4-7-2017

Variables Impacting Southern Illinois Airport Activity Between The Years 2000 And 2010

Philip Justin Tuminaro
Southern Illinois University Carbondale, philip.tuminaro@gmail.com

VARIABLES IMPACTING SOUTHERN ILLINOIS AIRPORT ACTIVITY BETWEEN THE YEARS 2000 AND 2010

by

Philip Justin Tuminaro

B.S., Southern Illinois University, 2010

A Research Paper

Submitted in Partial Fulfillment of the Requirements for the

Master in Public Administration.

Department of Political Science

in the Graduate School

Southern Illinois University Carbondale

May 2017

RESEARCH PAPER APPROVAL

VARIABLES IMPACTING SOUTHERN ILLINOIS AIRPORT ACTIVITY BETWEEN THE YEARS 2000 AND 2010

By

Philip Justin Tuminaro

A Research Paper Submitted in Partial

Fulfillment of the Requirements

for the Degree of

Master in Public Administration

in the field of Public Administration

Approved by:

Dr. David A. NewMyer, Chair

Dr. Lashonda Stewart

Gary Shafer

Graduate School
Southern Illinois University Carbondale
April 6th, 2017

AN ABSTRACT OF THE RESEARCH PAPER OF

PHILIP JUSTIN TUMINARO, for the Master in Public Administration degree in PUBLIC ADMINISTRATION, presented on APRIL 6th, 2017, at Southern Illinois University Carbondale.

TITLE: VARIABLES IMPACTING SOUTHERN ILLINOIS AIRPORT ACTIVITY BETWEEN THE YEARS 2000 AND 2010

MAJOR PROFESSOR: Dr. David NewMyer

Southern Illinois Airport is a publicly used and operated airport that forecasts its airport activity for airport planning purposes. This research uses linear regression analysis to identify independent variables impacting based aircraft, local civilian operations and itinerant general aviation aircraft operations at Southern Illinois Airport between 2000 and 2010. Regression analysis is a Federal Aviation Administration approved method in determining relationships between airport activity factors and other variables, but is typically used in large scale airport system planning and not at general aviation airports such as Southern Illinois Airport. The results appear promising for future use in airport planning as the test did identify significant relationships between Southern Illinois Airport activity and independent variables.

Table of Contents

List of Tables

Introduction

Purpose

The purpose of this study is to identify independent variables impacting airport activity at Southern Illinois Airport from 2000 to 2010. Supply and demand independent variables will be tested to discover causal relationships through liner regression analysis, report results, and make suggestions to future airport activity forecasting methodology.

Significance of Topic

Aviation demand forecasting is necessary for United States airports to justify expansion/modernization projects on the airfield, to anticipate and meet future aviation demand, comply with federal, and state regulations, and allow airport sponsors to make accurate decisions regarding the airport. Demand forecasting is an essential part of airport master planning and can be used to obtain grants from the Federal Aviation Administration's (FAA) Airport Improvement Program (AIP) (Federal Aviation Administration [FAA], 2007). Since Southern Illinois Airport is included in the National Plan of Integrated Airport Systems, its airport sponsor—Southern Illinois Airport Authority—can receive grants for projects meeting specific criteria by the FAA (FAA, 2014; FAA, 2016). The FAA will determine an airport's need for a Federal grant based upon the airport's activity forecast. Forecasted airport activity figures for general aviation airports usually include local civilian and itinerant general aviation airport operations and based aircraft, while commercial service airports typically use emplaned passengers, air carrier and commuter operations factors. The figures selected in an aviation forecast should represent the type of airport being used for the forecast. A general aviation airport, usually, will not include passenger enplanements in their forecast due to a lack of air carrier operations at their airport. (FAA, 2007).

Regression analysis is recognized by the FAA as a method used to produce airport activity forecasts (FAA, 2007). Uses for accurate airport demand forecasting are exposed in the AIP handbook stating it can be used for justification for an Airport Layout Plan (ALP) and development projects. The FAA will review airport forecasts to ensure accuracy and that it establishes adequate justification for airport projects. Consistency will be determined by comparing an airport sponsored forecast to the FAA's Terminal Area Forecast (FAA, 2005). General aviation airport's, like SIA, sponsored forecasts when compared to the FAA's TAF must be within ten percent of each other in the five-year forecast and fifteen percent in the ten-year forecast (FAA, 2007). If the FAA determines an airport's forecast is not within these tolerances and does not provide adequate justification proving the validity of the forecast, then the FAA may require the airport to alter its forecast. However, if adequate justification determining the forecast's accuracy is presented by the airport sponsor, then the FAA will make changes to their TAF. The FAA's endorsement to an airport's forecast can determine the airport's entry into the National Plan of Integrated Airport Systems (NPIAS), it can change the airport's role in the National Airspace System, approve its Airport Layout Plan, or can be used to approve work included in the Airport Capital Investment Program (FAA, 2005). There are a few different ways a general aviation airport not already included in the NPIAS can be accepted into the plan. For general aviation airports thirty minutes or more average ground travel time from the nearest existing NPIAS airport may be included in the NPIAS if the airport sponsor can prove that at least ten aircraft will be based at the airport within the first year of its operation. For airports within thirty minutes average ground travel time (generally twenty miles) from the nearest airport within the NPIAS, the airport must meet all of the following criteria: be included in an accepted state airport system plan or metropolitan airport system plan, serve a community more

than thirty minutes from the nearest existing or proposed NPIAS airport, is forecast to have ten based aircraft during the next five years of operation, and there is an eligible sponsor willing to undertake the development and ownership of the airport (FAA, 2000). Once included in the NPIAS, airports are now eligible for Federal funding under the Federal Aviation Administration's Airport Improvement Program. The most recent NPIAS was approved by Congress in 2016 identifies 3,340 public airports in the United States that are estimated to require $32.5 billion in airport projects between 2017 and 2021. The Airport Capital Development Plan approved by the FAA for individual airports are driven by airport forecasted traffic, use and age of facilities and changing aircraft technology (FAA, 2016).

Literature Review

Forecast Methods

The Federal Aviation Administration in Advisory Circular 150/5070-6B on Airport Master Plans, specify the four most common aviation forecast methods that can be used in airport master plan preparation. The first method mentioned is regression analysis. The advisory circular suggests regression analysis to be restricted to simple models, since many independent variables affecting airport activity are related to each other. An independent variable affecting change in another independent variable can affect the validity of a statistical outcome in a regression formula. It also recommends the use of independent variables where reliable forecasts are available including, population, income and other economic measures. The second method mentioned is a trend analysis and extrapolation, which uses historical data to determine future trends. This method is most useful to airports with unique circumstances affecting it when compared to other airports within the same region. The third method is market share analysis or ratio analysis. This method determines relationships between national, regional and local forecasts. An airport's forecast is determined as a percentage or market share of national and

regional forecasts. This method assumes an airport will maintain the same percentage of a regional market share in the future, thus forecasting future activity at the airport. Of course, this method may not be useful when the airport is suspected to experience a change in its market share proportion over the forecast period. The last method recognized in this advisory circular is smoothing. Smoothing forecasts project historical data, but base forecasts more heavily on the latest airport activity trends. This method is believed to be more effective in calculating short term forecasts (FAA, 2007).

Key Independent Variables

The Forecasting Aviation Activity by Airport report published by the FAA (2001) recognizes supply and demand factors impacting aviation activity. Economic and demographic activity are demand factors, while cost, competition, and regulation are supply factors both impacting aviation activity. Factors usually affecting general aviation airport operations are local population, income levels, and the number of based aircraft. Aircraft activity at general aviation airports are usually measured as local and itinerant aircraft operations. These measures of aviation activity are generally required by the FAA for airport planning purposes (FAA, 2001).

The Airport Cooperative Research Program (ACRP) provides insight to factors generally driving airport activity (Spitz & Golaszewski, 2007). This synthesis report studies common practices among aviation professionals for forecasting aviation activity. Identified driving factors influencing aviation activity include: macroeconomic and demographic factors, air transport production cost and technology, regulatory factors, infrastructure constraints and improvements, and substitutes for air travel. Aviation travel is fundamentally derived by demand for services. The need or desire for individuals to be at a specific location at a given time creates aviation demand, which has more influence on aviation activity than the supply of

services do; therefore, the driving factors influencing aviation activity, mostly, attempt to measure the level demand for aviation services (Spitz & Golaszewski, 2007).

Macroeconomic and demographic demand indicators used commonly among the professional aviation industry include local and regional measures of GDP and income, employment levels, unemployment rates, measures of consumer confidence. These factors can be problematic when using many macroeconomic and demographic data due to these metrics having a high likelihood of correlating with each other. Air transport production costs and technology include elements such as fuel costs, labor costs and airport user fees. Many long-term aviation forecast studies consider fuel costs impacting aviation activity, but user fees and labor costs are more appropriate for forecasting airline activity instead of general aviation airport activity. Regulatory factors impacting aviation activity can include environmental noise and emission rules and time-of-day restrictions. Finally, infrastructure constraints and improvements can affect airport activity, but for short term forecasts, five years or less, these constraints can cause budgeting problems for airports and are avoided in these instances (Spitz & Golaszewski, 2007).

The 1994 Illinois State Aviation System Plan (ISASP) Technical Report identified a positive relationship between population and based aircraft. The ISASP included an inventory of the current Illinois aviation infrastructure and users of the Illinois aviation system. As of February 3, 1994, there were 124 public use airports in Illinois, and by the end of 1993 there were 7,090 based aircraft located on these 124 public use airports. A concentration of based aircraft was identified in the Northern and Northeastern Regions of the state with "sixteen of the top 25 public-use airports, ranked by based aircraft, were within a 60-mile radius of Chicago" (Illinois Department of Aeronautics [IDOT], 1994, p. 44). These sixteen airports contribute 46%

of all based aircraft in Illinois. These Northern and Northeastern regions of Illinois are the most populated in the state, which is near by the city of Chicago. The ISASP suggests most aircraft owners base their aircraft near to where they live; therefore, an increase in population should also increase an airport's amount of based aircraft (IDOT, 1994).

The 1994 ISASP suggests a positive relationship between population and annual operations at airports. As previously stated, the northeastern region of Illinois is the most populated region in the state due to the city of Chicago and is the region with the most annual operations. When the Illinois regions are ranked by population, then each region's respective amount of annual operations decline in the same order as their population does. The northeastern region encompasses six counties collectively containing the greatest population out of the four regions with 7,261,176 people and estimated 2,326,000 annual operations. Conversely, the southwestern region of Illinois with the smallest population of 534,512 only had 315,000 estimated annual operations (IDOT, 1994).

The number of pilots, level of employment, and number of households all as a county percentage of the state total were included in the 1994 ISASP's regression equation for determining based aircraft. The regression equation for based aircraft had an adjusted r-squared value of 0.893 at the 0.01 level of significance meaning the equation explained 89.3 percent of the variance in based aircraft figures. This data suggests, with a high level of confidence, the number of pilots, employment levels, and number of households influences the number of based aircraft for airports in Illinois at the regional level (IDOT, 1994).

The aircraft operations figures were calculated in the 1994 ISASP by including based aircraft and the number of pilots as independent variables. The formula yielded an adjusted r-squared value of 0.947 at the 0.01 level of significance. These values suggest the formula used

in the ISASP for aircraft operations explain 94.7 percent of the variance in aircraft operations at airports in Illinois. Furthermore, this level of correlation can be used with an extremely high level of confidence; therefore, the ISASP suggests the number of based aircraft and pilots in near an airport positively influences its number of aircraft operations (IDOT, 1994).

The ISASP completed an analysis identifying a relationship between based aircraft on aircraft operations on the same 124 public use airports located within the state of Illinois. There were estimated 4,460,000 aircraft operations in 1992. When ranking the following airports based on aircraft operations, fifteen of the top twenty five airports were located within a sixty mile radius of Chicago accounting for fifty two percent of Illinois's total aircraft operations. Many of the airports ranking high on the list for based aircraft are the same as high ranking airports based on aircraft operations suggesting a positive relationship between based aircraft and airport operations; therefore, an increase in an airport's based aircraft should result in an in increase in aircraft operations at that airport. The correlation between based aircraft and aircraft operations only became more apparent when ranking Illinois's five regions by population. When ranking Illinois regions in this manner, aircraft operations and based aircraft rank in the same order. In this study, the only outlier was Chicago's O'Hare due it being the busiest airport, for commercial operations, in the state and the country in 1992 (IDOT, 1994).

The FAA Office of Policy and Plans funded research in the year 2000 to test variables affecting airport activity at small towered airports with fewer than 100,000 general aviation operations per year. Data gathered from 127 small towered U.S. airports was used to determine that aviation activity at individual airports is highly dependent on local factors. The hypothesis tested by regression analysis resulted in a statistical output explaining seventy two percent of the variance. The local factors tested in this model were significant in increasing annual general

aviation operations. Independent variables identified in this study to be most influential in positivity impacting airport activity were total based aircraft at an airport and per capita income. Factors identified as negatively affecting airport activity were the airport's location and if the airport was certified for commercial operations under the Code of Federal Regulations part 139 (as cited in GRA, Inc., 2001).

Data and Methodology

Methodology

A linear multiple regression analysis was used to identify independent variables affecting based aircraft, local civilian aircraft operations and itinerant general aviation aircraft operations at Southern Illinois Airport from 2000 to 2010. Linear regression analysis was calculated using IBM SPSS statistical software, which can determine if a statistical relationship exists between dependent and independent variables. The data used in this analysis was collected mostly in 2012. The database created for every independent and dependent variable used in this analysis includes one case for each year from 2000 through 2010 for a total of eleven cases.

Research Method Justification

The FAA in Advisory Circular 150/5070_6b on *Airport Master Plans*, recognizes regression analysis as an acceptable approach in forecasting an airport's future activity. Regression analysis relates a dependent variable such as aircraft operations to independent variables such as community population or income. Furthermore, the FAA suggests, regression analysis should only be used in a simple model with few independent variables using dependent variables where reliable forecasts are available (FAA, 2007).

Per Berman (2007), linear multiple regression analysis is the one of the most widely used multivariate statistical tools for analyzing variables. Linear multiple regression analysis attempts

to obtain full model specification, meaning multiple regression techniques can determine all the variables affecting a dependent variable. Linear regression analysis models predict the change in continuous dependent variable between one or more independent variables through regression mathematical formulas (IBM, 2016). This is typically done through computer programs such as IBM SPSS Statistics or MiniTab. One hundred percent correlation between a model and a dependent variable is not likely in practice, but this capability to determine statistical relationships is valuable. Its ability to include many control variables into an analysis and its ability include many independent variables are the likely reasons for its popularity (Berman, 2007).

The information collected includes data for each dependent variable and independent variable from the years 2000 to 2010 for a total of eleven cases. Studies by Vittinghoff and McCulloch suggested a minimum of ten cases per variable were needed to accurately determine an expected relative bias of less than ten percent in logistic regression models (as cited in Austin & Steyerberg, 2015). A more recent study compared linear regression coefficients from a large data set of 6,982 subjects to multiple subsets with increasing numbers of subjects per variable to determine accuracy regression coefficients analyzed from the subsets with few subjects per variable. This study discovered, "in the context of linear regression estimated using ordinary least squares, a minimum of only two subjects per variable is required for adequate estimation of regression coefficients" (Austin & Steyerberg, 2015, p.636). Based upon these studies, the eleven cases collected for the regression models should be adequate in calculating regression coefficients.

Regression analysis was already used for aviation forecasting proposes in Illinois in 1994. The Illinois Department of Transportation: Division of Aeronautics developed a state

wide, aviation system plan to determine the action required at the federal, state, and local level in meeting changes in aviation demand. The Illinois State Aviation System Plan determined with a high degree of statistical confidence the independent variables affecting the amount of based aircraft and operations within the state (IDOT, 1994). The methods used in the Illinois system plan will be utilized on in determining relationships with the same dependent variables at the local level at Southern Illinois Airport.

Data Acquisition and Assumptions

Only general aviation itinerant aircraft operations used in this research, which excludes air carrier, air taxi and military operations. Southern Illinois Airport is a class IV part 139 airport meaning it only serves unscheduled air carrier operations (FAA, 2016). Air carrier, air taxi and military operations occur infrequently; therefore; these are not accurate measures of Southern Illinois Airport activity. Values used for local operations will only include civilian operations. In 2007, Southern Illinois Airport (SIA) only recorded four local military operations with 51,410 local civil operations in the same year (FAA, 2013). This large difference in amount of operations justifies the conclusion that SIA is overwhelmingly a civilian use airport and this study will attempt to reflect this.

The Federal Aviation Administration define based aircraft as "the general aviation aircraft that use a specific airport as a home base" (2007, p. 98).

Local aircraft operations are defined by the FAA as:

> Aircraft operations performed by aircraft that are based at the airport and that operate in the local traffic pattern or within sight of the airport, that are known to be departing for or arriving from flights in local practice areas within a prescribed

> distance from the airport, or that execute simulated instrument approaches at the airport. (FAA, 2007, p. 100)

Itinerant Operations are "operations by aircraft that leaves the local airspace" (FAA, 2007, p. 100).

Data collected on airport activity is typically generated from three organizations. The Federal Aviation Administration (FAA) and the Department of Transportation has the responsibility to review aviation forecasts that are submitted by the Southern Illinois Airport Authority for airport planning purposes. This information is then used by the FAA in its Terminal Area Forecast (TAF) and in the National Plan of Integrated Airport Systems (NPIAS) to justify government spending on construction projects at airports (FAA, 2001). This data is publicly available and is a trusted source of information of airport activity forecasting. Secondly, airport authorities often employ third party programs to measure activity at their own airports. This often occurs at non-towered airports or part time towered airports that are unoccupied for large amounts of time. Finally, data can be collected at airports with a tower where data is recorded electronically or manually by air traffic controllers. Information on takeoffs and landings, instrument operations, and approach operations are recorded. The FAA has collected this data since January 1990 from FAA and FAA-contract towers, summarizes this information in the Air Traffic Activity Data System (ATADS) and publishes it online for public access through The Operations Network (OPSNET) (Spitz & Golaszewski, 2007). Data collected for based aircraft were from the FAA's Terminal Area Forecast, whereas data collected for Total, Local and itinerant aircraft operations at Southern Illinois Airport were collected through OPSNET (FAA, 2012; FAA,2013).

Independent variables data was gathered through various online government databases. The acquisition of intercensal population estimates used for population variables in this research were gathered from the United States Census Bureau online data base. Data was collected for Jackson and Williamson County as well as the closest cities to SIA being Carbondale, Murphysboro, and the Village of De Soto, Illinois for years 2000 through 2010 (U.S. Census Bureau, 2012; U.S. Census Bureau, 2012). Additional information, other than population, collected from the Census Bureau were annual totals of county household units (U.S. Census Bureau, n.d.). Employment information including the actual number of people employed in Jackson County and the Jackson County unemployment rate was gathered through The Bureau of Labor Statistics records. These employment statistics are available online along with average annual pay for the same Illinois Counties (Bureau of Labor Statistics, n.d.). The average price of aviation gasoline per gallon in the United States was obtained from the U.S. Energy Information Administration (U.S. Energy Information Administration, 2016). Variables regarding pilot populations were obtained from the FAA's U.S. Civil Airmen Statistics database, which is updated annually. Contained in this database are the number of certificated pilots within each state (FAA, 2013). For this study, pilot population variables were broken down into total pilots, student pilots, private pilots, commercial pilots and certified flight instructors (CFIs). Total pilots and CFIs are including pilots certified by the FAA under all aircraft (i.e. helicopter, airplane, lighter than air, balloon, etc.), but student, private and commercial pilot data included pilots certified in an airplane only. Finally, Illinois state gross domestic product data was obtained from the Bureau of Economic Analysis and is represented as values in millions of current dollars for all industries (Bureau of Economic Analysis, n.d.).

Table 1: Variable Definition, Conceptualization and References

Variable	Definition	Operationalized	Reference
SIA Local Civilian Aircraft Operations	Total number of itinerant general aviation aircraft operations at SIA for each year from 2000 through 2010	The annual number of civilian aircraft that are based at the airport and that operate in the local traffic pattern or within sight of the airport, that are known to be departing for or arriving from flights in local practice areas within a prescribed distance from the airport, or that execute simulated instrument approaches at the airport.	Federal Aviation Administration Operations Network (FAA, 2013)
SIA Itinerant General Aviation Aircraft Operations	Total number of itinerant general aviation aircraft operations at SIA for each year from 2000 through 2010	The annual number of general aviation (Non-commercial or military) aircraft operations that leave the local airspace.	Federal Aviation Administration Operations Network (FAA, 2013)

SIA Based Aircraft	Total number of aircraft based at SIA for each year from 2000 through 2010	The annual number of general aviation aircraft that use a specific airport as a home base.	Federal Aviation Administration Operations Network (FAA, 2013)
SIA Based Aircraft Squared	Total number of aircraft based at SIA squared for each year from 2000 through 2010	The annual number of general aviation aircraft that use a specific airport as a home base. *(Squared)*	Federal Aviation Administration Operations Network (FAA, 2013)
Jackson County Population	Estimated number people living in Jackson County, Illinois for each year from 2000 through 2010	The annual estimate of people living in Jackson County, Illinois	(U.S. Census Bureau, 2012)

Jackson County Household Units as percent of State Household Unit total	Percent of estimated total of households in Jackson County, Illinois per the estimated total of household units in Illinois for each year from 2000 through 2010	The annual estimate of households in Jackson County, Illinois divided by the estimated number of households in the state of Illinois	(U.S. Census Bureau, n.d.)
Williamson County Population	Estimated number people living in Williamson County, Illinois for each year from 2000 through 2010	The annual estimate of people living in Williamson County, Illinois	(U.S. Census Bureau, 2012)

Illinois Gross Domestic Product (GDP)	Total amount of revenue produced by Illinois' industries for each year from 2000 through 2010	The annual amount of money, in millions of dollars, produced by all industries in the state of Illinois	(Bureau of Economic Analysis, n.d.)
Illinois Gross Domestic Product (GDP) Squared	Total amount of revenue produced by Illinois' industries, then squared for each year from 2000 through 2010	The annual amount of money, in millions of dollars, produced by all industries in the state of Illinois. *(Squared)*	(Bureau of Economic Analysis, n.d.)
Illinois Total Pilots	Estimated number of pilots in Illinois for each year from 2000 through 2010	The annual estimated amount of people who hold an airplane (not including flight instructors) pilot certificate and a valid medical certificate issued within the last 25 months within the state of Illinois (Includes all categories and classes of airmen)	(FAA, 2013)

Illinois Commercial Pilots	Estimated number of commercial pilots in Illinois for each year from 2000 through 2010	The annual estimated amount of people who hold a commercial pilot certificate and a valid medical certificate issued within the last 25 months within the state of Illinois. (Includes all classes of airmen i.e. single engine, multi engine, land and sea)	(FAA, 2013)
Change in Illinois Total Pilots from previous year per the Total Number of Illinois's Public Use Airports	Percentage of pilots in Illinois in each year per the number of Illinois public use airports in 2012 for each year from 2000 through 2010	The annual estimated amount of people who hold an airplane pilot certificate (Includes all classes of airmen, see above) and a valid medical certificate issued within the last 25 months within the state of Illinois subtracted by the previous year, then divided by the total number of public use airports in Illinois in 2012 (107)	(FAA, 2013)

U.S. Average Aviation Gasoline Price	U.S. average aviation gasoline price for each year from 2000 through 2010	The annual average price in U.S. dollars per gallon for aviation gasoline within the U.S.	(U.S. Energy Information Administration, 2016)
Jackson County Unemployment Rate	The percentage of people eligible to work but who have been unemployed or seeking a job for each year from 2000 through 2010	The annual average of unemployment within Jackson County, Illinois.	(Bureau of Labor Statistics, n.d.)
Jackson County Employment as percent of Illinois State total	Percentage of people who are employed in Jackson County per the people who are employed in Illinois for each year from 2000 through 2010	The annual average of unemployment within Jackson County, Illinois divided by annual average of unemployment within Illinois.	(Bureau of Labor Statistics, n.d.)

Jackson County Average Annual Pay	Average amount of income for each individual in Jackson County, Illinois for each year from 2000 through 2010	Jackson County average annual amount of pay per person in U.S. dollars	(Bureau of Labor Statistics, n.d.)
Trend	Case number ordered in sequence	This is dummy variable created to control for auto correlation. This variable is the case number starting at 1 for the first case (earliest year) in the model, 2 for the second case (following year), etc.	

This study assumes variables identified by the literature to impact local civilian aircraft operations, itinerant general aviation aircraft operations and based aircraft will apply to Southern Illinois Airport between years 2000 and 2010. For example, the Illinois State Aviation System Plan of 1994 identified population, number of pilots, number of households, level of employment as some of the independent variables impacting airport activity variables. These variables may or may not affect Southern Illinois Airport in the same way they did in the state of Illinois. Also, Illinois has changed since 1994. For example, Illinois total based aircraft in 1994 was 7,090

aircraft (IDOT, 1994). The number of total based aircraft in Illinois has decreased since 1994 to 5,135 aircraft in 2010 (FAA, 2012). Total Illinois population has increased from 11,912,585 people in 1994 to 12,830,632 people in 2010 (U.S. Census Bureau, 2012). This study will assume the external validity of the researched literature is also true at Southern Illinois Airport.

Research Questions

The overall hypothesis is to identify what independent variables impact airport activity at Southern Illinois Airport from 2000 to 2010. SIA is a general aviation, class IV part 139 airport and it is recommended by the FAA to determine airport activity at this type of airport by measuring local civilian operations, itinerant general aviation operations and based aircraft (FAA, 2007). For this reason, the overall hypothesis will be broken down into six smaller divisions and referred to as hypotheses to test each of the former factors used to measure airport activity.

Examining Hypothesis 1

Y (SIA local civilian operations) = B0 + B1 (Jackson County population) + B2 (SIA based aircraft squared) + B3 (Jackson County average annual pay) + B4 (U.S. aviation gas price) + error

Hypothesis one will be tested to determine the impact of Jackson County population, SIA based aircraft squared, Jackson County average annual pay, and U.S. aviation gas price's effect on Southern Illinois Airport's local civilian aircraft operations from 2000 to 2010. As recognized in the FAA's publication "Forecasting Aviation Activity by Airport" (2001), aviation demand factors such as local population, income levels and number of based aircraft may affect airport activity. Past regression models conducted suggest an increase in local population or income levels are expected to cause an increase in airport activity, such as local airport

operations. Also included in this statistical analysis, were based aircraft squared as an independent variable affecting airport operations. By squaring based aircraft, the study compensates for the slower rate at which the number of based aircraft increases when compared to the number of airport operations. The literature identified a positive relationship between based aircraft squared at an airport and aircraft operations at the same airport (as cited in GRA, Inc., 2001). Spitz and Golaszewski in "Airport Aviation Activity Forecasting" (2001), identified air transport production costs and technology as supply factors impacting airport activity including fuel costs. Fuel cost was the only supply variable identified in this publication impacting non-airline operations at airports. The U.S. aviation gas price variable used in testing hypothesis one, is an average price for the United States in dollars per gallon and an increase in U.S. aviation gas price is expected to have a negative impact on local operations. The error in the equation determines to what degree external factors or nonincluded independent variables impact SIA local operations.

Examining Hypothesis 2

Y (SIA local operations) = B0 + B1(Williamson County population) + B2 (Illinois commercial pilot total) + error

Hypothesis two will be tested to determine the effect of the Williamson County population and the amount of commercial airplane pilots in Illinois on SIA's local civilian operations from 2000 to 2010. SIA is not located in Williamson County, but is located approximately fourteen miles from the county's significant concentration of population in Marion, Illinois. The literature has suggested local population positively affects airport operations and, for the sake of this research, Williamson county will be considered as such. The Illinois State Aviation System Plan identified the number of pilots as a factor positively affecting

airport operations (IDOT, 1994). Hypothesis two includes the number of certificated commercial airplane pilots in Illinois as a variable positively affecting SIA local operations.

Examining Hypothesis 3

Y (SIA itinerant general aviation operations) = B0 + B1 (Illinois GDP) + B2 (US aviation gas price) + B3 (Illinois total pilots) + B4 Jackson County Unemployment Rate error

Hypothesis three will be tested to determine the effect of Illinois GDP, U.S. aviation gas price and Illinois total pilots on Southern Illinois Airport itinerant general aviation operations from 2000 to 2010. GDP is identified by the literature to be a macroeconomic demand indicator having a positive relationship with airport activity (Spitz & Golaszewski, 2007). Since itinerant operations count aircraft originating from and departing to airports other than SIA, there is a potential for factors not in the local area to impact airport activity; therefore, Illinois all industry GDP will be used in this case as opposed to a local GDP. An ACRP synthesis report suggested employment levels as a factor impacting airport activity (Spitz & Golaszewski, 2007). Hypotheses three includes Jackson County unemployment rate as an independent variable.

Examining Hypothesis 4

Y (SIA itinerant general aviation operations) = B0 + B1 (U.S. aviation gas price) + B2 (SIA based aircraft squared) + error

Hypothesis four will be tested to determine the effect of U.S. aviation gas price and SIA based aircraft squared on SIA itinerant general aviation operations from 2000 to 2010. The literature suggests the number of based aircraft will increase the amount of aircraft operations (FAA, 2001; IDOT, 1994). Aviation fuel cost is a supply variable identified by the literature to negatively affect aircraft operations. Fuel cost variables used in long term forecasts are supply variables correlating to general aviation activity as opposed to airline activity at an airport (Spitz

& Golaszewski, 2007). Since SIA is a FAA class IV part 139 airport only serving unscheduled airline operations and overwhelmingly serves general aviation, U.S. aviation gas price is fitting to SIA's type of airport (FAA, 2016).

Examining Hypothesis 5

Y (SIA based aircraft) = B0 + B1 (Jackson County employment as percent of Illinois state total) + B2 (Jackson County household units as percent of state household unit total) + B3 (the change Illinois total pilots from previous year per the total number of Illinois's public use airports) + error

Hypothesis five will test the effect of Jackson County employment as a percentage of Illinois state employment total, Jackson County household units as percentage of Illinois state household unit total and annual change in Illinois total pilots as a percentage of SIA's average Illinois market share on SIA based aircraft from 2000 to 2010. The basis of this hypothesis is Illinois State Aviation System plan where employment, household units and pilot population independent variables were determined to reliably cause 89.3% of the variance of based aircraft in Illinois airports with a high level of significance (IDOT, 1994). This formula used independent variables based upon the percent of state totals, therefore the employment and household unit variables in hypothesis five were calculated by dividing each variable's value in Jackson County, Illinois by the Illinois total value. Since pilot totals per county were not obtained in testing hypothesis five, the Illinois pilot variable was determined by calculating the difference from the year prior and dividing it by the number of public use airports in Illinois in 2012. Based upon the literature, it is expected that SIA based aircraft will increase with increases in hypothesis five's independent variables.

Examining Hypothesis 6

Y (SIA based aircraft) = B0 + B1 (Jackson County population) + B2 (U.S. aviation gas price) + B3 (Illinois GDP) + B4 (Jackson County average annual pay) + error

Hypothesis six will be tested to determine the effect of Jackson County population estimates, U.S. aviation gas price, Illinois all industry GDP, and Jackson County average annual pay on SIA based aircraft. The Airport Cooperative Research Program (ACRP) study conducted by Spitz & Golaszewski (2007), suggested demand factors such as GDP and income could be valid factors used to determine change in airport activity. These factors when increased should positively impact the amount of based aircraft at SIA. Hypothesis six also includes the supply factor of U.S. average aviation fuel cost in impacting SIA based aircraft. This variable is believed to have an inverse relationship on SIA based aircraft consistent with the ACRP study. Finally, the Federal Aviation Administration recognizes local population as a factor positively impacting airport activity (FAA, 2001).

Research Findings

Model for Hypothesis 1

Model A

Table 2 Model A: Regression Model Results for Hypothesis 1 affecting SIA Local Civilian Operations (N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
.937	.879	.798	6538.743	10.878	.006	2.594

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
Jackson County Population Estimate	-6.076	6.978	-0.167	-0.871	0.417	1.821
SIA Based AC Squared	-2.841	2.913	-0.248	-0.975	0.367	3.202
Jackson County Average Annual Pay	-2.701	1.966	-0.643	-1.374	0.218	10.848
US Aviation Gas Price	-7529.065	8312.147	-0.364	-0.906	0.400	8.011

The table above is the regression model results testing Jackson County population estimates, SIA based aircraft squared, Jackson County average annual pay, and U.S. aviation gas prices on SIA local civilian operations. The model is significant at the 0.01 level meaning the model ensures a 99% level of confidence in its accuracy in measuring the effect on SIA local civilian operations. However, none of the independent variables tested meet the minimum of 0.05 significance; therefore, based upon this model, none of the independent variables have any correlation between them and SIA local civilian operations. Plus, the t-test statistics are close to

zero meaning there is no relationship between all independent variables and SIA local civilian operations. The variance inflation factor (VIF) in model A for Jackson County average annual pay and U.S. aviation gas price independent variables have values greater than ten; therefore, these former variables are correlated to each other and similarly impact SIA local civilian operations. This effect is called multicollinearity among independent variables can affect the regression analysis's validity. To correct for this potential error in the analysis, Jackson County average annual pay is excluded in model B. Model A was also tested for auto correlation. Auto correlation is an error that can occur when testing regression models with time series data. Auto correlation occurs when a variables value at a specific time is highly correlated to its adjacent value (Berman, 2007). For example, auto correlation would be present if the gas price of today was influenced by the gas price of last week. The Durbin-Watson test identifies the potential for auto correlation to exist in a regression model. The Durbin-Watson value for model A was 2.594 meaning there some potential for auto correlation, but it is not certain. One way to control for auto correlation is to add a trend variable (Berman, 2007). This variable records the order of the variables/cases in which they appear. In model B, the trend variable is numbered one through eleven for each case starting at the year 2000 and ending in 2010.

Model B

Table 3 Model B: Regression Model Results for Hypothesis 1 affecting SIA Local Civilian Operations (Controlled for Multicollinearity and Autocorrelation, N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.933	0.871	0.784	6754.613	10.1	0.008

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
Jackson County Population Estimate	-4.625	6.981	-0.127	-0.662	0.585	1.708
SIA Based AC Squared	-1.221	2.307	-0.107	-0.812	0.448	1.881
US Aviation Gas Price	-7618.579	9385.038	-0.369	-0.812	0.448	9.570
Trend	-2450.669	2076.699	-0.559	-1.180	0.283	10.398

Model B controls for multicollinearity and autocorrelation the identified in model A between Jackson County average annual pay and U.S. aviation gas price. Furthermore, a scatter plot was created to determine the potential for heteroscedasticity. Heteroscedasticity occurs when variables have unequal variances of the error term resulting in the underestimation of regression coefficients and is a threat to the models validity. In observing model B's scatter plot no heteroscedasticity existed. Finally, model B did not identify any relationships between any of the independent variables and SIA's local civilian operations; therefore, the null hypothesis is accepted.

Model for Hypothesis 2

Model C

Table 4 Model C: Regression Model Results for Hypothesis 2 affecting SIA Local Civilian Operations (N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.965	0.930	0.913	4289.129	53.537	0.000

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
Williamson County Population Estimate	-6.755	0.771	-0.850	-8.763	0.000
Illinois Commercial Airplane Pilots Estimate	22.143	7.690	0.279	2.879	0.021

Model D

Table 5 Model D: Regression Model Results for Hypothesis 2 affecting SIA Local Civilian Operations (Outliers Removed N=10)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
0.971	0.942	0.926	3795.194	57.186	0.000	1.802

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
Williamson County Population Estimate	-5.775	0.874	-0.704	-6.609	0.000	1.378
Illinois Commercial Airplane Pilots Estimate	30.194	8.151	0.395	3.704	0.008	1.378

The tables above are the regression model results testing Williamson County population estimate on commercial airplane pilots on SIA local civilian operations. Model C has an adjusted R-square value of 0.913 indicating that the independent variables explain 91.3% of the variance with both variables being significant enough to reject the null hypothesis. However, in this model the year 2000 was identified as an outlier via Cook's Distance method. In 2000, SIA had 87,829 local civilian operations as opposed to 2001 having 76,172 local civilian operations. This large change in local civilian operations may have been the reason the year 2000 was identified as an outlier. A Cook's distance value of 0.869 for the year 2000 is higher than the acceptable critical value of 0.5 in this case. For this reason, model D was tested having the year 2000 removed from the equation.

Model D has an adjusted R-square value of 0.926 meaning that Williamson County population estimate and Illinois commercial airplane pilots explain 92.6% of the variance of SIA local civil operations. Model D is significant at the 0.001 level and both variables in this model are significant. The Williamson County population estimate has a t-test statistic of -6.609 meaning the relationship between it and SIA local civil operations and is highly significant at the 0.001 level. We can be 99.9% confident every increase in Williamson county's population by one person will result in a decrease of 5.775 local civil operations annually at SIA.

Model D also identifies Illinois commercial airplane pilot estimate as having a statistically significant relationship with SIA's local civil operations. Illinois commercial airplane pilot estimate variable has a t-test statistic of 3.704, which is significant at the 0.01 level. We can be 99% confident every increase in commercial airplane pilots in Illinois by one will result in an increase of 30.194 local civil operations at SIA.

Model D was also tested for multicollinearity, autocorrelation and heteroscedasticity. The VIF values of 1.378 are significantly lower than ten indicating that the independent variables do not correlate with each other and do not threaten the validity of the analysis. The Durbin-Watson value of 1.802 indicates there is no autocorrelation affecting this analysis. Finally, the scatter plot between the standardized residuals and standardized predicted values determine the values are equally dispersed on the error term plot indicating no sign of heteroscedasticity in the analysis.

Model for Hypothesis 3

Model E

Table 6 Model E: Regression Model Results for Hypothesis 3 affecting SIA Itinerant General Aviation Operations (N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.720	0.519	0.198	3644.050	1.618	0.285

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
Illinois All Industry GDP	0.087	0.111	1.359	0.785	0.462
US Aviation Gas Prices	-649.992	6,386.769	-0.112	-0.102	0.922
Illinois Total Pilots	4.386	3.714	1.290	1.181	0.282
Jackson County Unemployment Rate	-2,184.936	1,249.186	-0.633	-1.749	0.131

Model F

Table 7 Model F: Regression Model Results for Hypothesis 3 affecting SIA Itinerant General Aviation Operations (Outliers Removed years 2005 and 2009, N=9)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.925	0.856	0.712	2164.914	5.943	0.056

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
Illinois All Industry GDP	0.489	0.130	8.194	3.762	0.020	131.779
US Aviation Gas Price	-21,626.760	7,965.198	-3.942	-2.715	0.053	58.542
Illinois Total Pilots	14.582	3.940	4.199	3.701	0.021	35.763
Jackson County Unemployment Rate	-3,192.210	916.410	-0.888	-3.483	0.025	1.807

Model E tests the impact of Illinois all industry GDP, U.S. aviation gas prices, Illinois total pilots, and Jackson County unemployment rate on SIA's itinerant general aviation operations. This model does not offer any statistical significance between the dependent and independent variables. The significance for them model does not meet the 0.05 minimum level to determine there is a relationship between variables. Furthermore, each individual variable does not meet the minimum level of significance or have a t-test statistic at a value illustrating a relationship between variables either; therefore, in model E the null hypothesis is accepted.

Model F was tested having years 2005 and 2009 removed by utilizing Cook's distance method for detecting outliers. The critical value for this hypothesis was determined to be 0.666 and 2005 had a Cook's distance value of 2.1 while 2009's value was 0.93. Since these year's

Cook's distance values are over the critical value of 0.666, they were determined to be outliers. After the years 2005 and 2009 were removed from model E, the results depicted in model F detected some statistically significant relationships. The model employs an adjusted R-square value of 0.712 meaning the independent variables cause 71.2% of the variance in SIA's itinerant general aviation operations. Illinois all industry GDP has a t-test statistic of 3.762 that is significant at the 0.05 level. This suggests there is a positive relationship between Illinois all industry GDP and SIA's itinerant general aviation operations. Every one million dollar increase in Illinois all industry GDP should result in an increase of 0.489 itinerant general aviation operations at SIA. U.S. aviation gas price has an interesting output in model F. Its t-test value is high enough at 2.715 to illustrate a relationship with SIA's itinerant general aviation operations, but it is not considered to be statistically significant at the 0.05 level of significance. Also, if it were to be statistically significant, the model would offer evidence presenting a one dollar increase in U.S. aviation gas price would decrease SIA's itinerant general aviation operations by 21,626.760, which is an 84% decrease in operations for the year 2010. In model F, U.S. aviation gas price is not identified as having a relationship with SIA's itinerant general aviation operations. The Illinois total pilots independent variable in model F, has a t-test statistic of 3.701 that is statistically significant at the 0.05 level. This means we can be 95% confident that every additional pilot in Illinois will result in an increase of 14.582 in SIA itinerant general aviation operations. Finally, Jackson County unemployment rate is found to have a statistically significant relationship with SIA's itinerant general aviation operations in model F. The unemployment rate is significant at the 0.05. For every increase in Jackson county unemployment rate by 1%, will result in a decrease by 3,192.210 itinerant general aviation operations at SIA. The VIF values in model F for Illinois all industry GDP, U.S. aviation gas

price and Illinois gas price exposes problems with model F's validity. Each of these mentioned variables have VIF values significantly above ten meaning these independent variables have significant impact on each other. This relationship between independent variables is called multicollinearity and it can negatively alter the outcome of the analysis. Per Berman, one way to correct for multicollinearity is to remove variables with the highest VIF values from the analysis (2007). Model G, model H and model I are tested isolating independent variables correcting for multicollinearity.

Model G

Table 8 Model G: Regression Model Results for Hypothesis 3 affecting SIA Itinerant General Aviation Operations (N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
0.509	0.259	0.073	1.365	1.395	0.302	1.021

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
Illinois Total Pilots	0.632	3.314	0.181	0.191	0.854
Trend	-421.996	1196.079	-0.334	-0.353	0.733

Model H

Table 9 Model H: Regression Model Results for Hypothesis 3 affecting SIA Itinerant General Aviation Operations (Outliers Removed year 2001, N=10)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
0.887	0.788	0.727	1.381	12.978	0.004	1.913

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
US Aviation Gas Price	4039.396	2797.164	0.495	1.444	0.192
Trend	-2040.817	547.365	-1.277	-3.728	0.007

Model I

Table 10 Model I: Regression Model Results for Hypothesis 3 affecting SIA Itinerant General Aviation Operations (Outliers Removed year 2001, N=10)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
0.979	0.959	0.947	1.029	82.182	0.000	1.736

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
Jackson County Unemployment Rate	-2118.638	321.880	-0.777	-6.582	0.000	2.390
Illinois All Industry GDP	-0.28	0.013	-0.248	-2.098	0.074	2.390

Models G and H are tested as single regression equations to illustrate the change from model F. Model G testes the single impact of Illinois total pilots on SIA itinerant general aviation operations. Model H tests the impact of U.S. aviation gas price per gallon on SIA itinerant general aviation operations. In model F, Illinois total pilots is considered to have a

significant impact on SIA itinerant general aviation operations at the 0.05 level of significance, but when tested to control for the multicollinearity in model G there no relationship. The Illinois total pilots variable is not determined to be significant in model G suggesting Illinois total pilots is not an independent variable impacting SIA itinerant general aviation operations. Model H suggests U.S. aviation gasoline price per gallon is not a variable impacting SIA itinerant general aviation operations. The year 2001 was identified as an outlier through the studentized deleted method of identifying outliers; therefore, Model H was tested without the year 2001. Like model G, model H indicates U.S. aviation gasoline price per gallon does not impact SIA itinerant general aviation operations.

Model I tests the impact of Jackson County unemployment rate and Illinois all industry GDP on SIA itinerant general aviation operations. Like model H, the year 2001 was identified as an outlier through the studentized deleted method of determining outliers. A value of -3.001 studentized residual was calculated for the year 2001. Per Pennsylvania State University, studentized residual values above two or below negative two can conservatively be considered outliers (2017). Furthermore, by observing the error term plot for model a previous regression on Jackson County unemployment rate and Illinois all industry GDP on SIA itinerant general aviation operations heteroscedasticity was suspected. Per Berman, Model I was tested as a weighted least squares regression correcting for heteroscedasticity (2007). Model I is a highly significant model with a 0.947 adjusted R-squared value at the 0.001 level of significance. This means the model ensures 99.99% confidence that the independent variable explains 94.7% of the SIA itinerant general aviation operations variance. Jackson County unemployment rate is identified as having a strong relationship on SIA itinerant general aviation operations with -6.582 t-test statistic and 0.001 level of significance. For every one percent increase in Jackson County

unemployment rate, SIA itinerant general aviation operations will decrease by 2,118.638 operations. Illinois all industry GDP is not identified as an independent variable affecting SIA general aviation operations. A -2.098 t-test statistic suggests there may be a relationship, but the 0.074 significance value is does not meet the 0.05 level of significance to conclude there is a relationship between Illinois all industry GDP and SIA itinerant general aviation operations. Due to model I, the null hypothesis is rejected.

Model for Hypothesis 4

Model J

Table 11 Model J: Regression Model Results for Hypothesis 4 affecting SIA Itinerant General Aviation Operations (N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.722	0.521	0.402	3148.135	4.356	0.053

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
US Aviation Gas Price	265.331	1623.857	0.046	0.163	0.874
SIA Based Aircraft Squared	2.382	0.900	0.743	2.646	0.029

Model K

Table 12 Model K: Regression Model Results for Hypothesis 4 affecting SIA Itinerant General Aviation Operations (Outliers Removed years 2001 and 2007, N=9)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
0.953	0.908	0.877	1,472.643	29.433	0.001	3.137

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
U.S. Aviation Gas Price	297.775	984.836	0.048	0.302	0.773	1.622
SIA Based Aircraft Squared	3.086	0.497	0.982	6.206	0.001	1.622

Model J and model K test the effect of U.S. aviation gas price and SIA based aircraft squared on SIA itinerant general aviation operations. Model J is not considered statistically significant with its value of significance of 0.053 and a 4.356 global F value. However, model J does identify SIA based aircraft squared as having a positive relationship with SIA itinerant general aviation operations at the 0.05 level of significance. Model J also identified two outlier years through Cook's distance method. The year 2001 had a Cook's distance value of 0.564 and the year 2007 had a value of 0.621. Both years are over the critical value of 0.5 for this model; therefore, data in the years 2001 and 2007 were determined to be statistical outliers in model J. Model K was tested with both outliers removed from the equation.

Model K model explains the variance in SIA's itinerant general aviation operations. The model has a R-square value of 0.908 meaning it explains 90.8% of SIA's itinerant general aviation operations and is statistically significant at the 0.001 level. This high level of correlation ensures a level of confidence of 99.99% in the accuracy of the model. Like Model J, U.S. aviation gas price does not influence the dependent variable in this model. SIA based

aircraft squared is strongly correlated to SIA's itinerant general aviation operations with a t-test value of 6.206 significant at the 0.001 level. This means the model is 99.99% confident that every additional based aircraft at SIA, will result in an increase of 3.086 itinerant general aviation aircraft operations at SIA. The 1.622 VIF statistic suggests multicollinearity is not affecting the test results. The Durbin Watson statistic of 3.137 suggests there maybe auto correlation among variables, although it is not certain. For this reason, Model L is ran controlling for auto correlation by adding a trend control variable controlling for time.

Model L

Table 13 Model L: Regression Model Results for Hypothesis 4 affecting SIA Itinerant General Aviation Operations (Outliers Removed years 2001 and 2007, N=9)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
0.960	0.922	0.876	1478.161	19.794	0.003	2.977

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
U.S Aviation Gas Price	2172.736	2158.051	0.349	1.007	0.360
SIA Based Aircraft Squared	2.875	0.543	0.915	5.291	0.003
Trend	-562.430	575.440	-0.367	-0.977	0.373

Model L controls for auto correlation by the addition of a trend variable to U.S aviation gas price and SIA based aircraft squared effect on SIA itinerant general aviation operations. There is little impact on the model overall only with a change in significance from 0.001 to the 0.003 level from model K to model L. The significance of SIA based aircraft squared is lowered slightly to 0.003, so Model L is significant at the 0.01 level. This model suggests for every based

aircraft located at SIA increases SIA itinerant general aviation operations by 2.875; therefore, the null hypothesis is rejected.

Model for Hypothesis 5

Model M

Table 14 Model M: Regression Model Results for Hypothesis 5 affecting SIA Based Aircraft (N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.520	0.270	-0.043	6.556	0.863	0.503

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
Jackson County Employment % of Illinois State	22.712	241.610	0.042	0.094	0.928
Jackson County Household Units as % of Illinois State	210.099	585.250	0.168	0.359	0.730
Illinois Total Pilots change per Illinois Public Use Airports	-0.652	0.430	-0.557	-1.519	0.173

Model N

Table 15 Model N: Regression Model Results for Hypothesis 5 affecting SIA Based Aircraft (Outliers Removed years 2009 and 2010, N=9)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
0.747	0.558	0.293	3.201	2.107	0.218	2.048

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
Jackson County Employment % of Illinois State	256.812	230.777	0.694	1.113	0.316	4.400
Jackson County Household Units as % of Illinois State	419.296	387.622	0.628	1.082	0.329	3.821
Illinois Total Pilots change per Illinois's Public Use Airports	-0.429	0.270	-0.545	-1.587	0.173	1.338

Models M and N test Jackson County Employment as a percentage of Jackson County employment as a percentage of Illinois state employment totals, Jackson County household units as percentage of Illinois state household unit totals and Illinois total pilots per Illinois's public use airports on SIA based aircraft from 2000 to 2010. Both models did not suggest any relationship between any of the independent variables and SIA's based aircraft. Model M does not meet the minimum level of significance required to ensure a relationship between the model and SIA's based aircraft. The adjusted R-square value is very low at negative 0.043 suggesting that the model does not explain SIA's based aircraft variance. The independent variable with the highest level of significance is Illinois total pilots change per Illinois's public use airports at

0.173, but this is not high enough to identify a relationship between it and SIA based aircraft. Model M was used to identify two outliers in the equation using Cook's distance. Years 2009 and 2010 had values higher than 0.571 and were considered outliers.

Model N ran the same test at model M, except it did not include years 2009 and 2010 in the equation. This improved the outcome of the analysis, but still model N is not considered to be statistically significant with a value of 0.218. The adjusted R-square value for the model also improves to 0.293, but again this suggests the model is not a moderate fit in determining the variance in SIA based aircraft. The Jackson County employment and household variables' significance from model M dramatically increase, but they do not meet the minimum level of significance to determine a correlation with SIA based aircraft. Model N does not suggest that multicollinearity, auto correlation or heteroscedasticity is likely to be affecting the results. Due to the lack of significance produced in model N, the null hypothesis is accepted.

Model for Hypothesis 6

Model O

Table 16 Model O: Regression Model Results for Hypothesis 6 affecting SIA Based Aircraft (N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.930	0.865	0.776	3.041	9.641	0.009

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
Jackson County Population Estimate	-0.004	0.003	-0.246	-1.306	0.239
U.S. Aviation Gas Price	-3.582	5.381	-0.393	-0.666	0.530
Illinois All Industry GDP	0.000	0.000	2.084	2.728	0.034
Jackson County Average Annual Pay	-0.004	0.001	-2.213	-4.983	0.002

Model P

Table 17 Model P: Regression Model Results for Hypothesis 6 affecting SIA Based Aircraft (Outliers Removed year 2005, N=10)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.982	0.965	0.937	1.669	34.667	0.001

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance
	B	Standard Error	Beta		
Jackson County Population Estimate	-0.005	0.002	-0.327	-3.174	0.025
U.S. Aviation Gas Price	-20.742	5.336	-2.239	-3.887	0.012
Illinois All Industry GDP	0.000	0.000	3.860	6.218	0.002
Jackson County Average Annual Pay	-0.004	0.000	-2.096	-8.398	0.000

Model Q

Table 18 Model Q: Regression Model Results for Hypothesis 6 affecting SIA Based Aircraft Squared (Outliers Removed year 2005, N=10)

R	R Square	Adjusted R Square	Standard Error	F	Significance
0.982	0.964	0.936	333.960	33.881	0.001

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
Jackson County Population Estimate	-1.031	0.341	-0.315	-3.023	0.029	1.526
U.S. Aviation Gas Price	-4200.217	1067.448	-2.291	-3.935	0.011	47.651
Illinois All Industry GDP	0.077	0.012	3.927	6.256	0.002	55.372
Jackson County Average Annual Pay	-0.765	0.091	-2.112	-8.367	0.000	8.950

Models O and P tested the impact of Jackson County population estimate, U.S. aviation gas price, Illinois all industry GDP and Jackson County average annual pay on SIA's number of based aircraft. Model O's regression is significant at the 0.01 level with an adjusted R-square value of 0.776 meaning the independent variables explain 77.6% of SIA's based aircraft variance. However, Model O only has two independent variables that are significant. Illinois all industry GDP is significant at the 0.05 level with a t-test value of 2.728 meaning there is a moderate relationship between it and SIA based aircraft. The only concern is Model O's B value for Illinois all industry GDP of zero meaning one unit of change in Illinois all industry GDP will affect SIA based aircraft by zero. This problem is due to the values for each variable. In 2010, there were 88 based aircraft at SIA and 642,769 million dollars GDP in Illinois for the same

year. The statistical software in determining slope or B assumes there is a one million dollar increase in GDP in determining the effect on SIA based aircraft, which may be too small of an increase in GDP to effect SIA based aircraft.

Model P identified 2005 as an outlier with a Cook's distance value of 2.98. Since this value is above this model's critical value of 0.666, it was removed in models P and Q. Model P is highly significant with a global F of 34.66 and is significant at the 0.001 level. This model ensures a 99.99% confidence level that the independent variables explain 96.5% of the variance of SIA based aircraft. Each of the independent variables individually are significant and have at least a moderate relationship with SIA based aircraft. U.S. aviation gas price independent variable is the most interesting variable in model P. It is highly significant at the 0.05 level of significance with a t-test value of -3.887 identifying a moderate to strong relationship between U.S. aviation gas price and SIA based aircraft. The B value or slope indicates every one dollar increase in U.S. aviation gas price should result in a decrease of 20.742 based aircraft at SIA. This slope also implies the opposite to be true. Unfortunately, model P indicates B values for Jackson County population estimate, Illinois all Industry GDP and Jackson County average annual pay that are too small to use in any practical sense. To identify the degree of change these independent variables affect SIA based aircraft, model P was run using SIA based aircraft squared as the dependent variable. The results of this regression are identified as model Q.

Model Q tests the impact of Jackson County population estimate, U.S. aviation gas price, Illinois all industry GDP and Jackson County average annual pay on SIA's number of based aircraft squared. The results are almost identical to model P except for the B values or slope. Jackson County population estimate is significant at the 0.05 level with a t-test statistic of -3.023 identifying a moderate relationship between it and SIA based aircraft squared. The B value is

negative 1.031 meaning for every one person who moves to Jackson County should result in a decrease of 1.031 SIA based aircraft squared. Illinois all industry GDP is highly significant at the 0.01 level with a t-test value of 6.256 indicating a strong relationship between it and SIA based aircraft squared. The results suggests every one million dollar increase in Illinois all industry GDP will result in an increase of 0.077 based aircraft squared at SIA. Finally, Jackson county average annual pay is the most significant variable in model Q with a t-test statistic of negative 8.367 indicating a very strong relationship with a significance of 0.001. The data suggests every one dollar increase in Jackson County's average annual pay will result in a decrease of 0.765 based aircraft squared at SIA. Unfortunately, independent variables tested in model Q have extremely high VIF values. U.S. aviation gas price and Illinois all industry GDP impact each other affecting the results of model Q. This threat to validity is corrected in model R by removing U.S. aviation gas price from the analysis.

Model R

Table 19 Model R: Regression Model Results for Hypothesis 6 affecting SIA Based Aircraft Squared (N=11)

R	R Square	Adjusted R Square	Standard Error	F	Significance	Durbin Watson
0.922	0.851	0.787	586.579	13.294	0.003	2.289

Model	Unstandardized Coefficients		Standardized Coefficients	t	Significance	VIF
	B	Standard Error	Beta			
Jackson County Population Estimate	-0.860	0.561	-0.271	-1.532	0.169	1.465
Illinois All Industry GDP	0.034	0.009	1.686	3.840	0.006	9.042
Jackson County Average Annual Pay	-0.795	0.156	-2.170	-5.102	0.001	8.479

Finally, model R corrects for multicollinearity existing in model Q. Model R tests the impact of Jackson County population estimate, Illinois all industry GDP and Jackson County average annual pay on SIA based aircraft squared. Once the U.S. aviation gas price independent variable was removed from the analysis in model R the outlier in 2005 was no longer an outlier via the Cook's distance method; therefore, model R included the year 2005 in its analysis. This model has significantly reduced errors of multicollinearity existing in previous models. Per Berman, VIF values indicating either above five or ten indicate the existence of multicollinearity in a regression model (2007). In the case of model R, the VIF values for Illinois all industry GDP and Jackson County average annual pay are above five indicating a potential for multicollinearity to affect the regression results. Since there is an improvement from in the VIF values from model Q and the VIF values are below ten in model R, then it cannot be certain that

multicollinearity exists in model R although it is possible. Model R does not indicate through an error term scatter plot the existence of heteroscedasticity and the Durbin Watson test value does not indicate any auto correlation. Model R's 0.787 value for adjusted R-square indicates the independent variables tested explain 78.7% of the variance in SIA based aircraft squared and the model is significant at the 0.01 level of significance. The model identifies the Illinois all industry GDP variable as a factor affecting SIA based aircraft with a 3.840 t-test statistic value and is significant at the 0.01 level. For every one million dollar increase in Illinois all industry GDP, SIA can expect an increase of 0.034 based aircraft squared. Jackson county average annual pay is also significant with a t-test statistic of -5.102 indicating a very strong relationship and a significance of 0.001. The data suggests every one dollar increase in Jackson County's average annual pay will result in a decrease of 0.795 based aircraft squared at SIA.

Discussion

SIA Local Civilian Operations

Hypotheses one and two tested variables impacting SIA's local civilian operations. Hypothesis one could not identify any relationships between SIA local civilian operations and Jackson County population estimate, SIA based aircraft squared, Jackson County average annual pay or U.S. aviation gas price. SIA is unique to many other airports in the region due to Southern Illinois University's flight school existing on the field. The school conducts many local operations per day and plays a large role in the amount of SIA's total local operations. Hypothesis one suggests its independent variables do not impact the annual total of local operations at SIA. In this case, it may not impact the flight school's number of operations either. Jackson County population estimates tested in hypothesis one did not have any significant affect on SIA local civilian operations, which is surprising due to SIA being located within Jackson

County. However, hypothesis two identified strong statistical relationships with independent variables Williamson County population estimate and Illinois number of certificated commercial pilots. Williamson County population estimate has a negative impact on SIA local operations meaning an increase in Williamson County population decreases SIA's local operations. SIA is not located within Williamson County, but it is near Williamson County Regional Airport. Williamson County Regional Airport is approximately fourteen miles away from SIA and is also a towered airport like SIA. The statistical significance of Williamson County population identified in hypothesis two could suggest Williamson County Regional Airport has an impact on SIA airport activity. Illinois total certificated commercial airplane pilots is also identified in hypothesis two as having a moderate impact on SIA's local operations. In 2010, Illinois had 3,812 certificated, commercial pilots. Hypothesis two suggests each new commercial airplane pilot in Illinois will result in an increase of 30.194 in SIA local civilian operations, plus or minus 8.151 operations. This potentially could be related to Southern Illinois University's flight school certificating many commercial pilots and employing many commercial certificated instructors who operate mainly in SIA's local vicinity.

Itinerant General Aviation Operations

Hypothesis three and four used models testing variables impacting SIA's itinerant general aviation operations and both found some statistically significant relationships. Hypothesis three tested Illinois all industry GDP, U.S. gasoline price, Illinois total number of certificated pilots, and Jackson County unemployment rate's impact on SIA itinerant operations. The recognition of multicollinearity in the model indicated the necessity to separate independent variables into different tests. Model I proved to be an excellent model in explaining how Jackson County unemployment rate affects SIA itinerant general aviation operations. The literature is consistent

with the significant relationship found in hypothesis three with unemployment having a negative relationship on SIA itinerant operations.

Hypothesis four tested the effect of U.S. gasoline price and SIA based aircraft squared on SIA itinerant general aviation operations. SIA based aircraft squared was found to be a statistically significant independent variable. Based aircraft's impact on itinerant operations is consistent with the literature on airport activity. The model testing hypothesis four is highly significant at the 0.01 level with a high adjusted R-square explaining 87.6% of SIA's itinerant operations variance. SIA based aircraft is determined in this test to be a key variable impacting SIA's itinerant operations.

Based Aircraft

Hypothesis five and six tested factors affecting SIA's number of based aircraft. Hypothesis five attempted to identify household units, number of Illinois pilots and employment variables for either Jackson County as a percentage of state totals or per the number of public use airports in Illinois. The idea was to use variables as a SIA's market share of Illinois. This could potentially control for changes within the state that ultimately impact Jackson County and SIA. The literature supporting this hypothesis is the Illinois State Aviation System Plan of 1994 which focused on identifying variables affecting airport activity at the Illinois regional level. In this case, hypothesis five did not identify any individual statistical relationships, but could be due to two factors. First, taking these variables from the regional level and applying them to a specific airport is a threat to external validity of the independent variables tested in hypothesis five. Secondly, the variables could have been operationalized differently to better fit SIA. For example, instead of calculating Illinois total certificated pilots change from the previous year per total number of Illinois public use airports, the variable could be operationalized as the total

number of certificated pilots in Jackson County per the Illinois total certificated pilots. This could result in a better representation of Jackson County's market share of total pilots.

Hypothesis six identified two independent variables impacting SIA Based Aircraft Squared. Model R identifies Illinois all industry GDP and Jackson County average annual pay as highly statistically significant explaining 78.7% of SIA's based aircraft variance. However, the Jackson County average annual pay variable, although significant, act contrary to the information published by the Airport Cooperative Research Program and the FAA. This literature suggests a positive relationship between the former variable and SIA based aircraft, but model K identifies a negative relationship between SIA based aircraft squared and Jackson County average annual pay.

Conclusion

Hypothesis one tested the effect of Jackson County population, SIA based aircraft squared, Jackson County average annual pay and U.S. aviation gasoline price on SIA local civilian operations. Based upon the liner regression analysis, the null hypothesis is accepted. None of the independent variables were determined to be statistically significant in impacting SIA local operations.

Hypothesis two tested Williamson County population and the number of certified commercial airplane pilots in Illinois's impact on SIA local civilian operations. Model D determined with a high degree of certainty there is a moderate to strong relationship between SIA local civilian operations and the independent variables; therefore, the null hypothesis is rejected. The test determines both independent variables to explain 92.6% of the variance in SIA local operations meaning there are few other independent variables impacting SIA local operations not considered in this model. Model D aides in the understanding of why SIA local

operations have varied from 2001 to 2010. Model C of hypothesis two identified data in the year 2000 to be an outlier via the Cook's distance method. This is potentially due to the impact of September 11, 2001 on SIA local operations on the years after the year 2000.

Hypothesis three was affected by multicollinearity and heteroscedasticity in early models. After controlling for these errors, model I was tested with 2001 as an outlier via the studentized deleted method of statistically detecting outliers. The statistical analysis in model I identified the Jackson County unemployment rate to have a moderate to strong impact on SIA itinerant general aviation operations. Model I is a highly significant model explaining the variance in SIA itinerant general aviation operations; therefore, the null hypothesis is rejected.

Hypothesis four tested the effect of U.S. aviation gas price and SIA based aircraft squared on SIA itinerant general aviation operations. Model J was used to determine the years 2001 and 2007 as outliers via Cook's Distance method of statistically determining outliers. Model F was tested with these years removed from the analysis. The model L identified SIA based aircraft squared as a highly significant variable impacting SIA itinerant general aviation operations. SIA can be confident that an increase in SIA based aircraft increase the number of SIA itinerant general aviation operations in the future. This information can be used to justify future airport improvement projects to the FAA. U.S. aviation gas price was not found to be significant in impacting itinerant operations, which is consistent with hypothesis three's analysis. The null hypothesis is rejected.

Models testing Jackson County employment as percentage of Illinois total, household units as a percentage of Illinois total and pilot change per Illinois public use airports impacting SIA based aircraft did not identify any significant statistical relationships. Model M identified years 2009 and 2010 as outliers in the analysis via Cook's Distance method, and where were

removed from model M in the following test. These outlier years could be caused by the national recession that began in 2008. Regardless of the outliers being removed in model N, the null hypothesis is accepted since both models could not determine any statistical relationships. Independent variables tested in hypothesis five were calculated to represent Jackson County's market share in Illinois. This approach was first used in Illinois aviation system planning at the regional level, but using this method at the local level did not prove to be valid. This lack of translation may suggest key differences in impacts on airport activity at the regional and local level.

Finally, models testing Jackson County population, U.S. aviation gas price, Illinois all industry GDP, and Jackson County average annual income on SIA based aircraft suggest there are highly significant statistical relationships. Model O determined Illinois all industry GDP and Jackson County average annual pay to be significant independent variables affecting SIA based aircraft, but also identified the year 2005 as an outlier via Cook's Distance method. Model P and Q were tested with the year 2005 removed from the analysis resulting in Jackson County population estimate and U.S. aviation gas price in dollars per gallon to be identified as statistically significant independent variables affecting SIA based aircraft. Model P identified Illinois all industry GDP as statically significant in affecting SIA based aircraft, but with a slope of zero. This means every one million dollar increase in Illinois all industry GDP will result in a change of zero SIA based aircraft. It is suspected the difference in value between SIA based aircraft and Illinois all industry GDP was too large to calculate a useful slope; therefore, model Q was tested with SIA based aircraft squared for the statistical software to calculate a more comprehensive slope. Model P, like model Q, still identified Illinois all industry GDP to be highly significant in affecting SIA based aircraft squared, but with a more compressive value for

slope. In the end, model R removes U.S. aviation gas price to reduce the effects of multicollinearity identified in previous models. Model R suggests every one million dollar increase in Illinois all industry GDP will result in an increase of 0.034 in SIA based aircraft squared. The null hypothesis is rejected based upon this statistical analysis. All the models resulted in statistical significance between variables, but the change in the dependent variable from SIA based aircraft to SIA based aircraft squared and controlling for multicollinearity in model R improved the findings to explain the impacts on SIA based aircraft. Applying the results to forecasts allow for a high degree of confidence in the amount of new based aircraft per any change in independent variables.

Recommendations for Further Study

Future studies may want to test the impact of the Southern Illinois University's flight school on SIA's local civilian operations and itinerant general aviation operations. Independent variables testing the impact of the flight school on SIA activity could include total number of flight students, number of flight school aircraft, and/or number of flight instructors employed at the flight school. The impact of flight schools on airport activity was recognized in Lansing Municipal Airport's master plan update (The Village of Lansing, 2009). This is reason enough to try testing the impact of Southern Illinois University's flight school on SIA's airport activity and the external validity of Lansing's master plan.

Although hypothesis six testing the impact of Jackson County population, U.S. average aviation gasoline price, Illinois GDP, and Jackson County average annual pay on SIA based aircraft did identify some causal relationships, future studies could control the test by including supply variables such as cost of airport hangars and other airport fees. Including these supply variables could produce a more comprehensive model that better represents change in SIA based

aircraft. Potentially, inflation could be a factor in creating negative relationships between pay, Jackson County population and based aircraft. One suggestion assumes, although pay is increasing, buying power is decreasing among Jackson County residents. If this assumption is true, then reduced buying power among Jackson County residents could affect their financial ability to own and operate an aircraft at SIA.

References

Austin, P., & Steyerberg, E. (2015). The number of subjects per variable required in linear regression analysis. *The Journal of Clinical Epidemiology.* 68, 627-636.

Berman, E. (2007). Multiple Regression. *Essential statistics for public managers and policy analysts* (pp. 211-234). Washington, DC: CQ Press.

Bureau of Economic Analysis. (Undated). *Regional Data.* Retrieved on February 16, 2013 from http://www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1#reqid=70&step=10&isuri=1&7007=-1&7036=-1&7003=200&7035=-1&7006=17000&7001=1200&7002=1&7090=70&7004=NAICS&7005=-1&7093=Levels

Bureau of Labor Statistics. (Undated). *Local Area Unemployment Statistics.* Retrieved on February 10, 2013 from http://www.bls.gov/lau/#cntyaa

Federal Aviation Administration. (2000). *Field formulation of the National Plan of Integrated Airport Systems.* (Order 5090.3C). Retrieved February 26, 2017 from https://www.faa.gov/airports/resources/publications/orders/media/planning_5090_3C.pdf

Federal Aviation Administration. (2001). *Forecasting aviation activity by airport*. Washington, DC: Office of Aviation Policy and Plans Statics and Forecast Branch. Retrieved February 19, 2013, from http://www.faa.gov/data_research/aviation_data_statistics/forecasting/media/AF1.doc

Federal Aviation Administration. (2005). *Airport improvement program handbook.* (Order 5100.38C). Washington, DC: Airport Planning and Programming. Retrieved February 19, 2013 from http://www.faa.gov/airports/resources/publications/orders/media/aip_5100_38c.pdf

Federal Aviation Administration. (2007). *Airport master plans* (Advisory Circular 150/5070-6B). Washington, DC: Office of Airport Planning and Programming. Retrieved February 1, 2013, from www.faa.gov/documentLibrary/media/advisory_circular/150-5070-6B/150_5070_6b_chg1.pdf

Federal Aviation Administration. (2012). *Terminal Area Forecast.* Retrieved July 10, 2013, from http://taf.faa.gov/

Federal Aviation Administration. (2013). *The Operations Network.* Retrieved July 10, 2013, from https://aspm.faa.gov/opsnet/sys/

Federal Aviation Administration. (2013). *U.S. Civil Airmen Statistics.* Retrieved on February 16, 2013 from http://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics/

Federal Aviation Administration. (2014). *Airport Improvement Program Handbook.* Retrieved on February 25, 2017 from https://www.faa.gov/airports/aip/aip_handbook/media/AIP-Handbook-Order-5100-38D.pdf

Federal Aviation Administration. (2016). *National Plan of Integrated Airport Systems 2017-2021.* Retrieved February 25, 2017 from https://www.faa.gov/airports/planning_capacity/npias/reports/

Federal Aviation Administration. (2016). *Airport Data and Contact Information.* Retrieved November 10, 2016, from https://www.faa.gov/airports/airport_safety/airportdata_5010/menu/

GRA, Inc. (2001). *Model for estimating general aviation operations at non-towered airports using towered and non-towered airport data*. Retrieved on June 20, 2013 from

http://www.faa.gov/data_research/aviation_data_statistics/general_aviation/media/GAModel3F.doc

IBM. (2016.) *IBM SPSS Statistics Base 24.* Retrieved on February 28, 2017 from ftp://public.dhe.ibm.com/software/analytics/spss/documentation/statistics/24.0/en/client/Manuals/IBM_SPSS_Statistics_Base.pdf

Illinois Department of Transportation: Division of Aeronautics. (1994). *Illinois state aviation system plan technical report.*

Illinois Department of Transportation: Division of Aeronautics. (2013). *Airport System.* Retrieved on November 12, 2016 from http://www.idot.illinois.gov/transportation-system/Network-Overview/airport-system/index

Pennsylvania State University. (2017). *Identifying outliers.* Retrieved on March 29, 2017 from https://onlinecourses.science.psu.edu/stat501/node/339

Spitz, W., Golaszewski, R. (2007). *Airport aviation activity forecasting / consultants, William Spitz and Richard Golaszewski.* Washington, D.C. : Transportation Research Board, 2007. Retrieved February 2, 2013 from http://gra-inc.com/wp-content/uploads/2016/02/ACRP-AirportAviationActivityForecasting-2007.pdf

U.S. Census Bureau. (Undated). *Housing Units Intercensal Estimates (2000-2010).* Retrieved on February 16, 2013 from http://www.census.gov/popest/data/intercensal/housing/hu2010.html

U.S. Census Bureau (2012). *County Intercensal Estimates (2000-2010).* Retrieved on February 10, 2013 from http://www.census.gov/popest/data/intercensal/county/county2010.html

U.S. Census Bureau (2012). *City and Town Intercensal Datasets (2000-2010).* Retrieved on February 10, 2013 from http://www.census.gov/popest/data/intercensal/cities/cities2010.html

U.S. Energy Information Administration (2016). *U.S. Aviation Gasoline Retail Sales by Refiners.* Retrieved on February 10, 2016 from http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMA_EPPV_PTG_NUS_DPG&f=M

The Village of Lansing. (2009). Airport master plan update. Retrieved June 20, 2013 from http://www.igqdevelopment.com/Assets/pdfs/IGQ%20Final%20Master%20Plan_Exhibits_%20ALP%20100331_reduced.pdf

VITA

Graduate School
Southern Illinois University

Philip J. Tuminaro

Philip.Tuminaro@gmail.com

Southern Illinois University Carbondale
Associate in Applied Science, Aviation Flight, December 2010

Southern Illinois University Carbondale
Bachelor in Science, Aviation Management, December 2010

Research Paper Title:

Variables Impacting Southern Illinois Airport Activity Between the Years 2000 and 2010

Major Professor: Dr. David A. NewMyer