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HOW DOES INSTITUTIONAL CHANGE AFFECT HETEROGENEITY AMONG FIRMS?

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This paper examines the variation in performance of incumbents and entrants following the deregulation of prices and entry in the airline industry. Our approach is similar to earlier studies of interfirm performance heterogeneity across industries. Drawing on theories of industry evolution, we hypothesize that the performance of entrants will have higher variance than incumbents. Further, given the opportunities offered by price deregulation, we propose that incumbents will have higher variance in performance under deregulation than in the earlier regime. The findings indicate that entrant performance heterogeneity is significantly greater than incumbent performance heterogeneity following deregulation, but that the variation in performance among incumbents does not significantly change when deregulation occurs. The second result is surprising given the range of service and process innovations that incumbents initiated. These results suggest that the distinction between entrants and incumbents is critical to future studies of performance variation within and across industries.

INTRODUCTION

Studies analyzing the variance in business unit performance across industries have become an increasing part of strategic management research (Bowman and Helfat, 2001; Rumelt, 1991; McGahan and Porter, 1997, 1998). The thrust of these studies has been to examine how much variance is explained by different levels of analysis—industry, parent corporation, and the business unit itself. The initial focus was on the contribution of a firm's industry to variance in performance (Schmalensee, 1985), consistent with the theory that industry structure drives firm conduct and, in turn, firm performance (Scherer, 1980: 4; Tirole, 1988: 1–2). But over time, more weight has been put on the relative contributions of the corporate and business levels or classes of variance, each with its own important theoretical implications (Brush and Bromiley, 1997; McGahan and Porter, 1997, 1998; Rumelt, 1991). Interestingly, by far the most consistent result across these studies is that, when estimated over time, variance in business unit performance is most strongly related to differences across the businesses themselves (Brush and Bromiley, 1997; James, 1998; Roquebert, Phillips and Westfall, 1996; Rumelt, 1991). The present paper builds on this finding by testing a theory of heterogeneity in performance among firms.[1]

Rather than observe and compare the relative effects of different levels of analysis on

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[1] We use the term firm to designate a single business. In some earlier studies, notably Schmalensee (1985), firm meant the corporate parent of a business. We are not concerned with corporate effects here.

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firm performance, in this paper we test propositions specifically regarding interfirm heterogeneity within an industry. This approach is consistent with that of previous variance decomposition studies but goes beyond their intent. Our purpose here is to argue and show that heterogeneity differs across two classes of firms—entrants and incumbents—and that it is higher for entrants.

Over the course of its history, an industry is likely to experience periods of experimentation and of stasis. Major changes in technology or in the institutional environment typically entail the entry of new firms that vary substantially in performance due to the hit-or-miss nature of innovation in a new regime (Tushman and Anderson, 1986; Mitchell, 1989; Dosi, 1982; Henderson and Clark, 1990; Winter, 1984). As an industry ages, weaker firms exit and survivors are likely to become more similar in their operations, typically focusing more on price competition (Klepper and Graddy, 1990). Unique firm-level factors are thus likely to be a stronger contributor to performance differences among firms when firms are entrants than later when they converge on common practices. New firms, or entrants to an industry, should thus be more diverse, and older firms, or incumbents, more similar.

To examine this difference between entrants and incumbents, we analyze inter-firm variation in performance after a major change in an industry's institutional environment: the deregulation of entry and prices.[2] Entry and price deregulation turn the traditional view of industry evolution on its head in that the industry is roughly mature under regulation and is subsequently rejuvenated when price and entry are removed from government control. When the industry deregulates, entering firms develop strategies de novo to compete in the newly opened market, whereas incumbents are forced to adapt their traditional practices and initiate new programs in order to attract and retain customers.

The break in industry history caused by deregulation allows us to make two comparisons. First, we compare the variance in performance between entrants and incumbents that is attributable to firm-specific factors. Given that entrants are not encumbered by past experience in the industry, they are likely to perceive a wide range of opportunities and develop different strategies to address them. As entrants explore new market opportunities, following industry change, they should have a wider variation in their behavior relative to incumbents, leading to greater heterogeneity. The second comparison follows specifically from the implications of deregulation for the behavior of incumbent firms. As deregulation eliminates the market sharing arrangements established in the earlier regime, incumbents are forced to explore alternative strategies. This increase in experimentation should increase the heterogeneity of incumbents over that observed for these firms under regulation.

THEORY

In order to explain firm performance differences in general, a number of studies have proposed that firms develop capabilities and resources that are hard to copy (Barney, 1991; Dierickx and Cool, 1989; Hansen and Wernerfelt, 1989). These assets are protected from imitation in part by the difficulty of understanding how they are developed and maintained (Lippman and Rumelt, 1982). They are firm-specific innovations that are sufficiently complex or difficult to communicate that they cannot be adopted effectively by other firms (Kogut and Zander, 1992). A firm's ability to build capabilities and resources thus represents an enduring source of higher performance (Dierickx and Cool, 1989; Henderson and Cockburn, 1994; Teece, Pisano and Shuen, 1997). Likewise, a firm's inability to develop them, or its perpetuation of ineffective practices, keeps it in the industry cellar.

To contribute to performance, a firm's capabilities and the resources available to it must interact positively with the requirements of the firm's markets (Amit and Schoemaker, 1993; Henderson and Mitchell, 1997; Mahoney and Pandian, 1992; Mauri and Michaels, 1998). One important condition for an effective mapping of capabilities onto market requirements is an ability to define them relatively clearly. Unfortunately, the clarity with which customer preferences can be defined varies substantially over the course of an industry's history. When an industry is young, there is too much uncertainty regarding the benefits of the new products or services for buyers to develop stable

[2] This form of industry deregulation was common in the United States at both the national and state levels in the early 1980s. Six major industries deregulated from 1978 to 1985: airlines, natural gas, railroads, telecommunications, trucking and interstate banking. The deregulation of telecommunications continues today.

purchasing criteria. Correspondingly, early startups search for and experiment with diverse strategies to attract demand. Some of these strategies are successful, others less so. The variation in performance determined by startup experimentation is therefore quite large (Klepper and Graddy, 1990; Klepper, 1996). Over time, however, these differences in performance diminish as customers become more experienced, stable market segments emerge, and the strategies of the firms begin to converge. With the maturing of the industry, low performing firms exit and surviving firms imitate industry leaders (Klepper and Graddy, 1990). Firms thus become increasingly homogeneous in their capabilities and resources, which are mapped onto the relatively clear preferences of repeat or well-informed first-time buyers.

An analogous process occurs when an industry deregulates. New firms enter and initiate a new wave of industry evolution. These entrants are likely to introduce cost reduction or quality improvement innovations, exposing buyers to new products and services, thereby expanding the number of purchase criteria and altering customer preferences (Jewkes, Sawyers and Stillerman, 1958; Mitchell, 1989; Winter, 1984). Predicting these preferences is difficult owing to buyer inexperience with the potential benefits of the new services. Entrant strategies therefore proliferate, reflecting different predictions of what customers will ultimately want. When they enter the industry, these startups, as de novo firms, tend to be small compared to incumbents (Geroski, 1991; Klepper and Graddy, 1990). As they are less subject to inertia induced by bureaucratic procedures, entrants are also likely to differ in their rates of development, increasing further the degree of heterogeneity. Of course, it is easy to overestimate the degree to which the basic rules of competition in a deregulated industry are unknown. Many of the practices of the regulated era are likely to endure as conditions for effective competition, such as airplane maintenance in the airline industry.

In contrast to entrants, whose variation in strategy and performance reflects the relative uncertainty of the new deregulated era, incumbent strategies are initially constrained by the investment policies formed in the much more certain competitive conditions of regulation. Difficulties in an incumbent's adaptation to the regulatory changes may be partially attributed to its internal processes and factor-market positions. The path dependence of these processes and the stickiness of factor-market relationships delay adjustment to the conditions of the new market (Barney, 1991).

Further, competition between entrants and incumbents may constrain the latter's ability to adapt to the deregulated environment. Incumbents may not be able to develop strategies that cope with a wide range of challenges presented by rivals (Hedberg, 1981), and the diversity of strategies used by rivals may inhibit the ability of incumbents to adapt rapidly to environmental change (Miller and Chen, 1994). Consequently, differences in the rate of adaptation between incumbents and entrants may be amplified by strategic heterogeneity of the entrant population. A lower rate of adaptation by incumbents is likely to perpetuate their historical range of capabilities, which should be less than the range of capabilities among entrants.

These arguments suggest the following hypothesis:

> *Hypothesis 1: Following industry deregulation, the heterogeneity among entrants will exceed the heterogeneity among incumbent firms.*

The preceding section argues that, in contrast to entrants, incumbent performance variation under deregulation is constrained by the endurance of capabilities and resources developed under regulation. However, this argument does not imply that incumbents do not adapt at all to the new regime. In fact, observation suggests just the reverse. To compete effectively in the new regime, incumbent firms must revise their existing capabilities and resources or suffer decreasing performance (Carroll, Delacroix and Goodstein, 1988; Wade, Swaminathan and Saxon, 1998). The question is whether these innovations are associated with increased variance in firm performance compared with the practices of incumbents under regulation.

Deregulation is enacted specifically to break down non-competitive practices by incumbents, which may have been induced by government control over pricing and route expansion (McGahan and Kou, 1995). With the shift from a regulated to a competitive environment, incumbents' market share will begin to erode. Incumbents that have developed the ability to learn effectively may be able to adopt routines or behaviors that meet the demands of the new institutional regime, even in the presence of traditional resource commitments. Peteraf (1993) suggests that factors such

as reputation or brand equity that are built up over time may assist incumbents in retaining customers even in the presence of innovative and price competitive entrants. In the airline industry after deregulation, incumbent firms adopted various marketing devices, such as frequent flyer programs and travel agent commission bonuses, in efforts to maintain their brand equity and their customer base (Borenstein, 1989). Since customer retention increases performance, variation among incumbents in customer retention programs should lead to performance differences over time.

Greater performance variance among the incumbent population following deregulation may also be associated with incumbent firms' incentives to respond to the environment. In the airline industry, incumbent firms' investments in equipment and airport facilities provide incentives for adaptation in order to maintain an acceptable return to these assets. Without such incentives, an airline is likely to experience greater inertia, lowering performance compared to more adaptive rivals (Miller and Chen, 1994).

In addition, differences may emerge in the capabilities firms mobilize to adapt to the new regime. The ability of incumbents to adapt to deregulation is likely to be related to both time varying and time-invariant capabilities. Incumbent firms with greater abilities to adapt are likely to have the flexibility to develop changes in their factor-market positions faster than competitors. This variance in adaptive ability may contribute to greater performance heterogeneity during deregulation.

The hypothesis follows:

Hypothesis 2: The heterogeneity among incumbents during deregulation will be greater than the heterogeneity of incumbents during regulation.

Control for strategic position

In this paper, we focus on performance variation related to firm-specific capabilities and resources. The ability to observe these factors is ultimately a question of measurement, and the assumption that they are hard to imitate complicates the comparison of any measure of them across firms. As we describe below in greater detail, a typical approach to avoid this problem is first to assume that a qualitative variable can represent them over time. The second step is to estimate how much these qualitative variables contribute to inter-firm variance in performance over time. The greater the contribution, the stronger the inference that capabilities determine firm performance.

In earlier studies using this approach, there has been no control for the strategic position of the firms in the product market. Such a control is important for several reasons. First, as we point out above, part of the contribution capabilities make to performance may be due to their match (or mismatch) with characteristics of the market's structure. This interaction of capabilities with market structure obviously should be specified to get an accurate assessment of the degree to which capabilities contribute to performance. Such a control is particularly important in the present study since the capabilities of incumbents, given their greater age, are likely to be more closely aligned with their strategic positions, assuming these positions are relatively stable. The strategy of an entrant, in contrast, is likely to be less well defined early in its history under deregulation. Also, the strategic position of a firm may have a separate effect on performance. Although all firms may occupy a single strategic position in a regulated industry, industry structure under deregulation is likely to be more variegated. So it is important to control for that part of performance variation across firms that is due to their strategic positions.

To define a firm's strategic position within the industry, we construct strategic groups for periods in the industry's history. The strategic groups are based on a set of policy variables that encompass observable scope and resource commitments. The intent is to identify policies that are crucial to a firm's strategic position relative to competitors so that the effects of strategic position on inter-firm performance variation can be controlled for.

RESEARCH DESIGN

Industry

The hypotheses are tested on data from the U.S. airline industry from 1968 to 1988. The industry deregulated through the Airline Deregulation Act in 1978. This history of regulation and deregulation of prices and entry makes the airline industry almost ideal for the study of the variation in performance across entrants and incumbents. Entrants to national markets, such as Southwest,

Muse Air, and Peoples Express, pursued novel strategies to compete against incumbents, which suffered significant attrition under deregulation due to poor adaptation to price and service competition.

Prior to deregulation in 1978, the airline industry contained inefficiencies and inequities stemming from entry, route and fare restrictions (Fawcett and Farris, 1989). These conditions resulted in supra-economic rents for airline employees but limited pricing options for consumers and marginal returns for airlines. Opportunities for differentiation were limited to service-quality since the Civil Aeronautics Board (CAB) controlled fares. In 1970, the Board began to recognize the adverse effects of regulation and to consider reshaping the industry via route expansion (Howard, Hart and Glembocki, 1982). However, all route expansion ceased in 1971 with a moratorium until 1975. The inefficiencies of airline operation also became more apparent to the public with the energy crisis in the early 1970s as many planes flew half empty. From 1971 to 1975, the airlines challenged fare structures; and in response the Board initiated the Domestic Fare Investigation with the intent of a satisfactory service-based fare formula (MacAvoy and Snow, 1977). In 1976, the Board allowed carriers more freedom to set fares. All of these factors contributed to a reevaluation of regulatory environment, and in 1978 the Airline Deregulation Act was enacted.

By 1980, 22 new carriers entered the industry with lower costs than incumbent firms (Cappelli, 1985; McGahan and Kou, 1995). The industry then experienced a return to excess capacity and slow traffic growth. Subsequently, the industry's financial conditions weakened as carriers were plagued with earnings fluctuations, weak cash flow, decreases in shareholder equity and poor liquidity. Stability began to emerge in 1988 as hub systems began to dampen the frequency of route changes. In addition, traffic patterns and creative fare pricing schemes increased revenues while capacity expansion slowed. Negotiations for major labor concessions also ceased during this time and earnings rose based on increased demand.

Data

The data stem from the Department of Transportation CAB Form 41 and encompass all airlines that were classified as national carriers by the Civil Aeronautics Board from 1968 to 1988. We obtained quarterly data for 80 time periods, from the first quarter, 1968 to the last quarter, 1988. Variables are measured for each time period.

Analysis

Our analysis includes two techniques, variance components analysis and ordinary least squares (OLS). For the variance components analysis, we decompose the variance of firm rates of return to investigate the percent of variance explained by firm, year, strategic group and the interaction of firm and strategic group. Performance is defined as either Return on Sales (ROS), which is Net Income over Sales, or Return on Assets, which is Net Income over Operating Assets. The model is defined as follows:

$$\sigma_r^2 = \sigma_\tau^2 + \sigma_\gamma^2 + \sigma_\lambda^2 + \sigma_\eta^2 + \sigma_\alpha^2 + \sigma_\omega^2 + \sigma_\delta^2 + \sigma_{\alpha-\gamma}^2 + \sigma_{\omega-\gamma}^2 + \sigma_{\delta-\gamma}^2 + \sigma_\varepsilon^2 \quad (1)$$

where σ_r^2 = overall variance in financial return (ROS or ROA);
σ_τ^2 = variance in financial return due to time period (quarter years);
σ_γ^2 = variance in financial return due to strategic groups;
σ_λ^2 = variance in financial return due to whether the firm is an incumbent or an entrant;
σ_η^2 = variance in financial return due to whether the time period is in the regulated or deregulated regime;
σ_α^2 = variance in financial return due to the individual firm effects of entrants under deregulation;
σ_ω^2 = variance in financial return due to the individual firm effects of incumbents under regulation;
σ_δ^2 = variance in financial return due to the individual firm effects of incumbents under deregulation;
$\sigma_{\alpha-\gamma}^2$ = variance in financial return due to the individual firm effects of entrants under deregulation interacted with strategic group membership;
$\sigma_{\omega-\gamma}^2$ = variance in financial return due to the individual firm effects of incumbents under regulation interacted with strategic group membership;
$\sigma_{\delta-\gamma}^2$ = variance in financial return due to the individual firm effects of incumbents

under deregulation interacted with strategic group membership; and
σ_ε^2 = variance in financial return due to error.

We first estimate a baseline model that includes the following dummy variables: the time period (quarter years from 1968 to 1988), the strategic group, whether the firm is an entrant or an incumbent, and whether the time period occurs under regulation or deregulation. Then we add to the baseline model a variable that interacts a dummy variable for each firm with a variable representing whether the firm is a pre-deregulation incumbent, post-regulation incumbent, or post-regulation entrant. The variance component estimates for these firm-effects variables test our hypotheses. Finally, variables that interact these firm-effects with strategic group membership are added to the model to control for their potential confounding by strategic position.

We use SAS to estimate the variance components. The method follows Rao's (1971) MINQUE technique and produces asymptotically consistent and unbiased estimates for unbalanced data. Although it is theoretically possible to estimate the standard errors of variance components coefficients (Searle, 1971), these estimates are based on assumptions of normality that are difficult to verify. Our approach is to use the jackknife technique (Mosteller and Tukey, 1977, chapter 8) on the variance component estimates to produce standard errors that can be used in testing our hypotheses. We report the MINQUE estimates, the jackknife estimates, and the jackknife standard errors.

We also test the hypotheses using OLS. Several recent studies have critiqued variance components analysis because it assumes independence across the effects (Bowman and Helfat, 2001; Brush and Bromiley, 1997; McGahan and Porter, 1998). OLS does not make this assumption. Brush and Bromiley (1997) also argue that variance components analysis can provide unreliable estimates of the underlying distributions of the samples or populations under examination.

The OLS analysis is based on the following model of firm rates of return:

$$r_{it} = r_{it-1} + \tau_t + \gamma_g + \lambda_i + \eta_t + \alpha_i + \omega_j + \delta_k + \alpha_{i\_}\gamma_g + \omega_{j\_}\gamma_g + \delta_{k\_}\gamma_g + \varepsilon_{it} \quad (2)$$

where r_{it} = the financial return (ROS or ROA) for airline i in period t;
r_{it-1} = the financial return lagged one time period;
τ_t = a dummy variable for each time period (t);
γ_g = a dummy variable for each strategic group (g);
λ_i = a dummy variable indicating whether the firm is an entrant or incumbent;
η_t = a dummy variable indicating whether the time period is in the regulated or deregulated regime;
α_i = a dummy variable for each entrant firm (i) after deregulation;
ω_j = a dummy variable for each incumbent firm (j) under regulation;
δ_k = a dummy variable for each incumbent firm (k) under deregulation;
$\alpha_{i\_}\gamma_g$ = a dummy variable for each entrant firm (i) after deregulation interacted with strategic group membership;
$\omega_{j\_}\gamma_g$ = a dummy variable for each incumbent firm (j) under regulation interacted with strategic group membership;
$\delta_{k\_}\gamma_g$ = a dummy variable for each incumbent firm (k) under deregulation interacted with strategic group membership; and
ε_{it} = the error term.

The hypotheses are tested by estimating a baseline model, as in the variance components analysis above, and then adding the firm-effects and the interactions of firm-effects with strategic group membership.

Finally, we estimate the variance components and OLS regressions on two measures of financial performance, return on sales (ROS) and return on assets (ROA). Although studies of the airline industry have generally predicted ROS as the relevant measure of airline performance (Bailey and Williams, 1988), research on interfirm heterogeneity in performance, especially across industries, has used ROA (Schmalensee, 1985; Rumelt, 1991; McGahan and Porter, 1997, 1998). ROA controls for differences across firms in patterns of asset ownership. However, many airlines, both incumbent and start-up, lease their planes, which are by far the biggest assets an airline can own. The return on owned assets, especially planes, may therefore reflect more differences in financial policy than differences in economic performance among the firms.

To construct strategic groups for each firm over time, we adopted the procedure used by Fiegenbaum and his colleagues (Fiegenbaum and Thomas, 1990). The advantage of this procedure is that it accounts for changes in competition over time and for changes in strategic groups as a function not only of a single firm's investment decisions but of other firms as well. A complete description of this technique is provided in the Appendix.

RESULTS

Table 1 provides the means and standard deviations for firm performance and various firm characteristics across the samples studied. The variance components results are presented in Table 2 for both ROS and ROA. Table 3 shows the jackknife estimates and standard errors, and Table 4 the results of the hypothesis tests.

The findings for both ROS and ROA are consistent: Hypothesis 1 is supported, but Hypothesis 2 is not. The variation in entrant performance is significantly higher than the variation in incumbent performance after deregulation. However, incumbents do not become more diverse as their markets become more competitive, an interesting result that will be discussed below. These results are not influenced by the interaction of firm-effects with strategic group membership. The findings are replicated in the OLS analysis, which is reported in Table 5 and Figure 1.

There are several interesting comparisons between the ROS and ROA results. First, the results for ROS demonstrate some decrease in incumbent performance heterogeneity under deregulation, while those for ROA show no heterogeneity in incumbent performance under either regulation or deregulation. Also, in the ROS run, the entrant effect is substantially higher than the effect of its interaction with strategic group membership; but this pattern is reversed in the ROA analysis. This distinction is found in both the variance components and OLS analyses. Finally, more of the variance in ROS is explained than the variance in ROA. This result is due in large part to the explanatory power of the baseline model, which is weaker for ROA, primarily because time period has no effect. The net conclusion based on these differences is that the interaction of entrant capabilities with strategic position explains much more of the variance in ROA than any other factor, even as the results for ROA support Hypothesis 1.

DISCUSSION

To return to our original motivation in this paper, we show quite strongly that the distinction between entrants and incumbents determined by industry history—viz. the onset of deregulation—matters in examining variance in performance among firms. Interfirm heterogeneity is clearly higher among entrants than incumbents, and variation among incumbents does not grow after deregulation occurs. These results are consistent with two arguments. First, incumbents have difficulty copying wide-ranging entrepreneurial strategies; and second, incumbents converge on and stick to commonly understood ways of doing business. Given these findings, it would seem prudent to

Table 1. Means and standard deviations

	Incumbents during regulation		Incumbents during deregulation		Entrants	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
ROS	0.03	0.09	0.01	0.09	−0.02	0.18
ROA	0.01	0.03	0.01	0.07	−0.02	0.41
Route distance	421.98	348.80	502.74	231.86	447.88	213.12
Fare structure	0.52	0.44	0.67	0.43	0.35	0.46
Traffic	84.49	85.36	115.42	100.27	56.06	73.95
Capacity utilization	0.11	0.05	0.13	0.05	0.12	0.04
Labor costs	0.12	0.02	0.10	0.02	0.07	0.03
Efficiency	52.02	25.96	90.31	30.27	89.87	38.82
Leverage	3.14	8.21	1.28	8.34	2.32	10.26
Yield	86.14	32.16	141.97	55.75	155.44	90.25

Table 2. Variance components analyses

	Estimate	% Variance explained	Without strategic group interaction terms	
			Estimate	% Variance explained
(a) Airlines' return on sales (ROS), 1968–88				
Baseline model				
Time period	0.001483	4.3	0.001453	4.8
Group	0.000417	1.2	0.000446	1.5
Regulation/Deregulation[a]	0	0	0	0
Entrant/Incumbent[b]	0	0	0	0
Incumbent firm effect (Reg.)	0.001952	5.7	0.001914	6.4
Incumbent firm effect (Dereg.)	0.001669	4.9	0	0
Entrant firm effect	0.018004	52.5	0.018559	61.8
Incumbent firm effect (Reg.)* Group	0	0		
Incumbent firm effect (Dereg.)* Group	0	0		
Entrant firm effect* Group	0.003548	10.4		
Error	0.007162	21.0	0.007663	25.5
Total	0.034239	100.0	0.030036	100.0
(b) Airlines' return on assets (ROA), 1968–88				
Baseline model				
Time period	0	0	0	0
Group	0	0	0.000461	0.8
Regulation/Deregulation[a]	0.001225	1.3	0.000516	0.9
Entrant/Incumbent[b]	0	0	0	0
Incumbent firm effect (Reg.)	0	0	0	0
Incumbent firm effect (Dereg.)	0.000466	0.5	0	0
Entrant firm effect	0.013707	14.8	0.021302	36.2
Incumbent firm effect (Reg.)* Group	0	0		
Incumbent firm effect (Dereg.)* Group	0	0		
Entrant firm effect* Group	0.049088	52.9		
Error	0.028145	30.3	0.036534	62.1
Total	0.092632	100.0	0.058815	100.0

[a] Regulation/Deregulation variable = 1 if Regulation period, = 0 if Deregulation
[b] Entrant/Incumbent variable = 1 if Entrant, = 0 if Incumbent

Table 3. Jackknife estimates

	Variance component estimates	Jackknife estimates	Jackknife S.E.
(a) Estimates based on ROS analysis			
Incumbent firm effect (Reg.)	0.001952	0.001956	0.000295
Incumbent firm effect (Dereg.)	0.001669	0.001627	0.000525
Entrant firm effect	0.018004	0.017694	0.006206
(b) Estimates based on ROA analysis			
Incumbent firm effect (Reg.)	0	−0.000063	−0.000063[a]
Incumbent firm effect (Dereg.)	0.000466	0.000376	0.000238
Entrant firm effect	0.013	0.014382	0.011016

[a] 9 of 10 of the y^*_j jackknife values are 0 for incumbents during regulation

Table 4. Hypotheses tests

	Z-value	*p*-value
(a) Tests using ROS results		
H1: Following deregulation, variation in performance among entrants > variation in performance among incumbents during deregulation	8.15	<0.00001
H2: Variation in performance of incumbents during deregulation > variation in performance among incumbents during regulation	1.72	<0.08
(b) Tests using ROA results		
H1: Following deregulation, variation in performance among entrants > variation in performance among incumbents during deregulation	4.02	<0.00001
H2: Variation in performance of incumbents during deregulation > variation in performance among Incumbents during regulation	See note[a]	

[a] 9 of 10 of the y^*_j jackknife values are 0 for incumbents during regulation and the variance for incumbents during regulation is approximately 0

Table 5. Increment to explanatory power by effect

	Models	Adj. R^2	Increment to adj. R^2		
(a) Increment to explanatory power by type of effect for Figure 2(a) (ROS)					
Model 1	Model: Baseline (Lag(ROS) + Time period + Group + Entrant/Inc. Dummy + Reg./Dereg. Dummy)	0.26			
Model 2	Model: 1 + Incumbent firm effect (Reg.)	0.29	0.03*		
Model 3	Model: 1 + Incumbent firm effect (Dereg.)	0.31		0.05*	
Model 4	Model: 1 + Entrant firm effect	0.44			0.18*
Model 5	Model: 2 + Inc. firm effect (Reg.)* Group	0.31	0.02*		
Model 6	Model: 3 + Inc. firm effect (Dereg.)* Group	0.35		0.04*	
Model 7	Model: 4 + Entrant firm effect* Group	0.56			0.12*
Model 8	Model: 1 + Incumbent firm effects (Reg. & Dereg.) + Inc. firm effects* Group	0.40	0.09*	0.05*	
Model 9	Model: 1 + Entrant firm effect + Entrant firm effect* Group	0.56	0.30*		
Model 10	Model: 8 + Entrant firm effect + Entrant firm effect* Group (Full model)	0.68	0.28*		
(b) Increment to explanatory power by type of effect for Figure 2(b) (ROA)					
Model 1	Model: Baseline (Lag(ROA) + Time period + Group + Entrant/Inc. Dummy + Reg./Dereg. Dummy)	0.15			
Model 2	Model: 1 + Incumbent firm effect (Reg.)	0.14	0		
Model 3	Model: 1 + Incumbent firm effect (Dereg.)	0.14		0	
Model 4	Model: 1 + Entrant firm effect	0.32			0.17*
Model 5	Model: 2 + Inc. firm effect (Reg.)* Group	0.10	0		
Model 6	Model: 3 + Inc. firm effect (Dereg.)* Group	0.08		0	
Model 7	Model: 4 + Entrant firm effect* Group	0.58			0.26*
Model 8	Model: 1 + Incumbent firm effects (Reg. & Dereg.) + Inc. Firm Effects* Group	0.02	0		
Model 9	Model: 1 + Entrant firm effect + Entrant firm effect* Group	0.58	0.43*		
Model 10	Model: 8 + Entrant firm effect + Entrant firm effect* Group (Full model)	0.55	0.53*		

* $p < 0.01$; significance levels apply to changes in the unadjusted R^2

consider the stage of firm and industry evolution in future studies of performance variation within and across industries.

Our research design has used price and entry deregulation as an interesting and useful opportunity to compare the heterogeneity of entrants and incumbents and to study the effects on performance of incumbent adjustment to a major change in competition. This design offers a major benefit over an analysis of evolving firms in an industry from early stages to maturity. This benefit is that, as separate sub-populations, entrants and incumbents can be compared in the same time period. There is therefore no ambiguity regarding when an entrant becomes an incumbent, and we can compare variances in performance reasonably clearly.

Our design also allows us to examine whether increasing competition leads to greater variation in incumbent performance, stated as Hypothesis 2. The fact that our results do not confirm this hypothesis is interesting in the light of the many innovations incumbent airlines introduced after 1978. One might expect there to be significant performance advantages for innovative incumbents and disadvantages for weaker incumbents. But even if such advantages and disadvantages existed, they were not sufficient to differentiate the stronger from the weaker firms in order to increase performance variation compared to the pre-deregulation

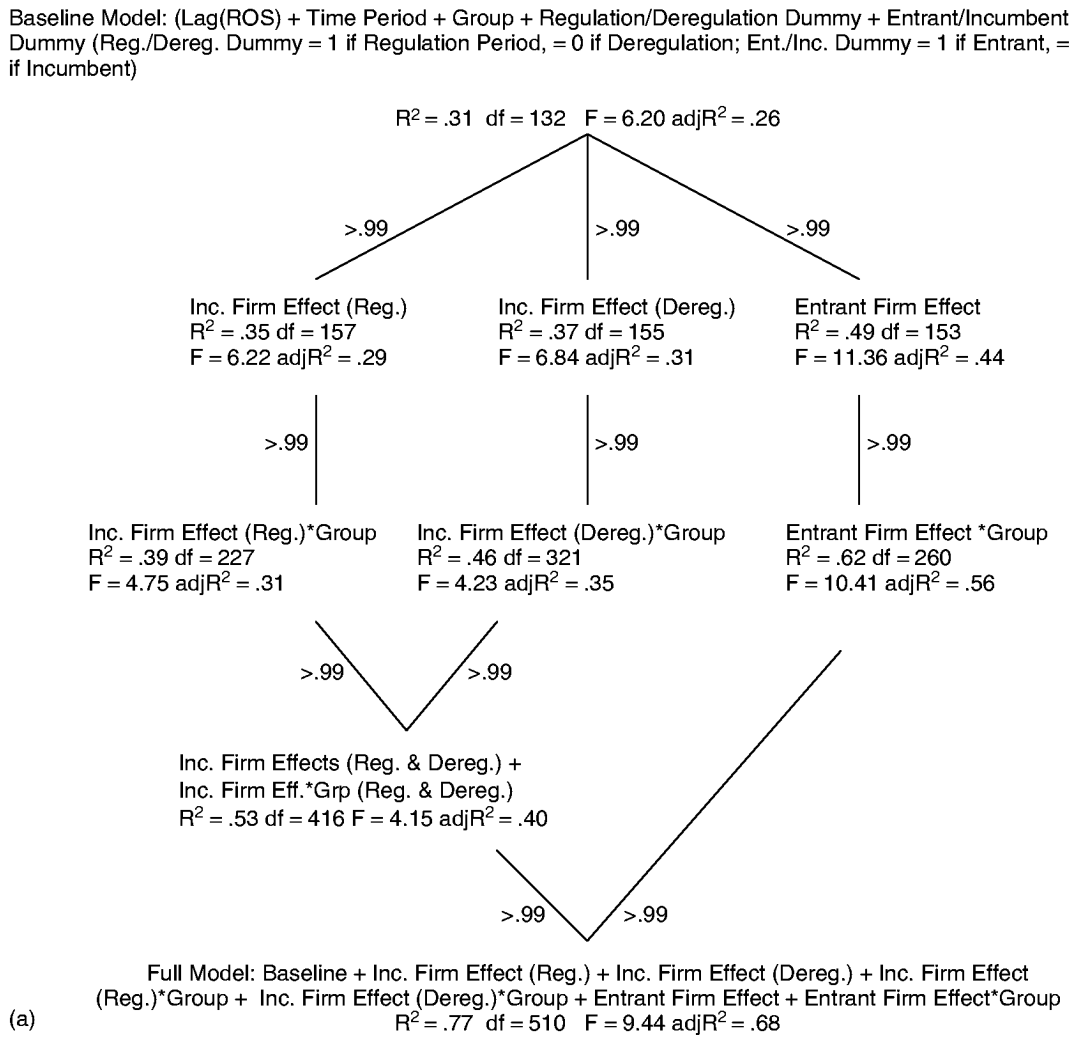

Figure 1. Analysis of variance: OLS estimations of Model 2 incumbents and entrants, 1968–88: (a) ROS results; (b) ROA results

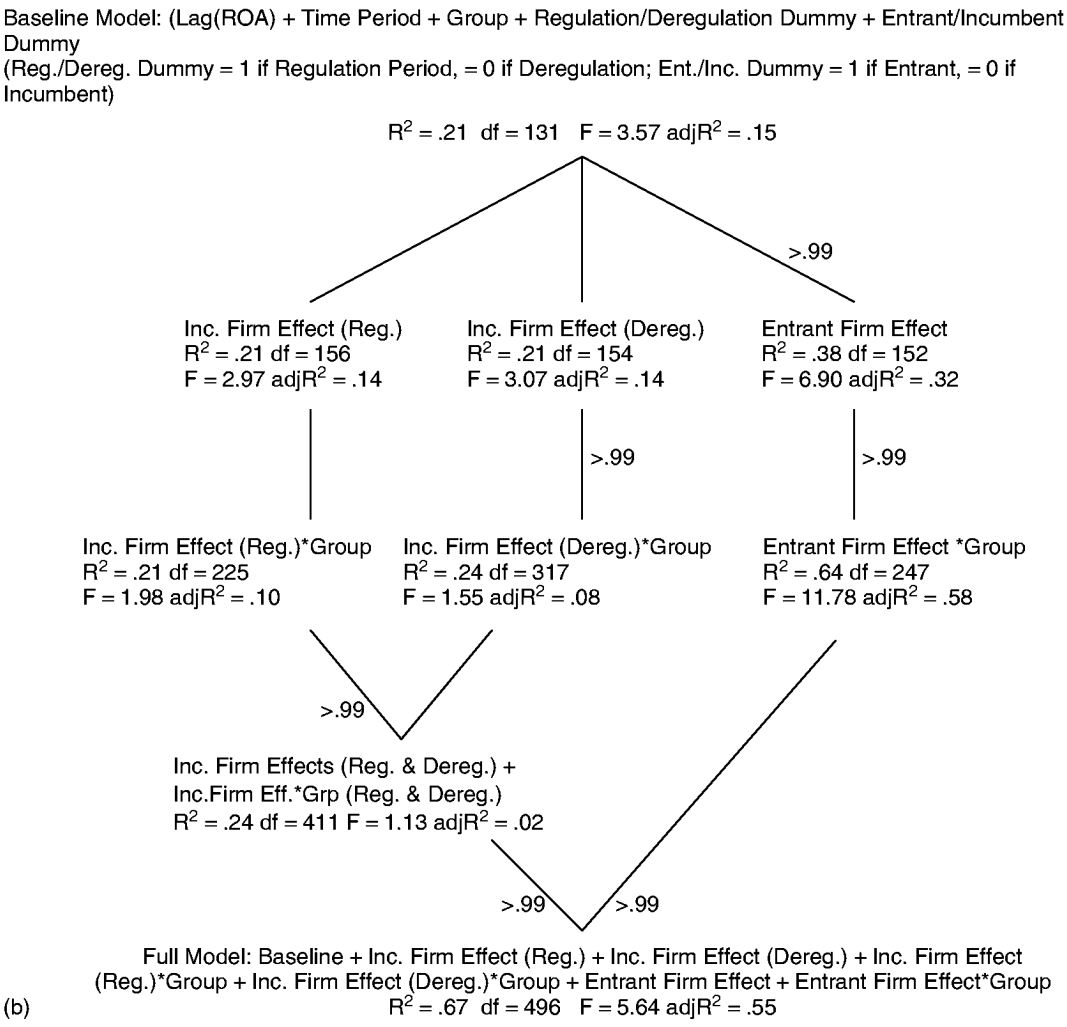

Figure 1. *Continued*

era. Since the mean ROS and ROA for incumbents in the regulatory and deregulatory eras are about the same, we can only conclude that during deregulation these firms engaged in a form of arms race.

There are several additional findings that deserve attention. First, the entrant–incumbent and regulation–deregulation dummy variables explain none of the variance in performance. Taken on their own, these results would suggest that entry and institutional change have no effect on performance variation in the airline industry. However, it is clear that this conclusion would not be quite correct. Although the variance in performance associated with the distinction between entrants and incumbents is zero, the variance among entrants is much greater than the variance among incumbents. The same kind of statement can be made about regulation and deregulation. Separating these two regimes does not contribute to performance variation. However, in a separate analysis we found that the variance in performance within deregulation is higher than within regulation (results not shown). Therefore, to understand the effects of entry or institutional change on performance variation, one needs to compare the differences among entrants to differences among incumbents, or the heterogeneity within one regime to that within another regime, not the variance in performance between these states.

Finally, it is possible that the high relative variance in performance among entrants is not due to

differences among the capabilities of these firms within time but to a common investment pattern over their histories. Specifically, when they are young, entrants may have a common need to invest in sizable projects, leading to negative accounting returns, and then later in their histories they reap the benefits of these investments, leading to greater accounting returns. If this pattern is pronounced for entrants, then a potentially large part of the variance in their performance under deregulation could be due to differences in performance across the stages of development, not to cross-sectional differences in strategies or capabilities. A necessary condition for this to be true is that mean entrant performance follows a time trend, growing with industry age. Interestingly, this is not the case. Time (as an ordinal variable) has no effect on average entrant performance (for ROS: $F = 0.91$, $p = 0.667$; for ROS, $F = 1.42$, $p = 0.235$), indicating that the variance in entrant performance is unlikely to be due to a shared developmental trend.

Our study provides an important increment to the literature measuring the influence of firm-specific resources or capabilities on performance. Our results show conclusively that studies in this domain should distinguish between incumbents and entrants. Entrant capabilities are far more powerful determinants of performance differences than the capabilities of incumbents, as evolutionary economics suggests. However, how incumbents leverage their practices over shifts in institutional regime remains an important question to be addressed.

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APPENDIX: STRATEGIC GROUP OPERATIONALIZATION

Overview

To construct strategic groups, we adopt the three-step process followed by recent studies examining strategic groups over time (Cool and Schendel, 1987; Fiegenbaum and Thomas, 1990). The first step is to identify policy variables on which firms in an industry compete. Second, time periods with similar patterns of policy covariation are identified and called stable strategic time periods (SSTPs). Third, within each SSTP, firms are clustered into

groups according to the similarity of their policies. Strategic groups are thus operationalized as a multidimensional construct, and each SSTP has a unique set of groups.

Identifying policy variables

To start, we identified policy variables based on an extensive review of the literature on the airline industry for the time period of our data. Since the timeframe of this study extends over twenty years, it was important to select variables that had enduring relevance. These policies were also chosen as important types of airline scope and resource commitments (Cool and Schendel, 1987; Fiegenbaum and Thomas, 1990) and as focal points in an airline's assessment of its strategic position compared to competitors.

Route distance

This variable identifies differences among carriers in route distance. Under deregulation, route distance has been frequently used to characterize airline strategies as short or long haul. Airlines did not exercise freedom over this policy under regulation. This constraint was removed after hearings on route reform from 1975 to 1979 (Bailey, Graham, and Kaplan, 1985). Major restructuring began and continued through the end of the study period (Bailey *et al.*, 1985; Douglas and Miller, 1974; Meyer, 1981). ROUTE DISTANCE is the ratio of Revenue Aircraft Miles Flown to Revenue Aircraft Departures Flown.

Fare structure

Until the ADA, the CAB maintained regulatory control over fares. As a precurser to deregulation, the Domestic Passenger Fare Investigation (DPFI) of 1975 inaugurated the CAB's approval of fare discounting (Bailey *et al.*, 1985; James, 1982). After the ADA, fares were believed to be an important dimension of competition in the industry, as carriers focused their efforts on price/service options (Keeler, 1978). This type of competition was reflected in the extent to which carriers attempted to shift price/service ratios between first class and coach seats. Many entrants under deregulation have not offered first class service at all. FARE STRUCTURE is measured as the ratio of Revenue Passenger Miles (Coach) to Total Revenue Passenger Miles Flown (Coach plus First Class).

Flight frequency

Route and fare restructuring induced by deregulation led to changes in flight frequency (Levine, 1987). The greater the flight frequency, the lower the predicted delay time and the higher the perceived value of the service offered by the carrier (Douglas and Miller, 1974). Some entrants under deregulation, notably Southwest, have explicit capacity expansion policies that involve increasing flight frequency in flight segments to both serve and stimulate demand. FLIGHT FREQUENCY is measured by the average number of aircraft flown by the carrier on all flight segments during the period (Borenstein, 1989).

Aircraft equipment

Airlines increase economies of scale through investments in aircraft (Bailey *et al.*, 1985; Borenstein, 1989). Larger aircraft have more seats and a lower cost per mile. Throughout the study period aircraft design improved. AIRCRAFT EQUIPMENT is the average number of available seat miles per aircraft.

Hub system

With greater control over their route structures after deregulation, many carriers reorganized their routes into hub and spoke systems to achieve economies of scale in logistics and service operations (Bailey and Williams, 1988). Implementation of these systems by large airlines mirrored the route organization of smaller airlines serving regional markets from one or two large airports. A HUB SYSTEM is measured by a Herfindahl index, reflecting the degree to which a carrier's route structure was concentrated in a small number of airports. The variable is calculated in each period for each airline by summing the squared proportion of departures it made from any of the forty-two major US airports. The more concentrated its departures in one or several airports, the higher the index. Since data on airline departures by airport are available only after 1978, this measure is not computed during the period of airline regulation.

Labor costs

LABOR COSTS have traditionally been a carrier's greatest expense. Throughout the timeframe of this study, unionization, the two-tier wage system, and cross-utilization of employees were the foci of labor-management negotiations. Labor issues were prevalent after competitive pressures associated with deregulation induced concern for labor costs (Brenner, Leet, and Schott, 1985; Cappelli, 1985; Levine, 1987). Consistent with numerous studies, LABOR COSTS is defined as the ratio of Crew Cost to Total Cost.

Load

Airlines choose routes and manage their price structures in order to fill each aircraft flown with passengers. To the extent an airline invests in policies to fill its planes, its capacity utilization rate should be high. We measure capacity utilization, commonly called the LOAD factor in industry parlance, as the ratio of total Revenue Passenger Miles to total Available Seat Miles in a quarter (multiplied by 100 to create a percentage).

Efficiency

Since the efficiency varies among carriers both before and after the ADA (Bailey *et al.*, 1985; Levine, 1987), it is included here as a critical strategic variable. EFFICIENCY is defined as the operating expenses per seat mile.

Leverage

The debt to equity ratio, our measure of LEVERAGE, was a strategic policy variable throughout the study period. Industry changes before and after deregulation influenced decisions regarding capital structure (Brenner *et al.*, 1985; James, 1982), and Chow, Gritta, and Hockstein (1988) found that a high debt to equity ratio contributed to the poor performance of several carriers after the ADA.

Constructing strategic groups

Strategic groups were identified in two steps. First, following Cool and others (Cool, 1985; Cool and Schendel, 1987; Fiegenbaum and Thomas, 1990), Stable Strategic Time Periods (SSTPs) were identified. To identify these periods, we analyzed the policy variables, excluding firm performance, using four methods: (1) Bartlett's test which tests for the equality of the covariance matrices of two contiguous quarters; (2) Kendall-Stuart's test, which is more sensitive to change than Bartlett's test; (3) Wilk's lambda to test for the equivalence of the means of the policy dimensions between quarters; and (4) a qualitative analysis of the industry's history over the 20 years. Because descriptions of strategic behavior in the literature on the airline industry were rarely specific or consistent regarding the actions of firms in each quarter, the SSTPs identified through qualitative analysis are coarser grained than those derived from the other methods. Thus, we impose the constraint that the SSTPs produced by the qualitative analysis are yearly rather than quarterly phenomena. To develop a robust partitioning of the 80 quarters into SSTPs at least two methods must agree on the location of each strategic break in the industry's history. This rule led to a fine-grained partition of the twenty-year history into seventeen periods of strategic stability.

The next step is to identify strategic groups within each SSTP. These groups were found by clustering the airlines on the policy variables, again excluding firm performance, within each SSTP. The clusters were identified using Ward's technique, a highly general method that agglomerates firms into clusters starting with each firm as its own

Table 6. Summary of SSTP determination

SSTP	Timeframe	Length of SSTP	Determined by
1	1/69–3/70	7	K, W, Q
2	4/70–3/73	12	K, W
3	4/73–2/75	7	B, K, W
4	3/75–3/76	5	B, W
5	4/76–4/78	9	K, Q
	Deregulation		
6	1/79–2/79	2	B, W
7	3/79–4/79	2	K, Q
8	1/80–3/80	3	K, Q
9	4/80–1/81	2	B, K
10	2/81–4/81	3	K, Q
11	1/82–4/82	4	K, Q
12	1/83–2/93	2	B, W
13	3/83–4/83	2	K, Q
14	1/84–1/85	5	B, K
15	2/85–1/86	4	K, Q
16	2/86–4/86	3	B, Q
17	1/87–4/88	8	End of study

Where B = Bartlett's test; K = Kendall-Stuart's test; W = Wilk's lambda; Q = qualitative review

group. The method is hierarchical in that, at each step of the procedure, two clusters are combined and these combinations continue until only two clusters of firm are left. Clusters are combined if their union raises the total within-group error sum of squares the least of all possible combinations at that step in the clustering process (see Anderberg, 1973: 142–144). The efficacy of rules for identifying the 'optimal' number of clusters ultimately depends on the structure of the data (Milligan and Cooper, 1985), and so this choice remains a matter of judgment (Anderberg, 1973: p. 15). We chose our rule for selecting the number of strategic groups in each SSTP based on methods adopted in the recent strategic group literature. First, consistent with Fiegenbaum and Thomas (1990), the final clustering of airlines into groups had to explain at least seventy-five percent of the interfirm variance in the policy variables. Second, selecting a partition with one more group had to increase the variance explained by at least five percent over that explained by the partition with fewer groups. Using this procedure, the maximum number of strategic groups in any SSTP was seven; and the minimum number of groups was three. The results are summarized in Tables 6 and 7.

Table 7. Strategic groups by SSTP

Airlines	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
American	1*	4	8	14	16	20	23	26	30	36	38	41	45	55	59	63	68
Alaska Air	3	5	11	14	18	21	23	28	30	33	38	44	48	54	58	61	69
Braniff	2	7	11	14	18	21	23	28	30	33	38			55	58	62	67
Air Atlanta														54	58	61	
Continental	1	7	11	14	18	21	23	28	30	33	38	44	49	55	60	62	68
Delta	2	7	11	14	18	21	23	28	30	37	38	44	50	55	59	64	68
Eastern	2	7	11	14	18	21	23	28	30	37	38	44	50	55	59	64	68
Frontier	3	5	9	12	19	22	24	29	32	35	40	43	47	54	57	61	
Hawaiian	3	5	9	12	19	22	24	27	31	34	39	42	46	52	56	61	66
America West													48	54	57	61	66
Muse										35	40	43	47	53	57	61	69
Midway							24	29	32	33	40	43	47	54	58	61	69
Mohawk	3	5															
National	2	7	11	15	18	21	23										
North Central	3	5	9	12	19	22											
Air New England				12	19	22	24	27	31	34							
Northeast	2	7															
Northwest	2	7	11	14	18	21	23	28	30	33	38	44	48	55	58	62	68
New York Air									31	35	40	43	47	53	57	61	
Air Cal						22	24	29	32	35	40	43	47	53	57	61	66
Ozark	3	5	9	12	19	22	24	29	32	35	40	43	47	54	57	61	
Pan Am	3	6	10	13	17	21	25	26	30	33	38	41	49	55	58	65	69
People Express												38	43	47	54	58	61
Piedmont	3	5	9	12	19	22	24	29	32	35	40	43	47	53	57	61	66
PSA						22	24	29	32	35	40	43	47	53	57	61	66
Air Florida							23	29	32	35	40	43	47				
Horizon Air														52	56	61	66
Republic								29	32	35	40	43	50	53	57	64	
Hughes Air West	3	5	9	12	19	22	24	29									
Southern	3	5	9	12	19	22											
Texas International	3	5	9	12	19	22	24	29	32	33	40						
TWA	1	4	8	14	16	20	23	26	30	33	38	41	49	55	58	62	69
United	1	4	8	14	16	29	23	26	30	36	38	41	45	55	59	63	68
US Air	3	5	9	12	19	22	24	29	32	35	40	43	47	53	57	61	66
Western	2	7	11	14	18	21	23	28	30	33	38	44	48	55	58	62	69
Wein	3	5	9	12	19	22	24	27	31	34	39	42	47	54			
Southwest							24	29	32	35	40	43	47	53	57	61	66
Air Midwest					19	22	24	27	31	34	39	42	46	52			
Air Wisconsin							24	27	31	34	39	42	46	52	56	61	66

* Numbers in cells represent airline memberships in strategic groups