Zealand government retains vote power over some of the airline's actions (Bollard & Pickford, 1998), it does not interfere in the airline's daily operations, such as what fares should be charged to passengers or which airports Air New Zealand should fly to.

have been used in prior studies (Tsui et al., 2016; Koo et al., 2013).

Table 2 presents the descriptive statistics associated with the variables of interest. The averages of the 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 averages 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 New Zealand's airports and regions. This dataset allows us to identify the effects of different types of airport activities on regional economies. To do so, however, it is important to use empirical estimation models that are sufficiently flexible to account for such cross-regional heterogeneity.

[see Tables 1 and 2]

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

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

where $lnGDP_{it}$ represents the logarithm of GDP per capita in region i in year t; $lnSeats_{it}$ represents the logarithm of scheduled airline seats ($lnSeats_{it}$) for region i in year t; γ_i and θ_t are regional and time fixed effects, respectively; and ε_{it} is the error term. The regional fixed effect non-parametrically controls for time-invariant unobservable regional characteristics, the time fixed effect non-parametrically controls 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, such as regional population size, that may be correlated with airport (air transport) activities. The parameter of interest is represented by β.

Although we present the estimation results using this simple static panel data specification, which is commonly used in empirical studies (with a few using air transport data, such as Mahutga et al. (2010) and Khadaroo and Seetanah (2008)), they are based on several assumptions. First, the fixed-effects panel regression model assumes that the airport activity measure, $lnSeats_{it}$, is exogenous,[10] which is unlikely in reality. A shock to economic activity is likely to influence the available scheduled seats. If the exogeneity assumption is violated, the estimate of β could be biased.

Second, it is common in empirical work to account for the dynamic process of economic growth by including the lag(s) of the dependent variable as a regressor. (See, for example, Smaoui and

[10] That is, it is uncorrelated with the error term. In this context, the error term represents shocks to economic development.

Nechi (2017) and Teixeria and Queiros (2016).) That is, (1) can be augmented to:

$$(1.1) \qquad lnGDP_{it} = \beta lnSeats_{it} + \alpha lnGDP_{it-l} + \Delta X_{it} + \gamma_i + \theta_t + \varepsilon_{it},$$

where $lnGDP_{it-l}$ represents up to lag l of the logarithm of GDP per capita in region i. Equation (1.1) cannot be estimated by traditional static panel data methods, such as the FE and RE estimators, as they are rendered inconsistent due to the violation of the strict exogeneity assumption. The inconsistency of the FE 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 explanatory variable, leading in turn to the failure of the strict exogeneity assumption. The inconsistency of the RE estimator arises from the non-zero correlation between the fixed effect and the lagged explanatory variable, as $lnGDP_{i(t-1)}$ depends on the fixed effect.

The dynamic system GMM procedure has been used to address endogeneity issues arising from the inclusion of regional FE in a dynamic panel (Arellano & Bond, 1991; Blundell & Bond, 1998). In the dynamic system GMM framework, fixed effects are accounted for by first-differencing, rather than demeaning, to overcome the FE and RE strict endogeneity assumption. Under the assumption of sequential exogeneity, internal instruments[11] can be used to expunge the effects of endogeneity and tease out causality. This assumption is based on the premise that previous values of endogenous and predetermined regressors are likely to be correlated with their contemporaneous levels but uncorrelated to future shocks in the dependent variable. Importantly, autoregressive terms are included to account for the dynamic nature of the dependent variable. This makes the dynamic system GMM model a versatile tool for identifying causality in many panel data contexts, such as in the aviation (Bilotkach, 2015), tourism (Koo et al., 2019), and finance (Schultz et al., 2010) literature. This method is consistent if the time effects are constant, the error terms are cross-sectionally independent, and the slope coefficients are identical across regions.

However, if the time effects within regions are heterogeneous, estimates generated using the dynamic system GMM model can still be biased (Pesaran & Smith, 1995). For example, an increase in airfare induced by oil price shocks may have different effects on the flow of air passengers across regions. This can be an issue for our estimations, given the significant heterogeneity of New Zealand's regions and airports. The dynamic CCE estimator developed by Chudik and Pesaran (2015) allows for heterogeneous coefficient estimates in addition to accounting for endogeneity and dynamic processes. As such, the CCE is the preferred model in this study, as it allows for a more realistic modeling environment.

The estimated equation for the CCE model is given by the following:

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

[11] Carefully selected lags of endogenous and predetermined regressors. See Roodman (2009) for more details.

where $\overline{z_{t-k}} = (\overline{lnGDP_{it}}, \overline{lnGDP_{i(t-1)}}, \overline{lnSeats_{it}}, \overline{X_{it}})$ is the cross-sectional averages of the dependent and explanatory variables, and p_T designates the number of lags in the cross-sectional averages. Note that all of the 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. The cross-sectional averages in Equation (2) are included to partial out the effects of any unobservable common factors between airports (see Ditzen, 2018).

Endogeneity is accounted for in the CCE model through the use of an airport competition measure, specifically the Herfindahl-Hirschman Index (HHI), as an external instrumental variable.[12] The HHI is calculated using the total number of scheduled airline seats across airports,[13] which proxies for the changes in the competitive landscape over time. This measure is used as an external instrumental variable (IV) because studies have shown it to be a valid instrument for airport activity in relation to macroeconomic measures. (See, for example, Homsombat et al. (2014) and Tsui et al. (2016).) Competition-type instruments such as the HHI are suitable because the level of competition is likely to be correlated with the level of airport activity yet orthogonal to shocks in measures of economic well-being, such as GDP and unemployment (Mumbower et al., 2014). Assuming sequential exogeneity, the lags of the first differences of the endogenous variables can be used as additional internal instruments.[14] This specification is expected to correctly identify casual relationships between airport activity and economies and economic well-being while relaxing the assumptions of the FE, RE, and GMM specifications.

As CCE allows for heterogeneous coefficients, we report the group mean of the coefficient estimates.[15] We use the recursive mean adjustment method to correct for small sample time series bias, following Chudik and Pesaran (2015). We also use the regional unemployment rate as an alternative dependent variable and measure of regional economic well-being. To ensure robustness, the natural logarithm of total ASK ($lnASK_{it}$) is used in place of the total number of scheduled airline seats ($lnSeats_{it}$) to ascertain the stability and robustness of the estimation results.

5. Empirical findings

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[12] The HHI of scheduled airline seats cannot be used as an external instrument in the dynamic system GMM model because its time variation is captured by the yearly dummy variables. As such, HHI is only included in the CCE model.

[13] HHI is calculated as $\sum s_i^2$, where s_i is the market share of airport i's scheduled airline seats in New Zealand. Therefore, it measures the level of competition between airports. See Hirschman (1945) and Herfindahl (1950) for more details on the index development and calculation.

[14] The dynamic system GMM model uses lags of the first differences of the endogenous variables as internal instruments under the assumption of sequential exogeneity (Blundell & Bond, 1998). As such, for consistency, the lags of the first differences of the endogenous variable are also used as instruments in the CCE specification.

[15] See Chudik and Pesaran (2015) and Ditzen (2018) for details of the asymptotic distribution of the group means.

In this section, the model estimates for the FE and dynamic panel GMM specifications are reported first, followed by those obtained using the dynamic CCE estimator. Table 3 reports the FE and dynamic panel GMM coefficient estimates, which are generated under different specifications, all of which are indicated in the table. As reported at the bottom of Table 3, the Arrelano–Bond autocorrelation test suggests that the internal instruments of the GMM specification are valid.[16] The Hansen-Sargan test statistics for the GMM specifications report that the over-identified moment restrictions are not systematically violated. This lends support to the orthogonality of the internal instruments.

The top panel of Table 3 displays the estimates yielded by the FE and dynamic GMM models using the natural logarithm of regional GDP per capita (*lnGDP*) in New Zealand. Models (1) to (3) are the FE specifications, namely the 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 0.06–0.77% in New Zealand's regional GDP per capita, *ceteris paribus*. Model (4) is analogous to Models (1) to (3) but is 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 lags of the first-differences of the endogenous variable) 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 0.77. This suggests that the inclusion of an AR(1) term to account for the dynamic process of economic development and the use of instrumental variables have a material impact on the estimation results.

[see Table 3]

Models (5) to (8) in the top panel of Table 3 report the estimation results with the natural logarithm of ASK (*lnASK*) as the proxy for (the measure of) airport activities in the FE 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

[16] Note that the presence of serial correlation would render the lags of the endogenous variable invalid. As such, the Arellano-Bond (1991) test for serial correlation is important in the dynamic panel GMM model. This test is performed on the first differences of the errors. For example, a reported serial correlation of order 2 in the differenced errors indicates serial correlation of order 1 in the levels equation. As such, autocorrelation of order 1 in the differenced errors is acceptable and uninformative, as adjacent differences in errors are mathematically related. Hence, only AR(2) is reported in Table 3.

example, Models (5) to (8) suggest that a 1% increase in ASK at a New Zealand airport increases regional GDP per capita by 0.04–0.05%.

In the bottom panel of Table 3, the natural logarithm of regional unemployment rate ($lnUnemployment_{it}$) is used as the measure of regional economic well-being in New Zealand. The relationship between airport activity and regional unemployment is less significant than that between airport activity and regional GDP per capita. Models (1) to (8) show that there is no statistical relationship between airport activity (as proxied by $lnASK_{it}$ and $lnSeats_{it}$) and regional unemployment ($lnUnemployment_{it}$). This estimation result is consistent across the FE panel and GMM models.

The results for the dynamic CCE estimator are reported in Table 4.[17] Note that the dynamic CCE model accounts for all of the factors indicated in Table 4 and allows for parameter heterogeneity, cross-sectional dependence, and the dynamic nature of the dependent variable, as discussed in the methodology section. The one-period lags of the first differences of the airport activity measure ($lnASK_{it-1}$) and HHI of scheduled seats ($lnSeats_{it-1}$) are used as instruments.[18] As shown in Table 4, in Model (1), $lnGDP_{it}$ is used as the dependent variable and $lnSeats_{it}$ as the measure of airport activity. This finding suggests that the measure of airport activity ($lnSeats_{it}$) is statistically significant and positive at the 1% significance level, and that a 1% increase in the total number of scheduled airline seats results in an average increase of 0.38% in New Zealand's regional GDP per capita in the same direction. Given that the CCE is applied to the same dataset of the prior specifications, this marked increase in economic significance suggests that the relatively strict assumptions of parameter homogeneity and unobservable variables have likely led to an underestimation of the causal relationship between airport activity and regional GDP per capita.

[see Table 4]

Model (2) in Table 4 uses $lnASK_{it}$ as a proxy for airport activity and regresses it against $lnGDP_{it}$. As in Model (1), its coefficient estimate is statistically significant, with a positive sign. This indicates that a 1% increase in an airport's total ASK results in an increase of 0.29% in New Zealand's regional GDP per capita on average, *ceteris paribus*. Consistent with the results in Table 3, we find that neither measure of airport activity affects regional unemployment.

Note that the one-period lag of $lnGDP_{it}$ ($lnGDP_{it-1}$) is found to be statistically significant and

[17] The CCE estimator is consistent, though inefficient, if the errors are cross-sectionally independent. The Pesaran (2015) test for weak cross-sectional dependence is applied to all model specifications to ascertain the suitability of the CCE framework. We conclude that the errors are cross-sectionally dependent. Moreover, the Hausman test is applied to the FE, dynamic GMM, and CCE models. The results suggest that there is a significant difference in model estimates between the CCE and the more restrictive specifications. This suggests that the presence of cross-sectional dependence will result in all of the specifications being biased except for the CCE estimator. Please contact the corresponding author for the results of the diagnostic tests.

[18] The first-stage regressions are reported in Table IA of the Appendix. The *F*-statistic and the proposed instruments are statistically significant, indicating a strong instrument set.

positive, indicating a degree of persistence (dynamism) in *lnGDP*. Similarly, a one-period lag of $lnUnemployment_{it}$ ($lnUnemployment_{it-1}$) is also reported to be statistically significant and negative.

In summary, there is strong evidence that airport activity has an important effect on the economies and economic well-being of New Zealand's regions, as measured by regional GDP per capita. The model estimates all show strong empirical evidence for a highly significant positive relationship between airport activity and regional GDP per capita. We rely on the estimates of the dynamic CCE specification because it is asymptotically more flexible (that is, it allows for different slopes for different regions) and robust (it accounts for cross-sectional dependence and feedback effects).

Industry-Level Analysis

We extend the analysis to industry-level GDP per capita to examine whether we can identify the sections of the regional economies that benefit most from airport activity. We source the industry-level GDP data from Statistics New Zealand. Seven types of industries are identified: 1) manufacturing, 2) agriculture, 3) electricity, gas, water and waste services, 4) construction, 5) accommodation and food services, 6) accommodation, and 7) rental, hiring and real estate services. The results of the industry-specific dynamic CCE estimators are presented in Table 5. Interestingly, we find evidence that the gains in economic development from airport activity are transmitted to the regional economy through the accommodation, accommodation and food, and manufacturing industries. This suggests that these three industries stand to benefit directly from an increase in aviation activity. The benefits to manufacturing are particularly promising. Button et al. (1999) found that hub airports contribute to the region's high-tech employment. Our estimation results further suggest that aviation services contribute to the manufacturing sector in general.

[see Table 5]

6. Summary and conclusion

The findings of this study suggest that a clear positive relationship exists between airport activities and economic wellbeing in regional economies. Although many prior studies, such as Green (2007), Button et al. (2010), Baker et al. (2015), and Bilotkach (2015), have examined the relationship between air transport and economic development, this study uses the FE and GMM models and a dynamic CCE estimator to analyze the New Zealand case. Importantly, the dynamic CCE estimation produces more robust results that account for the panel time series data, parameter heterogeneity, cross-sectional dependence, and dynamics. In addition, we have used panel data collected for New Zealand. 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 in New Zealand vary considerably in size, and the panel data cover a long period. Both of these features contribute to a robust identification.

Importantly, the study's findings, obtained in a New Zealand setting, supplement prior evidence in the air transport literature of airports' significant positive impact on the economic development of regional communities. Consistent estimates are obtained from the FE estimation, the GMM approach, and the dynamic CCE estimator in this study, which all suggest that airport activities have a significant impact on regional economic development, as measured by regional GDP per capita. Such results are consistent with the findings of the New Zealand Airport Association (2013) 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 employed in the airport sector has increased by 49% since 2000.

The policy implications of the findings of this study are quite important. The empirical findings indicate that a 1% increase in scheduled airline seat capacity at a local/regional airport will lead to a 0.38% increase in regional GDP per capita (see Table 4). The empirical results can be used by New Zealand's regional policy makers, airport owners, and airline management to strategically consider investing in and improving airport capacity and infrastructure, and to improve air accessibility by providing additional flight routes or increasing flight frequency at regional airports. Yet despite the importance of airport capacity expansion and investment on regional economic development, most of the airports in New Zealand have limited runway capacity (Forsyth, 2006), and recent airport infrastructure developments have largely been confined to the four key international New Zealand airports (Auckland, Christchurch, Queenstown, and Wellington airports), with less improvement in regional airports. Importantly, 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's policy makers and airport authorities at a regional level in terms of the benefits and costs of expanding and improving airport capacity and infrastructure, particularly smaller regional airports in New Zealand. Green (2007, p. 111) asserted that "*Should air traffic [airport development] be a large determinant of economic success, it is entirely possible that the benefits of new or expanded airports excess costs.*" This is particularly important for countries such as New Zealand and Australia, where major airports have been privatized and formal airport regulation removed (Forsyth, 2008; Yang & Fu 2015). Because air transportation has significant positive effects on regional economic wellbeing, it may be justified for New Zealand's regional governments to intervene, either through subsidies or regulation, in airports' long-term master plans and investment requirements. New Zealand currently has no national airport strategy (Lyon & Francis, 2016). Of course, other factors determining regional economic wellbeing, such as inter-regional business interactions and trade, may also be influenced by airport capacity and air connectivity. Likewise, New Zealand's airport system facilitates connections, allowing travelers, tourists, and air cargo to move seamlessly between different cities and towns within the country and overseas. New Zealand airports have a strong multiplier effect on the regional or local economies they serve and provide critical regional economic development and social infrastructure (New Zealand Airport Association, 2013). Hart (1993) argued that transport infrastructure planning should be well integrated with other policies to promote sustainable growth. Our study offers valuable and practical insights into this important contemporary issue that can help New Zealand's regional governments design comprehensive air transport infrastructure and transport policies.

The significant effects of airport activities on regional economic output and regional economic wellbeing identified in this study may be partly due to New Zealand's geographical isolation, which makes air transport a crucial means of connecting passengers (including tourists) and air cargo both domestically and with other overseas countries. It is notable that New Zealand is a tourism-related country that does not have a great deal of high-tech manufacturing. New Zealand often relies heavily on air cargo services to achieve efficient transport and logistics operations. Still, our empirical results suggest that aviation services directly benefit the accommodation, accommodation and food, and manufacturing sectors. Such effects may be even more significant in countries with larger manufacturing industries, and more in-depth analysis is necessary using data from other economies.

This study contributes to the air transport literature by being the first to quantitatively model the relationship between airport activities and the economic development of New Zealand's regional economies. Despite the strong evidence, 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 regional policy makers and airport owners in New Zealand 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). It is known that large airports are significantly different from small airports in terms of types of traffic flows (origin−destination/transit, international/domestic, business/leisure, and passenger/air cargo), airlines served (network carriers *vs*. regional carriers *vs*. low-cost carriers), aircraft used (widebody, narrow body, regional jet, business jet and propeller/training aircraft). The competition status at route level and airport level are also different. In addition, the precise definition of "large" *vs*. "small" airport also need to be justified. Therefore, it seems some careful planning are needed for such a study. Such an analysis may provide an interesting point of comparison between larger and smaller airports/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. Unfortunately, the largest carrier (Air New Zealand) has slashed its domestic flight services to some regional centers for commercial reasons, but smaller operators could fill the vacuum left by Air New Zealand's withdrawal from "unprofitable" regional routes (Stuff, 2018). Therefore, further research on the beneficial relationship between air transport services and regional economies should prompt regional policy makers and airport owners in New Zealand to raise capital for regional airport development and to negotiate with airlines (i.e., Air New Zealand, Jetstar, and other smaller regional air operators) to provide more flight routes or increase flight frequency to and from regional centers through incentives or subsidies, thus improving regional economies and tourism development.

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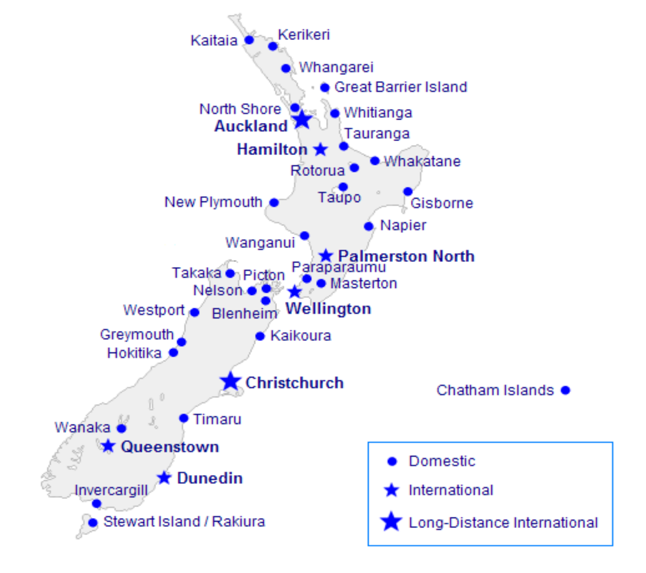
Figure 1. Locations of New Zealand airports and regions



Airports	Regions
Auckland	Auckland
Christchurch	Canterbury
Wellington	Wellington
Blenheim	Marlborough
Dunedin	Otago
Gisborne	Gisborne
Hamilton	Waikato
Invercargill	Southland
Napier/Hasting	Hawke's Bay
Nelson	Tasman/Nelson
New Plymouth	Taranaki
Palmerston North	Manawatu-Wanganui
Queenstown	Otago
Rotorua	Bay of Plenty
Taupo	Waikato
Tauranga	Bay of Plenty
Whakatane	Bay of Plenty
Whanganui	Manawatu-Wanganui
Whangarei	Northland
Westport	Westport/West coast
Kerikeri	Northland/Far North
Hokitika	West coast

Table 1. 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*	Official Airline Guide (OAG)
Total ASK$_{it}$	Total ASK at an airport in region *i* at year *t*	Official Airline Guide (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
HHI$_{it}$	The Herfindahl–Hirschman Index of total scheduled airline seats across airports from region *i* at year *t*. This is a measure of airport competition that varies over time.	Official Airline Guide (OAG)

Table 2. Descriptive statistics for variables (2001–2016)

Time series and variables	Observations	Mean	Standard deviation	Maximum	Minimum	Skewness	Kurtosis
Regional GDP per capita$_{it}$	374	38,849.75	10,793.36	79,289	21,959	1.21	5.19
Regional unemployment rate$_{it}$ (%)	462	5.13	1.58	9	2	0.51	2.31
Total scheduled seats$_{it}$	462	855,438	1,935,290	11,581,404	5672	3.20	13.26
Total available seat kilometres$_{it}$	462	1.18 billion	3.71 billion	22.7 billion	1267336.	3.40	18.18
Tourist arrivals$_{it}$	352	746,237	748,379	3,682,412	84,667	2.00	6.43
Regional population$_{it}$	462	187,541	301,257.20	1,614,300	7990	3.20	13.27
Net migration$_{it}$	462	734.53	3435.78	33,916	-3422	6.40	50.96
HHI$_{it}$	462	0.27	0.01	0.29	0.26	0.29	-0.91

Table 3. Relationship between airport activities and regional economic wellbeing (FE and GMM models)

Dependent variable	*lnGDP_it*							
Explanatory variables	**(1) FE**	**(2) FE**	**(3) FE**	**(4) GMM**	**(5) FE**	**(6) FE**	**(7) FE**	**(8) GMM**
$lnSeats_{it}$	0.0432*** (0.0159)	0.0041*** (0.0157)	0.0041*** (0.0157)	0.1225*** (0.0167)				
$lnASK_{it}$					0.0323*** (0.0110)	0.0288*** (0.0109)	0.0299*** (0.0109)	0.0232 (0.0247)
Airport fixed effects	√	√	√	√	√	√	√	√
Year fixed effects	√	√	√	√	√	√	√	√
Controls		√	√	√		√	√	√
Airport-specific time trend			√				√	
R^2	0.94	0.94	0.94		0.94	0.94	0.94	
Observations	374	374	374	352	374	374	374	352
Hansen-Sargan test				3.88				12.30
Arellano-Bond AR(2) test				0.53				1.57
Dependent variable	*$lnUnemployment_{it}$*							
Explanatory variables	**(1) FE**	**(2) FE**	**(3) FE**	**(4) GMM**	**(5) FE**	**(6) FE**	**(7) FE**	**(8) GMM**
$lnSeats_{it}$	-0.013 (0.0298)	-0.0129 (0.0295)	-0.0129 (0.0295)	0.6916 (0.7550)				
$lnASK_{it}$					-0.0209 (0.0204)	-0.0133 (0.0204)	-0.0133 (0.0204)	-0.0076 (0.0087)
Airport fixed effects	√	√	√	√	√	√	√	√
Year fixed effects	√	√	√	√	√	√	√	√
Controls		√	√	√		√	√	√
Airport-specific time trend			√				√	
R^2	0.79	0.80	0.80		0.79	0.80	0.80	
Observations	462	462	462	440	462	462	462	440
Hansen-Sargan test				3.51				3.33
Arellano-Bond AR(2) test				-1.20				0.57

Notes: Robust standard errors are in parentheses. ***, ***, and * represent p<1%, p<5%, and p<10%, respectively. One period lags in the first- difference of the endogenous variable and the *HHI* of scheduled airline seats are used as instrumental variables for airport activity in the levels equation of the GMM specification. An unreported AR(1) term is included in the GMM models.

Table 4. Relationship between airport activities and regional economies and economic wellbeing (dynamic CCE estimator)

Dependent variables	***$lnGDP_{it}$***		***$lnUnemployment_{it}$***	
Explanatory variables	**Model (1)**	**Model (2)**	**Model (3)**	**Model (4)**
$lnSeats_{it}$	0.3840* (0.1965)		-0.9376 (0.7978)	
$lnASK_{it}$		0.2868*** (0.1055)		-0.1229 (0.3850)
$lnGDP_{it-1}$	-0.7904*** (0.2451)	-0.4925** (0.2120)		
$lnUnemployment_{it-1}$			-0.6972** (0.3205)	-0.6359*** (0.2131)

Notes: All estimations include a constant region-specific term. Robust standard errors are in parentheses. ***, ***, and * represent $p< 1\%$, $p< 5\%$, and $p< 10\%$, respectively. The one period lags of $lnSeats_{it}/lnASK_{it}$ and HHI_{it} of schedule airline seats are used as instrumental variables for airport activity. The recursive mean adjustment method to correct for small sample time series bias.

Table 5. Industry-specific dynamic CCE estimator

Explanatory variables	Dependent variable = $lnGDP_{it}$						
	Manufacturing	Agriculture	Electricity, Gas, Water and Waste Services	Construction	Accommodation and Food Services	Accommodation	Rental, Hiring and Real Estate
$lnSeats_{it}$	1.1289** (0.5541)	0.3290 (0.9385)	0.6051 (0.8687)	0.5958 (0.4296)	0.0563 (0.1838)	1.1456** (0.6136)	-0.1086 (0.1526)
$lnGDP_{it-1}$	-0.0993 (0.1708)	1.1472** (0.5159)	-0.1206 (0.1245)	-0.1378 (0.1408)	0.0241 (0.2360)	0.3361 (0.2412)	0.0610 (0.1809)
$lnASK_{it}$	0.2045 (0.3594)	-0.4425 (0.6758)	0.3562 (0.5677)	0.0500 (0.6217)	0.6374** (0.3042)	0.7767 (0.4985)	-0.7533 (0.7313)
$lnGDP_{it-1}$	0.0953 (0.3047)	0.9705 (0.6957)	-0.1662 (0.1550)	-0.0965 (0.4558)	-0.1188 (0.2647)	0.1704 (0.1744)	0.6871 (0.6282)

Notes: All estimations include a constant region-specific term. Robust standard errors are in parentheses. ***, ***, and * represent $p< 1\%$, $p< 5\%$, and $p< 10\%$, respectively. The one period lags of $lnSeats_{it}/lnASK_{it}$ and HHI_{it} of schedule airline seats are used as instrumental variables for airport activity. The recursive mean adjustment method to correct for small sample time series bias.

Appendix

Table 1A. Results of first-stage regression

Explanatory variables	Dependent variables	
	***lnSeats**$_{it}$*	***lnASK**$_{it}$*
HHI_{it}	-0.9064*** (1.4514)	-13.2161*** (2.0807)
$lnSeats_{it-1}$	0.8020*** (0.0835)	
$lnASK_{it-1}$		0.7951*** (0.0892)
$Population_{it}$	2.23E-07 (4.62E-07)	-7.69E-07 (6.70E-07)
$Migration_{it}$	-2.54E-06 (4.82E-06)	4.35E-06 (6.98E-06)
Constant	-58.3013*** (5.8699)	-79.3658*** (8.5787)
F-statistic	51.04***	38.78***
Within R-squared	0.4572	0.3908
Groups	22	22
Observations	330	330

Notes: Variables of interest are defined in Table 1. The estimates are those of a region-fixed effect panel regression. Pooled regression estimations are consistent as those reported. Robust clustered standard error (by regions) are reported in parentheses. ***, ***, and * represent p<1%, p<5%, and p<10%, respectively. A statistically significant time trend is included.