Cost/Quality Trade-Offs in the Departure Process? Evidence from the Major U.S. Airlines

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Higher costs should lead to higher quality, according to conventional thinking. In airline departures, longer scheduled turnaround times and higher per passenger airport staffing levels should lead to better on-time performance, customer satisfaction, baggage handling, and safety. To test the foregoing hypothesis, a unique longitudinal measure of scheduled turnaround time for the 10 major U.S. carriers was used, controlling for aspects of product complexity such as flight length, passengers per flight, cargo per flight, meal service, and percentage of passengers who connect. Longer turnaround times and higher staffing levels are found to be associated with worse on-time performance, customer satisfaction, baggage handling accuracy, and safety, controlling for product complexity. In addition, individual airlines vary greatly in the efficiency with which they use turn time and staffing resources to achieve these outcomes. Field research suggests that longer turnaround times are a form of organizational slack that detracts from organizational learning. Conversely, quick turnaround strategies may have an organizational learning spillover effect on other departure outcomes. The traditional logic suggests a trade-off between cost and quality such that turnaround time and staffing must be increased to improve on-time performance, baggage handling, customer satisfaction, and safety. The new logic suggests that low levels of resource use can lead to better outcomes, with the support of organizational practices conducive to learning. Toyota introduced this logic into the automobile industry with its just-in-time inventory system; Southwest has introduced it into the airline industry.

Traditionally, there is some trade-off within each industry between the cost and quality of its products or services. Part of an individual company's strategy is the choice of where to operate along that boundary. But organizational learning fostered by total quality management, process redesign, and the reduction of buffers has been used by companies in some industries to mitigate this trade-off. When these practices are used in a key process, they can become an important source of competitive advantage and alter the competitive dynamics of that industry. For example, in the automobile industry, Toyota was the innovator in the 1980s and set a new standard for achieving higher quality (in the sense of product reliability) at a lower cost, a standard that other Japanese and U.S. producers have since adopted (*1*). This paper presents evidence that Southwest Airlines has set a new standard in the airline industry for higher quality at lower cost, potentially changing the competitive dynamics of the industry.

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HORIZONTAL COORDINATION AND REDUCTION OF TIME OR INVENTORY BUFFERS

Learning-intensive practices in the automobile and airline industries include two mutually supportive elements: (a) horizontal coordination based on teamwork and communication among frontline workers who perform different functions and (b) the reduction of time or inventory buffers. Each of these will be treated briefly.

Horizontal Coordination

Coordination is a problem that arises from specialization and the division of labor. It is a problem that every organization must solve. Coordination can be achieved primarily at the top of a vertical, hierarchical organization in which each functional group is relatively autonomous from the others. Or it can be achieved horizontally at each level of a relatively flat organization, across frontline employees and at each level of management. They are two distinct organizational designs, each with a set of supporting human resource and other practices that foster a distinct set of employee behaviors (*2*).

Horizontally coordinated organizations are thought to have certain competitive advantages over hierarchically coordinated ones in their ability to achieve higher quality at lower cost by achieving faster cycle times and by providing a more coherent interface with customers. These organizations can change the nature of competition in an industry by pushing out the cost/quality frontier rather than making cost/quality trade-offs along an existing frontier. Evidence has been found in the garment industry as well that "the strategic shift to greater coordination shifts the placement of the traditional 'cost/service' curve to a more favorable position" (*3*, p. 13).

Some set of organizational practices—work organization, human resource, and performance measures—appears to be needed to support horizontal coordination. A related project (based on observations, interviews, and surveys at four airlines) identifies some potential elements of this set (*4*). In the area of work organization, cross-functional teams or case managers can be used as coordinating mechanisms. These mechanisms shift the structure of accountability, authority, and the flow of information from vertical to horizontal. In the area of human resources, selection and training are used to develop generalists or, alternatively, specialists who can communicate across functional boundaries. Job rotation is also used in some contexts to achieve broader knowledge. In the area of performance measures, shared outcome measures and group rewards are used to foster teamwork and communication. Finally, the evidence also suggests the importance of mechanisms for resolving conflicts and reducing status boundaries between functional groups.

Reduction of Time or Inventory Buffers

In addition to these organizational practices, one of the supporting characteristics for horizontal coordination that helps to achieve both cost and quality gains is the reduction of buffers. In hierarchical coordination, in-process time or product inventories are used as buffers between stages of work to protect each functional area from the need to communicate with and resolve problems with other functional areas (*5*). Horizontal coordination is fostered by the reduction of buffers, which reveals problems, forces communication and learning across functions, and is conducive to continuous improvement of product or service quality. Reducing buffers has the secondary effect of reducing costs, so that organizations that do it successfully are able to offer customers lower-cost and higher-quality products and services.

Cost-Quality Breakthrough

In the airline industry, carriers that use shorter scheduled turnaround times should have better outcomes for on-time arrivals, customer satisfaction, baggage handling, and safety without resorting to excess staffing, if they have also instituted practices that support horizontal coordination. This would support the argument that longer turnaround times are a form of organizational slack that detracts from cross-functional learning and that quick turn strategies have an organizational learning spillover effect on other departure outcomes. The old logic suggests a trade-off between cost and quality such that turnaround time and staffing must be increased to improve on-time performance, baggage handling, customer satisfaction, and safety. The new logic suggests that low levels of resource use can lead to better outcomes, with the support of organizational practices conducive to learning. Toyota introduced this logic into the automobile industry with its just-in-time inventory system; Southwest Airlines, it is argued, has introduced it into the airline industry.

DEPARTURE PROCESS

The departure process is one of the core processes of an airline's operations. Its success or failure, repeated hundreds of times daily in dozens of locations, can make or break an airline's reputation for safety and reliability. It is also perhaps the most complex process that an airline performs on a repeated basis. The complexity of the departure process varies according to the carrier's product mix and division of labor. At American Airlines, which has a typical product mix and division of labor for a major commercial air carrier, the departure process requires the direct or indirect input of 12 departments. At the point of departure, the process requires rapid coordination among nine groups of frontline employees—ramp workers, mechanics, ticket agents, gate agents, skycaps, caterers, operations agents, flight attendants, and pilots—most of whom report to separate departments. Flights at American Airlines are currently turned around with a minimum scheduled time of 35 min (for the MD80)—from gate arrival to gate departure—whereas comparable flights (Boeing 737) are turned around with a minimum scheduled time of 15 min at Southwest.

A departure is successful from the customer's point of view if it does not involve unnecessary hassles and if it results in a safe, on-time arrival of the customer and his or her baggage. On-time arrival is generally found to be passengers' most important criterion for the quality of air travel (*6,7*). A departure is successful from the airline's point of view if these customer outcomes are achieved in a cost-effective way.

Scheduling To Reduce Departure Delay

Airlines attempt to reduce departure delay without mishandling bags, without treating customers rudely, and without resorting to overstaffing. Often they do this by improving the management and coordination of employee effort. Alternatively, however, they reduce departure delay by expanding scheduled turnaround time—adding buffers, as it were, to the schedule. Interviews with station managers and aircraft schedulers suggest that this latter practice is common.

These buffers are costly, however. Extra turnaround time increases the overall length of a flight for passengers who are continuing through the hub, which makes a flight less attractive and makes it appear lower on travel agents' screens (reduces "screen presence"). Extra turnaround time also increases the ground time of aircraft, which is costly. This is an especially important consideration on short-haul routes, where turnaround time is a higher percentage of total time.

Finally, extra turnaround time may even reduce rather than increase on-time departures, the integration of customer service, and productivity. If extra turnaround time serves as a buffer in the system that reduces the pressure for learning and problem solving, airlines with higher turnaround times may experience lower rather than higher outcomes, just as manufacturing processes with more in-process inventories have been found to experience more frequent defects and lower productivity (*8*).

Isolating the Influence of Coordination and Product Complexity

The goal here is to identify the components of turnaround time and departure delay that are influenced by the coordination of the work process, those that are influenced by a carrier's strategic choices about product mix, and those that are beyond the control of any individual carrier.

Turnaround time and transit time together account for an aircraft's total time in service. Turnaround time is the time from arrival at the gate until departure from the gate, and transit time is the time from gate departure to gate arrival at the down-line station. Reducing either one increases the number of flights an aircraft can make in a given day, thereby increasing the revenue generated by that aircraft. But reducing them below what the organization can reliably achieve risks late arrivals, which dissatisfies customers and causes further delays throughout the system.

Turnaround time can be usefully thought of as having three components (see Table 1). Every carrier has a systemwide minimum scheduled turnaround time (TURN1): the minimum period of time in which stations are expected to prepare an aircraft for departure. TURN1 varies for each plane type—larger planes have a longer TURN1—and differs for international flights, where more meals must be loaded and so forth. Often the total scheduled turnaround time is greater than the minimum, for reasons discussed later, but TURN1 is the period in which a station is expected to turn a plane around whenever a flight is running late and needs to be turned

TABLE 1 Components of Turn Time, Transit Time, and Delays

TURN1	Minimum scheduled turnaround time. The turnaround time an airline reverts to when the incoming plane arrives late, based on the minimum feasible time to turn the aircraft.
TURN2	Scheduled buffers. Extra time scheduled beyond the minimum scheduled turnaround time, to increase the likelihood of staying on schedule.
TURN3	Scheduled connect time. Extra time scheduled beyond the minimum scheduled turnaround time, to allow passengers to connect.
TRANS1	Taxi time at originating station.
TRANS2	Flight time.
TRANS3	Taxi time at destination station.
DELAY1	Delay caused by coordination problems among station personnel or between station personnel and flight crew.
DELAY2	Delay caused by weather or airport congestion.
DELAY3	Delay caused by passenger accommodation.

around as soon as reasonably possible. If a flight comes in late, the station is charged with a late departure only if it takes longer than the TURN1 for that plane and flight type to turn it around.

TURN1 also varies across carriers, even for the same plane and flight type, because of considerations like whether the airline carries freight and mail. For example, Southwest increased its TURN1 from 10 to 15 min in the late 1980s in large part because it began to carry freight and mail. TURN1 also varies across carriers depending on the speed at which the organization is geared up to turn the plane around. For example, TURN1 is 15 min at Southwest and 35 min at American. This depends in part on practices like equipment standardization and product simplification and whether flight attendants or special crews clean the planes. TURN1 also depends on the efficiency of the work process, it is argued, particularly the quality of cross-functional coordination.

There is a second component of scheduled turnaround time called buffer time (TURN2). It is added selectively to a schedule when a particular flight is always late in departing due to various problems in preparing the plane for departure and when it is considered less costly to add buffer time than to risk the late departures or to fix the problems. But when a flight is late in arriving from the up-line station, the scheduled turnaround time reverts to TURN1, and the station must do without the buffer time to avoid being charged with a delay.

A third component of scheduled turnaround time—connect time (TURN3)—depends a great deal on the route structure. In a hub-and-spoke system, where flights are scheduled to converge at a central location, transfer passengers, and continue to final destinations, additional ground time is scheduled at hub cities to allow passengers to connect and at spoke cities to time flights to converge back at the hub at the same time. Point-to-point route systems may schedule in some connect time at cities where passengers often connect, but they minimize the need for TURN3 by scheduling more frequent flights so that transfers do not require convergence and by designing the route structure so that continuing passengers have numerous ways to reach the same destination.

Transit time has three components. The first—taxi time (TRANS1)—begins as soon as the aircraft pushes back from the gate and continues until takeoff. The other components of transit time are flight time (TRANS2) and taxi time at the down-line station (TRANS3). Delays can occur in any of the three components because of airport congestion or weather but are relatively uncontrollable. Some carriers try to reduce TRANS1 by choosing airports that are less congested. This component of turnaround time is somewhat related to a carrier's route structure since a hub-and-spoke carrier does the kind of peak scheduling that contributes to airport congestion. But even point-to-point carriers may be affected by the congestion caused by hub-and-spoke carriers if they use hub airports. Other than changing airports or decreasing the peaking of one's schedule, increasing the scheduled transit time is often the only viable response to transit delays.

There are three primary kinds of nonscheduled turnaround time, or delays. The first is from lack of coordination of some kind (DELAY1). The second is from weather or airport congestion that prohibits the aircraft from pushing back from the gate (DELAY2).

The third is a discretionary delay made to accommodate passengers from another flight when the transfer time was not sufficient, or passenger delay in embarking or disembarking due to other problems (DELAY3).

Increasing the efficiency of the work process allows a carrier to reduce minimum scheduled turnaround time (TURN1) and buffer time (TURN2) and to reduce delays that result from a lack of coordination (DELAY1). But improved coordination does not reduce transfer time (TURN3), transit time, or delays due to congestion (DELAY3) since these are driven largely by the scheduling required to support the hub-and-spoke route structure and the airport congestion that results from it. These other kinds of turnaround and transit time are also costly to carriers, but because they are not affected by organizational efficiency they are not considered here. They are built-in costs of the hub-and-spoke system—presumably costs that are outweighed by the benefits of hubbing. The larger debate about hub-and-spoke versus point-to-point is heated and complex and will not be directly addressed here.

ANALYSIS AND FINDINGS

The following sections describe findings on product complexity, cost levels, and quality outcomes for the 10 major U.S. carriers, using longitudinal data from September 1987 through May 1994. The variables used in the analysis are given in Table 2. Their sources are given in Table 3. A detailed discussion of the selection and derivation of these variables can be found in a data appendix, available from the author upon request.

Differences in Product Complexity

Before we can compare cost levels or quality outcomes for the 10 major U.S. carriers, it is necessary to understand and adjust for differences in their products. Clearly, there is a demand for both a more and a less complex product. We do not want to assume that either is superior, nor do we want to bias our measure of efficiency in

TABLE 2 Variable Descriptions (Sample: U.S. Major Airlines' Domestic Systems, September 1987 to May 1994)

Name	Description	Mean	Std Dev	Obs
COSTS				
Turn Time	Minutes of scheduled aircraft time at the gate, for through flights.	43.1	11.4	737
Staffing	Airport employees (excluding maintenance) per thousand daily passengers.	125.9	37.8	810
Cost Index	((Turn Time/ avg(Turn Time) + Staffing/ avg(Staffing)) x 100) / 2	100.0	24.4	737
QUALITY				
Late Arrivals	Percent of flights that arrive more than 15 minutes late, disregarding mechanical delays.	19.3	6.7	810
Complaints	Departure-related customer complaints per million passengers.	15.5	24.4	810
Lost Bags	Mishandled bags per thousand passengers.	6.4	2.2	810
Deviations	Pilot deviations per thousand departures.	29.6	34.4	810
Qual Index	(4 * 100)/(Late/avg(Late) + Comp/avg(Comp) + Lost Bags/avg(Lost Bags) + Dev/avg(Dev))	131.8	69.7	810
PRODUCT COMPLEXITY				
Passenger	Passengers per departure.	72.0	12.2	810
Length	Thousands of miles flown per departure.	634.2	136.3	810
Cargo	Ton miles of freight and mail flown per departure.	724.4	450.8	810
Connects	Percent of passengers who connect.	38.2	12.0	810
Meals	Meal expenditures per passenger ($).	4.13	2.03	810

TABLE 3 Data Sources (Sample: U.S. Major Airlines' Domestic Systems, September 1987 to May 1994)

Name	Source
COSTS	
Turn Time	Official Air Line Guide Scheduling Data, archived by the Federal Aviation Administration
Staffing	Form 41, Schedule P10, U.S. Department of Transportation
QUALITY	
Late Arrivals	Air Travel Consumer Report, Table 1, U.S. Department of Transportation
Complaints	Air Travel Consumer Report, Table 3, U.S. Department of Transportation
Lost Bags	Air Travel Consumer Report, U.S. Department of Transportation
Deviations	National Transportation Safety Board, FAA Pilot Deviation Subsystems
PRODUCT MIX	
Passenger	Traffic Digest of Statistics: Commercial Air Carriers, International Civil Aviation Organization
Length	Traffic Digest of Statistics: Commercial Air Carriers, International Civil Aviation Organization
Cargo	Traffic Digest of Statistics: Commercial Air Carriers, International Civil Aviation Organization
Connects	Origin and Destination Survey Data, Average Coupons, U.S. Department of Transportation
Meals	Form 41, Schedule P7, U.S. Department of Transportation

favor of a less complex product. Ultimately, we want to compare apples with apples—not apples with oranges. Number of passengers per departure, length of flight, cargo carried, percentage of connections, and degree of meal service all reflect types of product complexity that affect the relative ease of the departure process. Airlines that offer a more complex product are therefore expected to require more scheduled turn time and more airport staffing per passenger.

Important differences are evident on Table 4. The average number of passengers per departure ranges from about 50 (for Alaska Air and Southwest) to about 85 (for United and American). These differences are not due mainly to load factors, which vary little across carriers, but rather to difference in average aircraft size.

Average leg length varies according to whether a carrier offers primarily a short- or long-haul product. Southwest and USAir are at the bottom of the distribution with 376 and 482 mil per flight, respectively. American and United lead the group with 785 and 810 mil per departure, respectively.

Cargo carried varies substantially across the major carriers in this period, with Southwest again at the low end, carrying only 7 percent of the industry average mail and freight. Northwest and United are at the high end with each carrying twice the industry average.

Percentage of passengers who connect is especially low for Southwest, with only 12 percent compared with an industry average of 38 percent. Southwest is the least hubbed of all the carriers, with a linear or point-to-point route structure. America West and Alaska Air approximate this structure most closely at 32 percent and 24 percent of connections, respectively. Delta is the most hubbed carrier, connecting 53 percent of its passengers, with American and Northwest close behind at 46 percent and 49 percent, respectively.

Finally, in meal expenditures per passenger, Southwest is also at the extreme low end, spending only $0.18 per passenger on average. American and Alaska Air have the highest expenditures, at $5.99 and $7.35 per passenger, respectively.

A trend analysis of these variables (not shown here) indicates that for the major carriers as a whole, each measure of product complexity has been increasing over the period.

Actual Turn Time and Staffing Levels

These carriers also differ significantly in the levels of turn time and airport staffing over this period (Table 5). Southwest Airlines has

TABLE 4 Differences in Product Complexity* (Sample: U.S. Major Airlines' Domestic Systems, September 1987 to May 1994)

	Passenger mean(SD)	Length mean(SD)	Cargo mean(SD)	Connnects mean(SD)	Meals mean(SD)
Alaska	50.8 (6.5)	586.1 (37.6)	679.7 (75.6)	24.1% (2.1)	$7.35 (0.93)
American	86.1 (7.5)	784.5 (51.8)	779.0 (201.5)	46.4% (1.6)	$5.99 (0.52)
AmWest	72.8 (7.5)	557.7 (77.8)	348.8 (145.9)	31.6% (2.3)	$2.01 (0.54)
Continental	72.4 (6.6)	749.0 (29.8)	700.0 (82.2)	40.2% (3.5)	$4.44 (1.65)
Delta	79.4 (7.1)	622.5 (7.7)	704.1 (63.7)	52.7% (3.0)	$4.46 (0.32)
Northwest	71.3 (7.3)	670.2 (39.3)	1501.0 (194.6)	48.8% (2.1)	$3.80 (0.53)
Southwest	51.0 (34.3)	375.9 (4.6)	51.0 (34.3)	12.1% (1.1)	$0.18 (0.05)
TWA	72.9 (6.3)	704.2 (18.2)	976.9 (87.3)	43.9% (2.0)	$4.62 (0.05)
United	85.8 (7.6)	810.0 (24.2)	1310.6 (100.2)	40.5% (1.4)	$4.90 (0.43)
USAir	61.5 (4.9)	481.7 (30.1)	192.6 (48.1)	41.7% (5.4)	$3.55 (0.91)
Total	72.0 (12.2)	634.2 (136.3)	724.4 (450.8)	38.2% (12.0)	$4.13 (2.03)

* See Table 2 for definitions of these five components of product complexity.

the lowest turnaround time by far; at 17.3 min it uses only 40 percent of the industry average. Southwest is followed by Alaska Air at 33 min and America West at 41. At the high end is Northwest, which turns planes in 55 min—28 percent above the industry average. TWA, United, and American have slightly lower turn times than Northwest.

In staffing, Southwest is at the low end again, employing an average of 65 airport personnel per 1,000 passengers enplaned daily, relative to an industry average of 126. America West follows closely with 77 airport employees per 1,000 passengers daily. Delta, American, TWA, and Alaska lead in staffing levels with more than 150 airport employees per 1,000 passengers enplaned daily.

Effect of Product Complexity on Turn Time and Airport Staffing

Differences in product complexity are expected to account for some of the differences in carrier levels of turn time and airport staffing. Length of trip influences the length of the fueling process and the number of bags to be loaded. The number of passengers boarded increases the staff and time required for check-in, baggage handling, and boarding. The amount of cargo loaded affects the time and staff required for handling. The degree of meal service likewise affects the time and staff required for handling. Connecting passengers require staff for transferring bags, checking them in, and rerouting them in case of missed connections. Connections also require additional scheduled turn time to allow a group of flights to meet up.

Table 6 gives the effects of these five elements of product complexity on turn time and airport staffing. As expected, flight length, cargo, and connections increase the amount of scheduled turn time (Column 1). The number of passengers and degree of meal service also increase the amount of scheduled turn time (equation not shown here), but their effects are overwhelmed and reversed by the other factors. Once individual carrier effects are accounted for, flight length, cargo, and connections continue to increase the needed turn time (Column 2).

Meals and flight length both have significant positive effects on airport staffing levels per passenger, controlling for individual carrier differences (Column 4). But the number of passengers per departure actually reduces rather than increases per passenger staffing needs. This likely arises from the tendency of carriers to conserve on staffing by using the same number of gate agents, ticket agents, and baggage handlers to staff a larger flight—it just takes longer. Also, once individual carrier effects are accounted for, cargo and connections have no systematic effects on staffing requirements.

From the coefficients on trend, it is clear that both turn time and staffing requirements have increased significantly over this period,

TABLE 5 Turn Time and Airport Staffing (Sample: U.S. Major Airlines' Domestic Systems, September 1987 to May 1994)

	Turn Time		Staffing		Cost Index**	
	Actual mean(SD)	Adj* mean(SD)	Actual mean(SD)	Adj* mean(SD)	Actual mean(SD)	Adj* mean(SD)
Alaska	33.0 (5.0)	40.2 (2.2)	153.2 (34.9)	109.6 (9.4)	98.7 (16.5)	90.0 (4.7)
American	50.8 (5.6)	46.4 (2.3)	156.8 (23.6)	171.7 (9.4)	121.3 (13.0)	121.7 (4.9)
AmWest	41.1 (4.0)	44.6 (2.3)	77.2 (11.0)	86.9 (9.4)	78.1 (7.2)	86.1 (4.8)
Continental	46.4 (2.8)	43.1 (2.2)	108.6 (14.7)	102.0 (9.4)	97.0 (6.9)	90.3 (4.8)
Delta	46.7 (4.5)	44.2 (2.2)	162.5 (19.2)	175.9 (9.4)	118.3 (7.3)	120.8 (4.8)
Northwest	55.1 (3.4)	47.2 (2.3)	132.3 (16.2)	130.0 (9.4)	116.1 (7.3)	106.1 (4.8)
Southwest	17.3 (2.0)	30.0 (2.7)	65.2 (6.1)	78.3 (9.4)	45.8 (2.7)	65.8 (4.9)
TWA	51.2 (4.7)	46.8 (2.3)	154.4 (19.3)	151.4 (9.4)	120.3 (10.6)	114.3 (4.7)
United	50.0 (4.7)	42.3 (2.2)	134.4 (15.7)	150.7 (9.4)	110.8 (7.8)	108.6 (4.8)
USAir	41.6 (2.5)	47.0 (2.2)	114.0 (20.3)	102.4 (9.4)	93.4 (9.2)	95.0 (4.6)
Total	43.1 (11.4)	43.1 (5.4)	125.9 (37.9)	125.9 (34.6)	100.0 (24.4)	100.0 (17.3)

*Adjusted for differences in product mix. See Table 6 for derivation.
**Cost Index includes turn time and staffing. See Table 2 for derivation.

over and above the increases one would expect from product complexity alone. This trend may result from competition among the airlines to achieve high rankings on the quality outcomes measured by the U.S. Department of Transportation over this period.

Adjusted Turn Time and Airport Staffing Levels

Coefficients from Columns 2 and 4 were used to compute turn time and staffing adjusted for these key aspects of product complexity and individual airline differences. The adjusted measure of turn time tells us how long a carrier's turn time would be if it had the average industry product mix. Likewise, the adjusted measure of airport staffing tells us how many airport personnel would be employed per passenger by a particular carrier if that carrier had the typical industry product mix.

Comparing the adjusted measures with the original measures (Table 5), we get a more accurate portrayal of the between-carrier differences in turnaround times and staffing. Southwest still has the lowest turnaround time, even adjusting for the simplicity of its product, but at 30 min its turn time is 70 percent of the industry average rather than only 40 percent before adjustment. Some of the difference in Southwest's actual turn time is clearly due to its very simple product. Adjusted turn times are also higher than the actual turn times for the other airlines with relatively simple products—Alaska Air, America West, and USAir—particularly for USAir. Considering the relative simplicity of its product, USAir has one of the longest turn times in the industry. The airlines with relatively complex products—United, Delta, Northwest, American, Continental, and TWA—have adjusted turn times that are lower than their actual turn times. United's adjusted turn time is particularly low, at 42 min, showing that, relative to its product, it has the speediest turnaround after Southwest and Alaska Air.

Once the effect of product complexity on airport staffing is accounted for, Southwest still has the leanest staffing in the industry at 78 employees per 1,000 passengers per day. Clearly, some though not all of Southwest's staffing efficiencies are due to its simpler product. Alaska Air has the most elaborate meal service and has among the highest airport staffing levels. But adjusted for that meal service, its airport staffing levels are among the leanest, following Southwest, America West, and USAir. The most highly staffed carriers, even accounting for the complexity of their product, are

TABLE 6 Effect of Product Complexity on Turn Time and Airport Staffing (Sample: U.S. Major Airlines' Domestic Systems, September 1987 to May 1994)

	Turn Time coefficient (t-stat)		Staffing coefficient (t-stat)	
	1	2	3	4
Trend	0.040 (6.00)	0.048 (6.84)	0.000 (0.00)	0.216 (6.91)
Passenger	-0.129 (6.65)	-0.019 (0.96)	-0.624 (6.09)	-1.942 (21.89)
Length	0.036 (13.81)	0.029 (5.82)	-0.008 (0.63)	0.567 (2.62)
Cargo	0.004 (7.61)	0.005 (3.93)	0.011 (3.83)	0.002 (0.28)
Connects	0.590 (34.86)	0.229 (4.63)	1.190 (13.16)	0.069 (0.32)
Meals	-0.976 (8.27)	-0.931 (5.12)	9.780 (15.83)	1.867 (2.39)
Constant	6.67 (6.42)		82.410 (15.06)	
Alaska		12.94 (4.94)		195.42 (16.95)
American		18.97 (5.12)		257.51 (15.76)
AmWest		17.42 (6.49)		172.69 (14.53)
Continental		15.68 (4.61)		187.86 (12.50)
Delta		16.78 (5.05)		261.73 (17.89)
Northwest		19.92 (6.02)		215.83 (14.88)
Southwest		2.95 (1.53)		164.19 (19.30)
TWA		19.53 (5.97)		237.23 (16.45)
United		14.88 (4.12)		236.48 (14.92)
USAir		19.82 (7.39)		188.21 (15.92)
Adj Rsquared	87%	92%	64%	84%

Note: Coefficients are retained from columns 2 and 4 to compute adjusted turn time and staffing.

American and Delta, respectively, at 172 and 176 employees per 1,000 daily passengers. Notably, these two carriers have engaged in projects to reduce airport staffing in 1994 and 1995.

In the final columns of Table 5, turnaround time and staffing are combined into a cost index (see derivation on Table 2), which will be used for subsequent analyses.

But neither turnaround time nor staffing, actual or adjusted, alone or in combination, itself suggests efficiency or inefficiency. They can only be judged by their effects on outcomes. The following section offers a brief review of the quality outcomes that are most closely tied to the departure process—on-time performance, customer complaints related to the departure process, baggage handling accuracy, and safety. The final sections address the relationship between the key inputs—turnaround time and airport staffing—and quality outcomes.

Quality Outcomes

There is some variation in on-time performance across the 10 major carriers (Table 7). United has the poorest record of on-time performance for the period as a whole, with 23 percent of its flights arriving late (at least 15 min past scheduled time of arrival). TWA, Continental, Delta, and USAir belong to the same performance group, with 21 percent of their flights arriving late. Southwest and America West lead the group with late rates of about 15 percent. Six of the 10 carriers improved on-time performance for the period as a whole—Northwest, Southwest, and Alaska had the greatest rates of improvement for the industry. Both Northwest and Southwest, notably, have competed for the distinction of being first in on-time performance in the 1990s and have used the distinction as a marketing tool.

TABLE 7 Differences in Outcome Quality (Sample: U.S. Major Airlines' Domestic Systems, September 1987 to May 1994)

	Late Arriv mean(SD)	Complaint mean(SD)	Lost Bags mean(SD)	Deviate mean(SD)	Qual Index* mean(SD)
Alaska	18.4 (6.5)	3.1 (7.1)	6.4 (1.5)	18.8 (50.1)	187.6 (77.0)
American	18.7 (5.3)	11.5 (6.5)	6.1 (2.0)	42.4 (28.3)	107.3 (33.2)
AmWest	14.9 (6.0)	11.7 (7.3)	6.6 (2.6)	14.8 (29.8)	159.3 (63.6)
Continental	21.4 (5.7)	31.9 (44.2)	6.4 (1.5)	43.9 (38.2)	91.2 (37.9)
Delta	21.4 (5.7)	5.4 (4.1)	6.4 (1.7)	33.9 (25.4)	121.6 (37.5)
Northwest	17.9 (6.6)	24.0 (41.7)	6.7 (2.0)	30.4 (28.4)	119.4 (54.3)
Southwest	14.5 (6.5)	4.4 (4.2)	3.9 (0.6)	11.1 (17.3)	229.9 (88.7)
TWA	21.2 (6.4)	39.2 (24.4)	7.6 (2.7)	33.1 (42.4)	81.8 (40.2)
United	22.9 (6.3)	13.6 (10.2)	6.8 (2.1)	38.1 (33.3)	103.0 (36.9)
USAir	21.2 (6.4)	10.5 (8.5)	6.8 (2.2)	30.0 (21.5)	116.4 (40.1)
Total	19.3 (6.7)	15.5 (24.4)	6.4 (2.2)	29.6 (34.4)	131.8 (69.7)

*Quality Index is the reciprocal of late arrivals, customer complaints, baggage mishandling and safety deviations. See Table 2 for derivation.

The variation across airlines in customer satisfaction, as measured by the thousands of passengers per departure-related complaint made to the U.S. Department of Transportation, is greater than the variation in on-time performance. Alaska Air, Southwest, and Delta received only 3.1, 4.4, and 5.4 departure-related complaints per million passengers, respectively, over this period. On the low end, TWA, Continental, and Northwest received 39, 32, and 24 complaints per million passengers, respectively, for the same period. Every airline experienced significant declines in customer complaints over the period, particularly the three with the most complaints.

Baggage mishandling rates for the period as a whole ranged from 3.9 mishandled bags per 1,000 passengers at Southwest to 7.6 for TWA. Every airline except Southwest experienced significant improvement in this area over the period.

Safety outcomes, measured as pilot deviations per thousands of flight departures, vary substantially across airlines over this period. Southwest and America West made the fewest deviations per departure over this period, whereas American and Continental made the most.

The quality index is constructed from these four measures of quality outcomes of the departure process (see Table 2 for its derivation). Southwest and Alaska Air have the strongest performance along these four dimensions for this time period, whereas TWA is weakest.

Effects of Turnaround Time and Staffing on Quality Outcomes

Turnaround time, staffing, and quality outcomes do not tell us much about efficiency. Even when we adjust the inputs for differences in product complexity, they are still just inputs. And quality outcomes are just outputs. To learn about efficiency, we need to look at the effect of the inputs on the outputs. First, for airlines as a whole over this period, do on-time performance, customer satisfaction, baggage handling accuracy, and safety require higher levels of turn time and airport staffing? Second, how much on-time performance, customer satisfaction, baggage handling accuracy, and safety can be achieved with a given level of turnaround time and airport staffing? These questions lead us to the central hypothesis of the paper.

Instead of the trade-off traditionally expected between costs and quality—where higher quality is achieved with higher costs—we find that over this period higher quality was achieved with lower costs (Table 8). The negative trade-off is significant even once costs are adjusted for differences in product complexity (Column 2). For the industry as a whole, the logic of cost and quality has shifted.

TABLE 8 Higher Quality at Lower Costs (Sample: U.S. Major Airlines' Domestic Systems, September 1987 to May 1994)

	Cost Index** coefficient (t-stat)	Adj Cost Index*** coefficient (t-stat)
	1	2
Trend	0.348 (10.07)	0.276 (11.16)
Qual Index*	-0.197 (17.17)	-0.134 (16.37)
Constant	111.8 (1.82)	106.2 (81.6)
Adj Rsquared	30%	29%

*Quality Index is the reciprocal of late arrivals, customer complaints, baggage mishandling and safety deviations. See Table 2 for derivation.
**Cost Index includes turn time and staffing.
***Adjusted for differences in product mix. See Table 6 for derivation.

TABLE 9 Differences in the Ratio of Quality Achieved to Costs Expended (Sample: U.S. Major Airlines' Domestic Systems, September 1987 to May 1994)

	Quality/Cost* mean (SD)	Qual Index** mean (SD)	Cost Index*** mean (SD)
Southwest	354.1 (1.30)	229.9 (88.7)	65.8 (4.9)
Alaska	208.6 (0.84)	187.6 (77.0)	90.0 (4.7)
AmWest	187.8 (0.70)	159.3 (63.6)	86.1 (4.8)
USAir	121.8 (0.40)	116.4 (40.1)	95.0 (4.6)
Northwest	108.8 (0.51)	119.4 (54.3)	106.1 (4.8)
Delta	102.7 (0.31)	121.6 (37.5)	120.8 (4.9)
Continental	102.1 (0.41)	91.2 (37.9)	90.3 (4.8)
United	95.3 (0.33)	103.0 (36.9)	108.6 (4.8)
American	91.1 (0.27)	107.3 (33.2)	121.7 (4.9)
TWA	72.1 (0.34)	81.8 (40.2)	114.3 (4.7)
Total	145.5 (1.02)	131.8 (69.7)	99.5 (17.3)

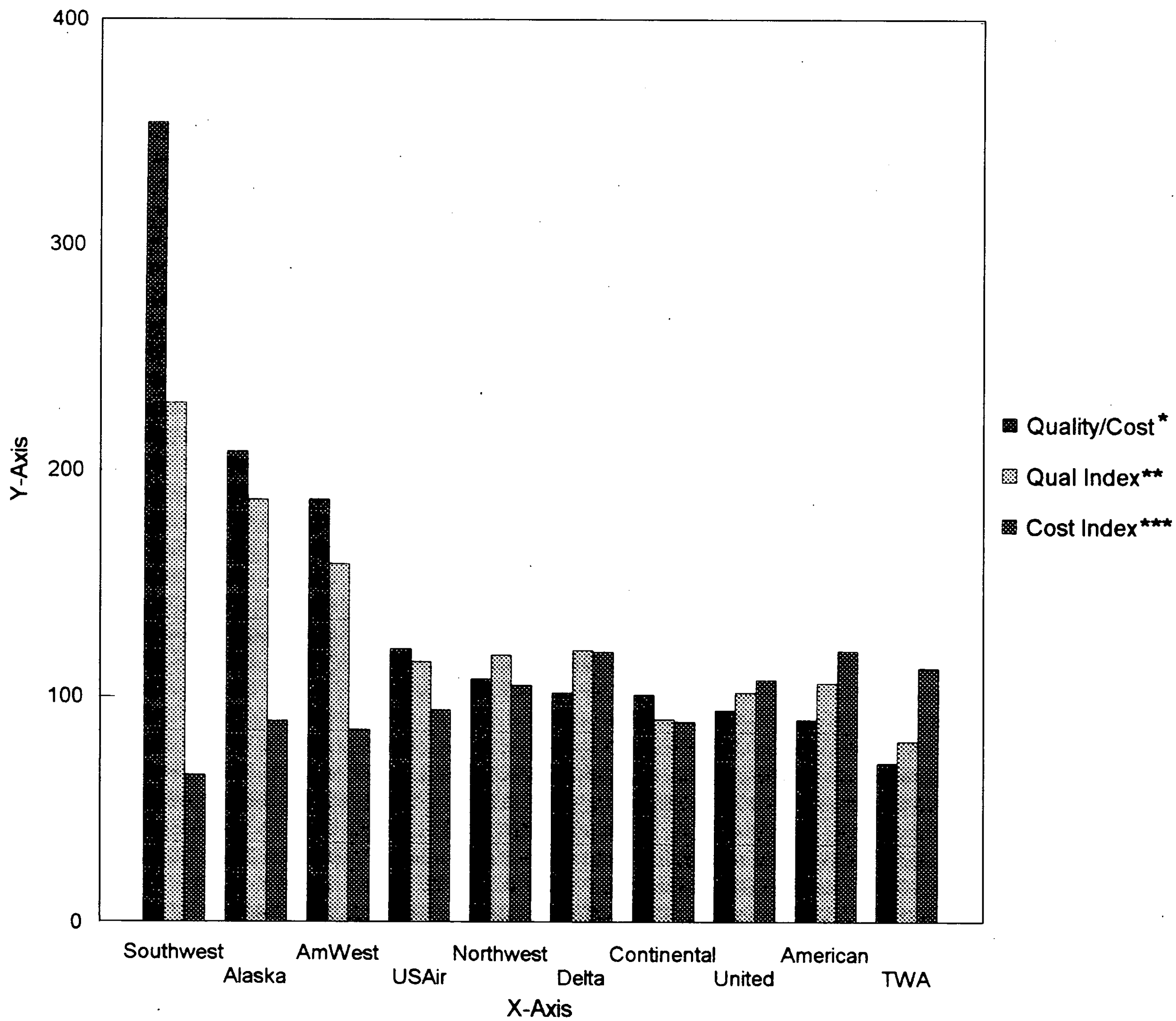
*(Quality Index/Cost Index)
** Quality Index includes ontime, customer satisfaction, baggage handling and safety.
***Cost Index includes turn time and staffing and is adjusted for differences in product mix.

Across individual airlines, there are substantial differences in the ratio of quality achieved to costs expended (Table 9). For the most part, airlines with lean operations over this period relative to their product's complexity—that is, those with low adjusted costs—have also achieved the best quality outcomes relative to those costs (Figure 1).

DISCUSSION OF RESULTS

Is there a cost/quality trade-off in the departure process? Clearly there is, but in the opposite direction of the trade-off traditionally expected. Higher quality is associated with lower, not higher, costs over this period. For some airlines, quality was achieved at a low expenditure of turnaround time and staffing relative to product complexity. For others, the expenditure was substantially higher.

The role of product complexity has been carefully accounted for. The product offered by the airlines became substantially more complex over this period in ways that increased the complexity of the departure process and consequently the need for turnaround time and staffing. But the use of these resources in many cases increased out of proportion to the complexity of the product.



*Quality/Cost Ratio = (Quality Index/Cost Index) x 100.
**Quality Index is the reciprocal of late arrivals, customer complaints, baggage mishandling and safety deviations. See Table 2 for derivation.
***Cost Index includes turn time and staffing and is adjusted for differences in product mix.

FIGURE 1 Ratio of quality achieved to costs expended (sample: U.S. major airlines' domestic systems, September 1987 to May 1994).

These findings lend support to this paper's central hypothesis—that excess resources can serve as organizational slack that lead to less efficient resource use, and vice versa, perhaps because they tend to be used as substitutes for organizational learning. Both turnaround time and staffing have the potential to play this role in the departure process. Over the period observed, among the major U.S. carriers, both turnaround time and per passenger airport staffing served as organizational slack.

For practitioners, these findings raise new questions. What are the organizational practices that allow lean resources to be used effectively? Lean resources in the form of less ground time and leaner staffing could inspire teamwork across functional groups to "get the job done," or the added stress could simply engender unproductive conflict and a deterioration of service. Other research suggests that Southwest has developed a set of organizational practices that build cohesion and common goals across groups, allowing the stress to be used in a productive way (*4*). These practices include horizontal coordination based on communication and teamwork across functional groups, combined with the reduction of time and staffing buffers. As more organizations in the airline and other industries press toward the limit in dropping excess resources, these kinds of practices may be the critical determinant of whether expected outcomes are achieved.

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