Deregulation and Labor Demand: Sources of Pilot Employment Variation, 1979–1985

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Since domestic airline deregulation, labor markets in the industry have experienced unprecedented turmoil. The purpose of this study is to identify primary sources of pilot employment variation over the 1979–1985 period. Labor demand is estimated to determine the separate influences of increased competition, route system expansion, hubbing, and fuel price shocks. Most of the observed variation in employment can be linked directly to elimination of Civil Aeronautics Board route authority. Labor market volatility in the years to come will be due primarily to traditional economic influences.

Since airline deregulation, labor market conditions have been exceptionally volatile. Several studies highlight the development of sharp contrasts in compensation between competing firms (*1*). Related observations include experimentation with two-tier pay scales (at American Airlines, for example), decertification of existing union representation (Continental Airlines), and even discussion of employee purchase of the firm (United Airlines). It is clear that labor relations in the airline industry are in the midst of fundamental change.

Nowhere is this volatility more evident or widespread than in the area of employment. Table 1 summarizes annual data on employment of pilots and copilots for the domestic operations of former trunk airlines. Observations have been excluded in cases of unreported data and strikes in excess of 100 days. Remaining employment fluctuations determine the coefficient of variation (standard deviation divided by the mean), which has been calculated for each firm over two distinct time periods. Employment variation under Civil Aeronautics Board (CAB) regulation (1972–1977) is exceeded in every case by employment variation within the deregulated era (1979–1985).

In this discussion these employment fluctuations will be explored. What are the primary sources of observed employment variation? To what extent is this a transitory adjustment to recent regulatory change? To what extent is it a response to more traditional economic influences? Is this the type of instability that can be expected continuously in an unregulated environment? These questions may be answered by understanding the employment decisions of airlines with respect to pilots and then identifying the determinants of 1979–1985 employment changes.

Labor demand provides a useful general framework for technical analysis of issues relating to employment levels. First firm-specific demand for the labor services of airline pilots is empirically evaluated. Second these results are used to illustrate the individual effects of actual regulatory and economic changes. Finally, the combined effects of these 1979–1985 changes are shown and conclusions are offered.

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TABLE 1 EMPLOYMENT OF PILOTS AND COPILOTS

	1972–1977		1979–1985	
Airline	Mean	Coefficient of Variation	Mean	Coefficient of Variation
American	2,685	.03	2,853	.09
Braniff	884	.06	725	.70
Continental	1,031	.13	1,249	.28
Delta/Northeast	3,001	.02	3,718	.03
Eastern	2,909	.04	2,828	.05
Northwest	1,448	.07	1,215	.09
Pan Am/National	559	.03	498	.37
Trans World	2,355	.09	1,560	.15
United	3,585	.03	3,517	.06
Western	1,296	.07	1,249	.12

LABOR DEMAND ESTIMATION

The demand for labor is a theoretical relationship between wages and the firm's profit-maximizing level of employment. Movement along the labor demand curve represents the response to alternative wages, holding all other influences constant. The firm will react to a wage increase, in general terms, by substituting other productive inputs for labor and decreasing its level of output. In this case, decreased employment will result from these combined "substitution" and "scale" responses (*2*). Substitution is determined primarily by relative input prices and technological considerations, whereas the scale decision is influenced by production costs and characteristics of the product market environment.

The demand for labor will serve as the framework for evaluating employment variation for pilots during the 1979–1985 period. Labor demand is a useful context because it describes the employment decisions of the firm. Here the employment effects of competitive and technological changes due to deregulation can be analyzed. By estimating labor demand the actual impact of various proposed influences can be statistically measured. It is also important to identify significant nonregulatory economic effects (*3*) such as fuel price variation. Estimating labor demand enables one to distinguish between regulatory and unrelated sources of employment variation.

This empirical strategy explicitly incorporates both substitution and scale decisions as well as the implications of nonprice competition (*4*). Service quality will influence both consumer demand and production costs in a number of industries (*5*). Excess capacity has long been recognized as a fundamental element of airline behavior (*6*). Convenience, enhanced by additional scheduled seating capacity, serves as an important consideration for consumer choice, and the level of seating capacity is a primary element in the firm's production decisions. Theoretical discussion from Rich (*4*) implies that this particular form of nonprice competition can be represented, for the purposes of labor demand analysis, in a simple fashion. Traditional measures of output are replaced by the relevant quality-enhancing variable, seating capacity.

The distinction between input substitution and scale determination motivates the "two-step" approach to labor demand estimation. Input substitution is the primary focus of the conditional labor demand equation

$$L = g(w, r, S) \tag{1}$$

where

L = pilot employment,
w and r = input prices, and
S = scheduled seating capacity.

The particular specification for Equation 1 is obtained from Diewert (*7*) with route system characteristics included as proposed by Kim (*8*). The determination of seating capacity,

$$S = h(MRs, MCs) \tag{2}$$

where MR is marginal revenue and MC is marginal cost, serves as the firm's relevant output decision under nonprice competition. Output is determined jointly by marginal revenue and marginal cost considerations; therefore, scheduled seating capacity will be influenced by input prices, technological considerations, and significant aspects of the product market in which the airline operates. Previous empirical studies of airline market behavior, including those by DeVany (*9*) and Trapani and Olson (*10*), have influenced the particular specification of Equation 2 employed in this study.

Data

Data for this study consist of the annual observations on the domestic operations of a dozen airlines. Firms were selected on the basis of CAB regulatory classification. The 12 former U.S. trunk airlines (American, Braniff, Continental, Delta, Eastern, National, Northeast, Northwest, Pan Am, Trans World, United, and Western) shared a regulatory history quite different from that experienced by any "nontrunk" airline (*1*). The full sample contains 118 observations during the period 1972–1985; however, the unregulated subsample (1979–1985) will be referred to frequently. Table 2 contains definitions of variables and means. Insufficient data, firm bankruptcies, and strikes in excess of 100 days led to the deletion of additional observations.

The two dependent variables required no calculation. Employment (L) is limited to pilots and copilots engaged in the firm's domestic operations. Data represent annual observations on full-time equivalent employees. Available seat miles (S) is the total number of seat miles carried by the firm, whether filled or unsold, in domestic operations.

The price of the labor input (*Wage*) is calculated as total pilot and copilot expenses to the firm divided by employment. The price of fuel (*Pfuel*) is similarly derived from the firm's reported expense accounts. *Pfuel* is total fuel expense divided by gallons of fuel consumed in all domestic operations.

The nature of the market competition facing the firm is an important element of the analysis. Industry aggregate measures of concentration are useless because competition occurs at the "city-pair" level and not all firms serve all city pairs. For this study a unique firm-specific measure of airline competition has been devised. First, an annual Herfindahl index of market concentration is calculated for each of 250 domestic city pairs. This index is based on passenger shares for all firms (trunk or nontrunk) that provide passage (nonstop or other) between those two cities. Second, a weighted average of these city-pair values is constructed for each firm in which the relative importance of that city pair in the firm's route system is used as a weight. The resulting variable (*Herf*) is an annual measure of actual competition facing the firm across its individual route system.

Cities is simply a count of the domestic destinations served by the airline. *Hub* is calculated as the number of departures from the firm's three most active airports divided by the firm's total departures.

Results

Conditional labor demand is estimated for the full sample to obtain information on long-run factor substitution. The seat

TABLE 2 VARIABLE DEFINITIONS AND MEANS

Variable	Definition	Mean 1972–1985	Mean 1979–1985
L	Employment of pilots and copilots	1,986.83	2,086.88
S	Available seat miles (in 10,000,000s)	25,884.23	30,891.83
Wage	Wages of pilots and copilots ($)	52.25	72.47
Pfuel	Price of fuel ($)	50.72	82.60
RK	User cost of capital ($)	23,485.35	28,767.50
Dist	Average stage length (miles)	696.46	756.91
Hub	Concentration of flight operations	0.35	0.39
Cities	Number of cities served	52.21	56.55
Incrl	Real income of consumers ($)	105.71	112.39
Herf	Index of market concentration	0.44	0.38
Dens	Average market density	45,130.48	57,641.60
TICO	Texas International-Continental merger		
NAPA	National-Pan Am merger		

equation is estimated only for the unregulated subsample to reflect scale decisions in the absence of regulated price or barrier-to-entry constraints.

Conditional labor demand is estimated as follows:

$$L = Sx\left[\underset{(-0.578)}{-0.012} - \underset{(-0.586)}{0.011(^1/_2)}\left(\left|\frac{Pfuel}{Wage}\right|\right)^{1/2} + \underset{(2.010)}{0.004(^1/_2)}\right.$$
$$\times\left(\left|\frac{RK}{Wage}\right|\right)^{1/2} - \underset{(6.303)}{0.045}\left(\left|\frac{Dist}{Wage}\right|\right)^{1/2}$$
$$\left. + \underset{(7.800)}{3.306(^1/_2)}\left(\left|\frac{Hub}{Wage}\right|\right)^{1/2}\right] \qquad (3)$$

where the sample size is 118, the F-statistic is 674.075, and t-statistics are shown in parentheses. Available seat miles is estimated as follows:

$$\ln S = \underset{(-1.596)}{-18.837} + \underset{(6.403)}{1.056}\ \ln Dist - \underset{(1.998)}{0.058}\ \ln Hub$$
$$+ \underset{(12.464)}{1.634}\ \ln Cities + \underset{(0.265)}{0.357}\ \ln Incrl - \underset{(-1.216)}{11.846}\ \ln Herf$$
$$+ \underset{(2.269)}{0.430}\ \ln Dens - \underset{(-0.044)}{0.010}\ TICO + \underset{(1.243)}{0.255}\ NAPA$$
$$+ \underset{(0.573)}{0.688}\ \ln Wage + \underset{(1.204)}{1.353}\ (\ln Wage \times \ln Herf)$$
$$+ \underset{(1.411)}{1.904}\ \ln Pfuel + \underset{(1.404)}{2.205}\ (\ln Pfuel \times \ln Herf)$$
$$- \underset{(-0.214)}{0.197}\ \ln RK - \underset{(-0.336)}{0.286}\ (\ln RK \times \ln Herf) \qquad (4)$$

where the sample size is 60, the F-statistic is 58.367, $\bar{R}^2 = .931$, and t-statistics are shown in parentheses.

Calculated elasticities of interest may be found in Table 3. Detailed methods of estimation have been described by Rich (*4*).

From the conditional labor demand results in Table 3 it is clear that the firm's choice of seating capacity is the primary determinant of pilot employment. A 1 percent increase in available seat miles leads to an approximate 1 percent (1.014) increase in employment. Conditional labor demand elasticity with respect to wage (–0.587) indicates a significant substitution response. Wage increases induce the firm to select less labor-intensive modes of production.

Results from the seat equation reveal a variety of important influences. The initial objective is to determine the scale response to a wage change. After route system differences, determinants of firm-specific demand, disequilibrium effects of mergers, and regulatory influences have been controlled for, the predicted response to marginal costs can be identified. The elasticity with respect to wage (–0.616) indicates that increased marginal costs lead to reduced seating capacity.

The full response of employment to a wage change is then a combination of both substitution and scale responses. Figure 1 shows estimated labor demand. Here one may observe the full employment response, implied by the estimation results, to representative wage variations. Figure 1 is obtained with all other variables held constant at their mean values for the unregulated subsample. This gives a picture of average firm-specific demand for airline pilots isolated from regulatory and nonregulatory external influences.

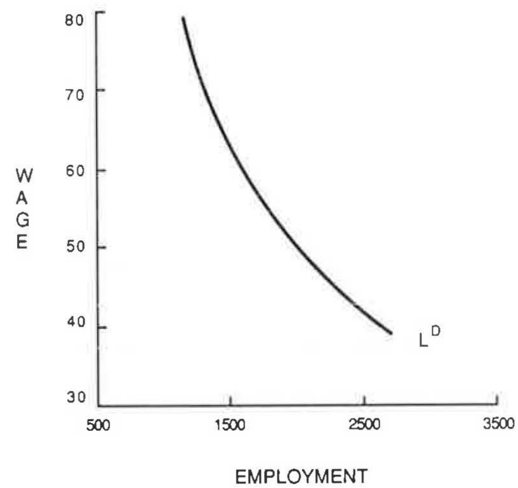

FIGURE 1 Estimated labor demand.

SOURCES OF EMPLOYMENT VARIATION

In this section four important labor demand influences were reviewed. From the results of preceding technical analysis, it is clear that these are the primary sources for increased variation in pilot employment as shown in Table 1. First, the most commonly cited by-product of deregulation—increased market competition—is examined. Elimination of CAB route authority led to other changes during the 1979–1985 period as well. Expansion by incumbent firms into new markets and increased hub system utilization will be discussed in the context of labor demand. In addition to regulatory transition, 1979–1985 has

TABLE 3 SELECTED RESPONSE ELASTICITIES

Condition Labor Demand	*T*-Statistic	Elasticity	Available Seat Miles	*T*-Statistic	Elasticity
Available seat miles	11.687	1.014	*Wage*	–1.395	–0.616
Wage	–3.959	–0.587	*Wage* × *Herf*	1.204	1.353
Pfuel	–0.586	–0.037	*Pfuel*	–0.902	–0.221
Hub	7.800	0.852	*Hub*	–1.998	–0.058
			Cities	12.464	1.634

been marked by substantial fuel price fluctuation. The implications for pilot employment of all of these potential influences will be explored.

Competition

One of the goals of airline deregulation was to create a more competitive market environment. The data presented in Figure 2 clearly indicate that competition has increased for the firms in this study. Figure 2 presents annual average values of *Herf*, the firm-specific measure of market concentration. From 1972 to 1977 trunk airlines operated in highly concentrated markets with extremely limited opportunities for increased competition. Removal of CAB barriers to entry opened the door for other trunks, nontrunks, and even new entrants. Market concentration generally declined following deregulation, giving the 1979–1985 pattern for *Herf* in Figure 2.

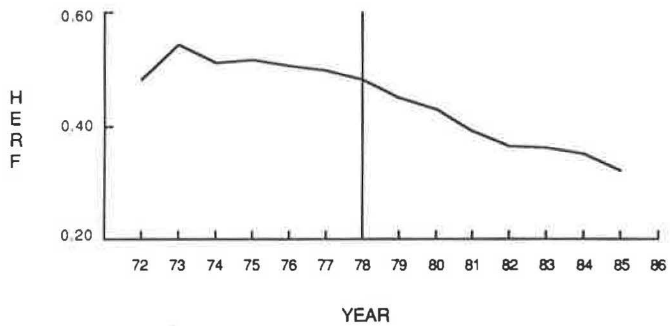

FIGURE 2 ***Herf*: measure of market concentration.**

Estimation results in Table 3 (*Wage* × *Herf*) suggest that this trend has a unique impact on the firm's demand for labor. Faced with a greater number of air travel alternatives, the consumer is more responsive to price or quality changes. The firm must now be more responsive, in terms of output and employment, to any variation in marginal costs. Increased market competition will lead to an increased scale response and therefore more elastic labor demand.

In Figure 3 the effects of changing *Herf* are simulated. Labor demand is calculated as before but with *Herf* set alternatively at the 1977 level (.50) and the 1985 level (.32). The individual impact of increased competition is a flatter or more elastic labor demand curve. For pilots this means a more severe trade-off between wages and employment. Under a given contract this should produce short-run employment loss. In the long run, elastic labor demand serves as a deterrent to wage increases. Changes in competition have been at the heart of labor market volatility during 1979–1985.

It is doubtful that market concentration, as measured here, will continue to decline at such a rapid pace. Some recent mergers, such as Trans World with Ozark, have tended to increase concentration. The 1979–1985 changes in *Herf* should be viewed as resulting from a historic period of regulatory transition.

Route System Expansion

Deregulation not only opened the door to increased competition but permitted incumbent firms to expand into additional

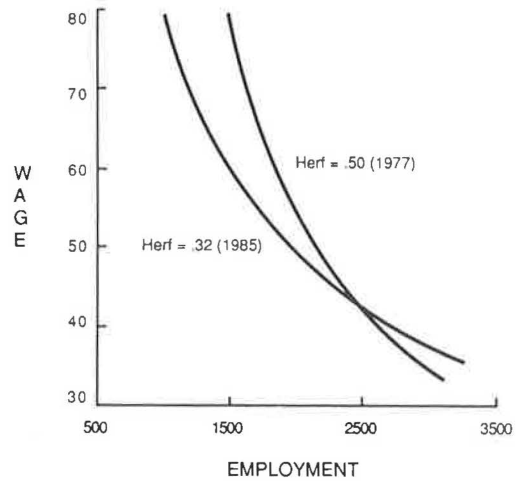

FIGURE 3 Simulated effects of market concentration.

markets. in 1938, at the inception of CAB regulation, all firms were strictly regional carriers (*1*). After 40 years of CAB route authority, the route systems of trunk carriers retained much of their regional flavor. One of the most striking trends of the deregulated era has been route system expansion beyond the firm's traditional regional territories, which is shown in Figure 4. Very little change is evident during the 1972–1977 period. Route system expansion was severely restricted during this period of CAB regulatory control. During 1979–1985 a general increase may be seen in the number of cities served on average by the firms in this study. This trend is slowed by recession initially and reversed at the end because of the experiences of a few firms that dramatically curtailed operations.

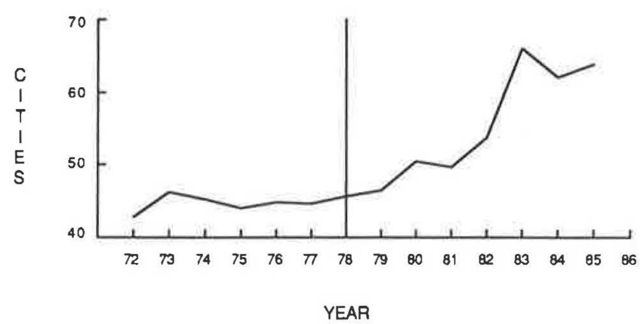

FIGURE 4 ***Cities*: measure of route system expansion.**

The estimated impact of *Cities* in the seating-capacity equation (1.634) reveals route system expansion as a very significant determinant of pilot employment during the period. Figure 5 shows the simulated effect of expansion on the demand for labor. Labor demand is derived with *Cities* set at the 1977 average (44.7) and then at the 1985 average (63.7). As firms increase the number of cities served in their route system, labor demand increases.

For pilots this expansion has more pleasant implications than the previously discussed increase in competition. The resulting labor demand shift leads to expanded wage and employment opportunities.

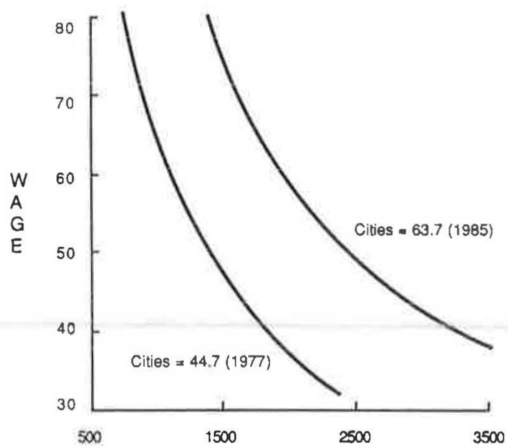

FIGURE 5 Simulated effects of route system expansion.

Ten years of deregulated airline behavior have not yet erased 40 years of regulation. Airline route systems remain somewhat regionally biased. The general trend toward expansion has resumed since 1985 but through a different method. Some mergers, such as Delta with Western, were primarily regional expansions. How will employment in the merged entity compare in the long run with the combined employment of the two separate firms? With a measured elasticity in excess of 1, these results suggest that a merger between two firms with completely distinct route systems would increase pilot employment.

Hub System Utilization

With the removal of CAB route authority, airlines were permitted to rearrange route systems. Combining diverse city-pair passenger flows through traffic centers allows the firm to enjoy economies of scope (*11*). Consumer preferences for nonstop travel limit airline hubbing activity. Although the hub concentration of Federal Express is a model for cost minimization, it is not a blueprint for passenger airline profit maximization.

Figure 6 shows that hubbing has increased substantially during 1979–1985. This trend should be interpreted as a move from CAB route assignments toward optimal hub system utilization.

Estimation results presented in Table 3 revealed conflicting effects of this trend. In the seat equation the negative elasticity (–0.058) reflects more efficient use of seating capacity. Higher load factors are in part due to hubbing activity. The positive elasticity with respect to *Hub* (0.852) in the conditional labor demand equation indicates that hub concentration leads to more pilot labor-intensive production. For a given number of seat miles, hubbing requires shorter hops and more frequent departures.

The combined impact during 1979–1985 has led to increased labor demand. Figure 7 shows the simulated effects of hubbing. Pilots will enjoy greater wage and employment opportunities with hub concentration at the 1985 level (0.44) as opposed to the 1977 level (0.35).

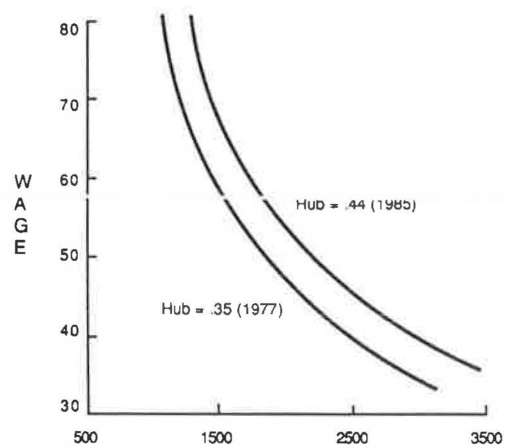

FIGURE 7 Simulated effects of hub system utilization.

It is important to note that increased hub utilization may have a very different impact on other labor groups. Centralization of ground activities may decrease demand for employees not involved in flight operations.

It is difficult to imagine increased use of primary hubs by the firms in this study. Movement toward new secondary or regional hubs and exploration of profitable nonstop opportunities are trends that will very likely dominate in the foreseeable future.

Fuel Prices

Several potential sources of pilot employment variation during 1979–1985 are independent of industry deregulation. Fuel

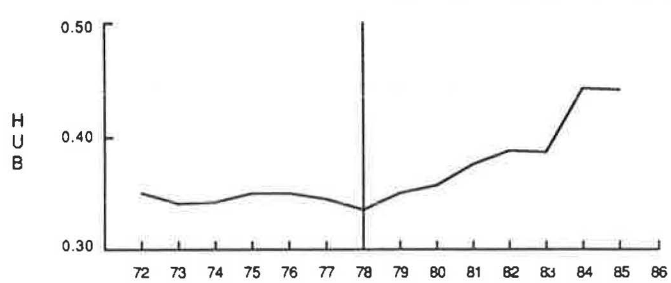

FIGURE 6 ***Hub*****: measure of hub system utilization.**

price shocks, recessions, and changes in the cost of acquiring capital equipment have come and gone regardless of the regulatory environment faced by airlines. It was decided to focus on fuel prices because of their relative significance during this period (*12*).

Figure 8 shows *Pfuel* rising continuously from 1972 through 1981 and then falling through the end of the sample. Fuel price increases are particularly substantial during the early days of deregulation, with an observed 164 percent increase from 1978 through 1981. Again, this fuel price increase is independent of airline deregulation. For example, a 147 percent increase may be observed over a comparable time span beginning in 1973.

The estimation results confirm the belief that pilot employment, in the long run, is affected adversely by high fuel prices. Labor and fuel are complements in both the conditional labor demand and seating capacity equations. Higher fuel prices increase costs, leading the firm to reduce scheduled seating capacity (–0.221), which will result in less employment. The firm will also respond by altering its input mix. Long-run fuel-saving decisions regarding route systems and aircraft fleets appear to be labor saving (–0.037) as well. These estimates suggest that a 1 percent increase in fuel prices will lead to a combined 0.25 percent decline in pilot employment. Although this would appear to be a relatively inelastic response, it becomes significant in light of the tremendous fuel price fluctuations observed.

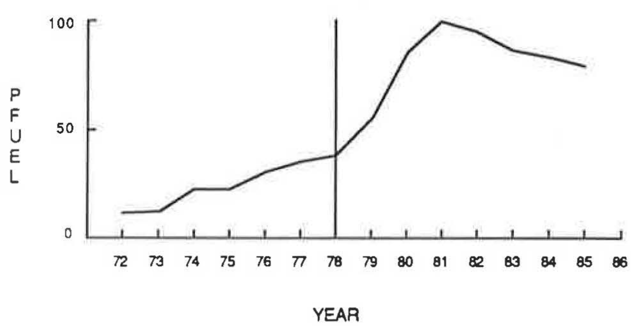

FIGURE 8 ***Pfuel*: cost of fuel per gallon.**

Figure 9 shows the simulated effects of a representative fuel price change. As *Pfuel* increases from the 1979 value (56.4) to the 1979–1985 mean value (82.6), labor demand declines. Thus, fuel price increases during the initial years of deregulation had a depressing effect on pilot wages and employment levels. Subsequent fuel price declines expanded the demand for labor.

It should be noted at this point that the firm's ability to react to fuel price and other exogenous shocks is enhanced by the elimination of route restrictions and price regulation. The response shown here, though limited, is greater than the response to equivalent fuel price changes experienced before deregulation (*4*). As for the future, continued surprises from fuel price movements should be expected and corresponding inverse movements of pilot employment levels predicted.

CONCLUSION

Employment variation during the deregulated era has been caused by a variety of forces. These influences are shown to

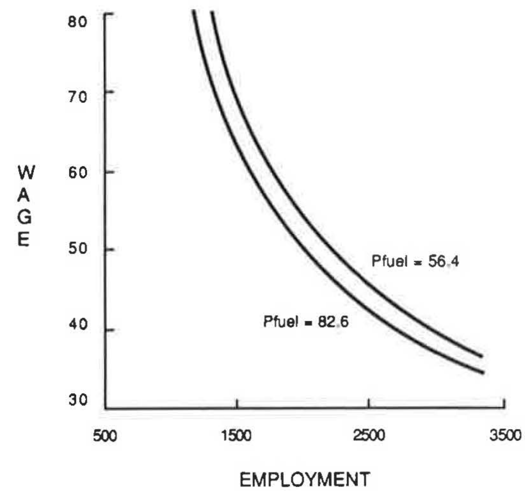

FIGURE 9 Simulated effects of fuel price variation.

have conflicting effects. Figure 10 shows the combined impact of the sources of employment variation. Representative labor demand curves are obtained by setting all variables in the analysis at annual mean values for 1979, 1982, and 1985. The overall increase in labor demand over the period is primarily a result of route system expansion, increased hub utilization, and 1982–1985 reductions in the price of fuel. The overall flattening observed is primarily the result of increased market competition.

FIGURE 10 Simulated labor demand in the deregulated era.

During 1979–1985 a tremendous change has been observed in the determinants of pilot labor demand and significant adjustment in pilot employment. The long-run impact of the labor demand shifts shown in Figure 10 has been increased employment at only a few firms. American, Continental, and Delta are the only former trunk carriers to increase pilot employment relative to the regulated period. It is not surprising that employment growth is observed at the firm with the greatest expansion (American), the firm with the most aggressive wage strategy (Continental), and the firm that has been exposed to the least new competition (Delta). Pilot employment over the same period for all other former trunk carriers has declined.

Pilots with the airlines studied have, for the most part, taken the potential gains from increased labor demand in the form of wages. These wage increases initially exceeded the rate of inflation; however, the effects of increased market competition have continued to increase the employment cost of this wage choice relative to earlier periods. In the last 2 years of this sample, wages fail to keep pace with inflation, leaving real earnings as of 1985 only slightly better than they were in 1978.

Estimation of labor demand has identified separate sources of employment variation. Removal of route restrictions produced multiple regulatory effects during 1979–1985. Fuel prices served as an example of labor demand influences independent of regulatory change. Most of the employment variation during this period apparently represents transition to a deregulated environment. Although there will continue to be changes in competition, hub utilization, and route systems, the magnitude of changes observed here is unique to the 1979–1985 period. Nonregulatory influences such as fuel price variation, recession, and technological change will certainly continue to arise. Some continued labor market volatility should be expected, but in the future it will be primarily in response to these traditional economic influences.

Predictions regarding the future course of events in airline labor markets must be made with a note of caution. Although all carriers have faced low-cost competition in some limited percentage of markets, the impact of a full-service carrier with a significantly different cost structure and extensive nationwide route system has yet to be observed. An increase in competition of this sort at this time would flatten labor demand without creating conflicting expansion and hubbing effects. This would put unprecedented wage or employment pressure on the high-cost firm. The success or failure of Texas Air in achieving its apparent long-term goals is quite significant in this context.

Finally, it is important to note the limited scope of this study. First, it focuses on pilots and copilots only. Employment variation for other groups has exceeded the employment variation observed here. Labor demand for workers not involved directly in flight operations will be determined by a different set of considerations. Second, the analysis is limited to former trunk carriers. Extension of this research to other airlines may provide interesting contrasts and additional insight.

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