AUTHOR'S PROOF!

Review of Industrial Organization **00:** 1–34, 2004.
© 2004 *Kluwer Academic Publishers. Printed in the Netherlands.*

Entry Patterns in the Southwest Airlines Route System

CHARLES BOGUSLASKI[1], HARUMI ITO[2] and DARIN LEE*
[1]*Gordian Group, LLC*
[2]*Department of Economics, Brown University*
**LECG, LLC. 350 Massachusetts Avenue, Suite 300, Cambridge, MA 02139, USA.*

Abstract. We estimate a model of city-pair entry for Southwest Airlines using data from 1990 to 2000. In addition to quantifying the market characteristics which have influenced Southwest's entry decisions, we find evidence that Southwest's entry strategies have changed significantly throughout the decade. Based on our model's estimates, we provide an estimate of the foregone fare savings resulting from the Wright and Shelby Amendments. Finally, we identify those markets that are the most likely for future non-stop entry and suggest which network carriers are most vulnerable to future Southwest expansion.

Key words: airlines, market entry, low cost carrier.

> "Our major competition over the last 15 years was other people doing the same things we do. That's not the case anymore." – Donald Carty, Former Chairman and Chief Executive, AMR Corporation.[1]

I. Introduction

The growth of low cost carriers generally, and Southwest Airlines in particular, has arguably been the single most important development in the domestic airline industry over the past decade.[2] Numerous studies have estimated the fare savings attributable to Southwest and other low cost

* Author for correspondence: Darin Lee, LECG, LLC. 350 Massachusetts Avenue, Suite 300, Cambridge, MA 02139, USA. Tel: +1-(617)-761-0108; Fax: +1-(617)-621-8018; E-mail: Darin_Lee@lecg.com

[1] "American Airlines to Retrench In Bid to Beat Discount Carriers," *The Wall Street Journal*, August 13, 2002.

[2] See, for example, Transportation Research Board which found that "Probably the most significant development in the U.S. airline industry during the past decade has been the continued expansion of Southwest Airlines and the resurgence of low-fare entry generally."

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

airlines to be in the billions of dollars each year. For example, the U.S. Department of Transportation estimated direct fare savings from low cost carriers at $6.3 billion annually, and more recently, Morrison estimated annual fare savings from Southwest Airlines – both directly and indirectly – to be $12.9 billion. Other studies of low cost carriers include Bennett and Craun (1993), Whinston and Collins, (1992), Dresner et al. (1998) and Morrison and Winston (1990,1995,2000).

Throughout the 1990s, Southwest Airlines solidified its position as the pre-eminent low cost carrier in the U.S. airline industry and its expansion is likely to continue into the foreseeable future. The purpose of this paper is three-fold. First, by estimating simple probit models, we examine the patterns of non-stop entry by Southwest into city-pair markets throughout the 1990s and attempt to assess the degree to which their entry strategies have changed. Second, we assess the degree to which the Wright and Shelby Amendments – which limit the markets that Southwest can serve to and from Dallas' Love Field – have been binding constraints on Southwest and estimate the forgone fare savings resulting from these regulatory restrictions. Finally, based on the markets which our model predicts are the most likely candidates for future non-stop entry, we estimate the magnitude of competitive threat that Southwest's future expansion poses on the rest of the airline industry.

While the hub-and-spoke model remains the predominant network model in the airline industry, arguably the most successful airline since deregulation – Southwest – has explicitly avoided adopting a hub-and-spoke route network. For example, while Southwest's top three airports collectively accounted for roughly 18% of its aircraft departures in 2001, Northwest's top three airports accounted for 52% of its domestic departures and United's top three airports accounted for 43% its domestic departures. It is also important to note that Southwest's predominantly linear route system is somewhat unique, even among low cost carriers. For example, both AirTran and Frontier (two other rapidly growing low cost carriers) utilize hub-and-spoke networks. In light of the financial crises currently facing virtually every large hub-and-spoke carrier, there are rising academic, business and policy interests in understanding alternative airline network models. However, while a large literature has evolved analyzing numerous aspects of the predominant hub-and-spoke model (Brueckner, 2002; Brueckner and Spiller, 1994; Evans and Kessides, 1993; Ken Hendricks and Tan, 1995), few studies have explicitly studied non-hub-and-spoke airline networks.[3] This

[3] Two exceptions are Brueckner (2001), which compares flight frequency, fares and welfare in hub-and-spoke Vs. fully connected networks and Oum et al., (1995) which finds that a carrier has multiple incentives (including cost, service quality and commitment) to choose a hub-based, rather than linear route system.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

paper aims to fill this gap in the literature by documenting a few stylized facts of Southwest's entry strategies and their network structure.

In general, we find that passenger density (both actual and potential), distance, the hubs of its competitors, and per capita income at the endpoints of a market have been important factors in determining which city-pairs Southwest chooses to enter. Our results also show that Southwest has typically avoided building a hub-centric network of its own. Moreover, we find that Southwest's entry strategy evolved rather dramatically during the 1990s. In particular, while Southwest focussed almost exclusively on short haul, dense markets throughout the first half of the 1990s, its strategy evolved during the latter half of the decade to include a much more heterogenous mix of markets, including a number of markets which were both long-haul and surprisingly thin (i.e., generated few passengers prior to entry).

Our analysis also suggests that of the major network carriers, Alaska, Continental and American are the most vulnerable to future Southwest expansion, in the sense that these carriers generate the greatest proportion of their domestic revenues in markets that our model predicts Southwest is likely to enter. If Southwest continues to enter new markets at the same rate as it has over the past decade, our results also suggest that the degree of network vulnerability for most large carriers will be greater over the next decade than it was throughout the 1990s. Overall, we predict that roughly 7.8% of the large network carriers' current revenue will be exposed to new non-stop Southwest competition within the next few years; over the next decade, roughly 14.4% of current network revenues could be exposed. Finally, our analysis finds strong evidence that the restrictions imposed by the Wright and Shelby Amendments (restricting the routes carriers can serve to and from Dallas' Love Field) are binding on Southwest. Indeed, our probit results suggest that four of the top fifteen markets which Southwest would likely enter absent these restrictions are to/from Dallas.

The remainder of this paper is organized as follows. Section II provides a brief overview of the growth of Southwest Airlines over the past decade. Section III presents our basic model and estimation results. Section IV presents our network vulnerability analysis and assesses the implications of the Wright and Shelby Amendments. Brief conclusions are summarized in Section V.

II. The Growth of Southwest Airlines: 1990–2000

By virtually every measure, Southwest Airlines prospered enormously throughout the 1990s. Table I, for example, summarizes the market shares

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

Table I. Market share of domestic origin and destination passengers, 1990–2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Southwest	7.0	8.2	9.6	11.3	12.7	13.6	14.1	13.8	13.7	14.3	14.9
American	14.8	15.3	16.2	14.7	12.7	11.5	11.0	10.6	10.8	10.4	10.9
Continental	6.8	7.4	7.4	7.3	8.3	7.2	6.5	6.6	7.0	6.9	6.7
Delta	12.6	15.0	15.5	15.0	14.8	13.4	14.8	15.7	16.2	15.9	16.1
Northwest	7.1	7.3	7.5	7.3	7.1	7.4	7.5	7.6	7.0	7.6	7.6
United	11.5	12.8	12.7	11.8	11.2	11.9	11.9	12.1	13.2	12.7	11.7
U.S. airways	14.0	13.1	12.4	11.8	12.3	10.7	10.1	10.7	10.7	10.2	10.4
TWA*	3.9	3.8	4.1	3.6	3.7	3.6	3.5	3.6	3.9	3.8	3.8
Other carriers	22.2	17.1	14.6	17.0	17.1	20.8	20.5	19.3	17.5	18.2	17.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Acquired by AMR Corporation in 2001.
Source: U.S. DOT OD1A Database, 1990–2000.

of domestic Origin and Destination (O&D) passengers for Southwest and the other large U.S. carriers throughout the 1990s.[4]

Following the entry by Southwest into a city-pair market, average airfares in that market typically decline – often dramatically – while the number of passengers travelling in that market usually increases sharply, a phenomena often referred to as the "Southwest Effect." For example, Bennett and Craun noted that after Southwest entered the Oakland–Ontario route in 1989, prices declined 60% while traffic more than tripled. Likewise, the Transportation Research Board analyzed routes that Southwest entered between 1990 and 1998 and found that on average, passenger trips increased 174% while average prices fell 54%. Southwest is able to generate such dramatic new traffic growth by appealing to the most price elastic passengers, many of whom would have otherwise chosen to drive rather than fly (or not travel at all) prior to Southwest's entry.

Southwest's aggressive pricing strategy has not come at the expense of its own financial well-being. Indeed, Southwest is the only major airline in U.S. aviation history to have been profitable every year since its inception. Nowhere is Southwest's history of profitability and confidence in its future economic prospects as evident as in the financial markets. Indeed, as of

[4] O&D passengers count travellers based on the starting and ending point of their journey regardless of whether or not they are making a connection.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

Table II. Operating costs of select U.S. airlines

Carrier	Unit costs (cents/ASM)
Southwest	7.82
American	9.49
Continental	9.76
United	10.18
Northwest	10.23
Delta	10.38
Alaska	10.41
U.S. Airways	11.68

Notes and Sources: Not adjusted for differences in average stage length. Data is from the first quarter of 2004.
Source: U.S. SEC Filings.

June 2004, Southwest Airlines' market capitalization exceeded that of all of its peers' market capitalizations combined.[5]

Southwest Airlines' ability to remain profitable throughout changing economic conditions has relied on its ability to keep its operating costs at levels far below those of the large hub-and-spoke carriers. Table II summarizes the cost per available seat mile (ASM) – the standard measure of capacity in the airline industry – for the largest U.S. airlines.

Southwest, like other low cost carriers, is able to achieve such dramatic cost advantages in a number of ways. In addition to offering "no frills" service, Southwest has significantly higher labor and capital productivity than most of its competitors.[6] Southwest also maintains lower ticket distribution costs than its competitors by booking a much higher proportion of its tickets through less expensive channels such as their own website.[7] Moreover, Southwest typically avoids congested airports, or those with high facilities charges in favor of secondary, less crowded airports. This strategy

[5] As of June 1, 2004, Southwest's market capitalization was $12.1 billion. In contrast, the combined market capitalizations of Alaska, America West, American, AirTran, Continental, Delta, Northwest, United, US Airways, Frontier and JetBlue was $9.61 billion.

[6] In 2001 for example, Southwest's pilots fly roughly 72% more hours per month than United's and 58% more hours per month than American's. Source: U.S. DOT Form 41, (1996).

[7] In 2000, for example, Southwest generated nearly 30% of its passenger revenue via tickets purchased on its website, thus avoiding both travel agent commission fees and computer reservation system fees. In comparison, United and Continental generated 4% and 7% of their respective passenger revenue via their websites. Source: *The Online Travel Marketplace 2001-2003*, PhoCusWright Inc., Sherman CT., 2001.

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

Table III. Some summary statistics of markets entered by southwest, 1991–2000

Year	Markets entered	Median passenger density	Median distance (miles)
1991	4	415	442
1992	10	512	412
1993	7	205	601
1994	31	220	547
1995	24	202	586
1996	31	264	796
1997	23	144	688
1998	9	357	1,257
1999	36	268	1,007
2000	26	185	1,269

Notes: Median Passenger Density reflects the average daily number of O&D passengers in 1990.
Sources: U.S. DOT OD1A and T100 Databases.

lowers costs in two main ways. First, smaller and secondary airports tend to have lower passenger facility charges (PFCs). For example, of the 51 airports Southwest served in July 2002, 34 had PFCs of $3.00 whereas only 17 collected the maximum permitted PFC of $4.50. Secondly, less congested airports allow Southwest to minimize congestion related delay costs and exploit their comparative advantage in providing quick-turn service.[8]

Finally – and perhaps most importantly – Southwest, like all low cost carriers, carefully selects the types of markets they enter, historically choosing only very dense, short and medium haul markets. Limiting service mainly to these types of markets allows Southwest to exploit well known economies of density (Brueckner and Spiller, 1994; Caves and Tretheway, 1984) and maintain a fleet comprised of a single aircraft type, thus minimizing maintenance, spare parts inventory and pilot training costs. Table III presents some stylized facts on the markets Southwest entered between 1991 and 2000.

To put the passenger density figures from Table III into context, we computed the density (i.e., average number of passengers per day) in all city-pair markets served throughout 2003. Of the 36,901 unique markets in

[8] For example, when Southwest discontinued service from San Francisco International Airport (SFO) in March 2001, CEO Herb Kelleher stated “San Francisco International Airport operation has not been profitable for a considerable period of time; operation into and out of that airport produces a disproportionate number of flight delays rippling across our system.” *Sacramento Business Journal*, January 22, 2001.

Uncorrected Proof

the U.S. DOT's database, only 943 (or roughly 2.5%) generated more than 200 passengers per day. While low density does not, by itself, preclude entry by Southwest (Southwest entered five markets during the 1990s generating 50 or fewer daily passengers), it clearly plays an important role in their entry decisions.

III. The Data and The Model

Our empirical goal is to identify the factors which have influenced Southwest's entry decisions over the past decade. To this end, we estimate probit entry models using cross-sectional data. Our unit of observation is a non-directional city-pair market. Thus, we assume that (a) passengers are in the same "market" regardless of which direction they are travelling (i.e., passengers travelling from Boston to Los Angeles are considered to be in the same market as those travelling from Los Angeles to Boston) and (b) airports within the same metropolitan area are substitutes for one another.[9] We elect to use city-pairs rather than airport-pairs as the primary unit of observation since the main interests of our analysis are understanding Southwest's geographic expansion throughout the 1990s and the competitive impact of Southwest's continued expansion on the legacy hub-and-spoke carriers. It is well understood that Southwest's influence on air fares extends well beyond the particular airport-pair route they serve (Morrison, 2001). For example, United's fares between San Francisco (SFO) and Chicago's O'Hare airport are influenced by Southwest's service between Oakland and Chicago's Midway airport. Consequently, using airport-pairs as the unit of observation would, in our opinion, understate Southwest's true competitive impact. While we recognize that using city-pairs rather than airport-pairs will necessarily result in excluding some potentially interesting airport-specific variables (in particular, slots and airport capacity constraints) we feel that the benefit of including these additional variables is outweighed by the added insight we can gain from using city-pairs.[10] In particular, Southwest offers significant service in two of the three metropolitan areas (Washington D.C. and Chicago) with slot constrained airports

[9] Our airport groupings are based largely on those in the *Official Airline Guide*: Washington, D.C. (BWI, DCA, IAD), San Francisco Bay Area (SFO, SJC, OAK), Los Angeles (LAX, BUR, LGB, SNA), Houston (IAH, HOU, EFD), Dallas (DAL, DFW), Chicago (ORD, MDW, GYY), Detroit (DET, DTW) and New York City (LGA, JFK, EWR, HPN). We also group airports in nearby cities that Southwest actively promotes on their website as "alternative airport locations", which include Miami (via FLL), Boston (via PVD and MHT), Palm Springs (via ONT), and Santa Fe (via ABQ). See `http://www.southwest.com/travel_center/routemap.html`.

[10] For the period of analysis in our paper, take off and landing "slots" were required at Chicago O'Hare, Washington's Reagan National Airport (DCA), and New York's La Guardia and JFK airports.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 TYPESET ✓ DISK LE ✓ CP Dispatch: 24/8/2004 Pages: 34

and in light of the fact that JetBlue has become the single largest carrier at slot-controlled JFK airport in New York, it does not appear as though slots *per se* have prevented low cost carriers from accessing these key metropolitan areas.

There are series of empirical papers that have modelled entry in the airline industry. Morrison and Winston have analyzed entry and exit in the post-deregulatory airline industry using a probit model. Similarly, Sinclair has used a bivariate probit model of entry and exit to test the importance of network economies and sunk costs in the airline industry. By taking advantage of the richness and dynamics of airline industry data, another group of papers has taken a more structural approach to modelling the market equilibrium. Reiss and Spiller (1989), for example, present a model of conjectural variations that explains fare differentials and endogenous entry. Berry (1992), develops a fully structural model of entry that explains the equilibrium number of firms by taking account of factors such as firm heterogeneity, post-entry competition and profitability and the sequence of entry orders.

1. EMPIRICAL MODEL

Since our empirical goal is mostly descriptive, we have chosen the simplest model that fits our purpose. The basic premise of our empirical model is that Southwest chooses to enter a market when it expects positive post-entry profits (net of entry costs). Let Y^* be a latent variable that measures such post-entry profitability. We assume that Y^* is related to a vector of observable market characteristics, X:

$$Y^* = X\beta + u,$$

where u is unobservable variation and is assumed to be independently drawn from a normal distribution with a mean of zero and a standard deviation of one to conform to the probit model.

As shown in Table III, Southwest entered 201 new city-pair markets between 1991 and 2000. While Southwest had already established itself in the Midwest and California by 1990, its expansion into Florida and the Northeast had not yet begun. As with many growing firms, we expect that Southwest started its eastward geographic expansion by entering the markets it perceived as the most profitable to mitigate its risk, slowly lowering its profitability threshold over time as it expanded. Thus, the actual decision would involve the profitability over an entry threshold W:

$$Y_t^* - W_t.$$

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

We include time subscripts on both variables to allow for the possibility of a changing threshold as well as changing levels of overall route profitability, where the latter results from changes in the industry/economic environment, or potential constraints that Southwest may face in acquiring the necessary resources (i.e., aircraft) to enter all of the markets it deems as desirable in any given year.

Although $Y_t^* - W_t$ is inherently unobservable, we can observe Southwest's actual entry decision, Y_t:

$$Y_t = \begin{cases} 0 & if\, Y_t^* - W_t < 0 \quad (no\, entry) \\ 1 & if\, Y_t^* - W_t \geq 0 \quad (entry). \end{cases}$$

We estimate this probit model by the maximum likelihood method and examine which factors have influenced Southwest's entry decisions.

2. DATA

Passenger and traffic data for this study is taken from the U.S. Department of Transportation's OD1A Origin and Destination Survey, a 10% sample of all tickets reported by U.S. Scheduled Passenger Carriers. For the purposes of this study, we consider all domestic passengers in the data set travelling on roundtrip and one-way itineraries with three or fewer flight coupons per directional trip leg within the continental (i.e., lower 48) U.S. states.[11]

Our base sample consists of the largest 2,500 domestic city-pair markets which Southwest did not serve on a non-stop basis as of 1990. Each of the markets are between cities that are large enough to be classified as Metropolitan Statistical Areas (MSAs). Although there are 18,823 unique city-pair markets among all the MSAs, the majority of them do not generate sufficient passenger traffic to make non-stop air service commercially viable. Thus, we restrict our attention to the largest 2,500 markets, which together account for roughly 90% of all domestic O&D passenger traffic. We also excluded markets with distances greater than 3,000 miles or less than 100 miles from our base sample as they are not likely to be the targets for Southwest entry. For example, the shortest route served by Southwest is 152 miles (Austin to Houston) while their longest route is 2,438 miles (San Jose to Baltimore).

Within our base sample, we consider all markets which Southwest entered between 1991 and 2000, of which there are 201. In particular, an entry is defined as scheduling new daily non-stop service in a city-pair market and thus, serving a market on a connecting basis is not counted as an

[11] A separate flight "coupon" is required for each flight with a unique flight number on a given itinerary. We also exclude "interline" passengers (those using multiple marketing carriers on a single itinerary), "open-jaw" tickets (i.e., BOS-LAX-JFK) and "circle" (i.e., BOS-LAX-SFO-BOS) itineraries.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

entry. For consistency, we required that Southwest served a market for four consecutive quarters before counting it as a valid entry data point.

Our data is constructed as cross-section of markets. Because the number of entry incidents is too small to conduct a year-by-year probit analysis, we aggregate entries from multiple years into one cross-section. Our first probit results, therefore, include all the Southwest entries from 1991 to 2000 in the dependent variable. Although most demographic variables are quite stable, some market variables are slightly trended. Thus, drawing exogenous variables from the entry year can introduce an unwanted endogeneity problem. Consequently, we draw our exogenous variables from the year 1990. While this approach abstracts from the time-series element of entry, it gives us an overview of Southwest's strategy, given the cross-sectional variation of city-pair markets. We also recognize that market conditions and entry strategies can evolve over time. In order to test the robustness of our analysis, we perform a separate probit analysis in which we focus on Southwest entries from 1995 to 2000, drawing the independent variables from 1994. We will discuss the similarity and differences of these two approaches in Section "combined distance samples"

We proceed with our analysis assuming that Southwest was free to enter any of the markets in our sample during the 1990s. In reality, some markets were (and continue to be) subject to regulatory restrictions. The Wright and Shelby Amendments, in particular, prohibit carriers from serving Dallas' Love Field (DAL) and any airport outside of Texas, Louisiana, Arkansas, Oklahoma, New Mexico, Mississippi and Alabama with aircraft of 59 seats or greater. These restrictions are particularly noteworthy as Southwest's corporate headquarters is located at Love Field. Moreover, DAL ranks sixth in terms of the number of daily aircraft departures for Southwest. In our data, DAL is grouped together with Dallas' other main airport, Dallas/Fort-Worth International (DFW). Since DFW is a hub of American Airlines and Southwest has a proclivity to avoid such hub airports, we suspect that the restrictions imposed by the Wright and Shelby Amendments have constrained Southwest's route expansion to and from Dallas. If the Wright and Shelby Amendments are binding constraints on Southwest's entry decision in specific markets to and from Dallas, our probit analysis should predict high probabilities of Southwest entry in these markets. We revisit this question later in this paper in Section IV and explore its economic consequences.

3. EXOGENOUS VARIABLES

The exogenous variables in our analysis are chosen based on their ability to impact – in our view – the post-entry profitability of Southwest in each market. We characterize these exogenous variables into four broad

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

categories: (1) market characteristics (i.e., market density and distance), (2) city characteristics (i.e., population, average per capita income, the degree to which the city is a vacation destination), (3) Southwest's pre-existing city/market presence, and (4) competition and concentration in the market and at the endpoint cities. These variables are detailed below.

(1) *Market Characteristics*: Southwest is known for choosing short and medium haul markets which generate sufficient O&D passenger traffic to support high frequency, point-to-point service. These types of markets allow Southwest to exploit its comparative advantage in quickly deplaning and boarding passengers, thus maximizing aircraft and labor productivity, which in turn results in significant unit cost advantages. Moreover, high flight frequency is attractive to travellers because it allows for scheduling flexibility. Thus, dense, short and medium haul markets are more likely candidates for entry because of their potential profitability.
Our density measure is **ln(dense)** and is defined as the natural log of the average number of daily O&D passengers in the market carried by all carriers.[12] We also include a set of several dummy variables (e.g. **D(distance300)**) that measures the non-stop (great circle) distance between endpoint cities of the market.

(2) *City Characteristics*: Southwest is known primarily for catering to highly price-elastic leisure travellers, many of whom would otherwise have chosen to drive (or not travel at all) prior to Southwest entry in a given market. Thus, in order to predict post-entry profitability, it is important to include not only the density of a market (pre-entry demand size), but also those exogenous variables which may influence a market's potential demand post-entry.
We include several city characteristic variables that attempt to capture Southwest's clientele characteristics. In effect, we hope that these variables will capture – in part – the depth of potential demand that Southwest can exploit after entry. **ln(meanpop)** is the geometric mean of populations at two end-point cities, in natural log, which is standardly used in the literature (Brueckner et al., 1992).[13] We expect this to be a positive covariate of potential demand.

[12] Some earlier papers studying network effects in the airline industry (Brueckner et al., 1992; Brueckner and Spiller, 1994) measure density in terms of total passengers on a route (O&D in addition to flow) since this ultimately determines suitable equipment type for network carriers which in turn influences unit costs. Since the bulk of Southwest's passengers travel on a non-stop basis, we measure density in terms of O&D passengers only.

[13] We also estimated our model with ln(maxpop) and ln(minpop), the natural log of the populations of the two endpoint cities ranked from largest to smallest, and the main results remained the same.

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

max(income) and **min(income)** are the larger and the smaller of the average per capita incomes (measured in $1,000s) respectively, at the endpoint cities of each market. Given Southwest's focus of attracting highly price elastic passengers, we expect these income variables to have negative estimated coefficients. Our demographic city variables come from the Bureau of Economic Analysis, U.S. Department of Commerce.

In addition, we include **max(vacation)**, which is the larger of the proportions that leisure travellers occupy in the end-point cities of each market. This variable was constructed from the Department of Transportation's 1995 *American Travel Survey* by computing the proportion of air travellers, by destination (MSA), who stated that the primary purpose of their trip was "vacation." We expect this variable to have a positive estimated coefficient.

(3) *Southwest's City/Market Presence*: The entry decisions of the traditional hub-and-spoke carriers are largely driven by their network strategies (Sinclair, 1995). In many of their spoke routes, local passengers constitute only a small fraction (often less than 10%) of total passengers. Thus, the importance of a route is evaluated not only by its stand alone profitability, but also by the flow-traffic contribution it brings to a carrier's total network.

We recognize the possibility that Southwest's entry decisions are also partly driven by such network externalities. Thus, we include several variables that reflect Southwest's pre-entry presence at the endpoint cities of each market. **max(swcities)** and **min(swcities)** are the numbers of destination cities served by Southwest from each of the endpoint cities of a market, sorted from largest to smallest. To the extent that Southwest is engaged in the formation of a hub-and-spoke type network, we would expect these variables to have strong explanatory power. In particular, the formation of a "hubbing" network would result in **max(swcities)** having a positive and significant estimated coefficient and **min(swcities)** having a negative and significant estimated coefficient.[14] It has long been observed, however, that Southwest's strategy is markedly different from that of the traditional hub-and-spoke carriers. If Southwest's network strategy is indeed different, we would expect to see different patterns in the estimated coefficients. The degree to which Southwest's entry decisions are driven by network considerations has yet to be studied in detail. Through these market/city presence variables, we hope to shed some light on Southwest's network strategy.

[14] It should be noted that economies of station costs – which might result in Southwest adding destinations from cities it already serves with developing large connecting hubs *per se* – could also result in the estimated coefficient on max(cityhhi) being positive.

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

We should stress, however, that since our base sample covers ten years of entry events – and in light of Southwest's rapid growth during the period – our market/city presence variables from 1990 may not reflect the market realities for the late 1990s. In order to address this point, we perform a separate probit estimation in which we restrict our sample to entries that took place between 1995 and 2000, employing data from 1994 for our independent variables.[15] An alternative approach would have been to use a combination of year dummy variables and interaction terms. However, because our dataset is essentially a cross-section, any time-varying variables dependent on the year of entry, such as entry year dummies, can cause endogeneity problems in the estimation.

Market entry by airlines often occurs when the carrier already serves one or both of the endpoint cities. That is, entry into a city-pair in which the carrier serves neither endpoint tends to be rare, since the carrier would have to absorb new station setup costs (hiring employees, obtaining gate and counter space, marketing, etc.) at both endpoints simultaneously. **D(swzero)** is a dummy variable which takes the value 1 if Southwest served fewer than 1000 local passengers at both of the endpoint cities and is likely to be a negative predictor of Southwest entry.

Conversely, we believe that Southwest might be more likely to enter markets on a non-stop basis if it already carries a high proportion of the passengers in that market on a connecting basis, since this would indicate that passengers in this market are already familiar with Southwest's service. We therefore include **swshare** which measures Southwest's share of O&D passengers (which by definition will be connecting passengers for Southwest) in each market. *A priori*, we expect the estimated coefficient on this variable to be positive.

(4) *Airport/Market Competition and Concentration*: Competition is a key determinant of post-entry profitability. Although post-entry competition is difficult to predict precisely, we include several variables that reflect the pre-entry state of competition and concentration in each market as our best predictor. In general, we expect markets with less intense competition pre-entry to be more profitable post-entry, and thus be more attractive candidates for Southwest entry.

Southwest's post-entry competition may come from either the large network carriers (some of which are known to respond aggressively

[15] Of Southwest's largest 10 airports (in terms of daily departures), only Baltimore–Washington was established as a Southwest base of operations during the 1990s (1993). Thus, we feel that our latter period probit does an adequate job of capturing Southwest's network patterns.

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

when low cost carriers enter into their hub markets (Transportation Research Board, 1999)) or other low cost carriers. First, we include a dummy variable **D(hub)** that takes the value 1 if the only commercial airport at either of the endpoint cities is the hub of a large network carrier.[16] Since Southwest has traditionally avoided large hub airports (the exceptions being Salt Lake City, Detroit and more recently Philadelphia), we expect the estimated coefficient on **D(hub)** to be negative. Second, we include **markethhi**, the Herfindahl–Hirschman Index (HHI) of O&D passengers for each market (Southwest's market shares are excluded from the calculation of this index so as to measure the competitive pressures from the rivals). A higher HHI indicates a more concentrated market structure and potentially less competitive environment. We also include **max(cityhhi)** and **min(cityhhi)**, which are the concentration levels measured (in terms of local O&D passengers) at the endpoint cities, sorted from the largest to smallest. Generally, high concentration at the city-level is observed in two opposing scenarios. On the one hand, there are some small "spoke" airports that are served by a single hubbing carrier such as Abilene, Texas or Duluth, Minnesota. One the other hand, we also observe high concentration at many hub airports, such as Pittsburgh, Charlotte or Cincinnati. In order to distinguish between these two types of aiport/city concentration, we interact **max(cityhhi)** with airport/city size dummies. More specifically, D_{small} (or D_{big}) is an indicator variable that take the value 1 if the airport/city referenced in **max(cityhhi)** has more (less) than 2 million passengers per year and zero otherwise, which roughly splits the sample into two equal halves.

Finally, we include a dummy variable to control for the presence of other low cost carriers already serving the market. In particular, **D(lowcost)** takes the value 1 if other low cost carriers (excluding Southwest) collectively have a 5% or greater share of O&D passengers.[17]

---

[16] Thus, **D(hub)**=1 for markets involving the following cities: Cleveland, Detroit, Cincinnati, Salt Lake City, Atlanta, Minneapolis, Memphis, Denver, Charlotte, Pittsburgh, Philadelphia and St. Louis. Although Detroit has a secondary airport (Detroit City Airport), its runway is generally considered to be too short (6,084 feet) to support the needs of most large carriers.

[17] The list of low cost carriers we include are Access Air, Air South, AirTran, American Trans Air, Eastwind, Frontier, JetBlue, Kiwi, Morris Air, National, Pro Air, Reno, Southwest, Spirit, Sun Country, ValuJet, Vanguard and Western Pacific. These carriers are the same as those used by the Department of Transportation in their studies *Dominated Hub Fares* (January 2001) and *The Low Cost Service Revolution* (May 1996), with the exception of JetBlue, which began service after the period of the DOT's studies.

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

Summary statistics for the variables described above for the full sample of routes are presented in Table IV below:

4. ESTIMATION RESULTS

We are interested in investigating two main aspects of Southwest's entry decisions. First, what factors influence the choice of markets Southwest enters? Second, how did Southwest's basic entry strategy evolve over the past decade (i.e., can we detect any changes in their choice of market entries?) Although our cross-sectional methodology is well-suited to answering the first question, identifying changes in Southwest's entry strategy – within our basic cross-sectional framework – requires that we perform additional estimations.

Although the ideal approach to study how Southwest's entry strategies have evolved over time would be to perform a series of year-by-year probits, the limited number of entries in any given year makes such analysis impractical. Preliminary analysis of the data, however, revealed some marked differences between Southwest's entries during the first half (1991–1994) and the latter half (1995–2000) of our sample period. In particular, we found that during the 1991–1994 period, only a small subset of available markets were targeted by Southwest for potential entry. More specifically, Southwest never entered a market longer than 1,200 miles during this period. And except for four markets, all the markets entered were fairly dense (i.e., generated more than 100 passengers per day). The most powerful predictors, however, were average per capita income. For the markets that Southwest entered, **max(income)** never exceeded \$22,500 and **min(income)** never exceeds \$20,000. Since both of these income upper bounds are well below both the mean and median of the entire sample, we suspect they played an important role in Southwest's entry decision process.

Within our base sample of 2,500 markets, there are 117 that satisfy the above criteria (more than 100 passengers a day, shorter than 1,200 miles, **max(income)** below \$22,500, and **min(income)** below \$20,000). Southwest entered 48 of these 117 markets between 1991 and 1994, and an additional 40 of these markets between 1995 and 2000, confirming that these markets have been among Southwest's primary entry targets. The rather discrete nature of these entry criteria, however, makes it difficult to measure the slope of the probability distribution function, yielding highly unstable probit results for the 1991–1994 sample. Thus, we do not present a separate probit analysis for this period. Rather, we group these years into the entire sample period and present a probit analysis that reveals Southwest's general entry strategies across time. In contrast, the markets entered by Southwest during the 1995–2000 period do not adhere to these strict criteria, suggesting that Southwest broadened (or was forced to expand) its

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

Table IV. Variable definitions and descriptive statistics

Variable name	Definition	Mean (S.D)
$\ln(\text{dense})_i$	Natural logarithm of average daily O&D passengers travelling in market i (00s).	−0.029 (1.102)
$D(\text{distance300})_i$	Dummy variable taking the value 1 if the distance of market i is greater than 300 miles (600, 900, 1200, 1500), 0 otherwise.	0.870 (.336)
$\ln(\text{meanpop})_i$	Geometric mean of populations (000,000s) of the two endpoint cities in market i, in natural logarithm.	−1.767 (0.599)
$\max(\text{vacation})_i$	Maximum of the proportion of leisure travellers at the endpoint cities in market i.	54.985 (14.907)
$\max(\text{income})_i$	Maximum of the average per capita income at the endpoint cities of market i (000s).	25.533 (3.687)
$\min(\text{income})_i$	Minimum of the average per capita income at the endpoint cities of market i (000s).	20.982 (2.728)
$\max(\text{swcities})_i$	Maximum of the number of cities served by Southwest from the endpoint cities of market i.	3.498 (4.288)
$\min(\text{swcities})_i$	Minimum of the number of cities served by Southwest from the endpoint cities of market i.	0.294 (1.091)
$D(\text{swzero})_i$	Dummy variable taking the value 1 if Southwest serves neither of the endpoint cities of market i.	0.477 (0.500)
swshare_i	Southwest's market share of market i passengers, served by connecting flights (between 0 and 10).	0.2383 (1.029)
$D(\text{hub})_i$	Dummy variable taking the value 1 if another carrier operates a hub at either endpoint of market i.	0.326 (0.469)
markethhi_i	HHI index (between 0 and 10) of O&D passengers for market i.	4.633 (2.174)
$\max(\text{cityhhi})_i$	HHI index (between 0 and 10) of O&D passengers for the more concentrated of the endpoint cities of market i.	3.085 (1.211)
$D(\text{big})_i$	Dummy variable taking the value 1 if the more concentrated endpoint city has 2 million passengers or more.	0.514 (0.500)
$D(\text{small})_i$	Dummy variable taking the value 1 if the less concentrated endpoint city has less than 2 million passengers	0.486 (0.500)
$\min(\text{cityhhi})_i$	HHI index (between 0 and 10) of O&D passengers for the less concentrated of them endpoint cities of market i.	1.815 (0.690)
$D(\text{lowcost})_i$	Dummy variable taking the value 1 if other low cost carriers are present in market i.	0.014 (0.118)
N	Number of markets	2,500

Uncorrected Proof

entry criteria during this later period to include longer-haul and less dense markets between cities with higher average income. These findings lead us to conjecture that Southwest, since 1995, started lowering the entry threshold to explore what were deemed – at least initially – as less desirable candidates for potential entry. Likewise, it is possible that the national growth of Southwest's network during the early part of the 1990s might have made these markets more viable options.

We use two approaches to identify these evolving changes in Southwest's entry decisions. Our first approach is to re-estimate our basic probit model using Southwest entries from the latter half of our full decade sample, i.e., 1995 – 2000. For this approach, we base our independent variables on data from 1994 (rather than 1990) and these estimation results are reported, along with the full-period probit, in Table V.

Our second approach takes advantage of the fact that the median distance of the new markets entered by Southwest steadily increased throughout the 1990s (see Table III). Thus, while the new markets entered by Southwest during the first third of the 1990's were almost exclusively short and medium haul (only one market, Las Vegas-Kansas City, was longer than 1,000 miles), the median distance of its new markets began to increase rather dramatically during the latter half of the decade, and by 2000, exceeded 1,200 miles. Maximum likelihood results for distance-split probits are reported in Section "split distance samples".

Combined distance samples. Table V summarizes the maximum likelihood estimation results of our probit model using markets of all distances. Period 1 considers Southwest entries between 1991 and 2000, using data from 1990 for the independent variables. Period 2 considers entries between 1995 and 2000 and uses data from 1994 for the independent variables.

Discussion of period 1 (1991–2000) estimation results. In general, the empirical model fits the entry data for 1991–2000 very well, predicting 143 entries in total, 117 of which Southwest actually entered. Moreover, of the remaining 26 markets for which the model predicts entry, Southwest has since entered two of them. Taking these additional markets into account, the model's entry predictions are correct 83.2% of the time. Overall, the model predicted 58.2% of all market which Southwest entered between 1991 and 2000. Even among the Southwest entries the model failed to correctly predict, the average predicted probability was 20.0%, significantly higher than the average of the overall sample, 8.2%.

(1) *Market Characteristics*: The estimated coefficients on the route characteristic variables indicate that throughout the 1990s, Southwest targeted short haul, dense markets. As expected, passenger density is a powerful predictor of entry. At the mean value of X, a 1% increase in density increases the entry probability, all other things equal, by

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

Table V. Probit estimation results–combined distance samples

Variable name	Period 1 Entries between 1991 and 2000			Period 2 Entries between 1995 and 2000		
	Probit coefficient	Standard error	Probability derivative	Probit coefficient	Standard error	Probability derivative
constant	8.507†	(0.876)	0.183	5.731†	(0.939)	0.069
ln(dense)	0.481†	(0.080)	0.010	0.478†	(0.078)	0.006
D(distance300)	0.367	(0.223)	0.008	0.258	(0.258)	0.003
D(distance600)	−0.204	(0.171)	−0.004	−0.240	(0.183)	−0.003
D(distance900)	−0.176	(0.175)	−0.004	−0.131	(0.182)	−0.002
D(distance1200)	0.149	(0.207)	0.003	0.025	(0.216)	0.000
D(distance1500)	−0.430*	(0.215)	−0.009	−0.441*	(0.221)	−0.005
ln(meanpop)	0.563†	(0.164)	0.012	0.468†	(0.160)	0.006
max(vacation)	0.008	(0.005)	0.000	0.013*	(0.006)	0.000
max(income)	−0.266†	(0.025)	−0.006	−0.251†	(0.030)	−0.003
min(income)	−0.117†	(0.025)	−0.003	−0.085†	(0.030)	−0.001
max(swcities)	−0.044*	(0.020)	−0.001	−0.002	(0.016)	0.000
min(swcities)	−0.021	(0.048)	0.000	0.068*	(0.032)	0.001
D(swzero)	−0.471†	(0.175)	−0.010	−0.616†	(0.211)	−0.007
swshare	0.048	(0.056)	0.001	−0.029	(0.039)	0.000
D(hub)	−1.149†	(0.209)	−0.025	−1.215†	(0.224)	−0.015
markethhi	0.075*	(0.037)	0.002	0.056	(0.044)	0.001
max(cityhhi)*D_{small}	−0.306†	(0.075)	−0.007	−0.003†	(0.001)	0.000
max(cityhhi)*D_{big}	−0.054	(0.077)	−0.001	−0.002*	(0.001)	0.000
min(cityhhi)	−0.123	(0.131)	−0.003	0.001	(0.001)	0.000
D(lowcost)	0.240	(0.408)	0.005	−0.079	(0.187)	−0.001
N		2,500			2,448	
Number of entries		201			149	
Pseudo-R^2		0.520			0.462	
Predicted p at means		0.008			0.004	
Log likelihood		−335.988			−302.151	
% of Entries predictions correct		81.8			77.2	
% of Actual entries predicted		58.2			40.9	

Notes and Sources: Probability derivatives are computed at means. For discrete variables, they measure the change from 0 to 1.
*Significant at the 5% level.
†Significant at the 1% level.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

0.01%. Moreover, Southwest tends to focus on short-haul markets less than 600 miles in distance. In particular, the range between 300 and 600 miles has the highest entry probability, which generally declines as distance increases.

(2) *City Characteristics*: The estimated coefficient on **ln(meanpop)** is large and significant at the 1% level, and indicates that a 1% increase in the geometric mean of the two endpoint cities' populations, holding all other variables constant, increases the entry probability by 0.012%. Thus, while market density measures the pre-entry demand size, **ln(meanpop)** measures the size of potential demand that Southwest can exploit. Numerous researchers (Bennett and Craun, 1993; Ito and Lee, 2003) have documented that market output expands significantly after entry by Southwest or other low cost carriers. This may reflect the common argument that Southwest primarily caters to customers who previously chose alternate forms of transportation (principally driving), or did not travel at all prior to entry.

Among the other city characteristics, the estimated coefficient on **max(vacation)** was positive, but not significant. This result may reflect the difficulty of measuring leisure passengers in general.[18] Moreover, pooling airports within a given metropolitan area may obscure the predictive ability of **max(vacation)**, especially in cases where specific airports within a metropolitan area are known to have lower average fares and cater more heavily to leisure travellers than others (i.e., BWI in the Washington area, or Oakland in the San Francisco Bay Area).[19] The estimated coefficients for **max(income)** and **min(income)** are both negative and significant at the 1% level. Southwest may favor low income cities for two possible reasons. First, Southwest tends to be popular among relatively lower income travelers, either because of its lower prices or brand image. Second, cities with lower average income may signal other favorable operational conditions, such as lower labor or airport operating costs.

(3) *Southwest's Airport/Market Presence*: As expected, the estimated coefficient on **D(swzero)**, a dummy variable indicating the lack of Southwest presence at both endpoint cities, is strongly negative and significant at the 1% level. The lack of Southwest's presence at either endpoint of a market decreases the entry probability by roughly 1%.

[18] While there exists reliable data for separately measuring business and leisure passengers for more recent years (Lee and Luengo Prado, 2002), this data is not available for 1990.

[19] In addition to **max(vacation)**, we also tried a variable **D(sunbelt)** which was used by Morrison and counts the number of endpoint airports in market *i* which were in either California, Nevada, Arizona, New Mexico, Texas, Louisiana, Mississippi, Alabama or Florida. However, the results did not change significantly.

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

Other variables confirm Southwest's unique expansion patterns. If Southwest were building a hub-based network throughout the 1990s, we would expect **max(swcities)** to be positive and significant. However, the estimated coefficient on **max(swcities)** is negative and significant at the 1% level, suggesting that instead of attempting to expand the scope of its own quasi-hub airports (i.e., Phoenix, Las Vegas, Houston) and building a hub-and-spoke like network, Southwest is doing the opposite. Indeed, Southwest is expanding the scope of its route system by slightly avoiding such concentration. The estimated coefficient on **min(swcities)** was not significant which is consistent with the rather dispersed growth of Southwest's network into new cities it had previously not served.

The estimated coefficient on **swshare** is positive, but very small and not significant. We had expected the presence of Southwest customers travelling via connecting service would encourage non-stop entry, however, this was not the case. One possible explanation is that there were too few Southwest passengers travelling on a connecting basis to make this variable a useful predictor. In 1990, for example, 89% of Southwest's passengers travelled non-stop, compared to 58% of Northwest's passengers, 54% of Delta's passengers and 57% of American's passengers. A more likely cause of this result, however, is the fact that Southwest entered a significant number of new cities throughout the 1990s (i.e., Baltimore, Providence, Islip, Buffalo, Albany, Norfolk, etc.) and since the data for **swshare** is from 1990, its value is zero for each of the markets involving these new cities. In general, the relatively weaker predictive power of the airport/market presence variables compared with that of city characteristic variables suggest that Southwest was focusing more on the independent profitability of markets and less on their contribution to overall network profitability.

(4) *Market/Airport Concentration and Competition*: As expected, our estimation results confirm that Southwest tends to avoid the hub airports of other network carriers. In particular, the presence of a hub airport at either endpoint of a market decreases the entry probability by 2.5%. There are numerous reasons why Southwest tends to avoid hub airports. First, large hub airports typically involve higher passenger facility charges which are largely absorbed by carriers, and thus, raise operating costs. Second, many hub airports tend to have either more significant delay problems (Brueckner, 2002) or longer taxi times than smaller, secondary airports, muting Southwest's comparative advantage in performing quick turn operations. Finally, Southwest may fear a potentially aggressive competitive response by the incumbent carrier. For example, when Southwest entered many of United's core

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

California markets during the late 1980s and early 1990s, United responded by launching a lower-fare subsidiary known as *Shuttle* to compete directly against Southwest in these markets.[20]

The estimated coefficient on **markethhi** is positive and significant at the 1% level. Higher concentration may indicate less competition and thus, higher operating margins and larger potential gains from entry. The estimated coefficient on **max(cityhhi)** is negative and significant at the 1% level when interacted with a dummy variable for small airports/cities. But, its effect is smaller and non-significant when interacted with a dummy variable for large airports/cities. This result suggest that Southwest tends to avoid small concentrated airports but relatively high concentration at large hub airports (controlling for the presence of hubs) does not dissuade Southwest entry. Finally, the estimated coefficient on **D(lowcost)** is positive but not significant, indicating that the presence of other low cost carriers has not tended to deter Southwest entry.

Discussion of period 2 (1995–2000) estimation results. In order to analyze potential changes in Southwest's entry strategies, we also estimated our probit model for Southwest entries between 1995 and 2000, updating our independent variables with data from 1994. By doing so, we can check if our key results differ from the 10 year span of Southwest entries using 1990 independent variables (i.e., Period 1 in Table V). Probit results for this sample are reported on the right hand side of Table V.

It is important to note that by 1995, Southwest faced an environment that was different from what it faced in 1990. Indeed, some of the most notable changes were the result of Southwest's own successful expansion. By the beginning of 1995, Southwest served a total of 45 airports, compared with 33 in 1990. Moreover, it had already entered many of the available high density, short and medium haul markets with low per capita income and had firmly established itself as a national carrier.[21] Consequently, we suspect that Southwest's entry strategies may have evolved as it expanded its network beyond its traditional type of markets. Thus, the changes we detect in our Period 2 probit are likely to reflect the co-evolution of the Southwest's entry strategies as well as its operating environment.

[20] United's *Shuttle* service was terminated in 2002. Similarly, Delta launched its no-frills subsidiary *Delta Express* to compete against low cost carriers in the Northeast-Florida markets and U.S. Airways launched (but subsequently discontinued) its *MetroJet* service. More recently, Delta has launched a new lower-cost subsidiary ("Song") to replace its *Express* service and United has started a lower cost subsidiary known as "Ted".

[21] As seen in Table I, Southwest's share of domestic O&D passengers almost doubled between 1990 and 1995, from 7.0% to 13.6%.

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

As expected, the overall fit of this sample is not as strong as the full period sample estimation. Moreover, and as one would expect, the model predicts a slightly lower percentage (40.9% vs. 58.2%) of the markets Southwest actually entered. This partly reflects the diversified entry strategy of Southwest during the later period. For example, the magnitude of the estimated density coefficient is considerably lower, suggesting that relatively lower density does not necessarily deter Southwest's entry as much as before. Moreover, Southwest's strategy to expand into new markets through entry into airports such as Albany and Islip came as a surprise to our model (and many industry observers as well). It is possible that these Southwest entries are "stepping-stones" to the future regional networks that Southwest intends to build. Thus, our current model that focuses primarily on route-specific profitability does not capture such long-term strategies.

The estimated negative coefficient on **max(swcities)** shrinks – relative to the full sample – and turn insignificant, signalling a slight change in Southwest's earlier strategy of explicitly avoiding a hub-centric route network. Moreover, the estimated coefficient for **min(swcities)** becomes positive and significant at the 5% level, suggesting that Southwest–in the latter period – has become more focused on connecting its existing cities with non-stop service. Having more cities in its network, of course, enables Southwest to expand its operation by connecting cities they already serve without incurring new station start-up costs.

The contrast between these estimates and those of the combined sample suggests an interesting evolution in Southwest's entry strategy after 1995. First, Southwest's focus has clearly shifted away from exclusively serving only short to medium haul, very dense markets. This may indicate – to some extent – that there are relatively fewer of these markets left untapped by Southwest compared to pre-1995. This, in turn, will likely have significant implications on network carriers in the future as Southwest continues to expand into long haul markets, which have traditionally been unchallenged by Southwest and other low cost carriers. And while our Period 2 estimation also confirms Southwest's avoidance of hub airports, the carrier's recent expansion into Philadelphia (a U.S. Airways hub) indicates that this long-held market selection criteria has also changed. Likewise, Southwest has become more inclined to leverage its existing network in the late 1990s than it was during the early 1990s. Nevertheless, it is important to stress that Southwest's network strategy is still quite different than that of a typical hub-and-spoke carrier. Whereas most hub-and-spoke carriers grow their networks by expanding the number of destinations served from their main hubs, Southwest has been leveraging its network by connecting the existing cities within its network. Moreover, whereas traditional hub-and-spoke carriers have built networks whose profitability relies heavily on

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**

the network externalities resulting from "flow" traffic, Southwest appears to have assembled a more loosely connected collection of dense markets, virtually all of which are profitable based on their own. Indeed, in this respect, Southwest's route network also differs significantly from those of a number of other low cost carriers (such as AirTran or Frontier) who have built their networks using a more traditional hub-and-spoke system.

Split distance samples. In this section, we split our base sample into three subsets according to route distance: (1) short haul (less than 600 miles), (2) medium haul (between 600 and 1,200 miles) and (3) long haul (1,200 miles and longer). Short haul markets are mostly regional and were the traditional target markets of Southwest during its early expansion (i.e., within California, Texas or the Midwest). Medium haul markets often carry North–South vacation traffic (i.e., Providence-Tampa) and Southwest entry into these types of markets happened frequently during the mid-1990s. Long haul markets are mostly transcontinental markets (i.e., Phoenix–Buffalo or Baltimore–Los Angeles) which Southwest has historically avoided, but began entering after 1995 and have been the target of many of Southwest's most recent entries. To reflect such reality, we use 1994 exogenous variables for the long haul market probit analysis while using 1990 variables for the other two segments.[22] Table VI summarizes our maximum likelihood results for the split distance samples.

The results from the short and medium haul probits resemble that of the combined sample reported in Table V. In short-haul markets, **ln(density)** is positive and significant, but **ln(meanpop)** has much weaker effect. If **ln(density)** measures current demand and **ln(meanpop)** measures potential demand, this would imply that the entry motive in short-haul markets are more likely to be current, rather than potential market demand. In medium haul markets, both of these two variables become significant, thus Southwest is exploiting both current and potential demand. One possible explanation for this is the fact that a higher proportion of passengers on Southwest's short haul flights (relative to its medium and long haul flights) are travelling for business. Put differently, the lack of in-flight amenities and less spacious seating on Southwest flights is better tolerated by business travellers on its short haul, rather than medium and long haul flights. Since its medium and long haul flights are likely to have proportionally more leisure travelers than its short haul flights, Southwest is better able to tap into "potential demand" (i.e., draw in passengers from the surrounding "catchment" area of its airports) in these longer markets.

[22] Since **D(hub)** predicts non-entry perfectly in the long-haul sample, it is excluded from the probit for the long-haul markets and the observations for which this dummy variable takes the value 1 are dropped.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

Table VI. Split sample probit estimation results

Variable	Short–Haul markets < 600 miles		Medium–Haul markets 600–1200 miles		Long–Haul markets > 1200 miles	
	Coefficient	(Standard Error)	Coefficient	(Standard Error)	Coefficient	(Standard Error)
constant	12.909†	(2.146)	11.708†	(1.579)	6.784†	(2.583)
ln(dense)	0.803†	(0.160)	0.169	(0.131)	2.445†	(0.503)
ln(meanpop)	0.862†	(0.334)	1.413†	(0.290)	−4.020†	(0.886)
max(vacation)	−0.010	(0.011)	0.014	(0.008)	−0.064†	(0.023)
max(income)	−0.452†	(0.061)	−0.270†	(0.042)	−0.421†	(0.102)
min(income)	−0.077	(0.054)	−0.217†	(0.044)	−0.073	(0.079)
max(swcities)	−0.086	(0.047)	−0.101†	(0.036)	0.072	(0.046)
min(swcities)	−0.083	(0.142)	−0.073	(0.074)	0.309†	(0.102)
D(swzero)	−0.655	(0.343)	−0.719*	(0.299)	−0.090	(0.988)
swshare	−0.161	(0.117)	0.133	(0.084)	0.056	(0.159)
D(hub)	−1.374†	(0.383)	−1.630†	(0.410)		
market hhi	0.126*	(0.062)	0.135	(0.071)	−0.939†	(0.268)
max(cityhhi)*D_{small}	−0.150	(0.127)	−0.289*	(0.123)	−0.001	(0.004)
max(cityhhi)*D_{big}	0.012	(0.127)	0.095	(0.138)	0.005	(0.003)
min(minhhi)	−0.186	(0.218)	−0.168	(0.243)	−0.005	(0.007)
D(lowcost)	0.309	(0.540)	0.141	(1.146)	−0.584	(0.638)
N		864		930		550
Number of entries		77		82		42
Pseudo-R^2		0.668		0.554		0.668
Likelihood function		−86.099		−123.604		−49.254
% of Entry prediction correct		87.5		84.1		73.7
% of Actual entries predicted		72.7		64.6		66.6

Notes and Sources: Probability derivatives are computed at means. For discrete variables, they measure the change from 0 to 1. The estimations include distance dummy variables, but they have been suppressed in the Table.
*Significant at the 5% level.
†Significant at the 1% level.

The results from the estimation of long-haul markets further reinforces our point that Southwest's strategy shifted in the latter half of the 1990s. However, we should caution that a relatively small number of Southwest entries (42) in this long-haul sample make the probit results not as stable as the results from the other samples.

Uncorrected Proof

The estimated coefficient on **ln(meanpop)** turns negative and is significant at the 1% level. In contrast, **ln(dense)** become even more powerful than it was before. These two coefficient suggest that Southwest has shifted from its traditional strategy of exploiting potential demand towards exploiting current demand as proxied by density. For example, seven of the long-haul entries involve either Providence, Rhode Island or Manchester, New Hampshire. Since Providence and Manchester are both grouped into the Boston city definition in our data, such entries actually represent fairly dense markets. In essence, Southwest is exploiting the current demand of these markets via nearby secondary airports.[23] The coefficients on both **max(swcities)** and **min(swcities)** are positive and **min(swcities)** is statistically significant, which suggests that these long-haul entries are taking advantage of Southwest's existing networks, which appears to be another evolution in their entry approach. However, the powerful coefficient on **min(swcities)** still reflects the dispersed nature of Southwest's network expansion.

These results, which are in stark contrast to the short and medium haul results, reinforce the evolving strategies of Southwest after 1995 (the first year that Southwest entered a market longer than 1,200 miles). First, Southwest appears to be relying more heavily on the connecting route presence it has developed in many long-haul markets as a precursor to entering the market on a non-stop basis. This is likely to intensify the confrontation between Southwest and the legacy carriers in coming years, an area we investigate in Section "POTENTIAL SOUTHWEST ENTRY TARGETS". Second, even though Southwest has not begun building hubs in the traditional sense, they appear to be developing a loosely connected quasi-network, in the sense of connecting many of their existing cities.

IV. Future Entry, the Wright Amendment and Incumbent Carrier Vulnerability

Continued expansion by Southwest and other low cost carriers is the most significant structural change currently shaping the U.S. airline industry, a fact recognized by the literature (Morrison, 2001; Transportation Research Board, 1999) as well as by industry leaders. For example, while unveiling its new lower-cost subsidiary in November 2002, Delta CEO Leo Mullin stated that "low-fare carriers represent a real threat to Delta – substantially

[23] When we disaggregate these three airports into separate markets, most of the entries become quite thin (i.e., Providence to Phoenix generated 62 passengers per day) and the coefficient on **ln(dense)** becomes much smaller and insignificant. However, the key interpretations of the long-haul market probit remain the same. We thank an anonymous referee for suggesting this change.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

more than that from other hub and spoke competition."[24] Likewise, one Continental Airlines executive recently stated that "We've finally reached the point, perhaps, where [low cost carrier] penetration may be fatal."[25]

In light the dramatic impact that low cost carriers – in particular Southwest – have had on the evolution of the airline industry in the post-deregulatory era, a number of questions come to mind. First, which markets currently not served by Southwest does our model predict as being the most likely for future entry? Second, have regulatory restrictions – in particular, those imposed by the Wright and Shelby Amendments – impacted Southwest's expansion, and if so, to what extent. Finally, based on the markets our model predicts as most likely for future entry, which of the large, incumbent hub-and-spoke carriers are the most vulnerable to continuing Southwest expansion? In this section, we attempt to provide some insight on these three questions using the estimation results from our Period 2 (1995–2000) model.

1. POTENTIAL SOUTHWEST ENTRY TARGETS

Table VII summarizes the markets currently not served by Southwest (on a non-stop basis) that our Period 2 model assigns a probability of entry of 50% or greater. Table VII also reports the largest incumbent carrier, its share of domestic O&D revenues in that market, and the 2003 passenger revenue that carrier generated in each of these markets by the incumbent. It is noteworthy that Southwest has already entered two of the top ten markets which the model predicts as likely entry candidates: Chicago–Los Angeles and Houston–Los Angeles.

2. IMPACT OF THE WRIGHT AND SHELBY AMENDMENTS

One interesting policy question that our analysis can shed some light onto is what the potential effects have been from the regulatory restrictions imposed by the Wright and Shelby Amendments that prohibit Southwest from flying between Dallas' Love Field and airports outside of Texas, Louisiana, Arkansas, Oklahoma, New Mexico, Mississippi and Alabama. As a starting point, Table VII suggests that four of the top fifteen markets that our model predicts Southwest will enter are in fact precluded by the Wright and Shelby Amendments. These four markets alone (between Dallas and Phoenix, Los Angeles, Chicago and Las Vegas) generated roughly

[24] Source: "Delta Air Lines Announces New Low-Fare Subsidiary," Delta Air Lines Press Release, November 20, 2002.

[25] See "Low cost airlines put crunch on biggest carriers," *The Wall Street Journal*, June 19, 2002.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 TYPESET ✓ DISK LE ✓ CP Dispatch: 24/8/2004 Pages: 34

Table VII. Top predicted entry markets

Rank	Market	Predicted entry probability%	Incumbent		
			Carrier	Revenue Share %	VulnerableRev. ($millions)
1.	Portland–Los Angeles	82.8	Alaska	65.3	66.6
2.	Dallas–Los Angeles†	72.6	American	75.3	132.0
3.	Orlando–Los Angeles	70.8	United	31.0	27.9
4.	Miami–Los Angeles	70.7	American	60.3	83.6
5.	San Antonio–New Orleans	70.5	Southwest	70.2	5.4
6.	Dallas–Phoenix†	68.4	American	51.9	35.3
7.	Houston–Los Angeles*	67.0	Continental	61.6	73.5
8.	San Antonio–Oklahoma City	66.7	Southwest	73.9	3.7
9.	Chicago–Los Angeles*	66.4	United	39.9	114.0
10.	Los Angeles–San Diego	65.7	American	69.6	7.6
11.	Los Angeles–Fresno	65.1	American	69.8	6.9
12.	Seattle–Los Angeles	63.6	Alaska	74.4	152.0
13.	Dallas–Las Vegas†	60.4	American	59.6	44.7
14.	Dallas–Chicago†	59.7	American	66.3	101.0
15.	Las Vegas–Fresno	54.5	Allegiant	51.8	4.0
16.	San Antonio–Albuquerque	54.2	Southwest	78.8	6.0
17.	Miami–Las Vegas	52.8	America West	40.8	23.6
18.	Los Angeles–Tampa	51.5	Delta	53.7	20.8

Notes: *Southwest entered post sample period.
†Entry precluded by Wright and Shelby Amendments. Revenue data from 2003. Los Angeles includes LAX, BUR, LGB and SNA, Miami includes MIA and FLL, Dallas includes DAL and DFW, Houston includes HOU and IAH. Predicted entry probabilities based on Period 2 probit estimation.

$470 million in passenger revenues during 2003, largely via non-stop service from Dallas-Fort Worth International airport (DFW). Of the top 100 markets our model predicts Southwest will enter, a total of twelve are to and from Dallas, which together generated more than $1 billion in passenger revenue during 2003. Thus, our results would indicate – not surprisingly – that the Wright and Shelby Amendments have imposed a binding constraint on the markets Southwest has entered in the past, and can enter in the future.

In order to provide an estimate of the additional costs borne by consumers as a result of the Wright and Shelby Amendments, Table VIII compares the average price per mile in the top twelve Dallas markets for which our model predicts entry to the average prices charged in markets where Southwest operates. At the outset, it is interesting to note that of these

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 TYPESET ✓ DISK LE ✓ CP Dispatch: 24/8/2004 Pages: 34

twelve markets, seven are currently served non-stop by Southwest from Houston – whose greater metropolitan population is smaller than Dallas's by roughly half a million people–but where the Wright and Shelby Amendments do not apply. Since airline unit costs decline as distance increases, we used 250-mile segments when computing the average price per mile in markets where Southwest operates.[26] For each market, we then computed the difference between the actual average price per mile in 2003 with the average prices in markets with Southwest and, in turn, calculated the potential costs of the Wright and Shelby Amendments to consumers, both on a per round-trip ticket basis, as well as for the market as a whole. For example, Table VIII indicates that if the average price per mile between Dallas and Chicago (22.4 cents) were the same as in the markets Southwest currently offers nonstop service between 750 and 1,000 miles (14.2 cents), the average roundtrip ticket would be approximately $130 less, resulting in annual fare savings of roughly $55 million.

On average, the mean price per mile in the twelve markets from Table VIII are 50% higher than those in comparable distance markets where Southwest operates. The largest difference is between Dallas and Nashville, where the average price per mile is nearly 90% greater than in comparable distance markets served by Southwest. The smallest difference is between Dallas and Orlando (10.2% higher), a market predominantly flown by leisure travelers. While there is no guarantee that Southwest would in fact enter all twelve of the markets in Table VIII in the absence of the Wright and Shelby Amendments, there is little doubt that these regulatory restrictions have resulted in Southwest serving fewer destinations from Dallas than it otherwise would (for example, while Southwest serves 23 destination from Houston, it only serves 13 from Dallas). Moreover, the potential fare savings if Southwest were to enter each of these twelve markets amounts to approximately $340 million annually.[27]

3. NETWORK VULNERABILITY

Having estimated the markets which Southwest is most likely to enter in the future, we now turn our attention to the implications of these

[26] The average prices per mile are based on all carriers in the market and were (in cents): 31.5 (<250 miles), 20.7 (251–500 miles), 17.3 (501–750 miles), 14.2 (751–1,000 miles), 11.2 (1,001–1,250 miles), 10.7 (1,251–1,500 miles), 8.5 (1,501–1,750 miles) 7.9 (1,751–2,000 miles) 7.1 (2,000+ miles).

[27] The reader should be aware that our approach to estimate these fare savings does not attempt to control for differences in passenger mix across markets. Likewise, we have excluded from our estimate the additional benefits of stimulated traffic resulting from lower fares in these twelve markets. Nevertheless, we feel that our estimates provides a reasonable baseline estimate as to the potential costs imposed by the Wright and Shelby Amendments.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

Table VIII. Wright and Shelby amendment implications

Rank	Destination	Avg.Price /Mile		Dist (miles)	Density (PPDEW)	Potential costs	
		Current (cents)	Avg. w/SW (cents)			Per ticket($)	Annual total ($mil)
2.	Los Angeles*	16.5	11.2	1,225	1,190	129	56.12
6.	Phoenix*	21.4	14.2	869	501	125	22.89
13.	Las Vegas*	15.8	11.2	1,055	617	97	21.87
14.	Chicago*	22.4	14.2	800	1,169	130	55.61
19.	Kansas City	33.5	20.7	460	366	118	15.73
46.	Orlando*	15.7	14.2	984	576	28	5.97
52.	Miami	17.8	11.2	1,120	464	149	25.20
53.	Tampa	19.0	14.2	929	344	90	11.26
77.	San Diego	17.7	11.2	1,171	328	152	18.22
90.	Sacramento	13.5	10.7	1,431	161	80	4.72
91.	Nashville*	32.8	17.3	630	200	196	14.33
100.	Washington*	18.4	11.2	1,238	1,357	179	88.66
Total							340.58

Notes: *Denotes destinations served non-stop by Southwest from Houston. PPDEW stands for passengers per day each way. Price, revenue and passenger data are from calendar year 2003 and are for all carriers serving the market. Per ticket potential costs are round-trip. Los Angeles includes LAX, BUR, LGB and SNA. Miami includes MIA and FLL.

predictions on the large hub-and-spoke airlines. Every major carrier has already experienced the "Southwest Effect" in some part of their network. As Southwest (and other low cost carriers such as JetBlue) expand into the long-haul markets where network carriers have previously operated without direct competition from low cost carriers, competition will almost certainly intensify. We are interested in measuring the vulnerability of the large network carriers to future Southwest expansion. In particular, we predict the proportion of current network carrier revenue that is likely to be exposed to future non-stop competition from Southwest.

At the outset, we stress that our predictions are likely to be the lower bound for the actual competitive exposure of network carriers to low cost carrier competition. Indeed, our predictions understate the likely impact for a number of reasons. First the networks of large hub-and-spoke carriers are currently under attack by a host of low cost carriers. Thus, while Southwest is the largest low cost carrier, other low cost carriers such as JetBlue, Frontier, AirTran and ATA have all been expanding rapidly. Second, while entry by a low cost carrier on a non-stop basis clearly poses the

Uncorrected Proof

greatest threat to an incumbent carrier's revenues in that market, connecting service on low cost carriers also has the effect of significantly depressing fares, especially leisure fares (Morrison, 2001). And since the number of connecting markets grows exponentially as new cities are added to Southwest's route system, the revenue impact from connecting competition also increases in a non-linear fashion. Finally, our airport groupings are based on those in the *Official Airline Guide* and on Southwest's website, which may understate the true catchment area of Southwest service.[28]

For our prediction, we define a vulnerability index that measures the proportion of a network carrier's revenues exposed to probable Southwest entries. We begin by defining some notation. Denote N as the set of all possible domestic city-pair markets and r_i^k as the passenger revenue generated by carrier k in market $i \in N$ during 2001.[29] Then, $R^k = \sum_i^N r_i^k$ denotes carrier k's total domestic passenger revenue. Finally, denote $\omega_i^k = \frac{r_i^k}{R^k}$ as the proportion of carrier k's domestic passenger revenue generated in market i.

Define P^s as the vector of predicted entry probabilities by Southwest with typical element p_i^s. Denote $p_{(k)}^s$ as the kth order statistic of P^s.[30] We define $S \subseteq N$ as the subset of markets such that $P_S^s = \{p_{(N)}^s, p_{(N-1)}^s, \ldots, p_{(N-|S|+1)}^s\}$. That is, S denotes the set of markets with the $|S|$ largest entry probabilities, where $|S|$ denotes the cardinality (i.e., the number of elements) in the set S.

Define carrier k's *vulnerability* as:

$$V_S^k = \sum_{i \in S} \omega_i^k$$

That is, V_S^k measures the proportion of carrier k's domestic passenger revenues that are generated by the $|S|$ most likely markets which Southwest will enter.[31] Table VIII summarizes the network vulnerabilities of the major network carriers (based on passenger and price data from 2001) for the 50, 100 and 200 most likely markets that Southwest will enter. Total figures represent the combined sum of the seven carriers.

The left hand side of Table IX indicates that the networks of Alaska, American and Continental are the most exposed to future entry by South-

[28] Morrison considers Southwest's influence on all routes where Southwest offers non-stop and connecting service–including service from airports within a 75-mile radius–and consequently, finds significantly larger impacts than we do.

[29] Note that in this section, N is not restricted to the top 2,500 markets.

[30] That is, $p_{(1)}^s$ denotes the smallest probability of entry and $p_{(N)}^s$ denotes the highest probability of entry.

[31] An alternative definition for our vulnerability index would have been $V_S^k = \sum_{i \in S} p_i^s \omega_i^k$. We elected not to probability weight V_S^k however, since we are assuming in this section that Southwest will eventually enter these 200 new markets.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 TYPESET ✓ DISK LE ✓ CP Dispatch: 24/8/2004 Pages: 34

Table IX. Network vulnerability

Entries	Top predicted markets						1990 Revenue
	All markets			W&S Amend. Adj.			1991–2000
	50 (%)	100 (%)	200 (%)	50 (%)	100 (%)	200(%)	200(%)
Alaska	20.3	25.4	30.8	20.3	30.2	31.1	17.1
American	17.9	23.1	34.6	13.9	15.5	20.3	9.8
Continental	10.8	16.7	32.1	13.6	18.1	30.9	6.5
Delta	4.1	7.7	12.8	4.8	6.9	11.3	9.1
Northwest	2.6	6.3	9.9	4.0	6.4	10.1	3.8
US airways	2.1	3.7	8.6	2.8	3.9	9.2	13.0
United	10.9	12.2	15.9	10.4	11.6	14.9	14.2
Total	7.7	10.8	16.7	7.8	10.0	14.4	10.6

west.[32] Care must be taken when interpreting these figures, however, as they do not take into account the restrictions imposed by the Wright and Shelby Amendments. The right hand side of Table IX excludes markets to and from Dallas which Southwest is restricted from serving due to regulatory constraints (assuming Southwest does not begin service from DFW). Again, these figures indicate that of the major airlines, Alaska is the most heavily exposed to future entry by Southwest. This is largely a result of Alaska having the smallest network of the major carriers, and consequently, its revenues are concentrated over a smaller number of routes. Indeed, roughly 16.5% of Alaska's domestic revenue is generated in two markets which our model places very high on Southwest's list of likely new entries: Portland–Los Angeles (#1) and Los Angeles–Seattle (#12).

As expected, American's network vulnerability drops significantly after considering the restrictions imposed by the Wright and Shelby Amendments, as its largest hub is in Dallas. Nevertheless, next to Alaska and Continental, our model suggests that American's network is the most vulnerable to future Southwest entry. Based on Southwest's average over the last decade of adding roughly 20 new non-stop markets a year, the right hand side of Table VIII would suggest that more than a quarter (30.2%) of Alaska's existing domestic revenue and 15% of American's will be exposed to new non-stop competition by Southwest over the next five

[32] Following the period of our analysis, Southwest announced a large expansion into Philadelphia, a US Airways hub. This represents the first major expansion by Southwest into a large hub airport in over a decade, and therefore, was not predicted by our model.

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

years. Continental's network also faces significant exposure, with 18% of its current revenues facing new non-stop entry by Southwest over the next five years. In contrast, the networks of Delta, Northwest, and U.S. Airways appear to be relatively less exposed to future Southwest expansion.

To put these vulnerability figures into context, the final column of Table IX summarizes the proportion of each carrier's 1990 domestic passenger revenue generated in the 200 markets that Southwest entered between 1991 and 2000. Comparing the figures from 1991 and 2000 with the Wright Amendment adjusted predictions suggests that the fears expressed by executives at most network carriers are well founded. In particular, our model suggests that future entry by Southwest is likely to overlap with a greater proportion network carrier revenue than it did throughout the 1990s. For example, while entry throughout the 1990s overlapped with roughly 6.5% of Continental's 1990 revenue, our model suggests that its exposure from the 200 most likely future entries could be over twice as large (30.9%). Likewise, Alaska could face the same – or more – new revenue overlap from the next few years of entry as its faced during the entire 1990s if Southwest continues to enter new markets at the same rate it did over the past decade.

V. Conclusions

The proliferation of low cost carriers, notably Southwest, has dramatically transformed the domestic airline industry during the last decade. Low cost carrier expansion has partly contributed to at least two recent bankruptcies (United and U.S. Airways) as well as significant labor concessions at other large hub-and-spoke carriers (i.e., American). Since Southwest's expansion is likely to continue, this paper assesses the magnitude to which the incumbent hub-and-spoke carriers are exposed to Southwest's future growth. In particular, we expect that roughly 10% of the large network carriers' revenues will be exposed to new Southwest non-stop competition within the next five years, roughly the same proportion that became exposed throughout the entire 1990s. Moreover, of the large network carriers, we predict that Alaska, Continental and American are the most vulnerable to future Southwest expansion.

We also examined the evolution of Southwest's entry strategies over the last decade – a time during which it has grown to become one of the largest domestic carriers. After successfully exploiting a number of very dense short-haul markets, Southwest expanded into medium-haul vacation markets by tapping into many customers who had previously not traveled on these routes. We also found that starting in 1995, Southwest began entering into a number of relatively thin, long-haul markets that it had previously avoided. Likewise, we found that Southwest's entry decisions

Uncorrected Proof

Journal: REIO Ms Code: REIO287 PIPS No.: DO00001970 ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: 24/8/2004 Pages: 34

during the latter half of the 1990s became more strongly influenced by network effects. However, Southwest's network is markedly different from that of traditional hub-and-spoke carriers, in that their route system tends to be far less concentrated. Finally, we found that the Wright and Shelby Amendments are strongly binding constraints on Southwest's entry decisions and have likely resulted in forgone fare savings in the hundreds of millions of dollars annually.

Acknowledgments

The authors would like to thank the participants of the 2003 International Industrial Organization Conference in Boston, Ken Boyer and an anonymous referee for useful comments. The views expressed in this paper are those of the authors and do not necessarily reflect those of LECG, LLC or the Gordian Group, LLC.

References

Bennett, R., and J. Craun (1993) 'The Airline Deregulation Evolution Continues: The Southwest Effect'. Office of Aviation Analysis, U.S. Department of Transportation, Washington, D.C.

Berry, S. (1992) 'Estimation of a Model of Entry in the Airline Industry', *Econometrica* **60**, 889–917.

Brueckner, J. (2001) 'A Model of Scheduling in Airline Networks: How a Hub-and-Spoke Systems Affects Flight Frequency, Fares and Welfare', *Journal of Transport Economics and Policy* **35**, 195–222.

Brueckner, J. (2002) 'Airport Congestion When Carriers Have Market Power', *American Economic Review* **92**, 1357–1375.

Brueckner, J., N. Dyer., and P. Spiller (1992) 'Fare Determination in Airline Hub-and-Spoke Networks', *Rand Journal of Economics* **23**, 309–333.

Brueckner, J., and P. Spiller (1994) 'Economies of Traffic Density in the Deregulated Airline Industry', *Journal of Law and Economics* **9**, 379–415.

Caves, D., and M. Tretheway (1984) 'Economies of Density versus Economies of Scale: Why Trunk and Local Airline Costs Differ', *RAND Journal of Economics* **15**, 471–489.

Dresner, M., J.-S. C. Lin., and R. Windle (1996) 'The Impact of Low-Cost Carriers on Airport and Route Competition', *Journal of Transport Economics and Policy* **30**, 309–328.

Evans, W., and I. Kessides (1993) 'Localized Market Power in the U.S. Airline Industry', *Review of Economics and Statistics* **75**, 66–75.

Ito, H., and D. Lee (2003) 'Incumbent Responses to Lower Cost Entry: Evidence From the U.S. Airline Industry', Brown University Department of Economics Working Paper, No. 2003–22.

Ken Hendricks, M. P., and G. Tan (1995) 'The Economics of Hubs: The Case of Monopoly', *Review of Economic Studies*, **62**, 83–99.

Lee, D., and M. Luengo Prado (2002) 'The Impact of Passenger Mix on Reported Hub Premiums in the U.S. Airline Industry'. Unpublished Manuscript, Cambridge, MA.

Morrison, S., and C. Winston (1990) 'The Dynamics of Airline Pricing and Competition', *American Economic Review* **80**, 389–93.

Uncorrected Proof

Morrison, S., and C. Winston (1995) *The Evolution of the Airline Industry*. Washington, D.C.: The Brookings Institution.

Morrison, S., and C. Winston (2000) 'The Remaining Role of Government Policy in the Deregulated Airline Industry', in S. Peltzman and C. Winston (eds.), *Deregulation of Network Industries: What's next?* Washington, D.C., 1–40, AEI-Brookings Joint Center for Regulatory Studies.

Morrison, S. A. (2001) 'Actual, Adjacent and Potential Competition: Estimating the Full Effect of Southwest Airlines', *Journal of Transport Economics and Policy* **35**, 239–256.

Oum, T., A. Zhang., and Y. Zhang (1995) 'Airline Network Rivalry', *Canadian Journal of Economics* **28**, 836–857.

Reiss, P., and P. Spiller (1989) 'Competition and Entry in Small Airline Markets', *Journal of Law and Economics* **32**, 179–202.

Sinclair, R. (1995) 'An Empirical Model of Entry and Exit in Airline Markets', *Review of Industrial Organization* **10**(5), 541–557.

Transportation Research Board (1999) 'Entry and Competition in the U.S. Airline Industry: Issues and Opportunities', National Research Council, Special Report 255, Washington, D.C.

U.S. Department of Transportation (1996) 'The Low Cost Service Revolution', Office of Aviation and International Economics, Washington, D.C.

Whinston, M., and S. Collins (1992) 'Entry and Competitive Structure in Deregulated Airline Markets: An Event Study Analysis of People Express', *Rand Journal of Economics* **23**, 445–462.

Uncorrected Proof

Journal: **REIO** Ms Code: **REIO287** PIPS No.: **DO00001970** ☐ TYPESET ☑ DISK ☐ LE ☑ CP Dispatch: **24/8/2004** Pages: **34**