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Patterns of U.S. Air Transport across the Economic Unevenness of 2003-2013

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Abstract

This map summarizes the relative change in activity at 379 airports during the tumultuous economic period that lasted from 2003 to 2013 in the conterminous United States. Rather than treating airports only as individual nodes, the work identifies relative regional spatial change in airport activity based upon the combination of the percentage changes in three factors: departures, passenger levels, and available seats. The geographic results, calculated by kriging, show that the outcome over the period is not spatially uniform. In particular, the map shows that parts of the rust belt, Appalachia, and the intermountain west fared relatively worse while the plains and coasts did somewhat better. The analysis expresses the fact that while footloose in the short-run, long-term adjustments in the airline industry, like those experienced across 2003-2013, did so in a spatially coherent way.

Key Words: airport activity, airline industry, economic recession, kriging

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1. Introduction

The U.S. airline industry is one of the most unique and geographically unconstrained sectors of the modern American economy. It comprises a fundamental but volatile component of medium and long-term mobility within the country (Crandall, 1995; Doganis, 2010). On the other hand, the nodes that comprise the backbone of the network, and through which the industry operates –the airports—are spatially fixed. This tension between demand shifts and supply-side stability creates some very special geographic dynamics. As such, the geographic changes of the industry can be viewed via operations at these various nodes relative to one another (Butler and Keller, 1995; Prosperi, 2015). Moreover, spatial autocorrelation in these patterns lends regional insights into larger configurations of geographic shift over time (Goetz and Sutton, 1997).

The air transport industry can contribute to local and regional and global economies (Conventz and Thierstein, 2015; Graham 2014), but in itself is particularly affected by shifting economic cycles (Franke, and John, 2011; Dobruszkes and Van Hamme, 2011; Pearce 2012). Swelbar and Witman (2013a; 2013b) have recently shown that it is smaller markets which have been hit the hardest over the recessionary period. A wide array of research has shown that local idiosyncratic local economic conditions, competition at proximate airports (Suzuki et al., 2003; Fuellhart, 2007), aircraft choices (Ashford et al., 2013), patterns of the urban hierarchy (Derudder and Witlox, 2008; Derudder et. al, 2007; O'Connor, 2003), corporate strategies (for example, selection and strength of hubs) [see e.g., United Communications, 2014], and airport/airline relations and constraints (Butler and Keller, 1995) are all among the many correlates of air transport activity (Grubesic et al., 2009)

The 2003-2013 time period is a particularly interesting one for the industry as it includes a major economic downturn between 2007 and 2009 sandwiched between relative periods of growth. In this research, the relative 'strength' in change in air transport is measured through airline activity at 379 airport facilities between 2003 and 2013. Figure 1 shows 'higher' scores (see discussion below) in the green and yellow portions of the map while "lower" scores are toward the orange/and red parts of the spectrum. Additionally, the top and bottom 25% of performing places are indicated by green-up and red-down pointed triangles respectively. Airport locations for these top and bottom performing airports are also indicated by their three-letter IATA codes (a list of airport codes can be found at: http://www.world-airport-codes.com/).

Figure 1: Airport scores at 379 study airports in the contiguous United States, 2003-2013

2. Data and Methods

The map was created using three elements of publically available enplanement data from the U.S. Federal Aviation Administration [FAA] (2014): departures, seats, and passengers. The 'raw' patterns across the study period for each of the measures are shown in Figures 2-4.

Figure 2. Total airline departures from 379 study area airports in the contiguous United States, 2003-2013

Figure 3. Total seats supplied by airlines from 379 study area airports, 2003-2013

Figure 4. Total airline passengers from 379 study area airports, 2003-2013

In particular, we were interested in the relative change in airline activity at the airports between 2003-2013. To derive an overall score for each airport, we first calculated the percentage change in each of the three elements for each of 379 airports, and then created a summated score as follows:

$$Y = \ln(1 + d) + \ln(1 + s) + \ln(1 + p),$$

Where Y is the overall airport score for 2003-2013 and $d, s,$ and p are the percentage change in departures, seats, and passengers respectively. We used a calculated score of summated logged measures to reduce large spikes in the data and to reduce the impact of any single measure. While at first glance the three measures (Figs. 2-4) do not seem related (i.e., there have been general reductions in departures and seats while passengers have increased), an alpha reliability of 0.806 of our summated score indicated that it was appropriate to the task. The airport scores should not be interpreted as 'good' or 'bad', but rather more simply as relative performance versus other airport facilities. That is, higher scores show more vigorous activity when 2013 is compared to 2003 and lower scores less.

To facilitate the construction of regions of change, the scoring system was applied to 379 airports in the conterminous United States (airports in Alaska, Hawaii, and outlying areas such as Guam were not included). We selected airports that had full data for each year and that matched other data sources that we plan to link to in the future. We further filtered our data to include only (a) scheduled passenger service on (b) aircraft configured for passenger travel. Departures, seats and passengers to all locations (international and domestic) were included. One airport (Grand Canyon) was dropped from the analysis as an outlier (its score was more than double that of the next airport) so that it would not potentially affect this and subsequent planned analysis.

Map patterns were developed using the geospatial interpolation method of kriging (see Oliver and Webster, 1990). We used ordinary kriging with no trend effect and a maximum of 5 and minimum 2 neighbors. The procedure created a map that divided 2003-2013 airport dynamics into 10 colored "zones", mapped using the quantile method with green marking the most positive change and red being the least. The maximum score was 5.51, the minimum -5.23, the average -0.24, the standard deviation 1.14 and the median -0.18. The top and bottom 25% of individual airports are highlighted on the map as variable-sized up-pointing green or down-pointing red triangles, respectively, based upon their activity score. For ease in reference between the shaded and point symbolizations, the largest two of the three symbols for both the green and red triangles correspond with the top and bottom halves of most extreme regions from the kriging results, while the smallest triangles make up the rest of each group. All other airports that did not score either within the top or bottom 25% of the airport activity are shown a grey dot.

3. Conclusions

While it is obvious that individual airports will vary in their activity over time, the research here indicates that there are distinct regional patterns in airline and airport activity as the economy ebbs and flows. In short, the map indicates that both airports and regions did not traverse the time period evenly.

While there is little substitute for individual airport case studies to understand change over time, this study using aggregate data indicates that regional patterns in air transport dynamics can be revealed by using common measures of airline and airport activity. In particular, the highest performing regions appear to be in the northern plains, the vacation oriented regions of Florida and southeast coast as well as megalopolis (the heavily urbanized area between Washington, D.C. and Boston, MA). The lowest performing regions were highly clustered in the rust belt, Appalachia, the Mississippi valley and parts of the northern intermountain west. In the southern plains and parts of the northeast the patterns are less distinct from a regional basis.

Airports in the high-performing portions of the plains have no doubt benefitted from the natural resource boom in the area. Williston (ISN) and Dikinson (DIK), North Dakota, and Midland, TX (MAF) were all recently listed by CNN (Christie 2013) as some of America's 'fastest growing boomtowns.' Meanwhile, megalopolis (e.g., Boston [BOS], Philadelphia [PHL], Washington-Dulles [IAD] among others) has probably performed relatively better because of the combination of their place in the urban hierarchy as well as their important national and international connections. The rust belt and Appalachia has likely suffered because of continuing industrial decline and stagnation, and in some areas, relatively low incomes. While airport size may be an important correlate of performance in the study (more complete regional analysis will be made in forthcoming work), the relationship is not a simple one. For example, New

York (JFK), San Francisco (SFO), Denver (DEN) all were among the top group of 100, but Seattle (SEA), Memphis (MEM) and Pittsburgh (PIT) were in the lowest 100.

Several interesting components to these results require substantial further study and significant econometric modeling. One is the role of the Essential Air Service Program (EAS) which provides subsidies for air travel from small places. In our results, of the top 25% of airports, 27 were in the EAS as of 2013 (for example, Pueblo, CO). However, 38 of the airports in the bottom 25% were also in the EAS (e.g., Paducah, KY), pointing to conflicting and complex relationships between the program and the airport activity score. The entry and exit of locations from the program over time adds further challenges to measuring the effect.

Cities that are focused on by Low Cost Carriers also bring up important empirical questions for detailed future studies. Regarding Southwest Airlines, for example, some of their key cities such as Dallas (DAL) did rather well on the airport activity score. However others such as Baltimore (BWI), Chicago (MDW) and Phoenix (PHX) scored lower. It is important to remember that other airlines utilize these airports as well, including other low cost and legacy carriers which affects their score. But building an understanding of the relative strategies of LCCs and their routes may help in teasing out spatial differences in the score, both at some specific airports and within larger regions (Vowles, 2001).

Finally, as the airport activity score measured here is a combinatory one that includes departures, seats, and passengers, future work will need to account for the complex mix of services offered by airlines and consumed by customers. While the general trend over the past decade has been to offer fewer flights that are slightly larger in size (Capstats, 2015), there are a wide variety of possible offerings that could be made at specific places (for example more flights of smaller size; less flights of smaller size; more flights of larger size, etc.) that would affect the score. Accounting for the different mixes in frequency, gauge, and demand will be important additions to the work.In each of these areas, however, – Essential Air Service, Low Cost Competition, airline strategy and flight supply, as well as many other issues – significant econometric modeling will be needed to pull the effects apart in a spatially meaningful way.

The use of kriging to identify regions of change provides researchers with one limited tool with which to study air transport change, summarizing and analyzing larger areas and their commonalities and differences. Importantly, economic geographers, regional economists, and transport researchers stand to gain insight from this method of assessing air transport that combines both the analysis of individual nodes and the larger regions they reside within in order assess the dynamic airline industry and its operations at multiple scales. Future studies will benefit from a close examination of the methodology used both to determine the airport score as well as the delineation of regions via kriging. Both areas have substantial potential for modification and change to fit data in changing circumstances.

Software

Raw enplanement data on departures, seats and passenger data were downloaded from the FAA into Microsoft Excel readable form where scores were calculated as above. The scores were then linked to an airport layer in ArcGIS 10.2 where the kriging procedure was executed and cartographic results formulated using the software's geostatistical tools in the Geostatistical Analyst extension.

Map Design:

The map is of the conterminous United States at a scale of about 1:17,500,000

Geographic Coordinate System: GCS_North_American_1983

Datum: D_North_American_1983

Projection: USA_Contiguous_Equidistant_Conic

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Figure Captions

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