REGULATORY CONSTRAINTS AND IMPACTS ON AIRPORT LANDSIDE CAPACITY

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The regulatory authorities and their regulatory powers are enumerated. The extent to which the regulatory powers directly or indirectly impact on airport landside capacity is then identified and investigated. The role of environmental legislation in an expansion or new airport context is shown to be quite important. Likewise, the lack of the control of the Civil Aeronautics Board over scheduling and equipment deployment is shown to be a major influence on airport landside capacity. Few of the impacts are shown to be direct. A host of indirect impacts of varying degrees of intensity exist. The paper suggests that a systems analysis of the benefits and costs of the regulations be undertaken.

The airport is the supplier of a service that is consumed by the public, the airline carriers, the general aviation carriers, and the military. The air terminal is a facility for enplaning and deplaning and takeoffs and landings, a place of interest for sightseers, and a gathering place for people accompanying departing passengers or meeting arriving passengers. As a supplier, the airport provides facilities that permit the functioning of these and other services. The airport acts as an intermediary; that is, it supplies the facilities demanded by 2 types of consumers: the public and the air carriers. The latter group has a derived demand for facilities based on the public's desire to travel. The public's desire to travel is also a derived demand based on things such as the perceived benefits to be gained from traveling. The carriers also act as a supplier of services that the public wishes to consume.

The degree to which the airport serves the public and the carriers depends on its level of capacity. Determining what level of capacity to provide is difficult (as is defining capacity). This

problem also confronts the air carriers and all producers of transportation services and is caused by 2 items.

The first item is that the services produced by the facility cannot be stored. Thus a berth, which produces a certain number of passenger enplanes and deplanes during the rush hour, is capable of producing the same service during off-peak periods, but may not be called on to do so. Hence, excess capacity will likely exist at some point of the day, week, or year. What level of the demand should be served? If peak level is served, then significant excess capacity will exist during the off-peaks, and the investment and maintenance costs are likely to be large. (The level of excess capacity costs involved will be discussed below.) If capacity is set at less than the peak, the quality of the service must decrease as congestion occurs during the peak period. What is the trade-off between the cost of the investment in facilities (borne by the general public through general obligation bonds or the air carriers and all air customers through airport revenue bonds or by both groups), and the cost in congestion delay (borne by the air customer on the plane arriving during the congested period)?

The second item is the lumpiness of airport investment. A baggage facility that is built to handle 1 planeload of baggage per hour will also handle many more planeloads of baggage per hour with no increase in investment costs. The nature of providing the airport landside capacity is such that decisions to change such capacity are large ones and basically imply discrete moves rather than movement along a continuum of service.

The purposes of this paper are to point out some of the issues that are involved in the control (or exemption from control) of the air carriers by the economic regulation and activities of the Civil Aeronautics Board (CAB); the safety and security regulations and the administration of the Airport Development Aid Program (ADAP) of the Federal Aviation Administration (FAA); the processing regulations of the Department of Justice (DOJ) through its Immigration and Naturalization Service; the customs regulations of the U.S. Customs Service in the Treasury Department (TD); the passport requirements of the Department of State (DOS); the health requirements of the Department of Health, Education and Welfare (HEW); the agricultural importation restraints of the Department of Agriculture (DOA); the environmental controls of the Environmental Protection Agency (EPA) and the Council on Environmental Quality (CEQ); the fuel allocation powers of the Federal Energy Administration (FEA); the demands and ability to effect those demands for use of airport space by the Department of Defense (DOD); and the like functions by state and local agencies, where they exist, along with some idiosyncratic local and state regulations.

The policies of CAB, FAA, other federal, state, and local agencies with policing powers, and the carriers themselves (operating in the regulatory and promotional environment of the above agencies) can and do have an impact on airport landside capacity. A portion of this paper will explore the current situation and its implications and will also suggest how other policies that could be enacted by the regulatory agencies would be likely to influence landside capacity. A general discussion will first be given of the various regulatory powers of federal, state, and local agencies.

POWERS OF REGULATORY AGENCIES

In general, CAB has regulatory powers over the fares charged by the carriers. It also regulates carrier entry and exit from markets and controls carrier mergers. A major power of CAB from the point of view of this paper is its power to allow carrier collusion through the approval of formal carrier agreements. These include capacity limitation agreements, fuel reduction and rescheduling agreements, and congestion agreements. [This power of economic regulation stems from the Civil Aeronautics Act of 1938 (as annotated), which is basically found in the Code of Federal Regulations, Title 14: Aeronautics and Space. The economic regulation is in Title IV of the Civil Aeronautics Act and is repeated as Title IV of the Federal Aviation Act of 1958.]

FAA regulates air safety. It certifies the airworthiness of airplanes and competence of pilots and institutes a series of procedures that control traffic while it is in the air and taxiing on the ground. Although these safety procedures basically determine airside

capacity directly, they naturally influence landside capacity because of the interdependence of the 2 capacities. The rate at which planes can land creates limitations on the demands for berths, baggage facilities, restrooms, and other facilities. Determinations of the type of planes that can use the airport also influence the demands put on capacity. Air commuter, air taxi, and general aviation carriers and users are not regulated by CAB, and hence their control comes only from safety regulations and state regulations. The initial safety regulations of FAA were spelled out in the 1938 act and were substantially increased in the 1958 act, which formally created FAA. (The powers of FAA can be found in the Code of Federal Regulations, Title 14.)

DOS, DOJ, HEW, DOA, and TD influence landside capacity in several ways. DOS influences foreign scheduling because of its interaction with the president of the United States and the CAB in approving international routes. By requiring passports, DOS has, in essence, required many international airports to have duplicative terminal facilities for foreign and domestic flights; the difference is only that the international segment has customs and a passport check. Regardless of the duplicative effect, the existence of passports and customs requires that space be dedicated to such facilities. Passport control is under the Immigration and Naturalization Service of DOJ, and customs is under control of the Customs Service of TD. Further inspection relates to the health certificates of HEW and the agricultural inspection of DOA. These facilities can also be bottlenecks and influence the capacity use of other facilities. They can also ration the stream of passengers arriving and hence influence the demand for and use of other capacity.

FEA has power to allocate the production of jet aviation fuel and its distribution among the carriers. It has chosen to do so based on percentages of 1972 fuel consumption of the carriers. Such fuel rationing can influence the type of aircraft flown, the number of flights flown, and hence the carrier's internal origin-destination distribution of those flights. These results, in turn, impact on landside capacity at the affected airports. Studies by Yance (14) and comments by a CAB administrative law judge (13) suggest that the carriers do rearrange their flight schedules and hence their impact on landside capacity to remove unprofitable flights [which they feel they cannot remove unilaterally because of the S-shaped market share argument (7, 12)].

EPA, CEQ, and other federal agencies are entrusted with guarding the natural environment. A list of federal regulations that have potential impact on airports and their major requirements (3) is given below. Many of these acts and regulations can have an all-or-nothing impact on potential new airport landside capacity, i.e., if a new site were to have an adverse environmental impact statement, capacity would be zero, for the building of new capacity would be blocked.

1. National Environmental Policy Act of 1969, section 102(2)(c): An environmental impact statement must be prepared for major federal actions significantly affecting the environment.
2. Executive Order 11514, March 5, 1970: Federal agencies must direct policies, plans, and programs to meet national environmental goals.
3. Airport and Airway Development Act of 1970, section 16(c)(3): Fair consideration must be given to interest of communities near airport projects; section 16(c)(4): consideration must be given to environmental effect of airport projects, and adverse effects will be allowed only if there are no alternatives; section 16(d)(1): an opportunity must be provided for a public hearing to consider economic, social, and environmental effects of airport projects; section 16(e)(1): applicable air and water standards must be complied with; section 18(4): action must be taken to restrict use of land near airport to compatible activities; and section 23: secretary of transportation may request transfer of federal land (except parks) for airport use.
4. Department of Transportation Act of 1966, section 4(f): Parks and historic sites can be used for airport projects only if there are no prudent and feasible alternatives, and if land from parks or historic sites is used all possible planning must be included to minimize harm.
5. Clean Air Amendments of 1970, section 309: Administrator of Environmental Protection Agency must review legislation, federal projects, major federal actions,

and proposed regulations for impact on air quality (requirements are given for ambient air quality standards, state implementation plans, and EPA examination of aviation emission standards).

6. Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, all sections: Uniform policies on relocation and land acquisition must be complied with.

7. National Historic Preservation Act of 1966, section 106: If projects affect property in National Register, federal official must take the effect into account and give the Advisory Council on Historic Preservation an opportunity to comment.

8. Federal Aviation Regulations, part 152: Regulations are given for implementation of Airport Development Aid Program and planning grants.

9. OMB Circular A-95, revised, part 1, section 2a(4): When clearinghouse is notified of proposed federal or federally assisted projects, statement must be given as to whether environmental impact statement is required and what the nature of the impact is; part I, section 3c, and part II, section 2a(3): Clearinghouse must ensure that appropriate state and local agencies authorized to develop and enforce environmental standards are given opportunity to review and comment on proposed projects.

10. Council on Environmental Quality, Statements on Proposed Federal Actions Affecting the Environment, Guidelines, all sections: Requirements are given for preparation of environmental impact statements.

11. DOT orders and notices and FAA orders, notices, and advisory circulars: Regulations and instructions are given for implementation of the above.

Under the Airport and Airway Development Act of 1970 and through prior legislation, those airports receiving government funding must allow government aircraft (mostly DOD, but in some cases Executive Office flights) to use the facilities without charge (except under certain circumstances). In certain areas with a priori knowledge of a number of such flights, provision must be made for such capacity use.

Under the same act, space in the airport buildings, and hence capacity, must be supplied free of charge to air traffic control operations of FAA, some flight service operations of FAA, and to the U.S. Department of Commerce (DOC) for weather reporting. Of course, since ADAP funds can only be used at present for airside purposes, airside capacity could outstrip the ability of landside capacity to handle such capacity, e.g., at Chicago (O'Hare) Airport.

Local ordinances also influence capacity. Noise limitation ordinances (curfews) have closed some airports at night to commercial flights; e.g., Washington (National) Airport is closed from 11 p.m. to 7 a.m. This guarantees that virtually the total capacity will lie idle at such airports for almost 33 percent of the time. Fire ordinances limit restaurant capacity. Health ordinances may dictate the number of toilet facilities. Zoning ordinances may dictate the type of facility that can be built and hence its capacity. Local parking lot commissions may control rates and hence use of capacity (via the demand curve). City planning commissions, air and water pollution control districts, state and city environmental quality departments, regional planning agencies, and state and city highway departments also influence landside capacity by their actions.

State regulatory agencies may exercise certain controls analogous to those exercised at the federal level by CAB [28 states did so in 1969 (9), p. 808]. As a rule, regulations analogous to those of the CAB have been less stringent on the state level. So far the courts have interpreted FAA safety regulations as applying to both interstate and intrastate flights.

The concept of landside capacity entails the capacity of facilities from the open door of the plane at berth, through the terminal facilities, and out to the ground access periphery of the airport. Thus the concept entails (but is not limited to)

1. Berthing facilities,
2. Passenger staging areas,
3. Security facilities,
4. Restaurants,
5. Cocktail lounges,

6. Rest rooms,
7. Ticket counters,
8. Concessions (souvenir shops, car rentals, insurance sales),
9. Baggage facilities,
10. Parking facilities,
11. Telephone booths,
12. Surface transportation,
13. Access and egress roads to the terminal,
14. Customs facilities,
15. Terminal lobby,
16. Vending machines,
17. Air traffic control,
18. Airport support personnel facilities,
19. Air freight storage and staging,
20. Truck parking,
21. In-flight meal storage,
22. Ground services equipment and storage,
23. Emergency equipment services and storage, and
24. Maintenance and storage facilities for planes.

Some of the airside capacity of the airport is reflected in the facilities from the open door of the plane to the air access boundaries of the airport, i.e., aprons, runways, and taxiways.

Six general types of regulation affect landside capacity: economic regulation of the carriers initiated by CAB and state agencies, such as public utility commissions; safety, security, and ADAP regulation of FAA; general environmental regulation of EPA and CEQ; fuel allocation power of FEA; control powers of DOS, DOJ, HEW, DEA, and DT through customs and inspection; and local institutional regulations on items such as building codes, zoning, health, and safety.

REGULATORY POWERS THAT INFLUENCE LANDSIDE CAPACITY

One of the dimensions of airport capacity is time related: What is adequate for one time period (off-peak) may be inadequate for another time period (peak). Another is the lumpiness inherent in the process. Another relates to the use of the existing capacity. Many times existing capacity is not used to its maximum efficiency because of a lack of study by the provider of the facility. In many cases, a reorganization of existing resources will provide the capacity needed. The reorganization could be temporal (diverting peak to nonpeak), physical (redirecting traffic or allowing apron enplaning and deplaning), or institutional (allowing carrier X to use carrier Y's berths). [While writing a portion of this paper at Chicago (O'Hare) Airport, my TWA flight was, in fact, delayed 10 minutes in docking because of the unavailability of TWA berths while many empty berths were visible at Eastern.] The ability to change effective capacity by low-cost, noncapital alternatives is not a concept to be treated lightly.

In addition, since the provision of capacity is costly and that capacity is basically fixed in the short run, thought should be given to the concept that all the capacity desired at any given time cannot be obtained unless it is paid for. After all, the carriers do not let an individual fly from A to B unless the individual is willing to pay the fare. Although an immense demand to fly from A to B exists when the fare is $0 and a progressively less immense demand exists as the price increases, the only demand (quantity demand) that counts (at any given time) for the carrier is how many trips will take place at the stated fare. Likewise, the carriers have a demand for certain landside facilities. Just as the carriers will not let a customer ride if the fare is not paid, the carriers should not expect to have the capacity waiting for them unless they are willing to pay the fee. Since the capacity is fixed for the short run, some have suggested (2, 10) that, should the quantity demanded exceed the fixed quantity supplied, then the

supply should be rationed via a pricing scheme. The carriers could bid up the price for using the scarce capacity and would presumably be willing to do so until the level of the price was equal to the gains the carrier perceived from using the capacity at that time. As the price is bid up, certain operations would drop out of that market and presumably switch to the off-peak. The "excess" revenues earned during the peak period by the supplier of the capacity could be used to expand the capacity in the long run or for other purposes.

The use of prices for rationing should not be brushed off as a theoretical exercise. Seasonal and incentive prices (called per diem) paid for use of one railroad's equipment by another railroad now exist and are based on the season of the year and the investment cost and age of the equipment. In addition, fares for off-peak air travel also exist. Although the latter situation is probably not an example of pricing done with rationing in mind, the former certainly is. Proposals for incentive demurrage rates for rail equipment have been made (11). In addition, peak pricing exists in the pricing of phone calls and in the pricing of many public utilities. Thus, the peak-related pricing is no longer some economist's pipe dream but has become reality in a number of areas that are and are not related to transportation. These pricing mechanisms bear study in this question of the rationing of air capacity. It is not anticipated that such pricing would turn the daily, weekly, and yearly distribution of flights and passengers to a rectangular one, but rather would smooth the peaks so that top loads can be spread out over a tolerable time. It should be noted that, in order for the system to work, the carriers should be allowed to pass the cost onto their customers.

With this digression aside, the powers of the regulatory agencies that impact landside capacity will be described. CAB and state economic regulations will be discussed first. This will be followed by a discussion of the FAA regulations, other federal regulations, and local regulations.

CAB and State Economic Regulations

CAB does not regulate airline scheduling [Section 401(e) of the Federal Aviation Act of 1958]. This scheduling has a great deal of impact on landside capacity. CAB does regulate city pair entry and exit from service. The city pair entry tells who the likely consumers of airport capacity are (although charters, military, air taxi, commuter air, and general aviation are not included). One cannot schedule service unless one is certified to do so (subject to the exceptions cited above). But CAB does not specify the daily frequency, timing during the day, or type of aircraft to be used. CAB does regulate abandonment and hence does specify indirectly some minimum level of service (but in practice this has been zero on some routes). But aside from regulation telling who is allowed to provide service (entry) and who must provide service (exit), the service spectrum is open to carrier discretion.

It has been suggested (4) that, since fare is basically regulated by the CAB, the carriers take the price as a parameter and compete on the basis of service quality, the chief dimension of which is schedule frequency. Using a type of Chamberlain equilibrium process, the carriers add capacity (or subtract, depending on their initial position) until all excess profits on the given market segment are competed away. Given the equipment types, CAB's approval of fares establishes the break-even load factor for each market. (CAB does not generally set rates. Rates are basically proposed on the carrier's initiative. However, the net result is that all carriers have the same fare between any 2 points.) Carriers then compete on the basis of service so that actual load factor equals the breakdown load factor.

The above shows the crucial relation between price and quality of service, i.e., frequency of flights. A low fare will require a high break-even load factor and hence a tendency to reduce schedule frequency so that passengers can be "stored up" to allow for high load factors. Of course, the validity of this argument depends on the price elasticity of demand, since lower fares will increase quantity demanded, and the frequency elasticity of demand, since lower frequency will decrease the quantity demanded. Conversely, a high fare will require a low break-even load factor and hence a tendency

to increase schedule frequency to reduce the actual load factor to the level of the break-even load factor. To the extent that fares are high, "extra" flights may exist. These extra flights may tax airport capacity, depending on their timing.

The type of aircraft scheduled also plays a major role with regard to capacity and has different effects on different types of capacity. The arrival of a 707 or a 747 basically takes the same amount of an air traffic controller's time and the same time on the runway, in a berth, and so on. But the strain on baggage facilities, ground transportation, and other landside facilities, assuming the same load factor (at a reasonable level), is quite different.

Recently the carriers have discovered that, although they would not cut capacity unilaterally, since market share is proportional (with an S-shape) to frequency share (7, 12), they will mutually benefit if they all agree to cut frequency; i.e., if they act as quasi-monopolists, they can reap some of the excess profits that they competed away under the Chamberlain type of oligopolistic competition.

Section 412(a) of the Federal Aviation Act of 1958 allows the carriers to meet together to collude. One form of this collusion was the Carrier Limitation Agreements of 1971 between American, TWA, and United. Flight frequency was reduced in 4 long-distance markets (New York/Newark-Los Angeles, New York/Newark-San Francisco, Chicago-San Francisco, and Washington/Baltimore-Los Angeles) from 6.1 to 38 percent, averaging 28 percent depending on both season and market (4, p. 129). The agreement was renewed in 1972 (CAB Order 72-11-6, November 2, 1972). Other examples exist in the intra-Hawaiian market (CAB Order 71-12-143, December 30, 1971), the New York/Newark-San Juan market (CAB Order 72-6-70, June 16, 1972) and its extension (CAB Order 72-11-7, November 2, 1972).

This type of behavior was augmented by the fuel crisis of 1973. American, TWA, and United mutually agreed, upon CAB invitation, to reduce capacity in 20 markets (CAB Order 73-10-110, October 30, 1973). The same 3 airlines met in January 1974 and reached agreement on capacity allocations on 27 routes. The net result of these reductions, reductions made by other carriers, and some unilateral reductions was a reduction in scheduled air traffic by 15 percent or 1,700 daily departures eliminated from October 1973 to January 1974 (10).

In this period, American Airlines curtailed departures by 22 percent and personnel by 8 percent and grounded ten of its sixteen 747's. Clearly such reductions have repercussions on landside capacity, although the timing dimension is important here. The first reduction influenced the need for berths and baggage facilities, the second affected the need for restaurants and toilet facilities, and the third altered the need for the throughput ability of facilities at any given time.

A third type of capacity limitation in the airline industry relates to the Congestion Agreements of 1968. This situation involved both FAA and CAB. Air traffic controllers staged a slowdown by controlling the planes "by the book." This practice entailed a much greater time interval between landings than that of the de facto standards that were actually in practice at the time of the slowdown. This practice created a great deal of congestion at busy airports. FAA stepped in and announced quotas on airports, stating that operations would not exceed the maximum safe rate. This entailed the CAB allowing carriers to meet to rationalize their flights to and from congested airports. The final agreement set up scheduling committees at New York (Kennedy), New York (La Guardia), Newark, Washington (National), and Chicago (O'Hare) Airports. As might be expected, the carriers tended to cut out the least profitable flights. Thus, although the impact on airside capacity was great, the impact on landside capacity, except for berths, was much more limited.

In the latter case and in all cases that impinge on congestion, we will notice that the lack of a cyclical sensitive pricing policy for the facilities creates difficulties and creates a tendency for a plant size that is too large and, hence, too costly to be provided.

To paraphrase from Borts' article (1) on the inefficiencies caused by a lack of railroad cyclical sensitive pricing (a situation now somewhat mitigated by seasonal per diem rates), suppose that the total cost of providing for airport services was increasing at an increasing rate, i.e., diminishing returns have set in. Various sized plants

are all capable of producing the same levels of output, but for any given level of output only one plant is the cheapest. However, the situation being dealt with is one in which a wide and varied range of outputs need to be serviced (during a short-range time period—day, week, year) with only one plant size (at any given time, since changing plant size is a long-term investment and, once effected, a given plant size exists). To simplify matters, suppose 2 plant sizes exist: large and small. Suppose also that the various output levels are condensed into two: peak and trough. The situation is shown in Figure 1.

If just the trough output were to be produced at all times, the firm would choose the small plant to minimize the costs of production and to maximize profits. The situation would be reversed if just the peak output were produced at all times; i.e., the large plant would be chosen.

But what happens is that both the peak and the trough outputs are demanded in a short time period, and this creates a dilemma as to whether to choose to construct and operate the small plant and endure higher than optimal costs during the peak demand or to choose the large plant and endure higher than optimal costs during the trough demand. Optimal plant size will depend on the proportion of the time that peak demand exists and the proportion of the time that trough demand exists.

Clearly the proportions mentioned above can range from 1 to 0. Suppose that the actual peak proportion is Y, which makes the trough proportion 1 - Y. The average output produced over the course of the demand cycle would be $\hat{X} = Y \cdot \text{peak} + (1 - Y) \cdot \text{trough}$, and the cost of providing these 2 services over the demand cycle would be $\hat{C}_i = Y \cdot \text{peak cost}_i + (1 - Y) \cdot \text{trough cost}_i$, where i = small, large.

Depending on the level Y (which, in turn, determines $\hat{X}$), the cost of providing these 2 services (in varying proportions) is shown by a straight line connecting peak cost_i with trough cost_i (Figure 2).

Figure 2 shows that, if the average output between peak and trough, i.e., $\hat{X}$, is anywhere between the trough output and X_1, the small plant will have a lower total cost; i.e., $C_{small} < C_{large}$. The reverse situation exists if $\hat{X}$ is between X_1 and the peak output; i.e., the large plant will entail the lowest cost. However, suppose the same cyclical output was obtained by having $\hat{X}$ not being a weighted average of peak and trough but occurring continuously. Then the curves, not the straight lines, become relevant. A continuous output lying between the trough output and X would choose the small plant, and a continuous output lying between X and the peak output would choose the large plant. Notice that the above 2 situations do not give the same results. For an $\hat{X}$ between X_1 and X, a large plant would be chosen. However, for continuous output between X_1 and X, a small plant would be chosen.

The purpose of this long discussion is to show the bias caused by the existence of peak and trough in terms of creating a plant that is larger than needed to serve the same cyclical output during the length of the cycle. If the peak can be lowered and the trough raised, then the area of conflicting results becomes smaller. As alluded to above, a pricing mechanism that prices high during the peaks, thus reducing the peak quantity, and low during the troughs, thus increasing the trough quantity, will allow the system to operate at lower total cost (notice in Figure 2 that the small curved line is lower than the large straight line between X_1 and X). As suggested above, the use of pricing to ration the use of a system is not a foreign structure to transportation. Schedule regulation can do the same thing, but the efficiency of a market solution is lost under such an arrangement.

Although the pricing structure will redistribute demand over the cycle and some of the demanders thus redistributed will be inconvenienced, they will only be inconvenienced because they previously do not have to pay for a cost that they were causing. If they value the inconvenience highly enough, they will pay the peak fare, for surely airlines would attempt to pass on their peak user charges. Those who will not pay will be inconvenienced, but will reveal that the value of the inconvenience does not offset the costs of having the high level of capacity present.

What has been the effect of the capacity limitations? Table 1 (15) gives the number of air carrier departures in each of the market places involved in the initial capacity limitation agreements. Interesting relations can occur concerning the constituency of

Figure 1. Total cost curves of small and large plants.

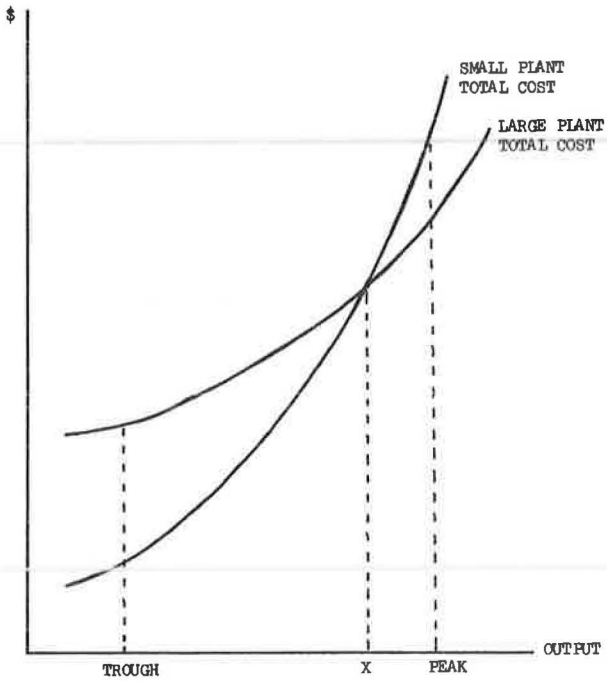
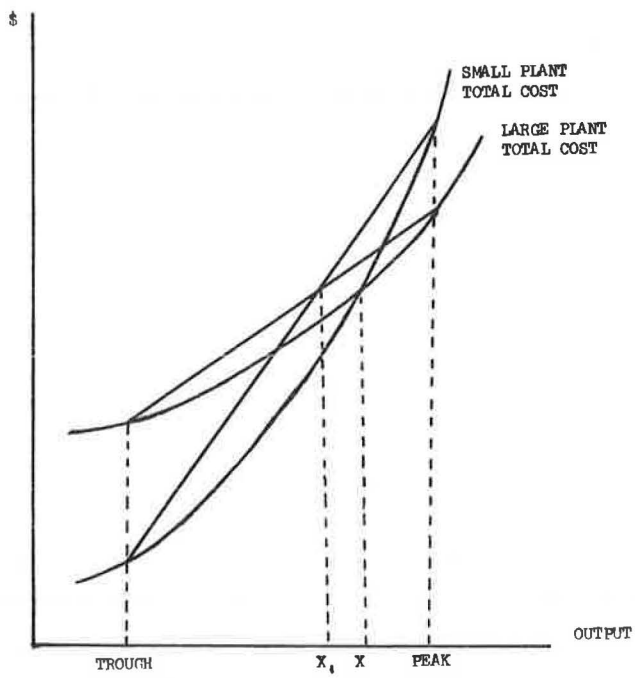


Figure 2. Total cost curves of small and large plants and total costs incurred when variable proportions of peak and trough outputs occur.



the capacity. For instance, although the number of flights has increased at Chicago, Los Angeles, and San Francisco, the ratio of the busy hours (the hours when capacity is mostly heavily taxed) to the average hours fell. This implies that peak flights fell while off-peak flights grew or that both peak and off-peak flights grew, but off-peak flights grew at a sufficiently faster rate to allow the ratio to fall. If the first occurred, a more efficient use of the airports was accomplished.

On the other hand, Washington (National) Airport lost flights, but the ratio of busy-hour to average-hour flights increased. This could also have occurred in several ways, one of which is beneficial to the capacity argument and one of which is not. The available data do not show the impact of the curfew on these figures, however. The remaining cases involve increases in flights and increases in the ratio or decreases in flights and decreases in the ratio. The former case can only strain capacity [New York (La Guardia), Newark, and Washington (Dulles)]. The latter case can only result in alleviated capacity [New York (Kennedy), and Washington (Baltimore-Washington)].

Unfortunately the data here are not sufficient to show the impact on landside capacity. Time precluded processing the information by carrier, by route, and by time to show the actual impact on each of the airports. However, Table 2 gives one figure, e.g., number of flights, that can be misleading, and the ratios can also be ambiguous.

A difficult problem also exists in terms of defining the capacity. In certain cases capacity of some elements is defined as a stock concept, e.g., the capacity of a 100-seat sit-down restaurant at any given time is 100 persons. But the capacity over time may differ substantially. A 100-seat McDonald's may have a much greater effective capacity in the course of an evening than will a 100-seat exclusive Paris restaurant.

Other definitions of capacity relate solely to the flow side. The capacity of a hallway is generally thought of in terms of the number of people able to pass between 2 given points in a given time period. At some point, as more people attempt to pass between these points, the quality measure (persons per minute) begins to deteriorate. If even more passengers attempt to pass between these points, service offered can approach zero. These 2 examples stress that capacity must have a time dimension explicit with the definition.

A recent decision by CAB Administrative Law Judge C. Robert Seaver (13) suggests that the effect of capacity limitation agreements in one market may be an increase in capacity in other markets. He cites specific cases in which American, Eastern, and United behaved in such a fashion. Thus, the ramifications of these changes on the system's capacity must be investigated.

Table 2 gives data (16) that show that airline departures have generally fallen significantly as the result of the capacity limitation agreements of the carriers. A specific example of airline capacity agreements can be shown as an extension of Jordan's data (8); he shows movements in a time series from June 1971 to November 1972. As a quick check, his assumptions have been replicated for March 1975 and are given in Table 3 (8, 17). For the 4 time periods that Jordan shows, the flight frequency has basically fallen over time. In general the 1975 data show a further, albeit slight, decrease.

The comparison of Jordan's first time period and the March 1975 period shows the dramatic change (decrease) in capacity (unadjusted for seasonality) that has occurred in these major markets (markets involved in capacity limitation agreements) during the last 4 years. The comparison can be distorted by explaining a fall as the result of making a nonstop a 1 stop (which does not influence the capacity of the originating and terminating airports, except an implied timing difference, but may influence the capacity of the intermediate airport). However, the magnitude of the difference between the 2 time periods is too large to be explained on such grounds. The drop in flights is 29.5 percent from New York to Los Angeles, 43.2 percent from New York to San Francisco, 6.1 percent from Chicago to San Francisco (the stability is due to United's significant addition of conventional flights that counterbalances the removal of wide-bodied flights), and 27.2 percent from Washington to Los Angeles. Clearly then, the capacity limitation agreements have had a strong effect.

The grounding and rearranging implications of wide-bodied jets are also quite dramatic. Although the number of wide-bodied flights fell by only 7.1 percent from

Table 1. Activity at major capacity-limitation airports.

Airport	Fiscal Year 1972 Departures	Fiscal Year 1972 Ratio of Busy Hour to Average Hour	Fiscal Year 1973 Departures	Fiscal Year 1973 Ratio of Busy Hour to Average Hour
New York				
Kennedy	330,309	2.431	331,636	2.297
La Guardia	289,678	2.424	295,298	2.471
Newark	172,381	2.550	175,121	2.700
Chicago				
O'Hare	581,137	2.303	586,285	2.239
Washington				
National	224,321	1.654	221,925	1.840
Baltimore-Washington	91,821	2.700	84,352	2.500
Dulles	61,298	2.857	63,120	3.429
Los Angeles				
International	366,445	2.190	383,438	2.182
San Francisco				
International	279,474	2.250	297,462	2.176

Table 2. Average daily airline departures.

Airline	October 1973	January 1974	Change (percent)
American	1,098	861	-21.6
Eastern	1,430	1,310	-8.4
TWA	920	690	-25.0
United	1,520	1,322	-13.0
Braniff	502	508	+1.2
Continental	392	364	-7.1
Delta	1,540	1,295	-15.9
National	400	—*	—*
Northwest	528	483	-8.5
Western	—*	—*	—*
Pan Am	430	325	-24.4
Allegheny	1,105	725	-34.4
Frontier	586	478	-18.4
North Central	639	606	-5.2
Big Four	4,968	4,183	-15.8
Domestic Ten	8,330	6,833	
Total	11,090	8,967	

*Not available.

Table 3. Equivalent 1-way nonstop flights scheduled in transcontinental city pairs in June 1971 and March 1975.

City Pair	Airline	1971 Flights Weekly EB	1971 Weekly WB	1971 Weekly Total	1971 Daily Number	1971 Daily Percent	1971 Wide-Bodied* Number	1971 Wide-Bodied* Percent	1975 Flights Weekly EB	1975 Weekly WB	1975 Weekly Total	1975 Daily Number	1975 Daily Percent	1975 Wide-Bodied* Number	1975 Wide-Bodied* Percent	1975 Flights as a Percentage of 1971 Weekly	Daily	Wide-Bodied*
New York-Los Angeles	American	70	75	155	140	96.6	84	57.9	48	48	96	77	80.2	56	58.3	66.2	55.0	66.7
	TWA	63	63	126	126	100	84	66.7	44	44	88	70	79.5	56	63.6	69.8	55.6	66.7
	United	49	49	98	98	100	28	28.6	35	41	76	70	92.1	56	73.7	77.6	71.4	200.0
	Total	182	187	369	364	98.6	196	53.1	127	133	260	217	83.5	168	64.6	70.5	59.6	85.7
New York-San Francisco	American	41	48	89	77	86.5	56	62.9	27	28	55	49	89.1	28	50.9	61.8	63.6	50.0
	TWA	49	49	98	98	100	56	57.1	25	26	51	42	82.4	28	54.9	52.0	42.9	50.0
	United	49	49	98	98	100	28	28.6	28	28	56	56	100	28	50.0	57.1	57.1	100
	Total	139	146	285	273	95.8	140	49.1	80	82	162	147	90.7	84	51.9	56.8	53.8	60.0
Chicago-San Francisco	American	49	49	98	98	100	28	28.6	35	34	69	62	91.2	14	20.3	70.4	63.3	50.0
	TWA	49	49	98	98	100	56	57.1	41	48	89	77	86.5	14	15.7	90.8	78.6	25.0
	United	49	49	98	98	100	28	28.6	62	56	118	112	94.9	14	11.9	120.4	114.3	50.0
	Total	147	147	294	294	100	112	38.1	138	138	276	251	90.9	42	15.2	93.9	85.4	37.5
Washington-Los Angeles	American	28	21	49	49	100	28	57.1	19	18	37	7	18.9	12	32.4	75.5	14.3	42.9
	TWA	21	21	42	42	100	0	0	14	14	28	28	100	0	0	66.7	66.7	0
	United	28	28	56	56	100	0	0	21	21	42	42	100	14	33.3	75.0	75.0	∞
	Total	77	70	147	147	100	28	19.0	54	53	107	77	72.0	26	24.3	72.8	52.4	92.9

*Equivalent to 2 narrow bodied flights.

Washington to Los Angeles, the fall was 14.3 percent from New York to Los Angeles, 40 percent from New York to San Francisco, and 62.5 percent from Chicago to San Francisco.

However, the timing of the flights is one of the crucial variables impacting on landside capacity. For instance, in March 1975 all 3 carriers had a 747 going from New York (Kennedy) to Los Angeles at noon and all 3 had wide-bodied jets going from Los Angeles to New York (Kennedy) at 8:45 a.m. These occurences are likely to press on capacity.

The CAB control over merger has an impact on capacity. To the extent that the merger decreases competition on a route, the more likely it is that flight frequency is reduced as the carriers attempt to exploit their monopoly power. In fact, Douglas and Miller (4) show that, in the 25 percent of the markets in this country that are effectively monopolistic, the flight frequency is lower than in comparable markets where competition exists. On the other hand, to the extent that merger creates a viable carrier (usually mergers are of the strong-weak partner variety), more business and hence more taxation of capacity may ensue.

A crucial element in the capacity analysis is the existence of bottlenecks. The system will basically perform as well as the performance of the weakest link. If an adequate number of berths exist but an inadequate baggage facility exists, the limiting factor will be the baggage facility. This bottleneck may, in turn, cause other bottlenecks (or alleviate potential bottlenecks at other facilities). For instance, a steady (normal) flow of passengers from an adequate baggage facility might be handled adequately by the ground service facilities. However, a bunched release of passengers from an inadequate baggage facility may strain an otherwise normally adequate ground transportation system.

Significant pressure for deregulation is likely to occur in future years. To dampen such pressures, the regulatory agencies will probably use their discretionary powers and relax regulation. The allowance of peak load pricing can only help the long-run capacity situation. Free entry could initially strain capacity levels, for such entry is likely to be in high-density markets that already have large numbers of flights. Entry is also likely to be high on monopoly routes where excess profits are currently being made. Such entry could strain terminal capacity depending on its timing.

User fees and air ticket taxes could influence the overall level of air demand and hence the demand for capacity.

FAA, Other Federal, and Local Regulations

The second type of regulation that influences capacity is the safety, security, and ADAP activities of the FAA. Perhaps the chief FAA impact on landside capacity is through air traffic control. The control procedures determine how many planes can take off and land during a given period of time. As a rule, this would put an upper limit on landside capacity, although for cost reasons this level of capacity might not be provided.

The security regulations require that each passenger and his or her carry-on luggage be searched. This has caused queues at certain airports at certain times and, in general, has taken up some lobby and hallway capacity.

The ADAP provisions require that free space be given to the 2 FAA activities and the National Weather Service as mentioned previously. Presumably this space would not have been built or would have been used differently were it not for this requirement.

Outside of the environmental legislation, virtually no regulations have been explicitly devised to deal with airport landside capacity. The ADAP legislation requires free space be provided to FAA traffic controllers and flight service personnel and also to the Weather Service. Local ordinances may dictate levels of capacity for restaurants and parking lots. These latter regulations are quite idiosyncratic. Thus, very little experience exists with respect to direct regulation.

Local noise limitations do affect landside capacity as previously noted. Since many airports involve local government ownership, such restrictions on the use of the

capacity can work against the peaking and troughing arguments that were advanced above.

Thus, the potential all-or-nothing effects of the environmental legislation are the only regulations that can be construed to be explicitly related to landside capacity. The security and international processing regulations do require that space be devoted, but are not explicit as to the amount of space or its precise location.

As in virtually all situations, there are trade-offs to be made among the various participants, and, of course, some of these involve the government and its regulations.

Whether the local airport is interested in weather forecasting or not, the ADAP Act of 1970 and the Airport Development Act of 1946 force the airport to pay the price for government aid by dedicating rent-free space to the Weather Service. Whether a municipality is security conscious or not, the antihijack provisions of FAA may require a greater degree of security than that municipality would have were it not for the regulation.

No explicit statement could be found to indicate that any regulator was conscious of effects of other regulation on landside capacity. Through forums such as this conference, through adversary proceedings before the regulatory agencies, through Congress, and through personal contact, the regulators can be informed of the interdependence of their regulations and airport landside capacity. This interchange should be facilitated by DOT in its role as the general government policy maker in transportation.

However, 2 separate issues exist. One is the issue in general. The other is the extremely idiosyncratic issue of a particular airport. Many of these latter situations are not likely subjects for generalization.

For the most part landside capacity is free from regulation. The carriers and the airport management usually negotiate consumption of capacity on long-term agreements. The level of capacity provided in a new airport is related to what the carriers and management foresee the increase (or decrease) in traffic to be. Once the airport is built, the deciding factor in the use of its capacity is new airlines certificated for a city pair involving the airport at issue and the scheduling done by the carrier. Although the first item is under control of CAB, the latter is not. The latter is also subject to frequent change.

The measurement of the trade-offs involved in evaluating a regulation (or nonregulation) that is designed to handle situation X but that also impacts on landside capacity is difficult. In some cases it relates to a regulation involving safety, e.g., air traffic control. Allowing planes to land more frequently could tax airport capacity, but would also tax safety (given current technology). In the case of airport security, how is the probability of being hijacked traded off with the cost of queues in the airport and decrease in lobby space? A situation exists in which a system is being maintained that has produced no hijackings since it went into effect. Is this the optimum situation? Or should less money be spent on airport security at the cost of an increased probability of being hijacked?

Clearly the American public has revealed by its behavior that the optimal incidence of other types of events is not zero. If automobile speed limits were reduced to 5 mph (8 km/h), passive restraint systems were made mandatory in every vehicle, and vehicles had rubber bumpers 15 in. (38 cm) thick in front and back, accidents on the highways would fall close to zero. However, impacts would include 20-hour trips by car from Philadelphia to Baltimore (much to the advantage of air and rail) and declines in automobile sales. The American public would not tolerate the "price" that would have to be paid to get the automobile death rate to zero. Even today individuals will not wear seat belts despite Puerto Rican and Australian experience with mandatory seat-belt laws that have markedly reduced automobile accident deaths in both places. Despite a dramatic fall in the death rate, i.e., deaths per miles driven, many individuals complain about the new 55-mph (88.5-km/h) national speed limit. The public appears to be saying that there is an optimal highway death rate. Optimal crime rates exist too; it is just too expensive to catch every criminal. Very likely an optimal hijack rate also exists. However, until the public's preference functions become known, the trade-offs will not be known.

CONCLUSION

I have already suggested that a pricing mechanism be allowed to allocate (or ration) fixed capacity when excess demand exists. The market test will approximate what the benefits are to those who wish to use the service at the peak periods, but will understate them since it does not measure the consumer's surplus. Presumably some people would be willing to pay even more than the amount required to travel at peak times.

Clearly a benefit-cost analysis of the regulation is necessary. Since public convenience and necessity are many times involved in this, the task is not simple or unambiguous. Since benefit-cost analysis is fully discussed in the literature, it will not be discussed in this paper.

Part of the discussion is a question of distribution and not resource allocation. The question from the point of view of society is proper resource allocation. If an airport operator saves money while at the same time a carrier incurs increased cost, the operator is better off but society may not be. The resources may merely have been redistributed among society's members. Of course, one might decide that individual i is more deserving than individual j. That decision, however, is a political decision and is not related to resource allocation.

In general, the system effects of actions are not considered because in many cases the regulator is not a systems analyst nor has a jurisdiction that does not entail the impacted area and in other cases the impact is not perceived or sought after.

The process of changing regulatory behavior is a slow one. Lobbying, finding advocacy in a department like DOT, testifying before Congress, and appearing in proceedings before the regulator are all potential ways to influence the regulators. In many cases the laws do not have to be changed because the regulatory agencies already have great interpretative latitude and a change in practice is all that is needed.

The pertinent issues in landside capacity boil down to the efficient use of a given capacity at any given time and the optimal provision of long-run capacity. Since regulation (as currently constituted) can only indirectly control the crucial scheduling variable and since more regulation to allocate the capacity by fiat is not advocated, the role of pricing of airport services looms large in the scheme of this paper. With this pricing, the short-run rationing will be accomplished and long-run expansion or contraction will be influenced by the consumers of the services.

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