PROCEEDINGS

OF THE 39TH ANNUAL MEETING OF THE

TRANSPORTATION RESEARCH FORUM

Montreal, PQ, Canada
October 16 - 18, 1997

Volume 2

211295

PREDICTING THE PROBABILITY OF LOSS OF COMMUTER AIR SERVICE IN THE UNITED STATES

By

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Over two hundred communities across the United States have commercial air service provided by carriers using turboprop aircraft only. Communities need to be aware of various factors that may endanger their commercial air service. The object of this research is to determine those factors . By predicting the loss of service for small communities, the communities are able to plan accordingly. Areas predicted to be in danger of losing service are concentrated in the Midwest.

1.1 Introduction

With the passage of the Airline Deregulation Act nearly nineteen years ago, the airline industry has become a topic of great discussion. The passage of the act in 1978 took control of the commercial airline industry out of the hands of the Civil Aeronautics Board (CAB) and put it into the hands of the airlines themselves. Control by the CAB included the power to decide entry and exit into all markets and the power to determine which airlines could serve each market. Airlines were required to serve certain CAB-designated markets whether the markets were profitable or not. Markets that proved unprofitable were subsidized by the government, providing the incentive for carriers to grow into smaller markets without the fear of losing money. Two sides have formed concerning the issue of airline regulation and the federal subsides provided to smaller markets. Proponents of subsidized service base their arguments for support of subsides on the assumption that air transportation is a vital component of economic growth in the United States. Opponents argue that market forces should be the sole determinants on which cities should receive air service. With the passage of the Airline Deregulation Act, market forces again play a larger role in determining which communities receive service. Airlines almost immediately began to pull out of smaller communities where there were no profits to be gained or where the profitability of the market was in question.

The question of commercial air service in small communities is not one that can be answered with a simple yes or no response without looking deeper into the dynamics of the situation. There are numerous variables that come into effect when airlines determine not only which communities will receive service but also what type of service will be provided in the market. Once a community receives service from a carrier, it has no guarantee that the carrier will stay in the market. Changes in corporate direction, fleet, company finances, traffic levels, customer preference, and competition from other carriers all play important roles in the determination of service levels and service types in all markets including small communities. These changes not only include which cities receive service but also which markets receive what type of service.

There are two aims to the research conducted in this paper. The first is to develop a model that predicts the probability of loss of air service in small communities based upon variables that are operational, economic, geographic, and social in scope. The second purpose of the research is to try to conclude if there are any spatial patterns to the communities predicted to lose service. When both tasks are completed, I will try to present some solutions and rationale why certain communities will continue to be part of the air transportation network and why some will look to other modes of transportation or other locations to serve their air service needs.

1.2 The Present and Future State of Regional Airline Service

The present and future state of regional air service is largely an optimistic one, with growth continuing well into the next century. Spearheading the growth is the regional airlines move from small capacity turboprop aircraft such as the Beech 1900 and the Jetstream 31 which both have a 19-seat capacity to larger capacity turboprops and regional jets like the Canadair Regional Jet which can seat between 50 -70 passengers. This change in equipment has been attributed to two different factors: technological advancement and customer satisfaction (RAA Annual Report, 1996).

Within the past three years the introduction of the small jet (50-70+ seats) by Brazil's Embraer and Canada's Bombardier have changed not only the destinations airlines are able to serve but also how they provide the service. These technological advancements have allowed carriers to begin servicing city- pairs with jet service where the demand was not quite at the level to support 737 or DC-9 service, which were the smallest capacity jets available to airlines. An example of this can be seen in the Moline/Quad Cities -New York City market. Although there is traffic demand between these two cities, there is not enough to support service provided by the smallest capacity jets in an airlines fleet. The cities are also located too far apart for service to be provided effectively by the larger turbo-prop aircraft. Passengers needed to fly through a connecting hub to travel between the cities. With the introduction of the regional jet, this market become a viable option for a carrier to serve. This is not what is known as "hub-bypass" but is instead an opportunity for carriers to open up new markets as new technology aircraft come on the market. (Boyd, et al., 1996). While this is a benefit for the medium sized airports who receive this type of service it is a hardship for smaller communities located in the same region because the increase in service level will act as a magnet drawing passengers away from the smaller airports.

Customer satisfaction is another motivation for the regional airlines to modernize their fleets. Customer satisfaction includes scheduling convenience, safety concerns, and in-flight comfort. As previously demonstrated, the introduction of the regional jet allows airlines to offer a greater number of scheduling options for the passenger to choose. Customer concerns with safety and comfort are at the cornerstone of the switch to larger aircraft. Some passengers perceive smaller aircraft to be unsafe and are willing to travel to larger airports to fly on larger turboprop and jet aircraft (RAA Plane Sense, 1996). An off shoot to this fear was the federal government's change in the regulations that governed regional airlines. Previously there were two standards under which the commuter airline industry operated, FAR Part 135 and Part 121. Part 121 specifies that all aircraft operating with 20 seat or greater must follow a set of standards that are different from aircraft that operate with 19 seats or less which operate under Part 135. Among the standards that Part 135 operators will have to meet include the development of FAA-approved dispatching systems and dispatchers, limiting of flight time, and various on plane emergency equipment; such as exit markings, and wing ice lights (Aviation Week and Space Technology, May 20, 1996). Cost estimates range from FAA figures of around $2,500 minimum per aircraft to RAA estimates that put upgrading costs at between $12,000 to $50,000 per aircraft. Mesa Airlines, which operates a fleet of 135 aircraft that will need to be upgraded, estimates the original recertification costs to be around $2 million and annual costs of nearly $800,000 (Aviation Week and Space Technology, May 20, 1996). It will be difficult for the airlines to pass the cost increase onto the passengers and as a result service in marginal markets will be terminated or severely reduced. Instead of spending the money to upgrade their entire fleets airlines will may decide to purchase newer, larger aircraft and concentrate on serving markets that will support this type of service.

Mesaba, a Northwest affiliate, has done just that. They are replacing their entire fleet of 19-seat Fairchild Metro's with the 34-seat Saab 340. Among the chief motivators in this decision was that the move was "economically prudent" and "commercially imperative in order to meet higher passenger expectations," (Aviation Week and Space Technology, March 18, 1996). The company also was planning on looking at expanding the range of its fleet beyond its current 400 mile range by looking into regional jets.

1.3 The Question: Who Will Lose Service

An extensive amount of research regarding the effects of deregulation on small communities and regions has been conducted (Warren, 1984; Addus, 1984; Addus, 1985; Jemiolo & Oster, 1987; Kihl, 1988; Vellenga & Vellenga, 1988; Connin & Leggett, 1992). Research found that in the deregulation era small communities' service levels fluctuated a great deal depending upon the carriers providing the service and other service variables, such as equipment, fares and schedules. Other work in the area has questioned the determinants of demand for regional air service (Kaemmerle, 1991; Fleming & Ghobrial, 1994; Reynolds-Feighan, 1995). While most of this research has focused on either the effects of deregulation or determinants which play an important role in the demand for service in small communities, this paper looks at regional air service from another angle. The research conducted here attempts to model and predict the probability of loss of air service in small communities served by only turboprop aircraft, based upon a variety of independent variables. The model will point out communities that have a high probability of losing air service. The research aims to discover whether these areas follow any spatial pattern. Solutions will then be crafted to offer alternatives for the communities targeted for loss of service.

1.4 Small Communities v. Air Service Providers

1.4.1 Small Communities

The communities claim a variety of rationales for the need to have continued service and subsidies. Molloy (1985) breaks down the rationale for communities to want continued service subsidies into four categories.

The first rationale are various needs in a community. Community needs include economic development, isolation, community pride, and land use planning. Two of these factors, economic development and isolation will become the basis for variables in helping determine which cities are targets for loss of service in the future. The Economic Development argument used by communities is that commercial air service is a necessity for communities to continue to grow economically. Dempsey (1990) points out that if a small community does not have adequate and reasonably priced transportation services it will be thrown outside the economic loop and slowly die. Molloy refutes this type of argument by stating that although industries do find scheduled air service as an attractive quality in a community, they also need resources and incentives to make the location an attractive alternative to their present location. A community's isolation is difficult to estimate. Isolation is measured two different ways by Molloy. The first measurement of isolation is drawn from the communities' geographic location in comparison to other communities. The second measurement of isolation is the type of service the community desires versus the type of service the community can support. In this paper isolation is a variable that will be measured in the distance that a communities residents would have to travel to find comparable service if they lose their current commercial air service.

The second rationale is the concept of the infant industry. The idea is rooted in the thinking that a subsidy is a good method to help accelerate the growth of a fledgling industry that is important to the economic well being of the nation. Molloy argues that air service has been available to more than 600 destinations throughout the years and he finds hard to believe that the airlines have not or would not serve an area that was important to the commerce of the nation.

The debate between rural and urban sectors concerning spending on transportation is the third rationale brought up by small communities. The argument put forth by the communities is that the subsides they receive are the equivalent to subsides given to large metropolitan areas for mass transit and other forms of transportation. Detractors to this argument point to the fact that mass transit systems are targeted toward a greater number of people, reduce various types of pollution, and help the poor where as air service subsidies provide assistance to a relatively small population.

Three of the rationales are tied to the National Interest. This collection consists of the need for a complete national air system, the idea of transportation as a public function, and special national benefits. These motives have a direct connection in some form to the "national interest." An example argument is that a subsidy allows airlines to spread their fixed cost over a greater number of travelers that in turn reduce the cost of traveling by air for all travelers.

1.4.2 Airlines

Airlines are the second participants in the debate. An airline is like any other business in the world. Their objective is to make a profit. Revenue is what drive the airlines to make the decisions that they do. They do not exist to serve the public interest. Boyd (1996) addresses five realities of providing regional air service facing the airlines. The realities are that 1) airlines are seeking revenues-not passengers; 2) low volumes of passengers mean higher fares; 3) airline dependency on the hub and spoke operating system; 4) traffic and service gravity and; 5) new fleets and changing service patterns objectives.

The first reality is rooted in the fact that all business are trying to increase revenue. Boyd points out that airlines are in the business of making a *profit* carrying passengers. The number of passengers willing to fly is not as important to the airline as the type of passenger willing to fly. Most major airlines are looking for the high paying business fare customer. Small communities do not provide the necessary number of these types of customers to make service a profitable venture so the airlines look to other destinations to satisfy their needs.

The second reality is based upon the common assumption that for airlines to be profitable they must match the service that they offer to the demand in a particular market. Most of the communities, whose service is in question only provide enough traffic to have service by small turboprop aircraft that are more costly to operate on a per-seat basis then other aircraft because of the short distances they are used. High operating costs are passed on to the passengers who use the commuter service as higher fares.

Dependency on the Hub and Spoke System is the third reality encountered by airlines operating in small communities. The hub-sites operated by the major carriers are the gateways to the national air transportation system for small communities. If a community is only producing enough traffic for one carrier to serve the market they are at a distinct disadvantage because they only have access to the network of the carrier providing service to their airport. The number of connecting hubs has decreased as have the number of carriers in the past ten years (Boyd, 1996). This means that small communities have fewer opportunities to link to the air transportation system.

The concept, Traffic and Service Gravity, is the fourth reality confronted by airlines serving small communities. The "gravity" effect occurs when the traffic from one airport is attracted to another airport for various reasons. In the small community airport, leakage occurs because the consumer views the benefits of using a larger airport to out weigh the costs. Some benefits may include lower fares, better service, more convenient scheduling, and airline preference. The only real cost the consumer must weigh is the time to drive to the larger airport. An example of Traffic and Service Gravity is seen in the state of Illinois. Chicago and St. Louis, MO. are both hubs for mega-carriers and also have service provided by Southwest and other low fare carriers. Although most of the communities in the state that have airports have the population base to support the type of service (turboprop) they receive at the present time, they are losing traffic to Chicago and St Louis because of lower fares, more convenient scheduling, and higher quality service.

The fifth and final reality to be addressed is that fleet composition is changing and along with this change so are the service objectives of carriers. Small jets, as previously mentioned, are becoming increasingly popular among regional carriers. The airlines are noticing a "turboprop avoidance factor" due to travelers' fear of small aircraft (Boyd, 1996) and have started to phase out the smaller aircraft in their fleets. This means that communities served by 19-seat aircraft are faced with the challenge of producing more traffic to fill at least a 30-seat aircraft or lose their air service. Some communities are even willing to guarantee the airlines a profit if they serve the community with a jet instead of turboprop aircraft. Amarillo, Texas has promised a profit to American Airlines to provide jet service to help the local economy prosper instead of large turboprop service (New York Times, February 12, 1996).

2.1 Problem Statement

The goal of this paper is to predict which cities presently served with commercial air service may be in danger of losing this service in the future based upon variables from a range of fields. The variables used in the initial modeling of this paper are a combination of variables from numerous fields of study. It is my hope that this combination of variables will give a clearer picture of the factors that go into the decision of whether a community can support commercial air service or not.

2.2 Model Variables

LOSS OF SERVICE - This is the dependent variable. A dichotomous variable, LOSS OF SERVICE is coded one if the community is predicted to lose commercial air service and coded zero if the community is predicted to retain commercial service in some form. The communities that were chosen for this research were all the communities in the United States that, as of August 1996, had commercial air service provided by carriers using *only* turboprop aircraft to serve the market. Communities in Alaska and Hawaii were omitted from the study because of the unique transportation conditions in those two states. A total of 235 communities fit the parameters set forth for study. The designation of whether a community was a one or zero was based upon work done by Boyd, et al (1996) in "The Future of Regional Air Service". The cities that were designated by Boyd as "Airports Faced with the Challenge of Losing Local Air Service" were given the value of one and all other cities within the study group were given a zero. Boyd based his determinations on his experience in the industry and present and future trends within the industry. This is only one way of determining the dependent variable and leads to a circularity of analysis. In essence, this project has quantified Boyd's thought process in determining loss of service. Other possible forms of analysis that could be incorporated include historical trends, the use of the Delphi method, and comparisons with other experts in the field.

The following list describes the independent variables that were tested for determining the probability of loss of commercial air service.

DES2 - This independent variable is the number of destinations served with non-stop flights from the community in question. The information used to construct this variable was taken from the Official Airline Guide, International Edition, August 1996. Every flight that went to another destination without stopping was counted and all of these types of flights were then summed for the community in question and a total was recorded. A drawback to this method is that some of the communities in the study group may have non-stop service from a particular point but not have non-stop service returning to that same point. The relationship between DES2 and the dependent variable, LOSS OF SERVICE is expected to be negative. As the number of non-stop destinations increases the probability of a community losing commercial air service will decrease.

EQUIP - The EQUIP variable is a dummy variable measuring the type of aircraft used in a particular market. For markets served by aircraft having 19 seats or less a one is designated. Markets with service provided with aircraft having 20 seats or more will be coded with a zero. This variable is based upon projections of fleet compositions done by the Regional Airline Association. The RAA predicts that the 19-seat aircraft will be gradually replaced by 30-seat aircraft as the baseline feeder and route development aircraft of regional carriers (RAA Annual Report, 1994). The Official Airline Guide, International Edition, August 1996 was the source of information concerning the equipment used on particular routes. The relationship between EQUIP and the dependent variable LOSS OF SERVICE is expected to be positive suggesting that a community that is served with 19-seat aircraft will have a higher probability of losing service

NSFLIGHTS - This variable is a measure of how many daily non-stop flights there are from the community in question to other destinations. This variable is different from DES2 in that it is a measure of the total number of flights that are non-stop regardless with the destination of the flight. The definition for daily flights is a flight that is offered at least five out of seven days during a week. The information for this variable was also taken from Official Airline Guide, International Edition, August 1996. The probability of a community losing air service is expected to increase as the number of daily non-stop flights decreases making the relationship negative.

CARRIER2 - The variable CARRIER2 is the number of different carriers that serve each of the communities in the study. The information for this variable was derived from Official Airline Guide, International Edition, August 1996. As the number of carriers serving a market increases, the expected effect would be that the probability of a community losing commercial air service would decrease because the carriers feel there are enough passengers in the market to have multiple carriers.

EAS - This variable is a dummy variable coded one for all communities that receive a government subsidy for service through the Essential Air Service Act. All communities that are not supported with a subsidy are coded zero. The presence of an EAS subsidy in a community guarantees that a community will continue to receive air service regardless of whether a carrier makes a profit. The purpose of the EAS variable is to target cities that are EAS communities because of the special circumstances behind their air service. The relationship between the EAS variable and the dependent variable is predicted to be positive, meaning that if a city is coded one, then the probability of losing service increases. This seems to be contrary to the purpose of the EAS funding, but I believe that if a community were to lose EAS funding, then a strong case could be made that the community would lose all of their commercial air service.

2.3 Logistic Regression

To test the hypothesized relationships between the dependent variable and the independent variables an econometric model was developed. To test the model constructed, logistic regression was used so that a prediction concerning the loss of service can be made. Since the dependent variable in this research had only two qualitative outcomes, loss of air service or retention of air service, they are able to be represented by binary indicator variables labeled either 1 or 0. The basic form a logistic regression model takes is:

$$P(Y=1) = Odds(Y=1) / [1+Odds(Y=1)]$$

Logistic regression allows the researcher to predict the probability of an event happening or not happening (Hamilton, 1992). In the case of this paper, the probability of interest is whether a community served only by turboprop aircraft will lose air service.

3.1 Results

Two hundred and thirty five communities were included in the study. All of the communities had commercial air service provided by carriers using only turboprop aircraft in August, 1996. The following table shows the summary statistics for the data used in this paper.

VARIABLE	MEAN	STANDARD DEVIATION	RANGE	MINIMUM	MAXIMUM
CARRIER2	1.43	.78	4	1	5
DES2	2.26	1.18	6	1	7
NSFLIGHT	7.83	6.18	43	1	44

DUMMY VARIABLE	MEAN
LOSS	.44
EAS	.31
EQUIP	.64

Table 3.1: Summary statistics (235 observations)

The summary statistics show the variation of the variables used in the model. The three variables shown in Table 2 are dichotomous variables coded one and zero, which their summary statistics reflect. The dependent variable LOSS had 104 of the communities coded one for loss of service. The remaining 131 communities were coded zero.

EAS, a variable defining which communities were receiving Essential Air Service funding, had 72 (30.5%) communities coded for receiving service and 163 (69.5%) coded zero for not receiving governmental funding for commercial air service.

Almost two-thirds of the communities in the analysis, 150, received service with 19-seat capacity aircraft and smaller, which was designated by the EQUIP variable and coded one. The remaining third, 85, had service from larger capacity aircraft and were coded zero.

The variable CARRIER2 had a mean of 1.43. The minimum number of carriers in a market was one and the maximum number of carriers in a market was five (Fayetteville, AR and Charlottesville, VA). The mean was skewed to the left of the distribution because 91% of the communities in the this study had service by either one or two carriers.

DES2, a measure of the number of destinations served from a community, had a mean of 2.26. This means that the "average" community had service to two other destinations. The distribution of this variable was also to the left. Eighty eight percent of the communities had service to three other destinations. The maximum number of destinations was seven from Escanaba, MI.

NSFLIGHT measured the number of non-stop flights from a community. The range of this variable was 43. Two communities have only one non-stop flight daily : Ironwood, MI to Minneapolis and Ely, MN to Minneapolis. On the other end of the spectrum, Fayetteville, AR has 44 non-stop daily flights. Over 70% of the communities have less than 10 non-stop flights a day and approximately 50% have five flights or fewer.

3.2 Model

The results of the model are shown in the following tables:

VARIABLE	B	STANDARD ERROR	WALD	SIG	EXP (B)
DES2	.6780	.3020	5.0402	.0248	1.9698
EAS	2.1682	.5576	15.1196	.0001	8.7427
EQUIP	1.1952	.5532	4.6670	.0307	3.3041
NSFLIGHT	-.5609	.1135	24.4095	.0000	.5707
CARRIER2	-2.0021	.9302	4.6329	.0314	.1350
CONSTANT	2.5112	1.1402	4.8502	.0276	

Table 3.2: Logistic regression statistics.

All of the variables in this model were significant at the .05 level and above including the constant. By checking the Wald χ^2 Test results the significance of all five variables is confirmed with all of the variables having scores greater than four, the cutoff for significance at the .05 level.

The model's ρ^2 was 1- 130.999 / 323.856 =.5955. This means that nearly 60 % of the variance in the dependent variable was explained by the five variables in this new model.

The prediction success index (PSI) calculated for this model was . 8898 - .5610 = .3288. This means that this model increased the ability to predict the correct classifications by approximately 33% over the null model.

The variable measuring government funding, EAS, showed the largest influence. For every community that received EAS funding the odds that the community would lose commercial air service increased by nearly 775%. A large increase in the odds of losing service was also seen concerning the equipment that was used to provide service. The odds of losing service were predicted to increase by 230% if the city was served by 19-seat aircraft, net of everything else .For every additional destination that an airport receives, the odds of losing service were increased by 98%, all other things being equal.

The final two variables, NSFLIGHT, and CARRIER, had negative relationships with loss of service. With every additional non-stop destination that is added to a community, the odds of losing service are decreased by nearly 43 %, ceteris paribus. The last variable measuring the number of carriers in a market showed that for every additional carrier that provided a community with service, the odds of losing service were decreased by almost 87%, net of everything else.

OBS.\PRED.	ZERO	ONE	% CORRECT
ZERO	118	13	89.39
ONE	12	92	88.46
			88.98

Table 3.3: Classification table for Model 2.

The model correctly classified 210 communities out of the 236 in the study group (88.98%). Of the correctly classified locations, 118 were observed and predicted to continue receiving service and 92 were observed and predicted to be in danger of losing commercial air service. Twelve communities were observed losing service but predicted to retain service. Thirteen communities were observed to keep air service while the model predicted that they would relinquish service.

The check for influential statistics was done by plotting the change in deviance versus the predicted probability of the model. Scores greater than four are considered to indicate a significant change. None of the scores obtained were greater than three, so no influential observations are recorded.

4.1 Analysis

4.1.1 Variables

The results obtained from the model constructed for this paper provide a substantial insight into the various determinants of commercial air service in small communities. The conclusions that are made from this model are based upon the model and work I have conducted with Michael Boyd concerning the subject of regional air service.

By no means should these results be considered to be the definitive answer but instead should act as a guideline for communities to judge their situation in regards to regional air service.

The variable that stands out of the model as having the most significant effect on turbo-prop commercial air service is the Essential Air Service (EAS) variable. The outcomes of the models show that if a community receives EAS funding they will definitely have a higher probability of losing air service than a community that does not receive government subsidies for commercial air service. This may seem counter-intuitive because we assume that a community with subsidized service will continue to receive service as long as the subsidy is in place. The object of this variable was to show that if the funding was removed, the a majority of the communities that are EAS destinations would lose service. With government funding cuts being seen in all parts of the government the loss of funding for the EAS program is likely.

Worthington, Minnesota is a perfect example of this idea. In November of 1995, Worthington was removed from the list of communities that received EAS funding. All of the United Express flights that were operated by Great Lakes Aviation using 19-seat aircraft were eliminated. The community had mixed reactions to the loss of service. The airport manager worried that passengers would have to drive an hour to Sioux Falls, South Dakota for air service. On the other side of the issue was the Chamber of Commerce, which understood that a majority of air travelers were already traveling to Sioux Falls for their air service needs because of the unreliable service in Worthington. Proponents of the cuts also pointed out that the federal dollars were being wasted because of passenger apathy towards the service (USA TODAY, December 5, 1995). The Worthington example shows what a strong influence federal funds have in keeping air service in a community. The model has predicted that a number of other communities may be headed in the same direction as Worthington.

The second variable that was a major determinant of whether a community will lose service or not was the equipment or "19-seat" variable. This variable predicted that the odds of losing service would increase by over 200% if the service in the market was provided by 19-seat aircraft *only*. As previously mentioned, the 19- seat aircraft is starting to be phased out by the regional carriers. Carriers will begin to shift the 19-seaters they do retain into markets where they can supplement already existing service such as a last flight of the day aircraft or as an aircraft for route development. There are three examples of this type of usage. Northwest Airlines provides three daily non-stop flights to Greenville , MS. The two earlier flights use a SAAB 340 aircraft which seats between 30-37 passengers depending on configuration. The last flight of the day at 8:00 PM uses a Jetstream 31 aircraft which only seats 19 passengers. What is happening here is that the airline has adjusted its equipment to meet the demand in the community. The second example by Continental providing service to Lake Charles, LA from Houston, TX. The airline shifts from using Embraer 120's, seating 30, during the week to Beech 1900, seating 19, on the weekends, another efficient use of the airlines equipment.

The final example is how an airline uses different equipment to provide service to two different markets from the same city. US Airways provides service from Huntington, WV to both Charlotte, NC and Pittsburgh, PA. The service to Charlotte is four times a day using a Jetstream 31 aircraft. The service to Pittsburgh is on a Dornier 328 which seats 30+ passengers. US Airways has recognized the differing demands to the different hubs and made efficient use of their equipment. There will be no justification for the carrier to continue providing the service with the 19-seater if the aircraft can be used in a profitable market.

The third variable that had a positive relationship with the dependent variable is DES2, a measure of the number of destinations that are served from a specific community. For every additional destination that a community has access to the odds of losing service increases by nearly 98%, with everything else being equal. This is contrary to what was predicted because creating another city pair should increase the desirability to travel within a community. However the additional destination could be added as a tag-on service as previously mentioned, meaning that the community cannot provide enough passengers to survive alone.

Of the two variables that have a negative relationship with the probability of a community losing commercial air service, the most interesting is CARRIER2. This variable is a measure of the number of carriers that provided service in a given market. The model estimated that for every additional carrier that provided service into an airport, the odds of losing service would decrease by almost 87%, net of everything else. This is a logical result because if there is more than a single carrier in a market there should be enough traffic in that market to support continued commercial air service. Both the community and the airlines benefit from this situation. The advantages the community sees are in the fares and the destinations served. Fares are expected to go down in this market because of increased competition. The connectivity of the community is enhanced because the increased number of service providers result in an increase in the number of accessible hubs. A number of communities in the study benefitted in this way.

Grand Junction, Colorado receives 18 non-stop flights a day from three different carriers to three different hubs. United provides eight non-stops to it's Denver hub and from there passengers can connect to flights to a multitude of destinations within United's system. Delta offers six flights to its Salt Lake City hub where passengers can connect to flights within Delta's system. Grand Junction also has the advantage of having commuter service provided by a low fare carrier, America West. This allows travelers to connect through Phoenix to a number of cities that are served by the airline. Grand Junction is also an example of a community that lost a carrier. When Continental shut down it's hubbing operation at Denver it also shut down the airlines commuter service which provided service to Grand Junction. Delta and America West recognized there were enough passengers to make the market feasible and filled the void, competing with United for passengers.

Lafayette, Indiana has the same type of service as Grand Junction, multiple carriers providing direct service to their hub. Air travelers have an option of choosing to connect through Chicago, using United or through Detroit using Northwest. A passenger can board a flight in Lafayette and, with only one stop and change of plane reach such destinations as Beijing, China or London, England.

The final example of how a community benefits from multiple carriers is that of Wausau, Wisconsin. Wausau has three carriers, Northwest, American, and United, vying for passengers.. American and United both send passengers from Wausau through their hubs in Chicago. Passengers have a wide array of choices because of the two airlines battling over who carries them. Benefits are seen in the form of lower fares and higher quality of service.

Cities that only have one carrier serving them are at the mercy of the carrier when it comes to service and fares. Instead of providing service when it is most beneficial for the passenger the carrier can provide service when it best fits into the airlines schedule. Two examples are Matoon, Illinois and Havre, MT. Let us assume a traveler wants to travel from Havre, MT to LAX. The passenger only has one airline option, Big Sky, and has to wait till 4:00p.m. to leave, make a stop in Lewistown, MT then on to Billings. In Billings, the passenger can choose between a flight to Salt Lake City or to Denver on either Delta or United, neither of which is aligned with Big Sky. Where again they change planes yet again for their final flight to Los Angeles, arriving around 11:00 p.m. The round trip cost of this flight is $800. The other option the traveler has is to drive 120 miles to Great Falls, Montana where they have two airlines to choose from, Delta or Alaska. Delta offers a low fare ticket of $580 round-trip and offers three departure times; morning, midday, and evening. All of the flights are on jets, with the passenger changing planes in Salt Lake City.

Travelers flying out of Matoon, Illinois face the same dilemma. United Express provides all of the service out of Matoon through United's hub at Chicago. The flight options for a traveler are to depart Matoon at 5:20 a.m. or 1:20 p.m.. The flight makes a stop in Danville, Illinois before going to Chicago. The total cost for a round trip ticket is $1650. The other option for a passenger wanting to travel between these two cities is to drive 120 miles to Indianapolis, where they can choose from a number of different carriers at numerous times with fares as low as $300. It is not surprising to see that the model predicted the probability of loss of service to be .96 in Matoon and .97 in Havre. Passengers aren't willing to use service that is inconvenient and highly priced when better service is within a reasonable distance.

The variable NSFLIGHT is a measure of the total number of non-stop flights from the community in question to other destinations. The model predicted that the odds of a community losing service would decrease by nearly 40% for every non-stop flight added to the community. This variable is interesting to examine because there are two different things that can occur with additional flights. In the first scenario, as traffic increases in a community the airline serving the community may increase the number flights offered to that community so that the consumer has a greater number of time options to choose from. Community A may have three flights a day, 6:00am, 11:00 am, and 9:00 p.m., but an additional flight may be added at 5:00 p.m. which would then decrease the probability that a community would lose service. The second scenario is that another airline notices that the traffic levels at Community A are high enough that they want to enter the market with flights of their own. Community A may also have their chances of losing service reduced this way. For smaller communities an additional non-stop flight may mean they become a tag on to an already existing route. The benefit in this type of arrangement is that the community does not have to fill the aircraft entirely by themselves but instead only has to supply a portion of the passengers needed to make the flight profitable because the other city on the route will provide passengers as well.

4.1.2 Communities

The main goal of this research was to identify which communities in the United States presently receiving commercial air service are in danger of losing service. In this section, the cities that were predicted to have a high probability of losing service will be identified and explanations will be given as to why the communities may lose service. The following table shows all of the communities with probabilities greater than .5 of losing service:

City	Prob.	City	Prob.	City	Prob.
Fairmont, MN*	0.987	Worland, WY*	0.969	Mountain Home, AR	0.799
Mankato, MN*	0.986	Silver City, NM*	0.969	Muscle Shoals, AL	0.799
Glendive, MT*	0.986	Visalia, CA*	0.969	Franklin, PA*	0.786
Yankton, SD*	0.986	Fergus Falls, MN*	0.957	Ironwood, MI	0.779
Sidney, MT*	0.984	Harrison, AR*	0.952	Frenchville, ME	0.779
Kingman, AZ*	0.984	Lewistown, MT*	0.952	Cortez, CO*	0.774
Keene, NH*	0.984	Kearney, NE*	0.952	Beckley, WV*	0.774
Merced, CA*	0.984	Mc Cook, NE*	0.952	Garden City, KS*	0.750
Glasgow, MT*	0.984	Brookings, SD*	0.952	Augusta, ME*	0.728
Massena, NY*	0.984	Hastings, NE*	0.952	Page, AZ*	0.728
Jonesboro, AR*	0.984	El Dorado, AR*	0.952	Williston, ND	0.718
Liberal, KS*	0.984	Crescent City, CA*	0.946	Hobbs, NM	0.693
Mitchell, SD*	0.984	Matoon, IL*	0.946	Sheridan, WY	0.693
Kirksville, MO*	0.984	Bluefield, WV*	0.946	Jackson, TN	0.693
Cape Giradeau, MO*	0.984	North Platte, NE*	0.946	Bridgeport, CT	0.693
Ottumwa, IA*	0.984	Scottsbluff, NE*	0.946	Sterling, IL	0.693
Chadron, NE*	0.975	Clovis, NM*	0.946	Prescott, AZ*	0.677
Miles City, MT*	0.975	Rockland, ME*	0.919	Tupelo, MS	0.668
Jamestown, ND*	0.975	Bar Harbor, ME*	0.919	Muncie, IN	0.668
Watertown, NY*	0.975	Dickinson, ND*	0.919	Hattiesburg, MS	0.668
Ogdensburg, NY*	0.972	Hot Springs, AR*	0.919	Huron, SD	0.668
Rutland, VT*	0.972	Vernal, UT*	0.903	Bloomington, IN	0.668
Wolf Point, MT*	0.972	Cedar City, UT*	0.903	Laramie, WY	0.668
Alliance, NE*	0.972	Galesburg, IL	0.898	Alamosa, CO	0.668

Topeka, KS*	0.972	Devils Lake, ND*	0.879	Rock Springs, WY	0.668
Dodge City, KS*	0.972	Carbondale, IL	0.874	Dubois, PA	0.592
Ponca City, OK*	0.972	Mt. Vernon, IL*	0.866	Cumberland, MD	0.564
Great Bend, KS*	0.972	Moses Lake, WA*	0.866	Las Cruces, NM	0.564
Alamogordo, NM*	0.972	Ruidoso, NM	0.861	Alpena, MI,	0.564
Hays, KS*	0.972	Ely, MN	0.861	Riverton, WY	0.564
Havre, MT*	0.969	Norfolk, NB	0.817	Grand Rapids, MN	0.564
Ely, NV*	0.969	Shenadoah Valley, VA*	0.805	Owensboro, KY	0.545
Enid, OK*	0.969	Thief River Falls, MN	0.799	Athens, GA	0.535
Moab, UT*	0.969	Salina, KS	0.799	Marion, IL	0.535
Fort Leonard Wood, MO*	0.969	Manistee, MI	0.799	West Yellowstone, WY	0.516

Table 4.1: Communities predicted to lose service

One hundred and six out of 235 cities were predicted by the model to lose service. Of these communities, 68 of them had probabilities of .8 or higher. There is a definite spatial pattern to the cities that are predicted to lose commercial air service according to the model. There is a band of communities running form the Canadian-US border in Eastern Montana to the western half of the Kansas-Oklahoma border that are predicted to lose air service. It is these cities that will be most drastically effected by loss of service.

Eastern Montana communities were predicted to lose service for a number of different reasons. All of the communities in Eastern Montana have service provided by Big Sky Airlines, which uses 19-seat aircraft and has no affiliation to any other airline. The service is only to Billings, which has jet service but no controlling carrier in the market. The problem is that all travel beyond Billings will be interline travel, which as showed earlier is more expensive then online travel. All of the communities receive EAS funding to subsidize their air service. If and when these funds are halted, the communities will lose service because at the present time they are only filling one out of every three seats.

It should be noted that although variables such as enplanement numbers and population were found to be statistically insignificant in initial modeling stages, I believe they play an important role in determining air service loss in this region. Only one of the cities in the region has a population over 10,000 (Havre 10,201). The region does not have a large enough population base to make service without subsidy viable. This is shown to be true when enplanement numbers are examined. The highest enplanement in the region is at Sidney with 6,224 enplaned. With over three flights a day for a year using a 19-seat aircraft this turns out to be almost six passengers a day or a load factor of 30%. The rest of the communities in the region enplane 2,000 or less. The major concern is that if air service is halted in this region there is not comparable air service within 150 miles of these communities, making the region "service blighted". In the following section solutions will be offered to try and remedy this situation.

Western Kansas has a situation similar to the Eastern Montana communities. The service in this region is provided by US Airways to Kansas City and by United Airlines to Denver. This is beneficial, because United operates a hub at Denver and US Airways is a dominant force at Kansas City. The drawbacks for the area are that all of the communities are EAS funded and service by both airlines is provided using 19-seat aircraft. The population and enplanement numbers are higher than in the Eastern Montana case, but in all of the cities except for Garden City the load factors are less than 50%. Most of these communities are located outside a 150 mile radius of comparable air service should the decision be made to terminate service. Communities in this region have already begun to lose service, with United terminating its service in Goodland, KS and Lamar, CO at the end of summer 1996.

4.1.3 Spatial Patterns

Spatial patterns can be seen in the communities that are predicted to lose service as well as those that are predicted by the model to have a low probability of losing air service. The first map (Figure 1) shows the geographic distribution of all the communities that were included in the study. The Midwest along with Texas and Pennsylvania had a large number of communities that were only served by turboprop aircraft.

A definite pattern can be seen on the map showing a high probability of loss of service (Figure 2). The central region of the United States, from Eastern Montana southeast towards the Gulf of Mexico, stands out as a region with a very high probability of losing commercial air service. It is interesting to note that there are no major airline hubs in this region. This does not allow the traffic created in these communities to be assembled at a hub and then flown on to other points within an air carriers system.

As with the second map, definite patterns can be observed in the map displaying communities who were predicted to retain service. Most of these communities are located along the perimeter of the United States and along the Upper Mississippi Valley. Most of the communities are also located near and around major airlines hubs allowing the traffic that communities create to be added to passengers already being assembled at those hubs.

4.1.4 Solutions

In the report *"The Future of Regional Air Service"*, Aviation Systems Research Corporation outlined numerous suggestions that small communities need to look at if wanting to retain some sort of commercial air service. One issue to this research is whether or not each community has its own commercial air service but rather do the communities have *access* to the air transportation network. Access is defined by frequency, airline, and distance (Boyd, 1996). Frequency and airline are defined as at least three daily non-stop flights to a connecting hub airport on the airline that dominates that particular hub. Distance is interpreted as any airport that meets the above criteria within a 60-90 minute drive. It is the last part of access that is the problem for the two regions mentioned in 5.1.2. Access is tied to the notion that communities need to start thinking on a regional basis when it comes to commercial air service instead of on a local basis.

A solution to the problem in Western Kansas can be found if the communities in the region think on a regional level. At the present time Garden City, has service by both United and US Airways providing service to Denver and Kansas City respectively. The other four cities in the region with the exception of Hays are within the 90 minute time frame set forth earlier. If the communities could agree to focus on using Garden City as their regional airport, they could still have access to the national air transportation system. The possibility of increased passenger level at the airport would possibly prompt the airlines to provide better service in the form of larger capacity turboprops and more convenient scheduling. Another alternative in the region would be for United to move its operations in the area to Dodge City which is the centrally located of the five communities in the region.

All of the communities are within the distance requirement for access. It all depends on the communities swallowing a little civic pride and understanding what is at stake, the chance to retain air service or losing service all together.

The situation in Eastern Montana is not so easily solved. Since service is provided by a non-aligned carrier two parts of the access equation must be solved. The solution of using one of the communities as a " regional" airport does not work as well for these communities because the cities are so far apart. Locating at Sidney, where the enplanements were the highest for the region would still leave Glasgow and Miles City without any access because they are located outside a 90 minute drive.

Three solutions could be used to solve the air service problem in Eastern Montana. The first solution would be to create regional service centers at Wolf Point and Glendive. All of the communities in question would be within the 90 minute drive. This solution does not address the airline part of the access problem. The creation of a "regional" center in Sidney would hopefully attract traffic from the blighted cities of eastern Montana as well as the community of Williston, which is also predicted to lose service. Service in Williston is presently provided by United and with the creation of this "regional" center United could possibly be persuaded to move operations. Miles City would be 120 miles away from this center and would possibly gravitate here if the service levels provided were near those of Billings 144 miles away. Glasgow, 138 miles away would be left out of the picture or possibly added on as a tag on route depending on traffic numbers. The final solution is not as optimistic. The cities can continue to retain local service as it is now structured. The problem occurs if Big Sky terminates service or EAS funding disappears they will be left without service because individually they cannot provide the passengers necessary to make air service feasible.

4.2 Conclusions

A check of the Official Airline Guide for April, 1997 showed that 12 of the communities that were predicted by the model to lose service had indeed already lost their scheduled commercial air service between the time the data was collected, August, 1996, and April, 1997. There were also three communities that were predicted to retain service that have loss service since the data was collected. All of the cities except for Saranac

Lake, NY and Tuscalosa, AL are located in the Midwest. The following table shows the communities that have lost commercial air service:

City	Prob.	City	Prob.	City	Prob.
Mankato, MN	0.986	Hastings, NE	0.952	Muncie, IN	0.668
Mitchell, SD	0.984	Galesburg, IL	0.898	Danville, IL	0.424
Fergus Falls, MN	0.957	Carbondale, IL	0.874	Saranac Lake, NY	0.424
Kearney, NE	0.952	Ely, MN	0.861	Tuscalosa, AL	0.406

Table 5.2: Lost commercial air service since August 1996.

A few of these communities were linked together on the same route. The only way that the airlines saw possible to provide service was to combine the communities on a single route. By correctly predicting the loss of service in these communities the steps taken in creating the models seem to be validated. By no means, however, are they the only steps.

The data and models that were applied while conducting the research are only a section of the possible study that could be conducted in this field. Possible advancements to this research would be to use a different selection criteria in determining loss of service. One suggestion is to look at loss of service from a historical perspective and find probabilities based upon historical levels of service. Expanding the model to include different variables such as travelers attitudes toward certain types of service, type of employment in the region, and other socio-economic variables would help provide more answers. Operational variables that would provide possible insight include the corporate direction of the carrier and safety records of the airline as well as the airport. Looking at the elasticities of some of the significant variables would provide valuable insight into what communities could due to try and save the service they have or possibly improve it.

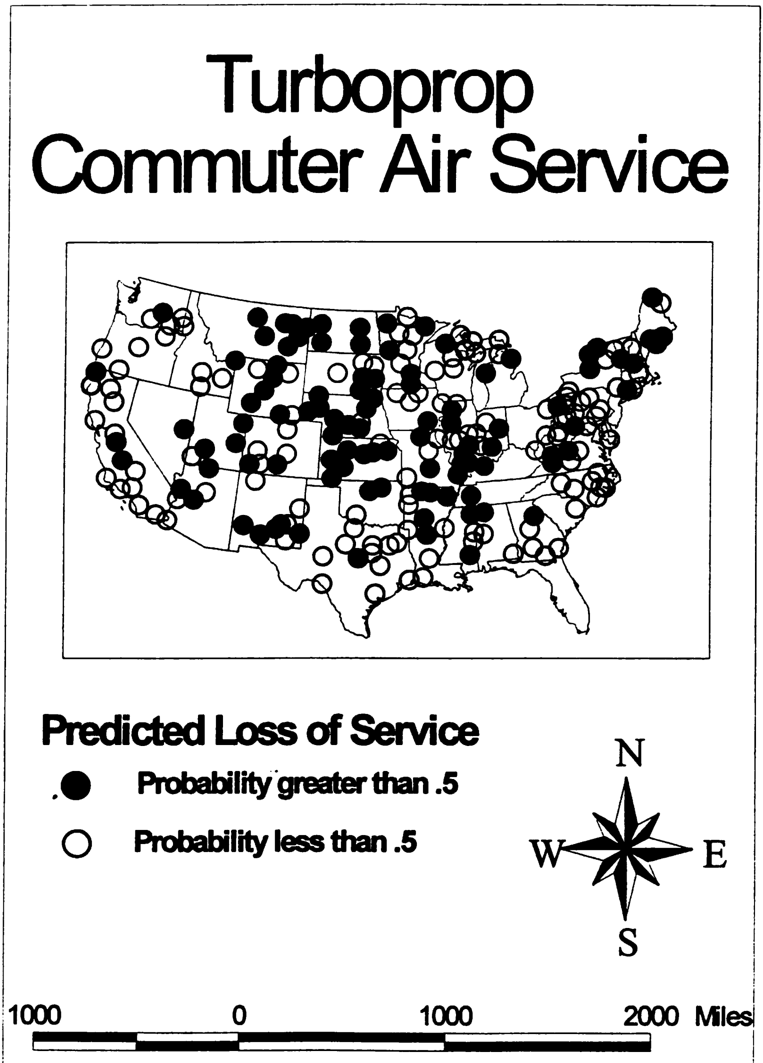

Figure 1 Map of all communities

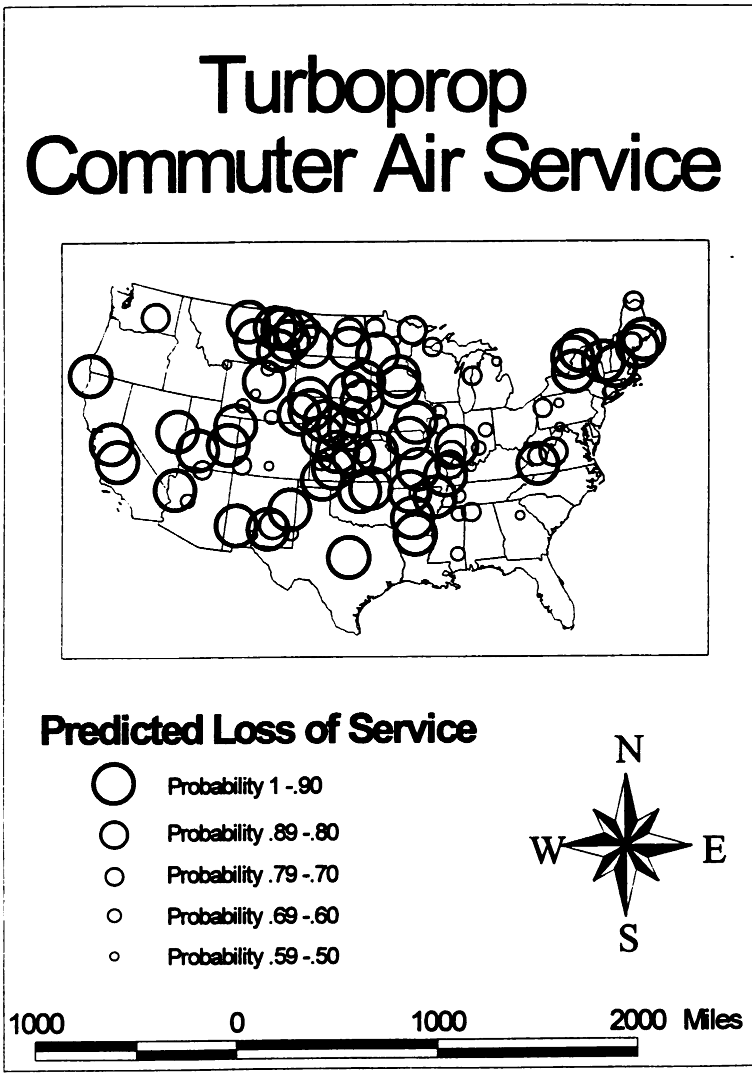

Figure 2 Map of high probability communities

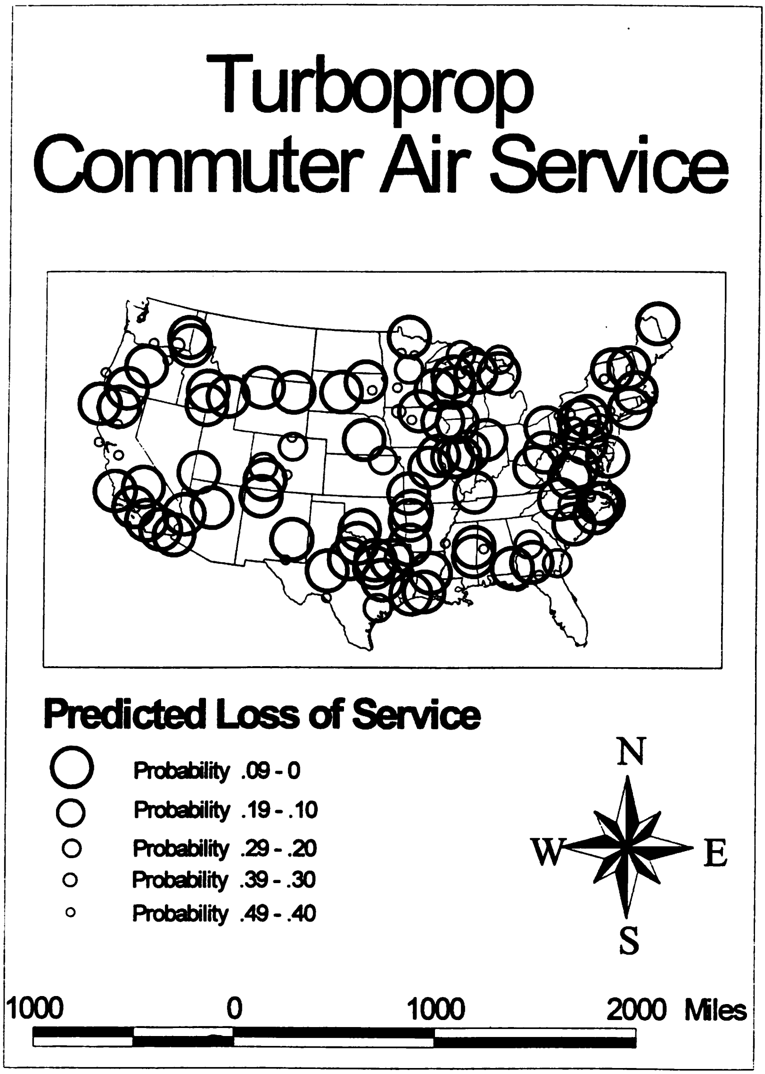

Figure 3 Map of low probability communities

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