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"FLYING UNDER RADAR": SOUTHWEST AIRLINES AND INCUMBENTS' RESPONSE TO ENTRY

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This paper investigates the competitive effect of Southwest Airlines, considering the factors affecting its decision to offer service in particular city-pairs and the effect of Southwest's presence on overall fares and the fare distribution of major airlines. Southwest is a formidable, apparently low-cost competitor when it is present it often garners a large share and creates significant fare pressure on major airlines. Despite this competitive success Southwest's network does not include service to many destinations, limiting its competitive effect. We investigate the factors affecting Southwest's decision to offer service, including the effect of Southwest on overall fares and the fare distribution of major airlines. We find that 'network efficiency' complementing inefficiency of hub-and-spoke network is one of the key factors explaining Southwest's selective entry and subsequent share. The ability of Southwest to offer more efficient network service then limits the markets where it operates. We also document empirical evidence that Southwest's presence decreases the fare dispersion of major airlines leading more fare reduction of high-valued customers rather than low-valued, price-sensitive customers. This results also support the hypothesis that 'network efficiency' is one of the key elements explaining Southwest's success.

Keywords: Network Efficiency, Entry, Incumbent's Response, Price Dispersion
JEL classification: L1, L9

1. INTRODUCTION

Since airline deregulation the hub-and-spoke route systems offered by major airlines have been the subject of systematic encroachment by smaller carriers.[1] Regionally

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[1] Numerous studies have investigated hub-and-spoke networks and the associated issues regarding market power, including among others, Berry (1992), Borenstein (1989, 1990), Brueckner and Spiller (1994),

based carriers like Southwest Airlines and others featuring low fares and few amenities regarding meals, seat selection, and the like have thrived in certain industry segments. In particular, when Southwest is present in a market it is often a formidable competitor, offering stiff competition with its low fares, garnering substantial market share, and lowering the prices of other carriers and in the market as a whole.[2] Despite these facts, Southwest and other similar carriers operate only in limited markets, limiting their impact on competition and prices. These facts raise the issue of what factors determine the markets where Southwest and other smaller carriers can offer service and compete successfully and what effect their presence has on market prices.

This paper provides to our knowledge the first in-depth analysis of the factors determining Southwest's decisions to offer service in particular markets, Southwest's success as measured by its share, and the effect of Southwest's presence on average fares and the fares of major airlines.[3] The goal of the paper is to determine when the hub-and-spoke systems of major airlines will be susceptible to service offerings by a firm such as Southwest, and the effect of such service offerings on prices and shares. That is, when can a reputedly efficient firm, like Southwest, offering more traditional point-to-point service with fewer amenities and lower fares compete effectively with major airlines, what is the effect of that competition on prices, and what factors limit the scope of such competition.

This issue is of considerable importance because small firms like Southwest provide significant competitive pressure and pricing discipline for major airlines. Further, there is relatively little empirical analysis of when a hub-and-spoke system operated by large firms will be vulnerable to competition from a competitive fringe, and the effects of that competition on market shares and prices.

The analysis focuses on Southwest Airlines because there is evidence that Southwest itself provides significant competitive discipline in certain markets (see e.g., Morrison and Winston (1995)). More generally, while Southwest remains a regional carrier with operations focused in the South and Southwest, its network is sufficiently large to create econometric variation in key variables to enable estimation of the factors affecting the decision to offer service and subsequent share. Further, we investigate Southwest's

Brueckner, Dyer, and Spiller (1992), Caves, Christensen, and Tretheway (1984), Dana (1999), Evans and Kessides (1993), Hendricks, Piccione, and Tan (1997, 1999), Morrison and Winston (1989, 1995), and Reiss and Spiller (1989).

[2] See, for example, the discussion in Morrison and Winston (1995), who argue that Southwest has had a very substantial impact on the fares of major airlines.

[3] The reader should note that the analysis addresses Southwest's decision to offer service in particular city-pair markets. The analysis relies on cross-section data and in a particular quarter and hence analyzes the markets where, presumably in equilibrium, Southwest has made a decision to offer service and to continue offering service. The initial decision to offer service, followed by a possible exit, is a distinct issue. In terms of Southwest's ability to compete effectively the decision to offer service is the relevant issue.

decision to offer service from four geographically dispersed airports, enabling econometric control for the possible role of an airport’s integration into Southwest’s network and proximity to major airlines’ hubs. Further, by focusing on a single carrier and variation in service offerings from several locations we can effectively control for cost and demand characteristics (see below).

A key finding of the analysis is that Southwest’s relative and absolute *network efficiency* is a key factor explaining both its decision to offer service, and its ability to garner a large share. Specifically, as major carriers fly passengers more circuitous routes through their hub-and-spoke network, Southwest is more likely to offer service and gain a large share. The ability of Southwest to offer better network service then limits the markets where it operates. Southwest avoids long routes and markets where airports are highly concentrated and congested. Hence the ability to offer relatively more efficient network is a key element of Southwest’s competitive strategy.

A second key finding is that when Southwest serves a market its presence appears to have a *larger effect* on fares paid by *high-value* customers than on the prices paid by more price-conscious, low-valued customers. These results are consistent with the results regarding network efficiency described above. If Southwest is more likely to provide service when it can offer more efficient network service, then that efficient network service will generate significant competitive pressure throughout the fare structure and could lead to a greater impact on high value customers. Southwest’s actual presence in a market lowers fares charged by major airlines in a market by an estimated 15 percent for low valued customers and 30 percent for high valued passengers.

The remainder of this paper is organized as follows: Section 1 compares the fares and network structure of Southwest and major airlines. It also presents short description of data and econometric methodology employed in this study. Section 2 presents an empirical model. Sections 3 and 4 present the results and conclusions.

2. DATA AND METHODOLOGY

The analysis below investigates the determinants of Southwest Airline’s service offerings in the fourth quarter of 1995, the factors affecting Southwest’s share, and the effect of Southwest’s presence on the level and distribution of fares. To provide control for numerous potentially important factors including cost variation and geographic integration into Southwest’s network, the analysis focuses on four airports: Austin, Birmingham, Louisville, and Phoenix. These airports were chosen in part for their geographical diversity: Birmingham and Louisville lie toward the outside of Southwest’s primary service area, while Phoenix is on the western side and Austin lies in the heart of Southwest’s network.

Another important factor influencing the choice of cities is that while Southwest has a significant share at each of these airports, with between twenty and forty percent of total enplanements, none of these airports is dominated by either Southwest or another airline. Since Southwest has a substantial share but does not dominate, one can observe econometric variation in the factors affecting Southwest's decision to offer service to particular destinations from these airports.

The analysis investigates Southwest's decision to offer service to all destination airports served from these given airports.[4] We refer to these four cities as the "origin" airports for ease of exposition and consider the decision to offer service connecting these "origins" to all "destinations" served. By analyzing the cross-section variation in these decisions the analysis can control for cost and demand factors by including variables for distance, size of the destination city, and so forth. Since we include all cities served from these airports, the cities not served become the control group, providing control for underlying cost levels and so forth. Further, because the "origin" airport has identical characteristics and cost elements, variation in service offerings can be linked to destination airport and route characteristics. Such a focus will permit us to isolate factors affecting Southwest's decision to offer service to particular cities based on distance, competition, demand characteristics, and service complementarities at the "destination" airport.

The data used in the analysis are the Department of Transportation's *Origin and Destination Survey (Data Bank 1A)* and *Service Segment Data (T-100 or DB28DS)* for the fourth quarter of 1995. The Origin and Destination survey is a ten percent random sample of all tickets that originated from the United States. It provides information on the carrier, origin and destination, ticket prices, fare class and travel distance for each customer on all trip segments. The Service Segment Data is a census of all flights provided by large domestic carriers. These data contain information on flight frequency, equipment, and the number of passengers enplaned for each flight.

Before turning to the formal econometric model it is useful to set the stage for the analysis by considering raw fare and market share information. Table 1 breaks data down into distance quantiles and adds average market share data for Southwest. Table 1 show that as distance rises Southwest offers less direct service and that its shares suffer accordingly. Hence there appears to be a linkage between the efficiency of Southwest network, as measured by the percentage of direct service, and Southwest's share.

[4] Throughout attention is restricted to markets where there is meaningful demand. We restrict our attention to markets where the total number of passenger is greater than forty-five in the quarter and airlines with at least five percent route share. Since the origin and destination data (DB1A) is ten percent random sample of the whole domestic passenger, the forty-five passengers restriction means that we confine the sample city pairs where the daily passenger is greater than five people. The data is also restricted to U.S. domestic one way or round travel that has direct or one-stop flight services.

Table 2 reports data on differences across the fare distribution rather than by distance. Recognizing that there is uncontrolled variation in distance, this preliminary data indicates that Southwest charges lower fares throughout the fare distribution and Southwest's presence is associated with lower major airline fares throughout the distribution. Further, Southwest marks up its higher fares much less than the major airlines. Southwest charges about thirty to forty percent more for its 80th percentile fares than for its 20th percentile fares, while major airlines often charge double that fare at the 80th percentile, and sometimes even more.

These data reveal several important issues regarding Southwest's factors affecting its success and its competitors impact. Southwest's shares decrease as flight distance increases linking network issue is an important element of Southwest's success. Southwest appears to significantly impact major airline fares but that impact varies with distance and throughout the fare distribution. These findings suggest that much can be learned about Southwest's success, its limitations and its competitive impact by addressing these issues in a formal econometric model, to which we now turn.

3. THE ECONOMETRIC MODEL

The econometric analysis consists of three elements: (i) Southwest's decision to offer service, (ii) determinants of Southwest's market share, and (iii) the estimation of fares. We deal with each of these in turn.

3.1. Southwest's Service Decision and Share Equations

Turning to the specification of the decision to offer service and the share equation, Southwest will choose where to offer service and then its share will only be observed where it offers service. This fact leads to sample selection bias, and biased coefficients in a share equation (Heckman (1976)). Accordingly, we employ Heckman's two-step sample selection model, where we estimate.[5]

$$E_{ij} = V_{ij}'\gamma + w_{ij}, \tag{1}$$

$$S_{ij} = P_{ij}'\alpha + X_{ij}'\beta + u_{ij}, \tag{2}$$

where $[w_{ij}\ u_{ij}] \sim N_2[0, 0, 1, \sigma_u^2,\ \rho_{uw}\sigma_u]$

E_{ij} is an indicator variable representing Southwest's presence in city-pair ij, V

[5] For the practical application of Heckman sample selection model, see Van de Ven and Praag (1981) and Green (1992).

represents variables affecting the decision to offer service, S represents Southwest's share, P represents prices, and X represents other determinants of share (see below). The error structure consists of w and u, which are bivariate normals with zero means, finite variances, and a correlation ρ. Subscripts ij are hereafter suppressed. As described in Equation (2) the decision to offer service and market share error terms have zero means and a correlation ρ. If ρ were zero then the errors would not be correlated and the unconditional model is appropriate. The selectivity corrected regression is:

$$\begin{aligned} E[S \mid S \text{ is observed}] &= P\alpha + X\beta + E(u \mid w > -V\gamma) \\ &= P\alpha + X\beta + (-\rho_{uw}\sigma_u)\lambda \\ &= P\alpha + X\beta + u_\lambda \lambda, \end{aligned} \tag{3}$$

where $\lambda = \dfrac{\phi(V\gamma)}{\Phi(V\gamma)}$, and $\phi(\cdot)$ and $\Phi(\cdot)$ are standard normal.

This problem can be thought of as an omitted variable problem (Green (1997)). A simple OLS regression of market shares (S) on the independent variables and λ will produce consistent estimates, while an OLS regression without λ will lead to an omitted variable problem. We also include an origin fixed effect dummy variable to control the unobserved 'origin airport' effect.

Factors likely to affect the decision to offer service include the size of the market and Southwest's potential share. Since we estimate decisions to offer service from four distinct airports, variation in potential market size is measured by the number of passengers at "destination" airports served from the "origin" airports. Similarly, Southwest's potential share and service complementaries in a market are represented by Southwest's share at the destination airport. Berry (1992) argues that larger scale of operations at an airport reduce costs due to economies of scope and enhance demand through network effects. Hence a high destination airport share increases the likelihood of Southwest offering service.

A primary inefficiency of major airlines is that passengers must fly indirectly through hubs, increasing the time and distance of travel. The high congestion of hub airport also increases the potential passengers' travel time by waiting the connected flight. As this inefficiency rises, Southwest's point-to-point network is more likely to offer relatively efficient flight through direct or more direct flights. Hence the efficiency of network is measured by the ratio of the weighted average flight distance of major airlines to statutory flight distance. This ratio measures how well or poorly hub and spoke systems serve a particular city-pair.

Competition is also likely to affect Southwest's service offerings. We include both the Herfindahl index at the destination airports and the number of existing competitors on a route. High concentration could affect service offerings either by attracting service due to high prices or by deterring it due to obstacles in a concentrated market. The number of competitors provides a route specific measure of competitiveness on the observed route. Airport congestion and flight delays may also affect Southwest’s service decision. Southwest flies a tight schedule with quick turnarounds and delays at congested airports could deter its service offerings.

When Southwest offers service, its subsequent share will depend on its own prices, competitors’ prices, common market factors, and Southwest’s network efficiency. Prices included in the equation are Southwest’s twentieth percentile price and the sales weighted average twentieth percentile price of Southwest’s competitors.[6]

Underlying market conditions should also influence Southwest’s share, including destination airport size, distance, and the number of competitors. Flight distance is likely to have a significant effect on the success of Southwest. Major airlines typically provide one-stop service through their hub-and-spoke network. In shorter haul markets the stops created by a hub-and-spoke system may create significant diseconomies, but as distance rises the added distance of hub stops becomes less important, and amenities like guaranteed seat selection may become more important. Finally, Southwest’s quick turnaround of planes becomes less important and so its relative efficiency should become less important. For all of these reasons, Southwest’s share could well decrease with distance. An increase of the number of competitors should similarly reduce Southwest’s share, while the sign of airport size is indeterminate.

A key hypothesis is that Southwest’s decision to offer service and its share will be heavily influenced by its relative network efficiency. Factors affecting Southwest’s network efficiency mainly include its relative distance compared to majors, flight frequency along the primary route servicing a city-pair, the portion of passengers who can and do opt for direct service, and Southwest’s destination airport share measuring brand identity and possible network effects. When Southwest provides better network service in these dimensions it is likely to be able to garner a high share with its low prices. In contrast, when these dimensions of efficiency deteriorate, Southwest’s share is likely to fall.

3.2. Price Equations

The third equation estimated below is a price equation. To account for price heterogeneity, we follow Borenstein (1989) and measure prices at twentieth, fiftieth, and eightieth percentiles.[7] We also follow Borenstein’s by estimating a double-log format in

[6] Qualitatively similar results are obtained if one uses median prices in these equations.

[7] Following Borenstein (1989), the measure of the price that we use for this analysis is a *one-way fare* for an observed airline on an observed route. A pair of airports defines a unique city-pair market and round trip tickets in the opposite direction are considered as the same city-pair market demand. We define a round trip ticket as two equally priced one-way tickets.

our pricing equation and in using a linear form to estimate the effects of variables such as shares and Herfindahl indices.[8] The analysis also addresses possible endogeneity using instrumental variables. The analysis investigates pricing differences between major airlines and Southwest, factors affecting pricing such as quality and share, and the effect of Southwests presence on major airline prices.

The basic pricing equation is:

$$P_{ijk} = Z_{ijk}\delta + u_{ijk}, \tag{4}$$

where P_{ijk} represents price for airline k in city-pair ij. Z includes factors affecting prices such as concentration, market characteristics, and service quality. Separate price equations are estimated for the majors and Southwest. A Chow test rejects the null hypothesis that each firm behaves with same pattern at the four origin cities and it also rejected the hypothesis that all major airlines behave in the same way at each origin city.[9] This means that each major carrier shows different behavior across origin cities. To control for origin-firm heterogeneity, we include origin city-firm interaction fixed effect dummy variables in the major firm's pricing equation.[10]

Competitive factors likely to affect fares include route specific variables for Southwest presence, concentration at the destination, route concentration, and the number of competitors. Southwest's presence should lower fares, though these effects may differ for high fare compared to low fare customers. Borenstein and Rose (1994) and Perloff, Suslow, and Seguin (1996) argue that a dominant firm will charge higher fares to its brand loyal customers and so price dispersion will increase with competition. They argue that the results are consistent with the model of monopolistically competitive price discrimination in that the discrimination is based on customers' elasticity of substitution to alternative airlines or flights. This implies that even if the lower end fares decrease with competition, fares at the higher end may decrease less along with the entry of low-cost up-start carrier like Southwest. We test this argument by allowing differential effects of Southwest presence throughout the fare distribution.

High concentration, as measured by the Herfindahl Index and the fewness of competitors on a route should raise fares. Large market size could decrease fares, other things equal, if size increases the number of competitors.

Underlying market characteristics such as the number of passengers and distance

[8] As a check on robustness, we also performed linear functional form estimation and the results were qualitatively similar to each other. For further justification of this analytical method see Borenstein (1989).

[9] The Chow test indicates that F-statistics=7.74 in FR20, F-statistics=10.98 in FR50, F-statistics=13.62 in FR80. The pattern shows that the heterogeneity of carrier pricing becomes more serious as the price level goes up.

[10] Because we estimate Southwest separately, we include only origin fixed effect dummy variable for Southwest pricing equation.

may also influence prices. The number of passengers for a city-pair should be linked to market demand and influence fares. Correcting for market share, increased market size will lower costs per passenger and hence fares due to economies of traffic density (Reiss and Spiller (1992)). On the other hand, increased flight distance should raise fares.

Finally, the network efficiency affecting fares include relative flight distance, direct service, flight frequency, and destination airport share. The flight distance ratio is the (weighted average) actual flight distance of a carrier divided by the shortest observed flight distance. A larger distance ratio indicates that the carrier provides less direct service. Direct service is the percentage of a carrier's passengers who fly direct. Flight frequency raises quality due to convenience and destination airport share raises quality through network effects. Higher service quality will increase prices, so that lower distance ratios, more direct service, more frequent flights, and higher destination airport share will increase fares.

3.3. Endogeneity and Instrument Variables

A key econometric issue regards endogeneity. Hausman specification tests rejected exogeneity of several variables and we used instrumental variables to address the problem.

In the equation analyzing Southwest's presence, the destination airport share of Southwest and the total number of city-pair passengers are treated as endogenous. Destination airport share will be correlated with Southwest's decision to offer service on a given route. We used the total number of other carriers' destinations at the airport in question as an instrument. Controlling for airport size, the number of other carriers' destinations should have a negative effect on Southwest's airport share because a larger number of other carrier destinations implies more competing service, lowering Southwest's share, but should be uncorrelated with Southwest's decision to offer service on a single route to the destination.[11]

We also instrumented for market size, as measured by the number of city-pair passengers, by using the number of passengers at the two endpoint airports. The number of passengers of both airports is likely highly correlated with the number of passengers on the observed routes but should not be significantly affected by the decision to offer service on an individual route.

Turning to prices, a Hausman specification test shows the exogeneity of Southwest fare (20th percentile fare) at any reasonable significance level, but the exogeneity of the weighted average price of major airlines (20th percentile fare) is rejected at the five

[11] The simple regression of Southwest Airlines= airport share on other carriers= total number of network at the airport shows significant negative relationship. The coefficient was -0.005 with t-value 10.78.

percent level (see below).[12] Southwest's fares are accordingly treated as exogenous. For majors' fares we used as an instrument their sales weighted average flight distance. Flight distance should be strongly correlated with carriers' costs and prices, but should be uncorrelated with shares.

Finally, following the literature, market shares, route Herfindahl index, and the number of passengers on a route are treated as endogenous in the price equation. To solve the endogeneity problem, following Evans and Kessides (1993), we use 'market share ranks' as an instrumental variable for the market share. Estimating 2SLS with this instrument, we use the predicted value of market share instead of market share itself. The route Herfindahl index is replaced by the Herfindahl index calculated with the predicted value of market share. The number of passengers in a city-pair is also a function of price and is correlated with the error term. As discussed above, we use the number of passengers at the endpoint airports as an instrument.

4. EMPIRICAL RESULTS

4.1. Summary Statistics

The empirical analysis starts with the investigation of the factors driving Southwest's presence, then evaluates market share, and finally pricing. Table 3 presents summary statistics.

Table 3.A shows that the sample covers 444 city-pair markets with Southwest Airlines providing service on 133 of those routes. An average of five carriers serve a given route and on average there are 933 sampled passengers. Given the ten percent sample, the average number of passengers on a route is about 10,000 per quarter, or about 100 passengers a day. Daily flight frequency averaged 7.3 per day and about thirteen percent of customers flew direct. Fares vary widely with high-end passengers (eightieth percentile) paying 273 dollars, more than twice the average fare at the twentieth percentile. Table 3.B reveals substantial differences between major carriers and Southwest in fares and direct service. As described above, Southwest charges lower and less dispersed fares and offers more direct service.

[12] Considering that market share is the portion of total number of passengers in a route, it is generally believed that the low end fares (FR20) has a larger effect on demand and shares than higher fares. Allowing for endogeneity for FR50 and FR80 did not qualitatively change the results.

Table 3. Summary Statistics

A. Summary Statistics for All Airlines

	Variable Name	Mean	Std. Dev.
Carrier Characteristics			
1) Fares			
	Twentieth Percentile	127	(45)
	Fiftieth Percentile	171	(68)
	Eightieth Percentile	273	(127)
2) Destination Airport and City-pair Market			
	Airport Share	0.22	(0.22)
	Average Distance (Actual)	1353	(663)
	Direct	0.13	(0.29)
	Flight Frequency	7.33	(4.96)
	Route Share	0.31	(0.25)
	Statute Distance Ratio	1.16	(0.19)
Common Destination Airport and City-pair Market Characteristics			
1) Destination Airport			
	Airport Herfindahl Index	0.31	(0.22)
	Airport Passenger (Total)	20.92	(27.81)
	Busy Airport	0.21	(0.41)
	Hub Airport of Major Airlines	0.18	(0.38)
2) Citypair (Route) Market			
	Citypair Passenger (Total)	933.49	(2387.75)
	Number of Competitor	4.9	(2.34)
	Route Herfindahl Index	0.48	(0.22)
	Statute Distance	1095	(630)

B. Summary Statistics for Major Airlines vs. Southwest Airlines

		Major Airlines (N=1167)		Southwest Airlines (N=133)	
	Variable Name	Mean	Std. Dev.	Mean	Std. Dev.
1) Fares					
	Twentieth Percentile	130	(45.15)	105	(40.99)
	Fiftieth Percentile	178	(67.12)	108	(41.08)
	Eightieth Percentile	287	(124.45)	143	(56.58)
2) Destination Airport and City-pair Market					
	Destination Airport Share	0.21	(0.22)	0.34	(0.2)
	Average Distance	1383	(667)	1095	(562)
	Direct	0.1	(0.26)	0.42	(0.4)
	Flight Frequency	7.37	(4.52)	7	(7.86)
	Major Distance Ratio	1.11	(0.17)	-	-
	Southwest Distance Ratio	-	-	0.95	(0.17)
	Route Share	0.29	(0.24)	0.51	(0.26)
	Statutory Distance	1228	(631)	1002	(531)

Source: Author's calculations from DB1A and DB28DS. The full sample includes 444 city pair markets from 4 origin cities and the total observation number is 1300. Total Airport Number of Passenger is measured in unit of 100,000 passengers. Flight Frequency is measured by scheduled number of daily flights in DB28DS.

4.2. Estimation Results: Service Offerings

The service offering and market share equations are estimated using Heckman's two-stage sample selection model. Possible endogeneity and heterogeneity problems are corrected using 2SLS with instruments and dummy variables. The first columns of Table 4 report the estimation results using 2SLS estimation and compares those with the OLS results in the second set of columns. The origin-fixed effects for service offering and market share are not reported in the Table. Overall the results of the estimations are similar, but the Statutory Distance Ratio reverses sign and becomes insignificant in the OLS version, and the Number of City-pair Passengers becomes significant in the equation with 2SLS. The magnitude of the estimated coefficients also varies significantly. Hence endogeneity is a significant issue and we focus on the 2SLS results.[13]

The overall estimation results show that Southwest offers service where it can offer more efficient network service through direct flights or shorter service, where the market size is large and unconcentrated, and where the airport fits well into Southwest's own network. Tying into the share and pricing equations below, the central finding is that network efficiency is a key dimension affecting Southwest's presence and its success.

hub-and-spoke service and increase the likelihood of Southwest offering service. Its marginal effect is 0.271 at sample means with z-value 2.48. A one standard deviation increase of major airlines' flight distance ratio (19 percent longer service) is associated with an increase of the probability of Southwest offering service by 0.06, an increase of twenty percent over the mean probability.[14] More indirect, hence more inefficient major airline service, substantially increases the likelihood of Southwest presence.

Southwest is more likely to offer service in markets where it can offer shorter flights or direct service. Increases in the weighted average distance major airlines fly their passengers divided by statutory distance indicate inefficiency of major airlines'

[13] These equations were also estimated separately for the individual cities of origin: Austin, Birmingham, Louisville, and Phoenix. The results show that the qualitative results are highly similar to the pooled regression results. The separated regression results are available from the author upon request.

[14] The predicted probability of Southwest Airline=s presence is 0.273 with our model, while actual presence was 0.299 in our sample data set. For the interpretation of estimation results, we used the actual mean service offering probability, 0.299.

Table 4. The Estimation Results of Heckman Sample Selection Model

		Probit with 2SLS				Probit			
		Coeff		*Marginal Effects*		*Coeff*		*Marginal Effects*	
Presence	Statutory Distance Ratio	0.816		0.271		-1.208		-0.335	
		(0.326)	**	(0.109)	**	(0.875)		(0.254)	
	Southwest Airport Share	3.88		1.289		14.141		3.918	
		(1.125)	***	(0.371)	***	(1.606)	***	(0.841)	***
	Airport Herfindahl Index	-3.793		-1.261		-2.322		-0.644	
		(0.915)	***	(0.299)	***	(1.052)	**	(0.237)	***
	Hub Destination	1.621		0.581		2.298		0.746	
		(0.499)	***	(0.149)	***	(0.616)	***	(0.132)	***
	Number of City-pair Passengers	0.433		0.144		0.109		0.001	
		(0.189)	**	(0.062)	**	(0.089)		(0.001)	
	Number of Competitors	0.005		0.002		0.098		0.027	
		(0.062)		(0.002)		(0.067)		(0.018)	
	Busy Airport †	-0.311		-0.097		-0.608		-0.143	*
		(0.313)		(0.091)		(0.429)		(0.083)	
	-CONS	-		-		-		-	
		-		-		-		-	
		2SLS Coeff				OLS Coeff			
Market Share	Southwest Distance Ratio	-0.23				-0.279			
		(0.071)	***			(0.066)	***		
	Direct	0.2				0.213			
		(0.040)	***			(0.039)	***		
	Southwest Airport Share	0.446				0.383			
		(0.079)	***			(0.091)	***		
	Flight Frequency	0.003				0.006			
		(0.001)	**			(0.002)	***		
	Statutory Distance	-0.198				-0.127			
		(0.053)	***			(0.050)	**		
	20th Percentile Major Fares	0.002				0.001			
		(0.001)	**			0.000	*		
	20th Percentile Southwest Fares	-0.002				-0.002			
		(0.001)	*			(0.001)	**		
	Number of Competitors	-0.022				-0.013			
		(0.014)				(0.007)	**		
	Number of City-pair Passengers	0.002				-0.01			
		(0.046)				(0.004)	***		
	Hub Destination	0.004				0.017			
		(0.045)				(0.028)			
	-CONS	-				-			
		-				-			
	Lambda	-0.105	**			-0.043			

		(0.048)				(0.028)			
	rho	-0.774				-0.408			
	No. of Obs.	444				444			
	Censored Obs.	311				311			
	Uncensored Obs.	133				133			
	Wald Chi 2 (14)	641.98				538.6			

Notes: (1) Standard errors are in parentheses. (2) *, ** and *** denote, respectively, significance at the 10%, 5%, and 1% levels. (3) † Discrete dummy variable Statutory Distance is measured in thousands of miles. (4) Number of City-pair Passengers is measured in thousands of passengers.

Southwest's destination airport share is also positively associated with a high probability of offering service. The estimated marginal effect is quite significant at 1.289 with z-value 3.48. Holding other things constant, a one standard deviation increase in mean Southwest airport share (59 percent) increases the likelihood of Southwest offering service from a given origin by 0.258, which indicates an eighty-six percent increase of the mean probability of offering service. The positive coefficient of destination airport share on Southwest's service offerings implies that Southwest's brand recognition or the expected volume of connecting service significantly affects its service offerings.

Southwest is also more likely to offer service if the potential market size is large or the destination airport is a hub of a major carrier. The number of city-pair passengers is positively correlated with Southwest's presence and its economic effect is quite substantial. A one standard deviation increase of total number of passengers in a typical city-pair is associated with an increase in the mean likelihood of Southwest offering service of 0.34 or 115 percent. The marginal effect of hub destination is also positive with 0.581 and highly significant at the one percent level (z-value is 3.88), meaning that other things equal, Southwest is more likely to offer service to the hubs of major carriers. These hub airports are usually located in large cities with substantial demand and good facilities. Hence while at times Southwest may avoid head-on competition at airports like Love Field in Dallas, it actively seeks out hub destinations in other cases.

A highly concentrated destination airport, however, substantially discourages Southwest presence. Its marginal effect is quite significant at -1.261 with z-value 4.2. Holding other factors constant, a one standard deviation increase of airport Herfindahl index is associated with a decrease in the likelihood Southwest will offer service by 0.28 or 93 percent of the mean probability. Tying into the estimated results of hub airports and market size, the estimation results show that Southwest prefers to offer service in larger markets with unconcentrated airports.

There is also little evidence that airport congestion affects Southwest. The estimated effect is large at .09, which would reduce the likelihood of service by a third, but it is not statistically significant. Still, the p-value is 0.28, which raises the possibility that congestion discourages Southwest. Controlling for market size, the number of competitors in a city-pair market also appears not to be a serious concern of Southwest. The empirical result shows that the marginal effect of the number of competitors is quite small with 0.0018 and z-value is 0.09.

The estimation results strongly indicate that Southwest offers service when it can offer superior service through efficient network and compete well due to the inefficiency of hub-and-spoke systems offering out-of-the way service. The capability of offering superior service with shorter flights and flights that integrate well into Southwest’s network help to explain its service offerings. Concentrated airports discourage Southwest presence as does high quality major airline service. We now turn to the share equation.

4.3. Estimation Results: Market Share

Network efficiency also plays a key role determining Southwest’s share. Southwest’s share rises significantly when Southwest offers shorter or more direct service, direct flights, frequent flights and when it has a large destination airport share.

Relative flight distance, as measured by the ratio of Southwest average distance to mean passenger distance flown, is a key determinant of Southwest’s share.[15] The estimated coefficient of the relative distance is -0.23 and the z-value is 3.22, indicating that as Southwest provides more direct service its market share increases significantly. A decrease in relative distance by one standard deviation increases Southwest’s share by 3.9 percent. Since Southwest’s share averages slightly more than fifty percent, this represents a very significant 7.6 percent increase in the number of passengers who fly Southwest.

More direct service also contributes to Southwest’s market share. The coefficient is highly significant at 0.2 with the z-value 4.99. A one standard deviation increase in the percentage of passengers who fly direct on Southwest is associated with an eight percent increase in market share. Again this represents a sixteen percent increase in Southwest passenger load due to its mean fifty percent share. A one standard deviation increase in flight frequency (112 percent increase) is associated with an increase in market share of 2.6 percent. Southwest’s destination airport share is also important. The coefficient is highly significant at 0.446 with z-value 5.6. A one standard deviation increase in Southwest’s airport share is associated with a nine percent increase in route share.

Hence Southwest’s relative network efficiency is key to its success. Specifically, when Southwest offers more direct service, more frequent flights, and a destination is well integrated into Southwest’s operations, its shares are likely to be large. When these dimensions of efficiency are not present, its success is likely to be considerably more modest.

Efficiency dimensions together have a very large impact on Southwest’s success. Holding constant relative prices, increases in Southwest’s efficiency lead to very large

[15] Southwest’s Distance Ratio is calculated by taking the average distance its passengers fly divided by the share-weighted average distance flown by other passengers.

increases in its shares. Simultaneously increasing by one standard deviation Southwest's percentage of direct service and destination airport share and similarly decreasing its distance ratio lead to an increase in its share from its mean of fifty-one percent to 72.9 percent. Hence while there is no doubt that Southwest's low prices are central to its success, relative and absolute network efficiency is also central. These results, in turn, help explain why various dimensions of efficiency play such a key role in Southwest's decision to offer service and define the city-pairs where it chooses to have a presence.

Similarly, Southwest does not compete well in longer distance markets, holding fares constant. This effect is presumably linked to Southwest not offering advance seat selection and other amenities, which likely become more important for longer flights. The coefficient of statutory distance is negative and highly significant at -0.198 with z-value -3.72. A one standard deviation increase of statutory flight distance decreases Southwest's share by eleven percent or 20.6 percent of mean Southwest share.

The regression also includes Southwest's twentieth percentile price and the weighted average twentieth percentile of major carriers.[16] Both price variables show significant effects on market share as expected. The number of competitors is also negatively correlated with Southwest's share. Even though the coefficient is not statistically significant, its p-value is 0.107 and the result is suggestive. The market size measured by the number of city-pair passengers and hub destination airport did not have statistically significant effects on Southwest's market share.

Finally, the correlation coefficient of the error terms (ρ) is negative and statistically significant at the five percent level. This means that the errors in the service offering decision and market performance are correlated with each other and the sample selection model is warranted. The negative value indicates that unobserved factors making Southwest more likely to offer service tend to decrease its market share.

The overall regression results on market share equation show that Southwest achieves large shares when it provides high quality services with shorter or more direct flights, more frequent flights, and more connecting service. In contrast, for longer flights Southwest's low level of amenities becomes more important reducing share. Hence the results indicate strongly that product quality plays a key role in Southwest's success.

4.4. Estimation Results: Pricing

Table 5 presents the estimation results for the price equations. The focus of the analysis is to investigate the impact of Southwest on major airline fares and to evaluate differences between the pricing policies of major airlines and Southwest. The regression is performed at three different price levels, the 20th, 50th, and 80th percentiles.

[16] The 20th percentile fares appear to explain share movements in that they are significant and when they are included the remaining fares are not significant and so they were omitted from the final specification.

Table 5. The Estimate Results of Price Equation with Origin-Firm Fixed Effects Using 2SLS (Log)

	Major Airlines						Southwest Airlines					
	lnFR20		lnFR50		lnFR80		lnFR20		lnFR50		lnFR80	
ln(Average Distance)	0.394 (0.020)	***	0.318 (0.022)	***	0.382 (0.025)	***	0.677 (0.028)	***	0.607 (0.032)	***	0.484 (0.052)	***
ln(Number of Citypair Passenger)	-0.046 (0.018)	**	-0.066 (0.020)	***	-0.055 (0.023)	**	-0.028 (0.032)		-0.028 (0.037)		0.075 (0.060)	
ln(Major Distance Ratio)	-0.319 (0.077)	***	-0.503 (0.085)	***	-0.629 (0.098)	***	- -		- -		- -	
ln (Southwest Distance Ratio)	- -		- -		- -		-0.11 (0.081)		-0.01 (0.095)		-0.077 (0.153)	
ln(Flight Frequency)	0.011 (0.008)		0.01 (0.009)		0.029 (0.011)	***	-0.008 (0.005)		-0.01 (0.006)		-0.008 (0.010)	
ln(Number of Competitor)	0.013 (0.025)		0.044 (0.027)		0.105 (0.032)	***	-0.055 (0.031)	*	-0.077 (0.036)	**	-0.173 (0.059)	***
Direct	0.009 (0.061)		0.066 (0.067)		0.116 (0.078)		-0.068 (0.081)		-0.059 (0.094)		-0.153 (0.152)	
Market Share	0.254 (0.127)	**	0.004 (0.141)		-0.107 (0.163)		-0.058 (0.246)		-0.293 (0.287)		-0.327 (0.464)	
Citypair Herfindahl	-0.015 (0.005)	***	-0.01 (0.005)	**	-0.011 (0.006)	*	-0.01 (0.005)	**	-0.01 (0.006)	*	0.002 (0.009)	
Airport Herfindahl	0.114 (0.048)	**	0.174 (0.053)	***	0.18 (0.061)	***	0.087 (0.080)		0.096 (0.093)		0.086 (0.151)	
Airport Share	-0.251 (0.102)	**	-0.074 (0.113)		-0.022 (0.130)		-0.015 (0.194)		0.098 (0.226)		0.453 (0.366)	
Southwest Entry	-0.153 (0.024)	***	-0.232 (0.026)	***	-0.301 (0.030)	***	- -		- -		- -	
_Cons	2.296 (0.196)	***	3.194 (0.218)	***	3.03 (0.252)	***	0.258 (0.326)		0.844 (0.381)	**	1.27 (0.616)	**
R-squared	0.645		0.551		0.522		0.933		0.9		0.639	
No. of Obs.	1167		1167		1167		133		133		133	

Notes: (1) Standard errors are in parentheses. (2) *, ** and *** denote, respectively, significance at the 10%, 5%, and 1% levels. (3) The estimates of origin-firm specific fixed effect are not reported. (4) The intercept of major airlines indicates the fixed effect estimates of American Airlines in Phoenix, whose coefficient is the median value among all other fixed effect estimates.

As discussed, endogeneity and heterogeneity problems are corrected using 2SLS and origin-firm fixed effect dummies.[17] We first consider differences in pricing and then consider the effect of Southwest's presence on fares.

The estimation results show substantial differences in pricing between major carriers and Southwest. Southwest has a very simple pricing rule with low initial enplanement fees, while major airlines have more complex pricing policies and higher fixed enplanement fees. The intercepts of the price equations for Southwest range between 0.258 and 1.270, while for major airlines they range between 2.296 and 3.194. In the linear functional form, this is around 48 dollars to 73 dollars for Southwest and 91 dollars to 268 dollars for major airlines.[18] The variable prices per additional mile also show differences between the carriers. The average flight distance elasticity of price ranges between 0.318 and 0.394 for major airlines, while it is significantly larger, ranging between 0.484 and 0.677 for Southwest. In the linear specification, major airlines' marginal price per additional mile is about four cents for low valued customers and eight cents for high valued passengers, while Southwest charges about six cents across the three different types of passengers.

The more important differences in pricing strategies, however, are rooted in the simplicity of Southwest's approach compared to the complexity of major airlines' pricing. For Southwest, only flight distance and the number of competitors are statistically significant variables driving its prices, and these variables explain more than 90 percent of the variation in Southwest's prices. The only other variable that explains variation in Southwest's fares is the number of competitors. The simple pricing rule of Southwest contrasts sharply with that of the majors.

Southwest turns out to have a large and significant effect on major airlines' prices. The estimated results show that Southwest's presence is associated with a fifteen percent decrease in fares at the twentieth percentile and a thirty percent decrease in fares at the eightieth percentile.

That is, when Southwest enters there is fare compression as high end fares fall by more than low end fares. Southwest's presence clearly lowers fares throughout the fare distribution, but decreases high-end fares by more.

Another noteworthy element of Southwest's presence is that it has a significantly different effect than the presence of other competitors. Specifically, the coefficient of the number of competitors is significantly positively related to increased fares for major airlines' high-end customer fares. A one standard error increase of number of

[17] The results with linear specification are similar to the ones with logarithmic functional form and available from the authors upon request.

[18] The constant term of major airlines indicates the intercept for American Airlines in Phoenix, which is the median of other 36 fixed effect dummies. For Southwest Airlines, it also represents the fixed effect intercept for Phoenix. The origin-fixed effects for price equation are not reported in the table and available upon request.

competitors is associated with a five percent increase in fares for high-valued customers. These results are consistent with Borenstein and Rose who found increased price dispersion as competition increased. Further the results are consistent with the service offering and share results above, which indicated that network efficiency is an important element of Southwest’s success. Efficiency in terms of direct service and less out-of-the-way service will attract high-end customers, and Southwest’s presence leads to larger reductions in high end fares.

5. CONCLUSIONS

This paper has examined the decision to offer service and the associated market performance of Southwest Airlines. The results indicate that network efficiency, as measured by relative flight distance, direct service, and connectivity, plays a key role explaining Southwest’s presence and success. Southwest is more likely to serve markets where it can provide shorter flights and more direct service, as well as markets well integrated into its network. High airport concentration substantially discourages Southwest’s presence.

Southwest’s presence is related to significant price reductions by major airlines with the largest effect on high-value customers. The results indicate that Southwest competes effectively for high-end customers and provide corroborative evidence that network efficiency is a key element in explaining Southwest’s service offerings and successful market performance.

The results show a very large impact of Southwest’s presence. Southwest lowers average fares at the twentieth percentile by about twenty-three percent, median fares by thirty-nine percent, and eightieth percentile fares by forty-three percent.

In contrast, for longer haul routes Southwest has a much smaller impact. Its own fares are closer to majors’ fares, its shares decline with distance and it has a much smaller effect on majors’ fares. Hence Southwest is a formidable competitor in certain segments but it is much less effective in longer haul markets. In addition to distance, high airport concentration, congested airport facilities, and the capability of overcoming inefficiencies of hub-and-spoke explain why Southwest mainly offers service in middle size airports and is strong in short-haul markets.

Part of why Southwest is a much more effective competitor in short haul routes is clear. Shorter routes provide Southwest the opportunity to serve cities where hub-and-spoke service is highly inefficient. Smaller cities also permit Southwest to take advantage of its efficient turn rates, and passengers likely value in-flight amenities less for shorter haul. A more detailed treatment of these issues awaits further work.

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Table 1. The Portion of Southwest's Direct Flight Service and Average Market Share By Distance Quintile

	Austin					Birmingham					Louisville					Phoenix				
Distance Quintile	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
Distance Range (miles)	141-635	670-955	956-1143	1155-1449	1453-3759	132-406	411-591	596-761	769-1131	1386-4368	149-444	462-573	576-756	768-1228	1386-4381	109-875	894-1244	1256-1565	1575-1936	1942-2973
No. of Cities	20	20	20	20	20	18	17	18	17	17	20	19	20	19	19	32	32	32	32	32
No. Of Cities Southwest Present	8	7	5	8	5	4	5	8	4	12	7	4	2	7	13	18	8	5	2	1
Southwest Percent Direct Service	0.23	0.75	0.56	0.4	0.29	0.96	0.89	0.6	0.11	0.38	0.93	0.78	0.69	0.18	0.34	0.99	0.94	0.78	0.48	0.37
Southwest Average Share	0.74	0.65	0.52	0.39	0.32	0.94	0.96	0.62	0.59	0.4	0.89	0.71	0.49	0.57	0.4	0.78	0.67	0.54	0.2	0.18

Table 2. The Effects of Southwest Presence on Other Airline's Pricing

		Austin				Birmingham				Louisville				Phoenix			
Southwest Presence																	
Southwest Markets		33				33				33				34			
Total Number of Markets		100				87				97				160			
Average Fares and Distances		20th	50th	80th	Average Distance	20th	50th	80th	Average Distance	20th	50th	80th	Average Distance	20th	50th	80th	Average Distance
Southwest		96	99	140	891	72	75	121	625	51	54	84	512	53	55	90	528
American	SW present	118	169	253	1298	129	157	282	1325	134	163	279	1686	118	155	262	1552
	SW not present	122	175	327	1041	98	155	360	877	98	155	312	914	139	186	328	1703
Alaska	SW present	-	-	-	-	-	-	-	-	-	-	-	-	187	257	371	1694
	SW not present	-	-	-	-	-	-	-	-	-	-	-	-	171	203	274	1671
America west	SW present	59	95	133	1195	-	-	-	-	102	102	130	1808	36	50	93	606
	SW not present	109	120	161	1125	-	-	-	-	-	-	-	-	50	77	145	1143
Continental	SW present	104	139	204	1126	116	154	244	1305	98	159	197	1010	126	149	240	1839
	SW not present	96	130	209	818	87	142	172	711	97	139	236	862	143	174	274	1894
Delta	SW present	113	142	231	1324	126	172	280	1304	103	130	199	1293	71	104	150	923
	SW not present	121	180	301	1013	129	227	351	736	99	156	280	770	165	215	390	1789
Northwest	SW present	120	144	232	1102	101	137	224	1032	80	141	235	847	132	163	250	1729
	SW not present	133	171	395	1195	115	188	281	793	108	170	270	857	128	155	226	1601
Trans World	SW present	87	118	189	841	117	150	238	1321	73	92	129	930	91	100	162	1332
	SW not present	124	179	287	1424	146	185	268	1375	114	158	238	1295	134	165	299	1999
United	SW present	128	152	241	1667	142	162	277	1945	130	149	225	1705	51	72	109	732
	SW not present	140	196	353	1103	83	107	181	780	61	85	245	584	105	130	240	1348
US Airways	SW present	-	-	-	-	70	96	148	900	45	69	94	650	141	161	207	2008
	SW not present	152	235	412	1396	122	249	357	707	102	166	258	683	161	198	285	2122