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Airline Costs and Managerial Efficiency

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The drastic decline in profits of domestic trunk airlines after the introduction of jet service in 1959 brought many complaints from the airlines and financial columnists. In the winter of 1961–62, when the clamor was loudest, one analyst said that the airlines "as a whole are seriously sick, perhaps almost as much as their rivals, the railroads." [1] Most explanations of low profits centered on "CAB-induced over-competition" [2] and "an abrupt slowdown in the growth of passenger traffic." [3] In other words, it was assumed that lower profits were caused by a decline in revenues relative to costs, and not much attention was given to the possibility that costs were higher than necessary. But some of the airlines were making substantial profits, and at the same time there was considerable intercarrier variation in the level of average cost. A curious observer would notice, for example, that in 1960 the average cost of the operations of Continental Airlines was 74 per cent of that at United Air Lines. Was this inevitable? Were all intercarrier cost differences dependent on route structure, fleet structure, and other economic variables over which management had no control, or could more skillful managerial cost control have substantially lowered costs and raised profits?[4] The economist wonders: do the inefficient firms, protected by the CAB from price competition with their more efficient rivals, penalize the public by choosing to petition for fare increases instead of putting more effort into cost control?

NOTE: This paper was originally submitted in April 1962 as part of a senior honors thesis at Harvard College.

[1] *Forbes*, January 1, 1962, p. 34.

[2] *The New York Times*, January 8, 1962, p. 81.

[3] *Ibid.*, December 13, 1961, p. 13.

[4] These questions should interest the Civil Aeronautics Board, which has been requested to grant important mergers on the ground that a more highly concentrated industry will be better able to make a profit.

"Managerial efficiency" is not often discussed in empirical microeconomic work. It is usually necessary in *theoretical* writings to treat managerial talent as a constant. "Economic Theory often simply assumes that the individual businessman will find and use the lowest cost method of production." [5] "We must assume that it is not the case that a few firms, managed by men of superior gifts, can and will continue to attract the small number of superior managers, and thus will be enabled to outperform all rivals in all fields." [6] But perhaps this assumption has been too rigidly retained in empirical work; even when managerial efficiency is mentioned, the difficulties involved in quantifying it scare most authors away. Caves, in his recent industry study, thinks that although some inefficiency may be lurking about, "the extent of the inadequacy of the airlines' performance due to inefficiency is impossible to measure." [7]

What statistical techniques are appropriate to quantify the elusive concept of managerial efficiency? In the first place, there is no general airline industry cost function to work with. As Caves shows, every writer who has tried to compute such a function by multiple regression analysis has failed, primarily because the sample is small and the relevant variables are many.[8] However, while computation of a *general* cost function has failed, it is possible to disaggregate reported costs into separate accounting cost categories. The working hypothesis of this paper is that after elimination of intercarrier cost differences due to identifiable economic variables over which management has no control, there remains a substantial residual in each cost category which can be statistically related to differences in managerial efficiency. We should expect effective cost control to be consistently applied by some managements in each cost category, and some managements, likewise, to be consistently inefficient—hence we shall be looking for evidence that the ranking of the carriers' "adjusted" costs (i.e., after elimination of differences dependent on identifiable economic variables) in each category should be similar.

This study is static. Since 1960 was the first full year of jet operations, no earlier period is suitable for analysis; nothing later than the third quarter of 1961 was available when the statistical work was done in early 1962. Furthermore, important strikes made an analysis of the

[5] H. Thomas Koplin, "Public Utilities and Transportation," *American Economic Review*, May 1961, p. 335.

[6] C. Kaysen and D. Turner, *Anti-Trust Policy*, Cambridge, 1959, p. 9.

[7] R. E. Caves, *Air Transport and Its Regulators*, Cambridge, 1962, p. 420.

[8] *Ibid.*, pp. 63–64.

TABLE 1

AVERAGE TOTAL COST BY CARRIER, 1960-61
(cents per available ton-mile)

	1960 Quarters				1961 Quarters		
	1st	2nd	3rd	4th	1st	2nd	3rd
American	31.2	30.0	29.1	29.3	32.0[a]	29.1	28.8
Braniff	29.0	28.8	29.1	28.9	30.4	30.0	28.3
Capital[b]	35.0	33.0	34.4	34.2	33.9	--	--
Continental	24.5	23.1	22.8	23.7	25.0	22.7	22.5
Delta	29.4	28.8	29.3	31.0	30.0	30.0	30.3
Eastern	24.8	28.0[a]	25.6	25.2	27.8[a]	26.5	25.4
National	27.5	27.6	27.6	27.1	28.7[a]	22.6	22.8
Northeast	30.9	31.1	32.6	40.0	32.5	29.5	29.6
Northwest	26.6	24.8	25.8	29.6[a]	49.6[a]	27.7[a]	24.9
TWA	32.3	29.4	27.5	27.4	30.1[a]	26.1	26.3
United[b]	34.4	30.2	28.8	29.7	30.0	29.3	28.3
Western	29.2	29.5	29.6	32.5[a]	35.3[a]	28.3[a]	26.5

Source: CAB, *Air Carrier Traffic Statistics*, and *Air Carrier Financial Statistics*, various issues, 1960-61.

[a] Carrier was affected by a strike during this period.

[b] Capital figures from April 1 to May 31, 1961, included with United.

TABLE 2

AVERAGE CARRIER COST BY CATEGORY, THIRD QUARTER, 1961
(cents per available ton-mile)

	Flying Operations[a]	Maintenance	Passenger Service	Aircraft and Traffic Service	Promotion and Sales	General and Administrative	Depreciation[a]
American	7.2	6.0	2.4	4.9	3.5	1.3	3.5
Braniff	8.2	5.8	2.4	5.3	2.9	1.1	2.6
Continental	6.7	4.1	1.9	2.8	2.4	1.3	3.2
Delta	8.0	5.9	2.3	4.9	3.4	.9	3.4
Eastern	7.8	4.4	2.0	3.8	3.0	1.0	3.5
National	6.8	4.2	1.4	3.4	3.0	.6	3.4
Northeast	8.4	6.0	2.4	4.8	2.8	.8	4.4
Northwest	7.5	4.1	2.0	2.9	2.9	1.3	4.2
TWA	7.4	5.2	2.3	3.9	3.2	1.3	4.0
United	8.1	5.0	2.1	5.1	3.5	1.0	3.5
Western	7.0	4.0	2.1	3.5	3.6	1.3	5.1

Source: CAB, *Financial Statistics* and *Traffic Statistics*, September 1961 CAB, Form 41, September 30, 1961, Schedule P-9.2.

[a] Costs within the flying operations and depreciation categories have been rearranged from the officially reported figures. Carriers which lease flight equipment report this expense as "flying operations" even though, as a substitute for buying equipment, it should be considered equivalent to depreciation.

full 1960–61 period impossible. Table 1 shows that there were only three quarters during which strikes had no dislocating influence on cost levels. Fortunately, an analysis limited to the last of these periods, the third quarter of 1961, will not discriminate against any carrier or carrier group, since during this three-month period all carriers achieved their lowest cost levels of 1960–61 (with a few exceptions of only one- or two-tenths of a cent). Also, by concentrating just on the summer quarter, there will be no need to wonder to what extent unexplained intercarrier cost differences are due to differing winter weather conditions.

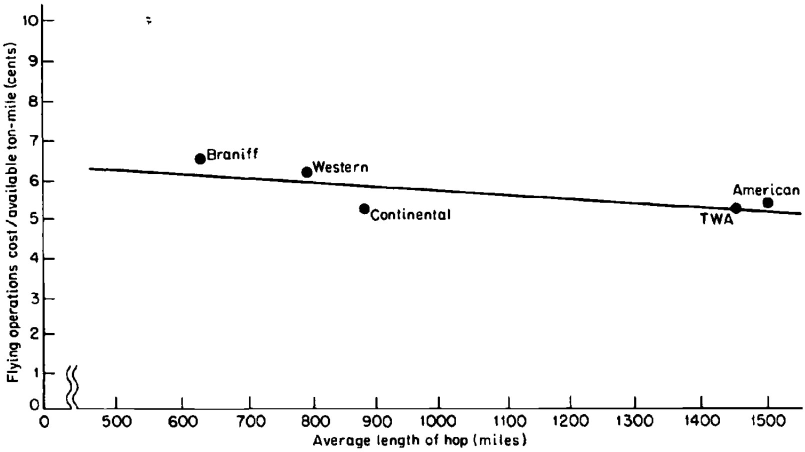
Table 2 shows average cost by categories for the third quarter of 1961. Flying operations consist of fuel costs and pilots' salaries; maintenance represents the costs of plane overhaul; passenger service includes stewardess salaries and food; aircraft and traffic servicing is mostly payroll for airport personnel who check in passengers, fuel planes, and load baggage; promotion and sales represents reservations agents, salesmen, and advertising; general and administrative covers the central office; and depreciation includes rental of planes as well as amortization of planes and ground equipment. Four of these categories cannot be considered in this analysis because a carrier's cost performance therein may be related to its marketing success, and thus economies might reduce revenues instead of increasing profits. These are: passenger service, promotion and sales, general and administrative, and depreciation (which, of course, reflects the structure and size of the fleet each carrier has chosen for competition on its routes). But the remaining three categories, flying operations, maintenance, and aircraft and traffic servicing, are relatively unrelated to attracting passengers, and so any savings from increased efficiency would increase profits.

Flying Operations

Pilot salaries and fuel are the major cost items in the flying operations category. The average cost of these items should vary inversely with the average length of flight hop. With costs measured per ton-mile, the longer the flight, the greater the proportion of salary and fuel expended in cruising, and the less spent in taxiing, landing, and taking off. Surprisingly enough, however, almost no statistical relationship can be established between average length of hop and average cost of flying operations: the correlation coefficient is only −.09.

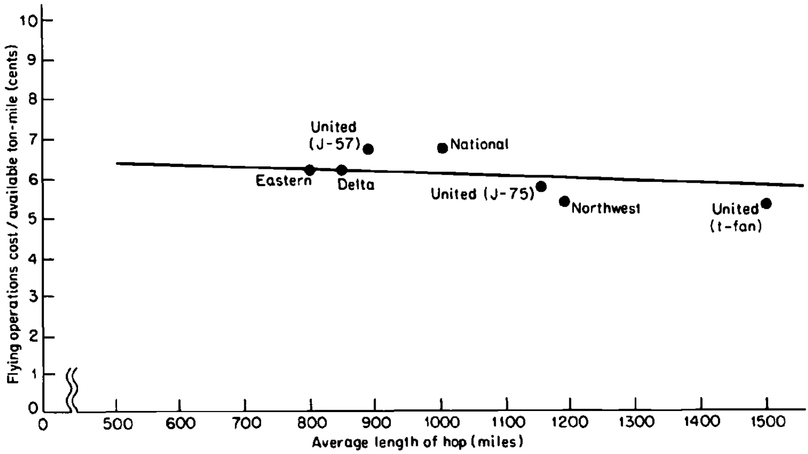
Two possible causes for intercarrier differences in average costs of flying operations are: the varying presence of relatively economical

Figure 1
Average Cost of Flying Operations Related to Average Length of Hop, Boeing 707



SOURCE: CAB Form 41, September 30, 1961. Regression line calculated to be $Y = 6.6 + -.0009X$.

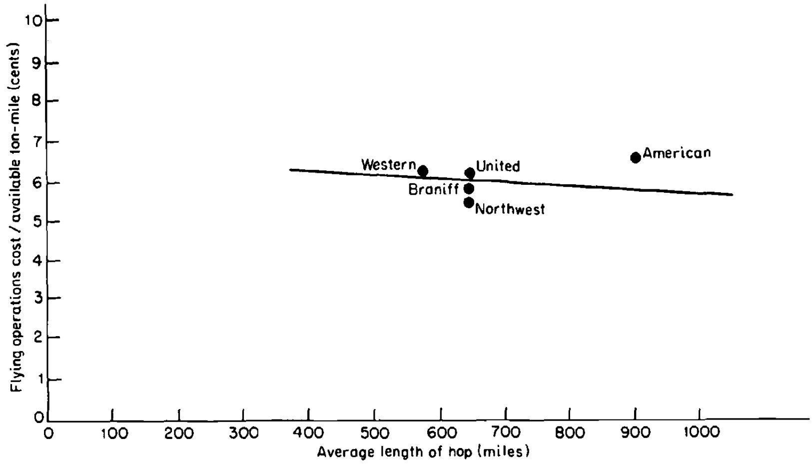
Figure 2
Average Cost of Flying Operations Related to Average Length of Hop, Douglas DC-8



SOURCE: CAB Form 41, September 30, 1961. Regression line calculated to be $Y = 6.55 + -.0004X$.

Figure 3

Average Cost of Flying Operations Related to Average Length of Hop, Boeing 720

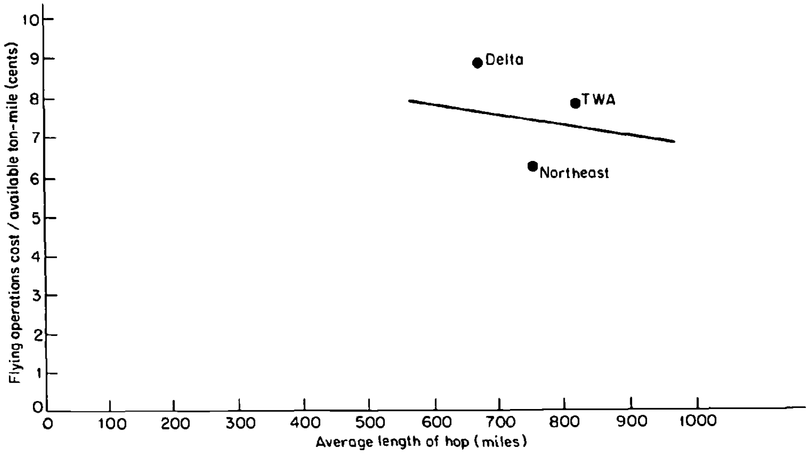


SOURCE: CAB Form 41, September 30, 1961. The calculated regression line has an upward slope, which conflicts with *a priori* expectations. The relatively high cost reported by American gives the curve an upward bias, but this may be due to some sort of inefficiency rather than to a fixed operational characteristic of the plane itself. Since the plane should have roughly the same cost characteristics at the relevant hop lengths of 500–900 miles as its big brother, the Boeing 707, the curve calculated for the latter has been used here.

and uneconomical planes in each carrier's fleet (hereafter referred to as "fleet structure"), and the differential efficiency of operating a particular plane a particular length of flight. To distinguish between these two possible causes, we must estimate a "normal" relation between length of hop and average cost of flying operations for each plane type.

Figures 1 through 10 present, by plane type and by carrier, average flying operations costs per available ton-mile (as opposed to revenue ton-mile) plotted against the average length of hop. The charts are arranged in a sort of reverse technological order, beginning with the pure jets, then the prop-jets, the four-engine piston planes, and finally a two-engine piston plane. Identification of a normal cost relation becomes progressively more difficult as one moves from the jets to the older planes. In fact, conventional regression analysis yields meaningful results only for the Boeing 707 and DC-8. After that, intuition must

Figure 4
Average Cost of Flying Operations Related to
Average Length of Hop, Convair 880



SOURCE: CAB Form 41, September 30, 1961. The calculated line has an extreme downward slope, which is illogical at the 600–800 mile length of hop relevant here. The curve was plotted, instead, with a slope similar to, but slightly steeper than, that of the 707, and raised upward to conform with the relatively high-cost performance reported for the 880.

take over the job; for instance, the calculated regression for Figure 3, the Boeing 720, would show costs *rising* with increasing length of hop! Intercarrier deviations become extreme for Figures 5 through 10; for instance, the three carriers using the Viscount have an almost identical average length of hop, but widely differing costs. A mathematically calculated curve for the Viscount would be vertical.

Most of the "normal" curves shown, then, are freehand, visual, and inductive representations rather than precise calculations.[9] Since any estimate of individual carrier deviations from the normal will be no more precise than the normal itself, the succeeding investigation must be taken as a description of general tendencies only.

Table 3 shows the calculation of each carrier's deviation from the "normal cost" of operating its fleet. This estimate is derived by

[9] Caves' study (*ibid.*, p. 68) presents some general information helpful in determining the relative expense of flying different plane types at different stage lengths.

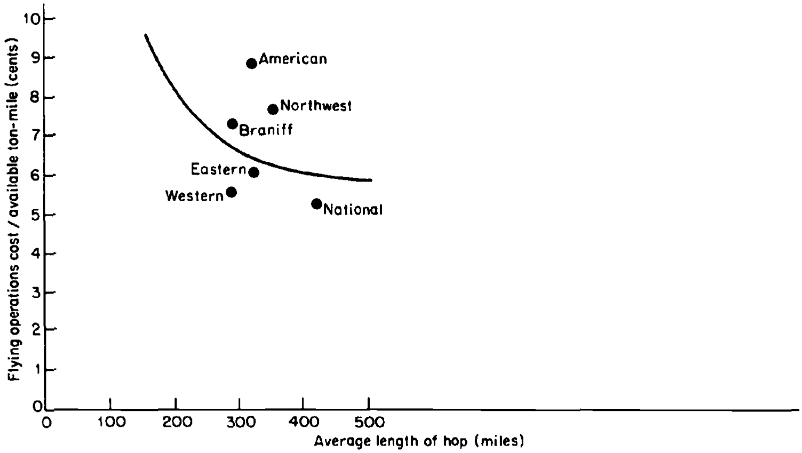
TABLE 3

WEIGHTED CARRIER DEVIATIONS FROM THE "NORMAL" COST OF FLYING OPERATIONS, THIRD QUARTER, 1961
(cents per available ton-mile)

	American	Braniff	Continental	Delta	Eastern	National	Northeast	Northwest	TWA	United	Western
Boeing 707	+.036	+.080	-.350						-.150		+.080
Douglas DC-8				+.027	-.019	+.288		-.114		+.039	
Boeing 720	+.320	-.016						-.072		+.036	+.022
Convair 880				+.238			-.624		+.132		
Lockheed Electra	+.254	+.119			-.084	-.210		+.505			-.380
Viscount			0				-.750			+.343	
Douglas DC-7	+.072	+.099		-.125	-.540	-.170		0		+.040	
Douglas DC-6	+.176	+.140		-.195		-.090	+.960	0		+.234	-.190
Constellation					-.150				+.405		
Convair Piston	+.125	+.184		0	0	-.140				+.026	
Total	+.983	+.606	-.350	-.055	-.755	-.322	-.414	+.319	+.387	+.718	-.468

Source: Figures 1 through 10 for normal costs; percentage of service provided by each plane type from CAB Form 41, 9-30-61, Schedule T-3. For method of estimation, see text.

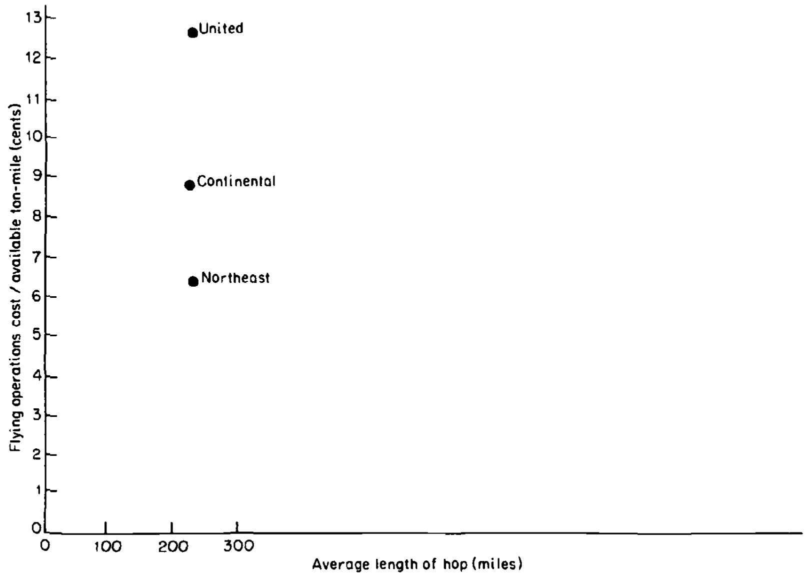
Figure 5
Average Cost of Flying Operations Related to Average Length of Hop, Lockheed Electra



SOURCE: CAB Form 41, September 30, 1961. This curve and those for the DC-6 and DC-7 were difficult to draw; almost anything could be justified. It was assumed that at some hop length in the vicinity of 100 miles the curves would become vertical, and that constant costs would eventually be reached between 500 and 1000 miles. Caves reports some general figures for these planes. With these in mind, the figures for this plane, the DC-7, and DC-6 were superimposed on each other, and the curves were drawn approximately parallel, with the DC-7 highest, the DC-6 next, and the Electra lowest.

multiplying the cost deviation for each plane type by the percentage of service provided by that plane type. For instance, Northwest reported 7.6 cents per available ton-mile for its Lockheed Electras (Figure 5) which flew an average hop of 356 miles; the "normal cost" at 356 miles was approximately 6.2 cents. Since the Electra contributed 36 per cent of Northwest's available ton-miles, the deviation of 1.4 cents is multiplied by .36, to obtain the .505 cent figure shown in Table 3. When these deviations are summed for all plane types, it can be seen that Northwest's average cost of flying operations would have been lower by .319 cents per available ton-mile if it had flown each of its planes at "normal cost." If we adjust each carrier's cost figures for their deviation from "normal," we provide some clues to the explanation of the absence of correlation between *reported* average cost of flying operations and length of hop. Length of hop related to *adjusted* costs

Figure 6
Average Cost of Flying Operations Related to Average Length of Hop, Vickers Viscount

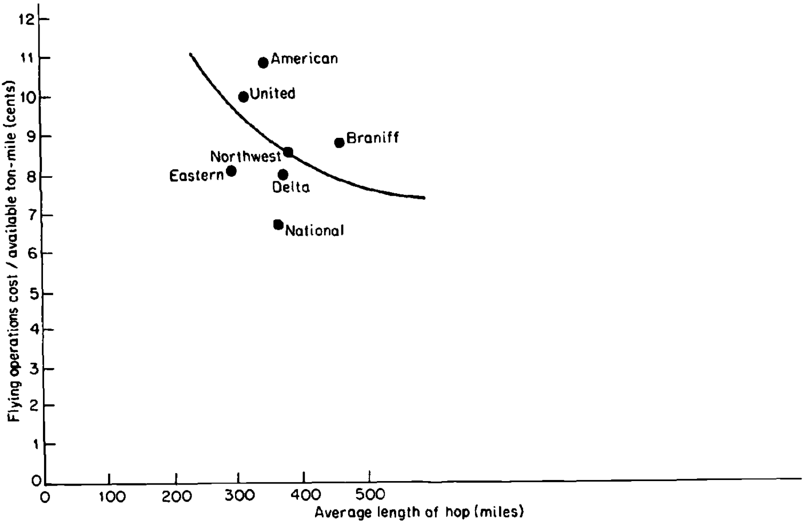


SOURCE: CAB Form 41, September 30, 1961. No curve was attempted here, since all carriers report the same length of hop. Continental is taken as "normal."

yields a —.77 correlation coefficient, as opposed to —.09 before adjustment. Most of the remaining unexplained difference is probably due to the structure of each carrier's fleet: the normal curves indicate, for example, that in general the Boeing 720 is cheaper to operate than the Convair 880.

Thus we conclude that intercarrier differences in flying operation costs are attributable to length of hop, fleet structure, and deviations from normal cost, as shown in Table 3. But what accounts for these deviations—why do some carriers operate more efficiently than others? It is difficult to believe that carriers differ greatly in the gas mileage they obtain from a particular plane type. Pilot salaries, on the other hand, may be susceptible to cost control. Pilots are paid a flat rate per month, with supplementary pay based on aircraft type, night flying, over-water flying, and so on; the maximum permissible flying time is eighty-five hours per month. Given this pay set-up, an efficient carrier would be

Figure 7
Average Cost of Flying Operations Related to Average Length of Hop, Douglas DC-7



SOURCE: See note to Figure 5.

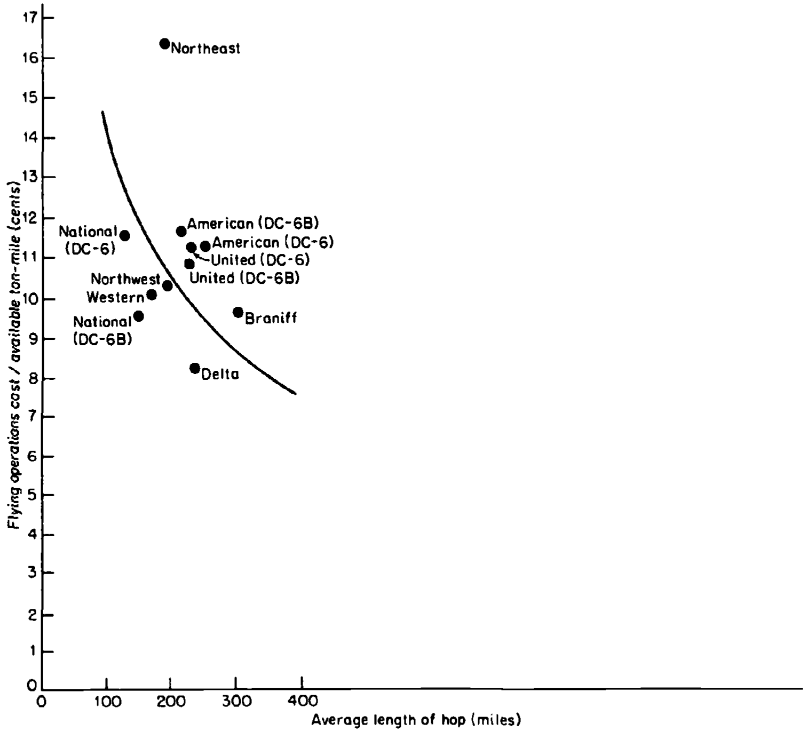
TABLE 4

A "PILOT STAFFING INDEX," THIRD QUARTER, 1961

	Man-Hours Required (1)	Flight Crew on Payroll as of 9/30/61 (2)	Column 1 Divided by Column 2 (3)
American	280,700	2,018	139.2
Braniff	80,800	510	158.0
Continental	61,900	287	215.0
Delta	121,900	785	155.0
Eastern	306,900	2,334	131.6
National	73,800	447	165.0
Northeast	62,800	363	172.9
Northwest	71,400	660	108.2
TWA	239,600	2,010	119.0
United	448,400	3,044	146.8
Western	57,900	353	163.8

Source: CAB Form 41, September 30, 1961, Schedules P-10 and T-3.

Figure 8
Average Cost of Flying Operations Related to Average Length of Hop, Douglas DC-6



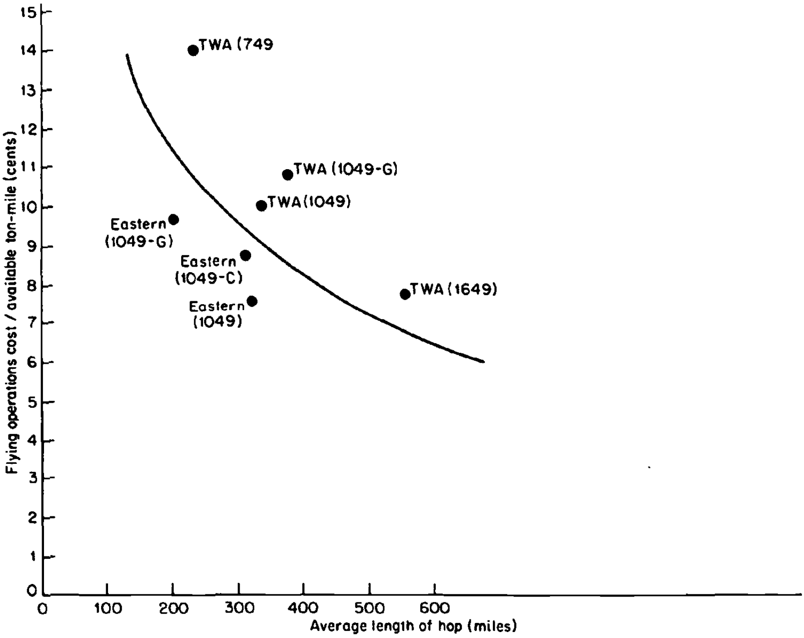
SOURCE: See note to Figure 5.

sure to schedule its pilots as close to 85 hours per month as possible, to spread the fixed base pay over maximum pilot output. An excess of pilots on a carrier's payroll might mean that some of the men were receiving full base pay for substantially less than 85 hours of work. (For instance, a former Northeast pilot cites instances of working three hours a month while receiving full base pay.[10]) Second, the presence of relatively few pilots on the payroll indicates that savings are being made in training expense.

Table 4 presents computations designed to indicate relative pilot understaffing or overstaffing. The total number of man-hours required

[10] Related to the author in a conversation with the former pilot, February 1962.

Figure 9
Average Cost of Flying Operations Related to
Average Length of Hop, Constellation (All Models)



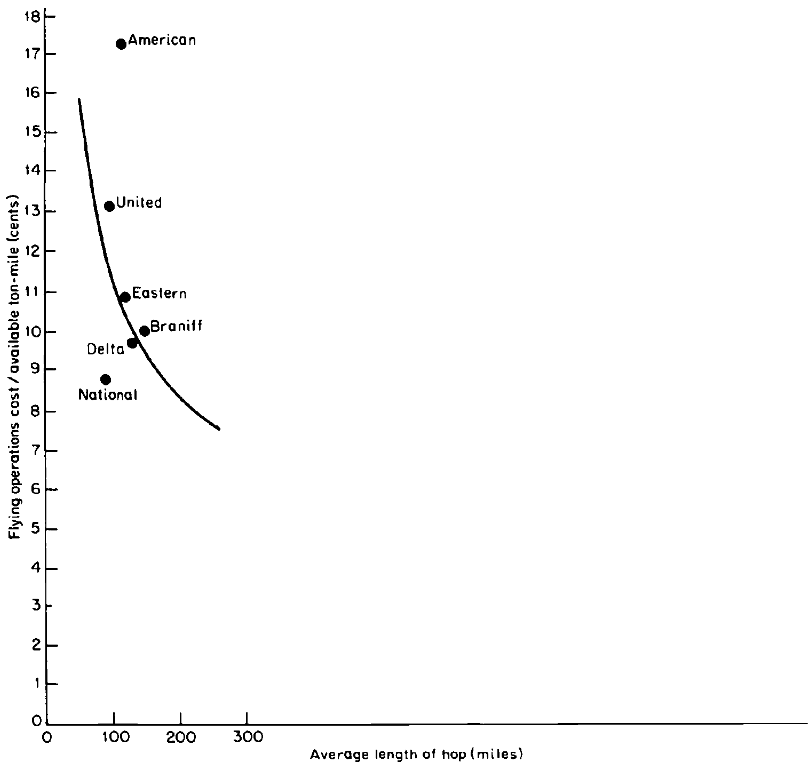
SOURCE: CAB Form 41, September 30, 1961. Since only two airlines report substantial use of this plane, it was impossible to achieve any idea of the "normal" when the many different models were viewed separately. Here they are combined. The curve, drawn parallel to, and between, the DC-6 and DC-7 curves, appears a good fit.

during the third quarter is divided by the total number of pilots, co-pilots, and flight engineers on the payroll as of September 30, 1961. (Total man-hour requirements take account of differing labor contracts and the fact that different plane types require different numbers of men in the cockpit.) Inspection of a scatter diagram indicates that this "staffing index" is negatively related to the deviations from normal cost calculated in Table 3. The fitted regression is clearly significant

$$y = 186.8 - \underset{(.52)}{1.12}x.$$ [11]

[11] Eastern was eliminated in this calculation. Its achievement of a substantial deviation below "normal cost" for its fleet, despite relative pilot overstaffing, may be due to its practice of cramming a large number of seats into its propeller planes.

Figure 10
Average Cost of Flying Operations Related to
Average Length of Hop, Convair Piston (Two-Engine)



SOURCE: CAB Form 41, September 30, 1961. The lower portions of this curve are parallel to the DC-6 and DC-7 curves; the upper portions are drawn almost vertical to represent the high average cost of stages under 100 miles. At all relevant stage lengths shown here, the curve represents lower cost than the DC-6, because the Convair was designed for relatively economical performance on short hops.

Although the use of freehand curves necessarily means that this analysis is imprecise, it is tempting to calculate total cost savings attainable through improved managerial efficiency. This will at least show the general orders of magnitude involved. In the preceding analysis, intercarrier cost differences were first adjusted for differing lengths of hop and fleet composition. Then the residual cost differences proved to be significantly related to a fleet staffing index. Let us postulate a "normal" carrier as one which has a zero deviation in Table 3. The regression line calculated above indicates that the five carriers which had deviations above "normal" in Table 3 would have saved money if they had achieved the same staffing index as the hypothetical "normal" carrier. Cost savings for the five high-cost carriers are calculated in Table 5.

TABLE 5

POTENTIAL COST SAVINGS FOR FLYING OPERATIONS, THIRD QUARTER, 1961

	"y" Indicated by Regression (dollars per ton-mile)	Actual Output (ton-miles)	Cost Savings (dollars)
American	.00309	356,186,000	1,100,000
Braniff	.00099	65,459,000	64,000
Northwest	.00657	83,174,000	546,000
TWA	.00536	291,521,000	1,563,000
United	.00224	470,896,000	1,054,000

Source: Tables 3 and 4.

The first column shows the "*y*" indicated by the regression equation for each carrier's reported staffing index; i.e., the average cost deviation above normal which is related to each carrier's subnormal staffing. This is multiplied in Table 5 by output to obtain an actual dollar figure of potential savings for the third quarter of 1961.

Maintenance

The economic variables affecting the level of average maintenance cost should be identical with those affecting average flying operations costs, with the addition of expected economies of scale. Length of hop is again revelant, since the government fixes overhaul intervals in hours for all plane types. High average speed (achieved by relatively long flight length) implies that a relatively large percentage of the time between overhauls is productive. Cost levels would be affected also by the structure of a carrier's fleet—airlines have different proportions of planes that are relatively expensive or inexpensive to maintain. A priori, economies of scale should be present, since a large carrier with large numbers of a specific plane type would presumably be better able fully to utilize its maintenance base, and would also make savings on spare parts. If our hypothesis regarding differential managerial efficiency is correct, we should expect the assembly-line techniques of airplane overhaul to show substantial potential for cost control.

TABLE 6

AVERAGE MAINTENANCE COST AND LENGTH OF HOP BY CARRIER AND PLANE TYPE, THIRD QUARTER, 1961

Plane Type	Carrier	Length of Hop (miles)	Maintenance Cost (cents per available ton-mile)
Boeing 707	American	1,500	4.7
	Braniff	630	3.9
	Continental	880	3.1
	TWA	1,445	3.3
	Western	795	3.0
Douglas DC-8	Delta	855	6.3
	Eastern	800	2.7
	National	1,010	2.5
	Northwest	1,190	3.0
	United (J-57)	897	3.7
	United (J-75)	1,162	3.3
	United (T-fan)	1,500	3.1
Boeing 720	American	900	4.7
	Braniff	650	2.6
	Northwest	650	2.2
	United	650	3.9
	Western	575	3.7
Convair 880	Delta	663	6.4
	Northeast	755	4.8
	TWA	815	6.0
Lockheed Electra	American	313	8.9
	Braniff	280	8.2
	Eastern	324	3.7
	National	415	4.0
	Northwest	356	3.8
	Western	298	4.1
Vickers Viscount	Continental	231	7.7
	Northeast	236	4.5
	United	230	8.6
Douglas DC-7	American	342	10.1
	Braniff	467	6.0
	Delta	381	6.2
	Eastern	307	4.9
	National	370	6.3
	Northwest	388	7.4
	United	315	7.2
Douglas DC-6	American (DC-6)	244	9.3
	American (DC-6B)	222	9.3
	Braniff	299	7.2
	Delta	239	6.8
	National (DC-6)	135	9.0
	National (DC-6B)	152	8.0
	Northeast	190	11.8
	Northwest	204	6.0
	United (DC-6)	234	7.0
	United (DC-6B)	233	6.4
	Western	179	5.5

(continued)

TABLE 6 (concluded)

Plane Type	Carrier	Length of Hop (miles)	Maintenance Cost (cents per available ton-mile)
Lockheed Constellation	Eastern (1049)	322	7.8
	Eastern (1049-C)	317	3.9
	Eastern (1049-G)	198	5.1
	TWA (749)	215	12.8
	TWA (1049)	348	4.9
	TWA (1049-G)	347	10.7
	TWA (1649)	557	4.4
Convair Piston	American	134	14.9
	Braniff	155	5.9
	Delta	144	4.2
	Eastern	126	10.8
	National	97	7.2
	United	112	9.2

Source: CAB Form 41, September 30, 1961.

The correlation between average maintenance costs and length of hop has a coefficient of .16, implying a very weak connection between high maintenance costs and *increasing* length of hop. Again we must look further and examine carrier fleets by plane type. These statistics are presented in Table 6.

To distinguish between the structure of a carrier's fleet and its efficiency in maintaining a given plane, we must consider "normal" maintenance costs for each plane type. This is a considerably easier task than the preceding analysis of flying operations. Table 6 shows no relation at all between length of hop and average maintenance cost for any type of plane. In some cases a carrier reports relatively high costs for a relatively short flight, but always there is a carrier reporting lower costs for about the same hop. For instance, Delta reports average maintenance cost for the DC-8 of 6.3 cents per ton-mile for an 855-mile trip, while Eastern achieves a 2.7 cost figure at an 800-mile trip. The lowest-cost carriers etch a constant average cost curve over relevant trip lengths for most plane types.[12]

Eliminating length of hop, then, as an explanation of differences, we need not develop normal curves. Instead, the lowest-cost carrier is considered "the efficiency norm" for each plane type; Table 7 presents deviations of costs of individual carriers from those of the lowest-cost carrier, weighted by the percentage of output contributed by each plane type in the carrier's fleet (thus, Table 7 is the equivalent of Table 3).

[12] To save space, these statistics are shown in tabular form instead of graphically as in Figures 1 through 10.

TABLE 7

INDIVIDUAL CARRIER DEVIATIONS FROM THE "EFFICIENT" COST OF MAINTENANCE, WEIGHTED FOR FLEET STRUCTURE, THIRD QUARTER, 1961
(cents per available ton-mile)

	American	Braniff	Continental	Delta	Eastern	National	Northeast	Northwest	TWA	United	Western
Boeing 707	.61	.14	.07						.15		0
Douglas DC-8				.76	.07	0		.10		.39	
Boeing 720	.80	.06						0		.31	.31
Convair 880				.30			0		.26		
Lockheed Electra	.57	.77			0	.11		.04			.15
Viscount			.67				0			.28	
Douglas DC-7	.21	.12		.32	0	.14		.25		.23	
Douglas DC-6	.42	.24		.17		.25	1.09	.09		.20	0
Constellation					.08	0			.84		
Convair Piston	.21	.44		0	.12	.12				.10	
Total deviation	2.82	1.77	.74	1.55	.27	.62	1.09	.48	1.25	1.51	.46
Adjusted cost[a]	3.20	4.00	3.40	4.40	4.10	3.60	4.90	3.60	3.90	3.50	3.50

Source: Tables 2 and 6.

[a]Adjusted cost is each carrier's actually reported maintenance cost minus the total deviation calculated in this table.

For example, if American had been able to overhaul each of its plane types as inexpensively as the lowest-cost carrier for each plane, it would have saved about 2.8 cents per ton-mile, lowering its reported average maintenance cost from 6.0 cents to 3.2 cents.

Adjusted costs after elimination of the "efficiency deviation" are shown in Table 7. Relating these costs to length of hop again, the correlation coefficient is —.45, as compared to .16 before adjustment for differences in efficiency. The structure of each carrier's fleet probably accounts for much of the remaining intercarrier difference. Northeast, Delta, and TWA could have improved their standing, for instance, by having ordered the Boeing 720 instead of the Convair 880 as their medium-range jet. Braniff flies the same selection of planes as American, but its shorter average trip length (dictated by its route structure) forces it to fly a much greater percentage of its output at unproductive low speeds.

Is this analysis reasonable? The individual carrier deviations for each plane type bear a marked resemblance to deviations from the "normal" curves calculated for flying operations. The .86 correlation coefficient between deviations in flying operations and maintenance is strikingly high, indicating that cost control is a talent which certain carriers apply with equal success to both flying operations and maintenance costs. Table 8 shows that maintenance deviations are strongly related to the productivity of maintenance labor, just as flying operations deviations are related to a "pilot staffing index." The data in Table 8 yield a linear regression given by the equation:

$$y = 2.49 - \underset{(.0000063)}{.0000145}x.$$ [13]

Potential cost savings are calculated in Table 9. Let us postulate an "efficient" carrier which repairs each of its planes as efficiently as the lowest-cost actually reported performance (i.e., this hypothetical carrier has a zero deviation in Table 7). The regression line calculated above indicates that carriers would have saved money if they had achieved the maintenance employee productivity of the postulated zero-deviation carrier. In Table 9 the first column shows the "y" calculated from the regression equation for each carrier's reported level of maintenance productivity. This is multiplied by output to obtain an actual dollar figure of potential savings for the third quarter of 1961.

[13] See footnote 11.

TABLE 8

RELATION OF MAINTENANCE DEVIATIONS TO PRODUCTIVITY OF MAINTENANCE LABOR

	Available Ton-Miles Divided by Maintenance Labor on Payroll (1)	Deviations from "Efficient" Cost of Maintenance (cents per available ton-mile) (2)
American	72,500	2.82
Braniff	61,000	1.77
Continental	113,000	.74
Delta	75,000	1.55
Eastern	76,000	.27
National	124,000	.62
Northeast	81,000	1.09
Northwest	85,000	.48
TWA	86,000	1.25
United	67,000	1.51
Western	169,000	.46

Source: Col. 1 from CAB Form 41, September 30, 1961, Schedule P-10. Col. 2 from Table 7.

TABLE 9

POTENTIAL COST SAVINGS FOR MAINTENANCE, THIRD QUARTER, 1961

	"y" Indicated by Maintenance Cost Regression (dollars per ton-mile)	Actual Output (thousands of ton-miles)	Cost Savings (thousand dollars)
American	.0144	356,186	5,129
Braniff	.0161	65,459	1,053
Continental	.0074	66,878	494
Delta	.0140	122,169	1,710
National	.0062	88,210	547
Northeast	.0132	48,860	645
Northwest	.0109	83,174	906
TWA	.0124	291,521	3,614
United	.0152	470,896	7,157
Western	.0046	62,544	300

Source: Tables 7 and 8.

Aircraft and Traffic Servicing

The aircraft and traffic servicing payroll includes most of the airline personnel at the airport. A relatively long hop should be related to low average cost in this category, since a long flight requires more or less the same airport operations as a short one. Different airports may have differing pay scales; some very large airports may require extra personnel because the check-in area is a long distance from the plane boarding area—thus an airline's costs may be affected by the varying requirements of its particular set of airports. Since the costs of cleaning, fueling, and checking a plane are greater at the end of a flight than at intermediate stops, an airline with a relatively large number of dead-end route segments should have a cost disadvantage. Differing managerial efficiency in cost control may also explain some intercarrier variation in the average cost of aircraft and traffic servicing.

Relating length of hop to average cost in this category yields a +.30 correlation coefficient, although there is an a priori presumption of a negative relation. But Table 10 looks strangely familiar. American, Braniff, TWA, and United, identified earlier as relatively inefficient in the flying operations and maintenance categories, again show higher costs and *longer* hops than Continental, Eastern, National, and

TABLE 10

RELATION OF AVERAGE LENGTH OF HOP TO AVERAGE COST OF AIRCRAFT AND TRAFFIC SERVICING, THIRD QUARTER, 1961

	Average Length of Hop (miles)	Average Cost of Aircraft and Traffic Servicing (cents per available ton-mile)
American	430	4.9
Braniff	344	5.3
Continental	298	2.8
Delta	278	4.9
Eastern	239	3.8
National	310	3.4
Northeast	232	4.8
Northwest	354	2.9
TWA	525	3.9
United	340	5.1
Western	294	3.4

Source: CAB Form 41, September 30, 1961, Schedule T-3; CAB, *Traffic Statistics*, and *Financial Statistics*, various issues.

TABLE 11

AVERAGE COST OF AIRCRAFT AND TRAFFIC SERVICING BY CARRIER, THIRD QUARTER, 1961

	Aircraft and Traffic Servicing Cost (thousands of dollars)	Seats Departing (thousands)	Cost Per Seat Departing (dollars)
American	16,442	4,497	3.34
Braniff	2,871	1,832	1.57
Continental	2,119	1,282	1.65
Delta	5,037	3,003	1.67
Eastern	10,959	7,222	1.52
National	2,863	1,681	1.70
Northeast	2,059	1,362	1.51
Northwest	2,621	1,651	1.59
TWA	9,643	3,386	2.85
United	19,935	8,864	2.25
Western	1,855	1,418	1.31

Source: CAB Form 41, September 30, 1961, Schedules P-9.2 and T-4; *Official Airline Guide Quick Reference Edition*, July 1, 1961; and Appendix A.

Western, which were efficient performers in the previous analysis. Is it possible that managerial cost control will again explain the illogical relation between average cost and length of hop? It is possible to isolate the effect of cost control from intercarrier differences in route structure?

We can extract trip length from average cost by changing our output denominator. Until now, output has been measured in available ton-miles. Airport operations, however, are better measured by "seats departing"—the product of departures and available sets per plane. This measure accounts simultaneously for frequency of operations and the size of planes used at each particular airport. We can account for the high cost of servicing turnaround flights by classifying each airline station as "turnaround," "through," or "mixed," and treating each type separately. Table 11 shows the wide variation among the carriers in average cost per "departing seat"—note that American's cost is more than twice Eastern's!

The analysis of flying operations and maintenance costs developed "normal" or "efficient" costs for each plane type in an attempt to separate the effects of managerial cost control and fleet structure. The same technique can be applied to aircraft and traffic servicing, to separate the effects of route structure and managerial efficiency, although the computation is more complicated (there are 254 airports with 568 separate airline station operations producing 8,600 departures per day, or 475,000 departing seats). When two or more airlines serve an airport with the same type or operation (turnaround, mixed, or through), the carrier/type with the lowest average cost is considered "normal." Thus, in Table 12, United has the lowest average cost, of the mixed carriers at Cleveland. Therefore \$2.08 per "departing seat" is considered the efficient cost for the other mixed carriers, American and TWA. Similarly, Northwest's performance is the better of the two through operations, so its cost is considered efficient for Eastern (the other through operation). When a carrier is the only one of its type serving a particular airport, its costs can be compared to a regional model—the airline station of the same size and type achieving the lowest cost in a three- or four-state region.

When we follow the procedure of Table 12 for all 254 airports (the detailed results are too bulky to be shown in detail), we obtain the totals shown in Table 13. At one extreme, American (quite consistently the "inefficiency champion") spent \$8,763,000 more than the "efficient cost" of operating its set of airport stations. This means that its actual costs were more than twice as much as the "efficient cost." Western, on the other hand, exceeded efficient cost by only 7 per cent.

Route structure explains much of the variation in average "adjusted cost" (col. 3 in Table 13). An examination of the raw statistics showed that costs are relatively higher at large airports, and also at terminal stations. A crude "route structure index," the percentage of output provided in large airports (more than 300,000 seats departing in the third quarter of 1961) multiplied by the percentage of output produced in terminal stations, has a .66 rank correlation with adjusted cost. This is shown in Table 14.

To further check our original assumptions, we again tested the relation of average cost to length of hop. "Raw" cost showed an illogical .30 correlation coefficient; adjusted cost yields a $-.76$ coefficient. As another support for the consistency of the analysis, the computed average *deviations* show a strong negative relation to airport output per airport employee, as shown in Table 15. The regression line relating aircraft and traffic servicing deviations to airport employee productivity is $y = 2.214 - \underset{(.00029)}{.00126}x$. As noted in the analyses of flying operations and maintenance, inefficiency seems to be a matter of overstaffing. The data strongly support the claim that a particular management is consistently efficient or inefficient across several cost categories. The carrier standing in aircraft and traffic

TABLE 12

CALCULATION OF "EFFICIENT" COST OF AIRCRAFT AND TRAFFIC SERVICING AT CLEVELAND, THIRD QUARTER, 1961

	American	Eastern	Northwest	TWA	United
A. Type of operation	Mixed	Through	Through	Mixed	Mixed
B. Seats departing (thousands)	102.2	141.5	54.4	23.6	434.2
C. Cost (thousand dollars)	253.0	169.5	50.6	73.0	903.0
D. Average cost (line C divided by line B)	2.48	1.20	.93	3.09	2.08
E. "Efficient cost"	2.08	.93	.93	2.08	2.08
F. Average cost deviation (line D minus line E)	.40	.27	.00	1.01	.00
G. Total deviation (line B times line F, thousand dollars)	41.0	38.2		23.8	

Source: See Table 11 and Appendix A.

TABLE 13

DEVIATION FROM "EFFICIENT COST" OF AIRCRAFT AND TRAFFIC SERVICING, THIRD QUARTER, 1961

	Total Deviation (thousand dollars) (1)	Deviation Divided by Seats Departing (dollars) (2)	Adjusted Cost Divided by Seats Departing (dollars) (3)
American	8,763	1.78	1.56
Braniff	759	.41	1.16
Continental	456	.36	1.29
Delta	1,018	.34	1.33
Eastern	2,291	.32	1.20
National	798	.47	1.23
Northeast	231	.17	1.34
Northwest	353	.21	1.38
TWA	3,440	1.02	1.83
United	6,969	.78	1.47
Western	131	.09	1.22

Source: See Table 12 and Appendix A.

TABLE 14

CALCULATION OF A "ROUTE STRUCTURE" INDEX

	Percentage of Output[a] Provided in Large Airports (1)	Percentage of Output[a] in Turn-around Stations (2)	Column 1 Times Column 2 (3)	Adjusted Cost (dollars) (4)
American	69	22	1,520	1.56
Braniff	50	14	700	1.16
Continental	40	28	1,120	1.29
Delta	60	18	1,080	1.33
Eastern	60	19	1,140	1.20
National	62	27	1,670	1.23
Northeast	65	37	2,400	1.34
Northwest	68	20	1,360	1.38
TWA	80	31	2,420	1.83
United	68	21	1,430	1.47
Western	48	25	1,200	1.22

Source: The first two columns were computed from the basic data referred to in Table 13 and Appendix A. Col. 4 repeats col. 3 of Table 13.

[a]Here output is in terms of seats departing, not available ton-miles.

TABLE 15

A COMPARISON OF AIRPORT EMPLOYEE PRODUCTIVITY WITH AIRCRAFT AND TRAFFIC SERVICING COST DEVIATIONS

	Seats Departing (1)	Airport Personnel (2)	Column 1 Divided by Column 2 (3)	Cost Deviation (4)
American	4,927,000	6,184	797	1.78
Braniff	1,832,000	1,406	1,302	.41
Continental	1,282,000	801	1,600	.36
Delta	3,003,000	2,765	1,085	.34
Eastern	7,222,000	4,255	1,690	.32
National	1,680,000	1,269	1,320	.47
Northeast	1,362,000	913	1,495	.17
Northwest	1,651,000	1,083	1,525	.21
TWA	3,385,000	4,416	765	1.02
United	8,864,000	6,559	1,310	.78
Western	1,418,000	801	1,720	.09

Source: Col. 1, see Table 11; col. 2, CAB Form 41, Schedule P-10, Lines 6126.1, 6226.1, 6326.1, 6126.2, 6226.3, 6226.4; col. 4, see col. 2 of Table 13.

TABLE 16

ESTIMATED COST SAVINGS POSSIBLE IN THE AIRCRAFT AND TRAFFIC SERVICING CATEGORY, THIRD QUARTER, 1961

	Dollar Deviation Indicated by Regression ("*y*") (1)	Output (Seats Departing) (2)	Dollar Cost Savings (3)
American	1.21	4,497,000	5,441,000
Braniff	.57	1,832,000	1,044,000
Continental	.20	1,282,000	256,000
Delta	.85	3,003,000	2,552,000
Eastern	.09	7,222,000	649,000
National	.55	1,681,000	925,000
Northeast	.33	1,362,000	449,000
Northwest	.29	1,651,000	478,000
TWA	1.25	3,386,000	4,232,500
United	.56	8,864,000	4,963,000
Western	.05	1,418,000	71,000

Source: Tables 13 and 15.

servicing deviations shows a .80 rank correlation with the average carrier ranking in the flying operations and maintenance deviations.

We again postulate an "efficient" carrier which services each of its airports at the minimum achieved cost for an operation of its type. (Note that Western is not far from achieving a perfectly efficient performance.) The regression line calculated above indicates that carriers would have saved money if they had achieved the airport employee productivity of the postulated zero-deviation carrier. Col. 1 of Table 16 shows the "*y*" calculated from the regression equation for each carrier's reported level of airport employee productivity. This is multiplied by airport output to obtain, as before, an actual dollar figure of potential savings for the third quarter of 1961.[14]

Conclusion

Clearly this investigation has revealed some rather extraordinary figures. On the assumption that inefficiency shows no seasonal variation, the

[14] Some of the high-cost performances in Table 16 may, to some extent, reflect sound long-run marketing strategy. For instance, extra people on the airport staff may be able to speed up check-in procedures or aircraft servicing during periods of peak traffic. Or, simply, having a large number of employees at the airport may improve an airline's marketing "image." But it is curious indeed that Continental, which maintains fewer airport personnel per departure-seat than its "high-cost" competitors, is able to service and turn around its planes in a shorter time.

quarterly savings calculated above for each cost category can be translated into an annual total of $176 million, as shown in the first column of Table 17. Table 17 also shows the potential improvement of profit margins and rates of return, on the assumption that potential economies in the three cost categories discussed above would not affect revenues and thus could be directly applied to operating profit. The industry's rate of return, on these assumptions, could have been more than tripled by more effective application of cost control.

Let us recall that the preceding analysis involved arbitrary assumptions and freehand curves, and to that extent the figures in Table 17 should be viewed with caution. It would be fair to conclude, however,

TABLE 17

NET PROFITS AND RATES OF RETURN BEFORE AND AFTER ADJUSTMENT FOR COST SAVINGS, YEAR ENDING SEPTEMBER 30, 1961
(dollar figures in millions)

	Cost Savings for the Year (1)	Net Profit: Before Adjustment (2)	Net Profit: After Adjustment (3)	Rate of Return (per cent): Before (4)	Rate of Return (per cent): After (5)
American	44.9	8.7	30.2	5.02	10.49
Braniff	8.7	0.7	4.9	3.71	10.09
Continental	2.9	1.1	2.5	6.38	8.43
Delta	16.4	4.1	12.0	7.81	16.50
Eastern	2.6	-6.2	-5.0	.04	.53
National	5.3	-5.0	-2.5	-3.96	.00
Northeast	4.2	-11.8	-7.6	-51.70	-29.03
Northwest	6.4	0.7	3.8	3.90	7.47
TWA	33.2	-0.4	6.5	.70	6.85
United[a]	50.7	-2.7	21.6	3.84	8.52
Western	1.2	0.5	1.1	3.35	4.44
Total	176.4	-19.2	67.5	2.16	7.05

Source

Col. 1: Savings for each airline were added from Tables 5, 9, and 16, and then were divided by the percentage of annual costs incurred in the third quarter, from CAB, *Quarterly Report of Air Carrier Financial Statistics, September, 1961.*

Col. 2: *Ibid.*

Col. 3: Because operating savings would be taxed at the 52 per cent corporate tax rate, 48 per cent of col. 1 has been added to col. 2. In the case of Northeast, taxes are not deducted because of that carrier's large outstanding tax credit.

Cols. 4 and 5: Rate of return is the sum of net profit after taxes plus interest charges, divided by investment. The figures for each carrier's interest charges and investment are taken from *ibid.*

[a]United's figures include those of Capital for the period prior to merger on June 1, 1961.

that there are differences between the cost levels of the various carriers which, after adjustment for identifiable economic variables, show a reasonably strong statistical relation to overstaffing. Every statistician knows, of course, that merely stating a statistical correlation does not prove a relation of cause and effect. Nevertheless, some field work has convinced this author that managerial laxity is an important cause of the various poor performances shown in Table 17.

Managerial inefficiency could be due to simple lack of concern with costs; possibly costs are considered "determined" by fleet and route structures so that management makes no effort to keep costs down. Or, again, it is possible that management realizes the importance of cost control but exercises it ineffectively. This author has found each of these attitudes in his contacts with airline management.

At "Everywhere Airlines" (for obvious reasons, names of airlines criticized have been changed), one of the worst performers in the preceding analysis, management officials interviewed seemed relatively unconcerned about costs; the main emphasis was on the need for fare increases. Instead of comparing the poor cost performance of their company to the competition, "Everywhere" men seemed to look at their problems either in isolation or as "general industry problems." When asked bluntly why Continental, for example, achieved a much lower average cost level, an "Everywhere" management man answered lamely: "It (Continental) is just a small airline which hasn't grown up yet." This comment, with its implications of diseconomies of scale, is not only meaningless in terms of the statistics presented above, but almost amusing considering the repeated comments at "Everywhere" that low profits were some sort of inevitable and uncontrollable plague wrought by disappointing demand, bad weather, and the CAB.[15]

"Columbia Airlines" is also a poor performer in our statistical analysis. In this light it is interesting to examine the "Columbia" treasurer's explanation of Continental's low costs:

"What are the factors limiting [Columbia] and other lines from lowering their costs to the 22–23¢ per ton-mile achieved by Continental?

1. A common sense balance between equipment utilization and load factor.
2. Differences in equipment types, average trip length, station locations.
3. Extent of obsolete piston fleet.
4. Maintenance policy differences—progressive versus deferred major overhaul.

[15] Based on an interview, December 18, 1961.

Continental has achieved a ton-mile cost lower than the industry principally through higher utilization . . . . I question Continental's method of achieving lower costs as an industry panacea. It may eventually be Continental's undoing." [16]

This statement supports our statistical suspicions; every factor mentioned except "maintenance policy differences" has been accounted for in our analysis of deviations from efficient performance. Utilization has been eliminated as a matter of concern by limiting our attention to two variable cost categories—flying operations and maintenance—and one category, aircraft and traffic servicing, which is unrelated to actual airplane costs. Differences in equipment types were accounted for by analyzing each plane type separately. Average trip length (length of hop) was adjusted for in flying operations, irrelevant in maintenance, or eliminated in aircraft and traffic servicing. Station locations were accounted for by taking individual stations or regional models as efficiency norms in the analysis of aircraft and traffic servicing. "Extent of obsolete piston fleet" is the same thing as differences in equipment types. Attributing cost differences to Columbia's deferred major overhaul as opposed to Continental's progressive maintenance proves nothing, as most of the efficient carriers in the maintenance category use deferred major overhaul. Certainly all these factors have something to do with Columbia's high cost level, but they do not disprove the implication of our analysis that Columbia could have saved a great deal of money by improving its cost control.

Another possible reason for managerial inefficiency is that, despite recognition of the need for improved cost control, the wrong techniques are used. The author witnessed this in detail during the past several years. "Economy" often seemed to be a matter of skimping on pencils, ticket stock, and paper clips, instead of that most important component of costs—people. Another factor is management's misuse of the quota system: in many cases the personnel quota develops from year to year by adding one year's expected traffic growth to the actual number of employees from the previous year. In this way an initial distortion, or a bad forecast, leads to overstaffing. Thus, in one case, even though ticket and reservations agents were sitting around with no work to do, the office manager was congratulating himself on being "two under quota" (the reservations manager was less blind; he admitted that he had hired fifty too many reservations agents). Another wasteful factor is the excess of supervisory personnel. Above an

[16] From a letter to the author, dated January 2, 1962.

ordinary ticket counter salesman at this same office was: one senior agent, three supervisors, one "chief," one "assistant to the manager of city ticket offices," and the "manager of city ticket offices," not to mention the "ticket agent trainer."

In contrast to all this was a visit to Continental Airlines. The management seemed to pride itself on its low costs and require of itself that it lead the industry in low-cost performance.[17] On the desk of each executive was a company booklet (prepared monthly) comparing Continental's costs to those of other airlines. Continental keeps station costs down in small cities by, for example, sending employees home between flights, and in large stations by handling work for international carriers between peaks in its own operations. The budgeting director, in contrast to the officials from "Everywhere" and "Columbia" quoted above, was well aware that the principal way to keep costs low is to hire as few employees as possible.

This field work, then, provides a reasonable explanation of the statistical analysis. The inefficient carriers explain their unsatisfactory profits in terms of low revenues and CAB-induced over-competition, and do not concentrate enough on cost control. When these carriers do examine their costs, they explain their relative inefficiency in terms of fixed economic variables like route structure, over which management has no short-run control. Finally, on the basis of one close observation, it may be suggested that when the management of an inefficient airline does sporadically try to control costs, it concentrates too much on equipment and not enough on people.

Even if the industry had been able to save a *third* of the estimated potential cost savings calculated in Table 17, its rate of return would have been almost doubled. This raises an important question for the Civil Aeronatuics Board the next time it is asked by certain carriers to approve a merger or a fare increase because of low reported profits. Perhaps, in requesting fare increases, the inefficient carriers are penalizing the public. Perhaps more diligent cost control could eventually lead to a lower fare level. It is interesting in this connection that United, which recently has been a price leader upward, performed poorly in the statistical analysis of managerial efficiency, while Continental, a price leader downward, performed well. If efficient lines had more freedom to engage in free price competition, the inefficient lines would of necessity have to put a greater effort into cost contol or risk going out of business. This paper is in agreement with Caves' recent

[17] Based on an interview, December 19, 1961.

recommendation that CAB price regulation of the domestic trunk airlines should be abandoned.[18]

An additional insight into the reasons for relatively effective or ineffective cost control comes from a close examination of each carrier's route structure. For instance, Continental is at a disadvantage in competing with American, TWA, and United, because Continental's routes stop at Chicago, while the larger carriers fly farther east. Thus Continental, on its routes west of Chicago, must subsist on local traffic and connections, while the larger carriers can feed traffic through from their eastern cities. To run the same flight frequencies as the larger carriers, Continental's load factors are thereby lower, and it is compelled to cut costs. In a similar case, Western, one of the smallest trunklines, must compete along the west coast with United, which is the largest private air carrier in the world and can shuttle its many planes up and down the coast between trips to the east. Thus Western, in order to maintain a fleet large enough to compete with United, feels compelled to cut its costs. By the same analysis, United, American, and TWA, inefficient performers in this analysis, with their large fleets and profitable long-haul high-density routes, can more easily than the smaller lines maintain a high load factor and thus feel less pressure to control costs. This semipsychological factor is probably more important than any possible diseconomies of scale as an explanation of the apparent relative efficiency of small carriers. Delta and Braniff, two other inefficient carriers, are relatively small lines, but have a relatively high proportion of monopoly traffic. Thus, they can easily maintain a high load factor and feel little pressure to control costs. If the CAB is interested in promoting a low fare level for the domestic trunk airlines, this analysis would suggest that it should maintain, or even perhaps increase, the present level of competition between the carriers on important routes.

The president of a major airline recently confirmed some of the conclusions of this paper. In our statistical analysis it was estimated that for the year ending September 30, 1961, American Airlines could have raised its net profit from about $9 million to about $30 million by more effective cost control. In a recent speech, C. R. Smith, president of American Airlines, said, "American should earn about $35 million after interest. American is trailing some of its competitors in doing a good job at cost control . . . we must find a way to do our work more economically." [19]

[18] Caves, *Air Transport*, Chapter 18.
[19] *American Airlines Flagship News*, January 21, 1963, p. 1.

APPENDIX A: Notes on the Calculation of Seats Departing and the Cost of Aircraft and Traffic Servicing

The calculation of seats departing involved adding daily seats for each station from the *Official Airline Guide Quick Reference Edition* (number of seats per plane was obtained from various airlines in Boston), and dividing by daily departures reported in the same source to obtain a daily average number of seats per plane for each station. The resultant figure was then multiplied by the total departures from each station during the third quarter as reported on Schedule T-4. A possible element of error was that several airline seating configurations were estimated.

Costs were obtained from CAB Form 41, Schedule P-9.2; costs listed in cols. 3, 4, 5, 8, 9, 10, and 12 of this schedule were added together. Some carriers listed large expenses in their home office, maintenance, or flight training cities which represented the costs of system, rather than station, expense. Thus cols. 9, 10, and 12 were excluded in each carrier's home office, maintenance, and flight training city. This had a small effect on intercarrier average cost ranking. The rank correlation between actual aircraft and traffic servicing expense and the adjusted figures is .86.

American's extraordinary cost at Fort Worth is discounted—some stewardess training or other system expense must have been reported.

Eastern's New Orleans cost figures were missed when these statistics were copied at the CAB.

COMMENT

CHARLES J. ZWICK, The RAND Corporation

I found this to be a very interesting and persuasive paper. Although much of the empirical analysis is shaky, due to inadequate data and the "first attempt" nature of the work, it does, I believe, represent an important contribution. My comments will be focused on the limitations of this first analysis and will include suggestions for improvement. I suspect that Gordon would in fact agree with most, if not all, of them.

The first point I would like to make concerns Gordon's equating of managerial efficiency with cost control. Certainly this is one aspect, and an important aspect, of managerial efficiency, but it is not the only one. He eliminates, for example, the whole general area of sales promotion, the material of direct interest to Kraft. Efficient firms should be both cost-conscious and effective marketers of their product.

Secondly, it would be highly desirable to reproduce the analysis using additional quarters of data. Gordon's analysis is based on one quarter's data. He extrapolates these results to an annual basis, assuming no differences with regard to seasonality. I would expect significant seasonal impact on cost performance since there are, as Kraft recognizes in his paper, important seasonal differences in demand.

I thought Gordon handled his data, given its limitations, with prudence. One way to increase our confidence in his conclusions is to reproduce the analysis with new data. I am sure unexpected analysis innovations would develop so that reproducing this analysis over a number of periods should increase significantly our confidence in the results. I would, however, like also to propose an alternative approach. Gordon infers standard or normal costs for an airline from historical data; an alternative procedure would be to model a carrier's operations, and cost these operations, using standard cost factors. This approach has, of course, been used in a number of situations,[1] and we do have fairly good data on costs of specific air carrier operations. I believe that in the long run this would be a more fruitful way of developing normal costs for an airline than inferring these from historical data. The alternative approach, of course, would be more expensive than the one employed by Gordon, and we therefore have the troublesome question of which approach is preferred on a cost-effectiveness basis. I suspect, however, that Gordon has done such a good job of pointing out that significant amounts of money are involved that we could make a case that a more refined costing approach would be worth the extra expense, especially if we could get a public agency, such as the CAB, to conduct these analyses in a continuing and competent manner.

Lastly, I want to suggest that being completely preoccupied with labor efficiency could lead a carrier into trouble. Gordon correctly points out that effective cost control is practically identical with efficient use of labor. It is clear, however, that one can push labor efficiency too far, as there is a stochastic element to producing air carrier services. Viewing the process from a queuing model point of view, there is an optimal waiting situation. Clearly, we do not want expensive equipment always queued up waiting for personnel—nor do we want to lose passengers because personnel unavailability affects schedule reliability. There is, in short, a balance in waiting times that must be struck in such

[1] See, for example, R. G. Bressler, Jr., *City Milk Distribution*, Cambridge, 1952.

a situation. There are real world examples where excessive concern with personnel utilization has lead to undesirable performance consequences.

Management efficiency has been considered, as Gordon points out, that part of firm behavior that is beyond the scope of economics. He has made an important contribution by indicating that it can be attacked in a systematic and useful way. I quite agree with his policy conclusion that it would be useful to generate these data on a continuing basis and to have them available in rate-making cases. We all can end our discussion, as Gordon did, with the hope that some day we may be so bold as to allow price competition as one form in which management efficiency could be reflected.

Over-all, I believe that it is important to stimulate additional empirical cost efforts in the transport industries. Important policy decisions will be facing us with regard to transportation over the next decade. It would be comforting to know that we have a significant body of cost analysis behind us when making these decisions. Outside of agriculture, detailed analysis of cost functions has been largely neglected.