The Effects of Mergers on Prices, Costs, And Capacity Utilization in the U.S. Air Transportation Industry, 1970-84

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ABSTRACT

We analyze the effect of mergers on various aspects of airline performance during the period 1970-84, using a panel data set constructed by Caves et al. Estimates derived from a simple "matched pairs" statistical model indicate that these mergers were associated with reductions in unit cost. The average annual rate of unit cost growth of carriers undergoing merger was 1.1 percentage points lower, during the five-year period centered on the merger, than that of carriers not involved in merger. Almost all of this cost reduction appears to have been passed on to consumers. Part of the cost reduction is attributable to merger-related declines in the prices of inputs, particularly labor, but about two-thirds of it is due to increased total factor productivity. One source of the productivity improvement is an increase in capacity utilization (load factor).

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I. INTRODUCTION

In a series of previous papers, Lichtenberg and Siegel (1987, 1989a, 1989b) analyzed the effect of ownership change on productivity and related variables (i.e., output and inputs) among U.S. manufacturing establishments using the Census Bureau's Longitudinal Research Database. They found that the least efficient plants in an industry are most likely to experience an ownership change in the future: that ownership change tends to be followed by above-average improvements in productivity; that reductions in administrative overhead are an important source of these productivity improvements: and that the productivity gains associated with management buyouts are much larger than those associated with "garden-variety" changes in ownership.

The purpose of this paper is to extend this line of research on the consequences of control changes for economic performance by analyzing the effects of mergers on prices, costs, productivity, and capacity utilization in the U.S. air transportation industry during the period 1970-1984. The rate of merger and takeover activity in this industry increased sharply in about 1979: there was apparently only one significant merger involving U.S. airlines during the years 1970-78, but four mergers during 1979-81. Although this increase may partly reflect an acceleration in merger and takeover activity throughout the economy at around this time, it is probably largely attributable to the deregulation of the industry that occurred in the late 1970s. In any case, these and subsequent developments have stimulated an intense debate about the effects and desirability of airline mergers.

In a recent paper, Morrison and Winston (1989) evaluated the effect of airline mergers (excluding the Texas Air acquisitions) during 1986-7 on travelers' welfare, accounting for both price and non-price effects, using an empirical model of air travelers' preferences. They noted that in principle, although mergers may reduce consumer welfare by reducing competition **and thus** increasing fares, this loss may be offset by a number of traveler benefits that mergers may provide. These include reducing transfer time by eliminating connections that require changing airlines, and providing a larger network and consolidated frequent flier mileage. They concluded from **their** empirical analysis **that these** mergers had mixed effects on travelers' welfare: half reduced it, and (provided that untaxed frequent flier mileage continues to be provided) half improved it. In the aggregate, though, the mergers had a modest positive impact on travelers' welfare: the welfare gain from increased frequent flier mileage and cities served slightly exceeded the welfare loss from increased fares.[1] Morrison and Winston provided evidence concerning the effects of recent mergers on travelers' welfare, but they acknowledged that research is needed to determine whether airline mergers enhance operating efficiency.

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[1] Morrison and Winston observe that their failure to account for changes in choice probabilities and for mode or destination shifts in response to mergers causes them to underestimate the net benefits of mergers. On the other hand, they argue that "mergers have largely foreclosed any opportunity to integrate the air transportation system more effectively, thus undermining deregulation's long-run performance" (1989, p. 69). This effect, since unmeasured, would cause net benefits to be overstated.

In the next section we describe the database for our analysis, and its limitations. The econometric methodology for determining the effects of mergers on airline performance is outlined in Section III. Empirical results are presented and interpreted in Section IV, and conclusions are reported in Section V.

II. DATA

The database for this investigation was developed by Caves, Christensen, Tretheway, and Windle and has been analyzed and described by them in a number of earlier papers (1981, 1984, 1987). It includes annual observations on 25 U.S. trunk and local service airlines for 1970-84, and on 10 (start-up) airlines for 1982-84. The underlying source of the data is the Civil Aeronautics Board's Form 41 report filed annually by each air carrier.

For each observation the database reports the value and quantity of output and of five inputs[2]: labor, fuel, flight equipment, ground property and equipment, and all other inputs (labelled "materials"). Output and some of the inputs are actually multilateral indices of a number of components. Output is a multilateral index of revenue passenger-miles (RPM) of scheduled service, RPM of charter service, revenue ton-miles (RTM) of mail, and RTM of all other freight. Because, as Morrison and Winston (1989) have shown, travelers value attributes such as travel and transfer time and schedule delay, this producer output index is a

[2] The value of output is total revenue, and the value of each input is its cost.

very imperfect index of true input in travelers' utility functions. However errors in measuring the "quality" of output pose a problem for determining the effects of mergers only to the extent that changes in these errors are correlated with mergers. Morrison and Winston found that frequent flier mileage was the only component of output quality significantly affected by merger. But apparently frequent-flier miles flown by passengers are generally included in the RPM data reported by airlines.[3] Therefore our output quantity and price indexes capture, or "adjust for", this aspect of output quality. Also, frequent-flier programs were much less important during our sample period than they were in the more recent period examined by Morrison and Winston.

Labor is an index of 15 categories of employees, flight equipment is an index of nine aircraft categories, and materials is an index of 7 categories of materials input. The output and input quantity indices are all normalized so that their values equal 1.0 for Delta Airlines in 1977.

In addition to these variables, the database includes three characteristics of airline operations: the number of points served, load factor (the ratio of seat miles sold to seat miles actually

[3] Although carriers are not specifically instructed or required to include frequent-flier miles in RPM in their financial reports, they generally do so, according to Clay Moritz, Supervisory Systems Accountant in the Department of Transportation's Office of Aviation Information Management (telephone conversation with author, 11/15/89). The issue of accounting for frequent-flier awards has been considered during the last few years by the American Institute of Certified Public Accountants and by the Air Transport Association.

flown), and average stage length (the average distance between takeoffs and landings). Caves et al (1984) have demonstrated that these characteristics are important determinants of the cost of providing airline services. We calculated the number of seat miles flown (FLOWN) by dividing the output index by the load factor.

Our objective is to compare the performance of carriers involved in a merger with that of other carriers in the years both before and after the merger occurred, and to calculate the difference between the before and after comparisons. The following five mergers occurred during our sample period:

YEAR	MERGER
1972	Northeast merged with Delta
1979	North Central and Southern merged to form Republic
1980	National merged with Pan American
1980	Air West merged with Republic
1981	Texas International merged with Continental

A key feature of our approach is to add tosether the values and quantities of output and inputs of two airlines for the years prior to their merger. This will enable us to contrast the relative efficiency of a given bundle of resources under divided ownership and control to its relative efficiency under common ownership. The unit cost or total factor productivity (TFP) of the pre-merger firm aggregates are essentially weighted averages of the unit costs or TFP of the two component carriers, with weights proportional to the relative sizes (total costs) of the latter.

After adding up the value and quantity data for pre-merger

observations, we calculated for all observations a number of additional variables. We calculated the implicit price of output (PQ) and of the five inputs ($P_1, \ldots, P_5$) by computing the ratio of its value to its quantity. We calculated the cost share of each of the five inputs ($S_1, \ldots, S_5$) by calculating the ratio of its value to the sum of the values of all inputs. We constructed Divisia-type indices of the quantity and price of total input, as follows:

$$QI = \exp\{ \Sigma_i (S_i * \ln Q_i)\}$$

$$PI = \exp\{ \Sigma_i (S_i * \ln P_i)\}$$

where QI and PI are the quantity and price, respectively, of total input and Q_i is the quantity of input i ($i = 1,\ldots,5$). We then constructed an index of total-factor productivity, TFP, by computing the ratio of output quantity Q to input quantity QI. Load factor (LOAD) was defined as the ratio of Q to FLOWN; for the pre-merger observations, LOAD is equivalent to a weighted average of the load factors of the 2 airlines, with weights based on their respective values of "potential output" FLOWN. Average stage length (LENGTH) for these observations was defined as a weighted average of the stage lengths of the two airlines, with weights based on their respective values of "actual output" Q.

Unfortunately, although the database constructed by Caves et al contains 420 observations, due to the absence of significant data and to the occurrence of strikes (of greater than 25 days), they consider only 272 (65 percent) of the observations to be reliable and meaningful. We eliminated from the sample the 148 observations identified by them as having bad data. Some of these

observations were of airlines about to merge with other airlines. Therefore some of the pre-merger observations in our merger-aggregated data set represent only one of the 2 carriers that merged. Including these observations in the sample precludes obtaining meaningful estimates of the effect of mergers on the levels of values and quantities, such as total cost and output quantity. However assuming the data are randomly missing we can still obtain unbiased estimates of the effects of mergers on ratios of variables such as prices (ratios of value to quantity),' unit cost, TFP, and LOAD. The efficiency of our estimates might be improved by giving less weight to "incomplete" pre-merger observations based on only one of the two airlines.[4]

III. METHODOLOGY

We seek to measure the effect of mergers on a set of interrelated airline performance variables. To determine the effect on any particular variable X we will estimate an equation of the form

$$\ln X_{jt} = \pi + \delta_t + \Sigma_{r=1}^{4} \beta_r M_{jt-r} + \Sigma_{s=1}^{4} \alpha_s M_{jt+s} + \epsilon_{jt} \quad (1)$$

where X_{jt} is the value of the variable for airline j in year t; a is the intercept; δ_t is a "fixed effect" for year t; M_{jt-r} is a dummy variable equal to one if airline j merged in year t-r (r=1,...,4),

[4] When incomplete pre-merger observations were eliminated from the sample, the estimation results were qualitatively similar but weaker than when they were included.

and otherwise equal to zero: M_{jt+s} is similarly defined; and ϵ is a disturbance term. (We will also generalize the model by replacing the intercept a with a set of airline fixed effects π_j.) The coefficient β_r measures the logarithmic difference in the mean values of X in t-r between airlines that did and did not merge in year t. Although we will allow for separate coefficients for each of the four years before and after merger, due to the fairly small sample (N=243) and the relative infrequency of mergers, we do not expect to be able to obtain very precise estimates of the individual β and α parameters. We will focus instead on the average values of the "before" and "after" coefficients, and on the difference between the two:

$$\beta \equiv (\beta_1 + \beta_2 + \beta_3 + \beta_4)/4$$

$$\alpha \equiv (\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4)/4$$

$$\Gamma \equiv \alpha - \beta$$

The parameter β indicates how the merger or "treatment" group compared with the non-merger or "control" group in the four years prior to merger, and α indicates how they compared in the four post-merger years. To obtain consistent and efficient estimates of the effect of the merger treatment, we will include airline effects π_j. In the presence of such airline effects, the estimates of β, α, and Γ are based entirely on the within-airline sample moments. Including the π_j is equivalent to using a "matched pairs" experimental design, which as Wonnacott and Wonnacott (1972, 172-3) note is desirable on efficiency grounds.

Of the variables we shall examine, the one most closely

related to consumer welfare is the implicit price of airline services PQ, defined as the ratio of **total** revenue (TR) to the output quantity index (Q):

$$PQ = TR/Q$$

PQ can also be represented as the product of the price-cost margin (MARGIN) --the ratio of TR to total cost (TC)--and of unit cost UC, the ratio of TC to Q:

$$PQ = (TR/TC) * (TC/Q) = MARGIN * UC$$

The growth rate of the output price is therefore the sum of the growth rates of the price-cost margin and of unit cost:

$$pq = margin + uc$$

where lower case symbols denote growth rates of the corresponding variables. The effect of mergers on the output price, measured by the parameter Γ based on eq. (1) with X defined as PQ, is therefore the sum of the effects of mergers on MARGIN and UC. One might conjecture that mergers increase firms' market power, thus raising MARGIN, but that they also reduce unit costs. In this case the effect of mergers on output price is indeterminate, *a priori*, and must be determined empirically.

There are two **distinct** ways --one external, the other internal, to the firms involved-- in which mergers could affect, and might be expected to reduce, unit costs. The first is by influencing the prices paid by the producer for inputs. There may be economies of scale in the supply of some of the firm's inputs. Also, the firm's monopsony power (as well as its monopoly power) may be increased by merger, thus lowering the prices of factors of production.

Second, merger may increase total-factor productivity, the technical efficiency with which resources are deployed. As noted above, Caves et al have documented that two features of airline network operations--the load factor and average stage length--affect output per unit of total input. Merging two airline networks might constitute a means to increase the rate of capacity utilization (load factor), and more generally, to reconfigure operations in a more efficient manner. Figure 1 summarizes the potential channels we shall investigate via which mergers may affect the price of airline services.

IV. EMPIRICAL RESULTS

Estimates of the parameters β, a, and Γ corresponding to different definitions of the variable X are presented in Table 1. We report "total" estimates (excluding fixed firm effects) of β and α, and both total and "within" estimates (including firm effects) of Γ. The estimates on the first line of the table indicate that the mean output price of airlines involved in mergers was 6.0 percent higher than that of airlines not involved in mergers in the 4 years prior to merger, and 5.1 percent lower in the 4 years after merger. The pre- to post-merger change in the merger vs. non-merger difference is therefore -11 percent. The total estimates suggest that merger is associated with a movement from above-average to below-average output price, but none of the parameters are significantly different from zero at conventional levels of

significance. However when we include fixed firm effects in the model, thereby utilizing a "matched pairs" design, the estimate of Γ is significant at the 5 percent level, despite the fact that the point estimate declines by more than half. The increase in the price of output of airlines involved in merger is 5 percentage points lower, from before to after the merger, than the corresponding increase of non-merger airlines during the same calendar period. The pre- and post-merger periods are centered two and a half years before and after the merger, so this is equivalent to about a one percentage point lower average annual rate of growth. Since the provision of frequent-flier miles is incorporated in our output price index, this result is consistent with Morrison and Winston's finding that mergers increase travelers' welfare, when frequent-flier mileage is accounted for.

As discussed above, in principle a change in the relative price of output could be due to a change in the price-cost margin, a change in unit costs, or both. The second line of the table indicates that merger is associated with a very small increase in MARGIN, from slightly below-average to slightly above-average, but the change in MARGIN is far from significant in both the total and within models. The reduction in the relative price of output is more than completely "explained" by the reduction in unit costs. Airlines involved in merger had 6.1 percent higher unit costs prior to merger, and 5.4 percent lower unit costs post-merger, than non-merger airlines in the same calendar year. As in the case of PQ, the total estimates of the parameters β, α, and Γ are not very

significant (although highly suggestive), but the within estimate of Γ is significant. It implies that the average annual rate of unit cost growth of carriers undergoing merger is about 1.1 percentage points lower, during the five-year period centered on the merger, than that of carriers not involved in merger.

We now proceed to a decomposition of the effect of merger on unit costs into its two components, the effect on TFP and the effect on input prices. Parameter estimates for the dependent variable ln TFP are reported in line 4 of the table. The estimates closely parallel, with an opposite sign, those for PQ and UC: airlines involved in mergers had below-average productivity before, and above-average productivity after, the merger. The findings that $\beta < 0$ and that $\Gamma > 0$ are very consistent with Lichtenberg and Siegel's (1987) results concerning productivity and changes in ownership of manufacturing plants. They found that plants changing owners had below-average levels of TFP prior to changing owners, and above-average TFP growth rates subsequent to the ownership change. Their estimates of the difference in TFP growth rates were highly statistically significant, whereas our within estimate of Γ is significant at only about the 9 percent level, using a one-tailed test. However their estimates were based on a panel of about 20,000 manufacturing establishments, while our sample includes only about 30 airlines. Our point estimate of Γ (.040) is much larger than (about 8 times) their point estimate of the effect of ownership change on manufacturing plant productivity. It is very similar, however, to Lichtenberg and Siegel's (1989b)

estimates of the effects of leveraged buyouts and management buyouts on the five-year (1981-86) productivity growth rates of manufacturing establishments: .028 and .039, respectively.

The lion's share of merger-related unit cost reductions thus appear to be due to increased productivity. How are these productivity improvements achieved? Two determinants of an airline's TFP are its load factor and average stage length. Lines 5 and 6 of the table examine the effect of mergers on these two variables. Carriers involved in mergers had significantly below-average load factors prior to merging; post-merger, their load factors were no longer below average. The within estimate of the change in LOAD is 4.1 percent, and is significant. Thus an increase in the rate of capacity utilization is one source of the productivity improvement associated with mergers.

The estimates of the effect of merger on average stage length are more ambiguous. The total estimates suggest that merger is associated with a 20 percent increase in stage length, from average to above-average values of LENGTH, implying that increased stage length is another source of productivity gain. The within estimate implies that stage length declines slightly in connection with mergers. Neither the total nor the within estimates are significant, however.

As we argued in the previous section, declines in unit cost may result from input price reductions as well as from productivity increases. Input prices are the last set of variables whose co-movements with merger events we analyze. The last five lines of

Table 1 display the estimates of β, α, and Γ for the five input prices, listed in descending order of the mean cost shares of the inputs.[5] As in the case of the stage length estimates, the total estimate of Γ for the price of labor is positive, whereas the within estimate is negative. But in this case the within estimate (which we have argued is more reliable than the total estimate) is significantly different from zero. It implies that the increase in the average price of labor paid by airlines involved in mergers during the five-year period around the merger date was 4.6 percentage points lower than the increase paid by other airlines during the same period. Because the labor measure is an index of 15 categories of employees, two different factors may be contributing to the lower average wage growth of merger-involved airlines. First, mergers may be associated with lower growth in wages <u>within</u> employee categories. Second, they may be associated with reductions in the employment shares of high-wage workers. Lichtenberg and Siegel (1989a, 1989b) found that reductions in the employment shares of high-wage workers (both central-office personnel and nonproduction workers in production establishments) tend to occur in connection with takeovers and leveraged buyouts of manufacturing firms; it is plausible that these also occur in connection with airline mergers. They also found that control

[5] The mean cost shares are:

Labor	.324
Materials	.311
Fuel	.181
Flight equipment	.149
Ground property	.034

changes have no effect or a small positive effect on the wage rates of production workers, but a large negative effect on the wage rates of white-collar employees.

Surveying the remainder of the input price estimates, the only other input price for which the within estimate of I' is even marginally significant is the price of flight equipment. The estimate implies that mergers are associated with 3.3 percent reductions in the average price of flight equipment over-a five year period.

V. CONCLUSIONS

In this paper we have analyzed the effect of mergers on various aspects of airline performance during the period 1970-84, using a panel data set constructed by Caves and his associates. Previous papers have examined the impact of airline mergers on fares and other determinants of traveler welfare, but we are not aware of any previous evidence on their impact on airline operating efficiency.

Our estimates, derived from a simple "matched pairs" statistical model, indicate that these mergers were associated with reductions in unit cost. The average annual rate of unit cost growth of carriers undergoing merger was (a statistically significant) 1.1 percentage points lower, during the five-year period centered on the merger, than that of carriers not involved in merger. Almost all (86 percent) of this cost reduction appears

to have been passed on to consumers: the annual growth rate of total revenue per unit of output was 1.0 percentage points lower during this period for carriers involved in merger. This result appears to be consistent with Morrison and Winston's finding that (more recent) airline mergers have modestly increased traveler welfare, when frequent-flier benefits are accounted for, as we believe them to be in our estimates.

Part of the reduction in unit costs is attributable to merger-related declines in input prices, particularly the price of labor: the five-year growth in the average wage rate is significantly lower among firms involved in mergers during those years than it is among firms not involved. But an increase in total factor productivity appears to be responsible for about two-thirds of the unit cost reduction. The level of productivity of carriers involved in merger was below-average prior to merger and above-average subsequent to merger. These findings are consistent with, albeit far less statistically significant than, Lichtenberg and Siegel's estimates concerning the effects of takeovers and leveraged buyouts on manufacturing plant productivity. Our estimates also suggest that increased capacity utilization (load factor) contributes to the productivity improvement associated with mergers.

Our findings are consistent with the hypotheses that the mergers that occurred during our sample period increased productivity and capacity utilization, and that they reduced unit costs, average revenue, and the average wage. Of course, one would

not expect our parameter estimates to be unbiased estimates of the effects of all proposed mergers. As documented by Morrison and Winston, 5 out of the 9 mergers proposed during the years 1979-82 were either rejected by the Civil Aeronautics Board (one proposed merger), or not consummated (4 proposed mergers). Presumably the efficiency gains and price reductions that would have resulted from these mergers would have been smaller in magnitude than (perhaps even opposite in sign from) the corresponding effects of the mergers that were completed. It is also not clear whether U.S. airline mergers since 1984 (of which there have been many), or mergers in other countries, have had effects similar to those we have estimated. Further research is required to address these issues.

FIGURE 1

POTENTIAL CHANNELS OF INFLUENCE OF MERGER ON OUTPUT PRICE

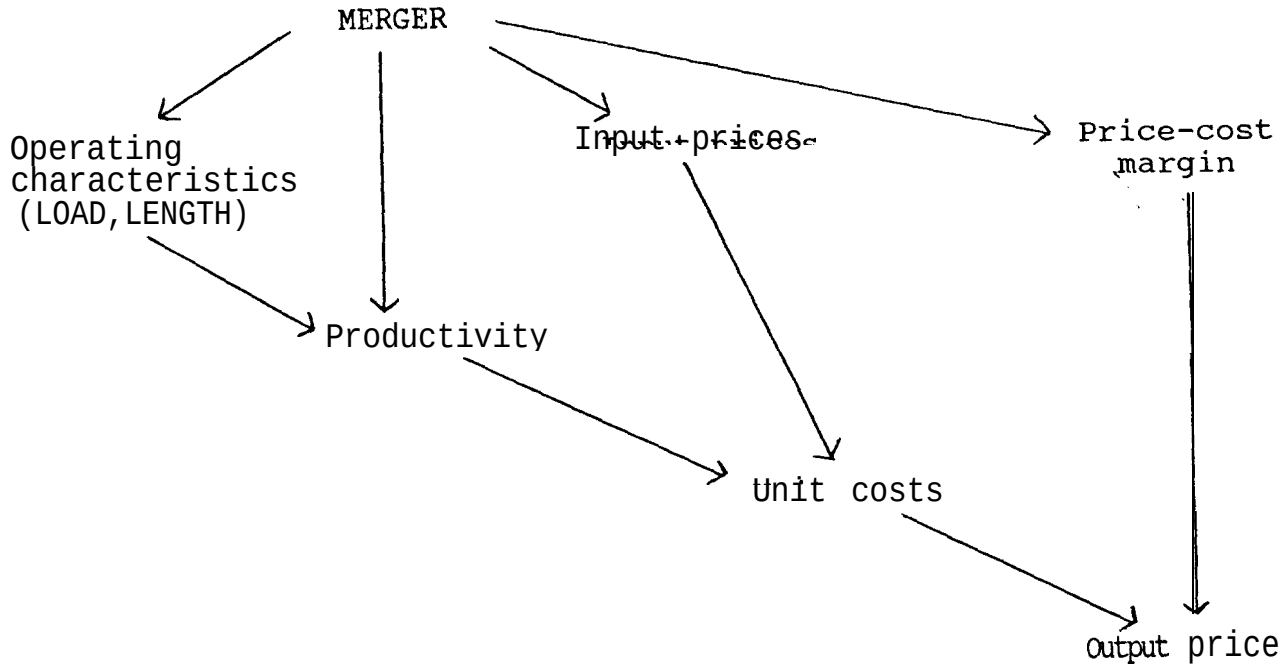

TABLE 1

Effects of Merqers on Selected Variables:
Estimates of Parameters Based on Equation (1)
(t statistics in parentheses)

	Without Fixed Effects			With Fixed Effects
Variable	Before (β)	After (α)	Chanse (Γ)	Chanse (Γ')
PQ	.060 (0.87)	-.051 (0.71)	-.110 (1.13)	-.050 (2.01)
MARGIN	-.001 (0.08)	.003 (0.19)	.004 (0.19)	.008 (0.47)
UC	.061 (0.93)	-.054 (0.77)	-.115 (1.22)	-.058 (1.96)
TFP	-.057 (0.81)	.074 (1.00)	.131 (1.31)	.040 (1.38)
LOAD	-.044 (1.80)	-.008 (0.34)	.036 (1.07)	.041 (1.92)
LENGTH	-.015 (0.09)	.186 (1.07)	.200 (0.85)	-.034 (0.65)
INPUT PRICES:				
Labor	-.003 (0.06)	.055 (1.14)	.057 (0.88)	-.046 (1.83)
Materials	-.000 (0.59)	-.000 (0.14)	.000 (0.31)	.000 (0.06)
Fuel	.034 (1.65)	.018 (0.84)	-.016 (0.53)	-.014 (0.49)
Flight Equipment	.018 (0.88)	.003 (0.13)	-.015 (0.52)	-.033 (1.35)
Ground Property	.000 (0.01)	.009 (0.57)	.009 (0.41)	.014 (0.64)

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