CONCLUSIONS

Railroads are frequently prevented from raising rates on "captive" traffic to a point where they can earn a reasonable return on total investment on the grounds that such rates would be unreasonably high and therefore unlawful. At the same time, water carriers argue that, whenever a joint water-rail rate would result in a lower rate to the shipper than an all-rail rate, railroads should be compelled to interchange with water carriers on a nondiscriminatory basis. Water carriers raise or lower rates in response to market conditions; railroads are compelled by law to provide service only at published prices. This amounts to forcing a railroad to give traffic to its competitor, who responds to market conditions in a way rail carriers cannot respond and receives subsidies rail carriers do not receive. Permitting railroad sharpshooting and mild price squeezing helps to redress the competitive imbalance between the modes. Imposing user charges further reduces the financial imbalance. User charges and increased rail pricing freedom would lower transportation costs to society and encourage a more equitable distribution of resources within the transportation system.

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Economic Cross Subsidization in Domestic Air Transportation

Douglas V. Leister, University of Nevada—Reno
Bruce N. Stram, Office of the Secretary, U.S. Department of Transportation

This paper presents an analysis of the economic incentives for a particular air carrier to provide air service to a particular point. Economic cross subsidization is discussed as it exists in many industries other than domestic air service. A suggested definition of economic cross subsidization is presented as well as an argument for recognizing this economic concept as primarily one of allocation of revenues rather than as primarily an allocation of accounting costs, which has been the traditional approach. Issues of product definition are also discussed.

There are a variety of proposed legislative measures currently before the Congress designed to reform economic regulation of the domestic airline industry. During the debate over regulatory reform, a central argument offered by the industry in defense of the 1958 Federal Aviation Act and against regulatory reform has been that there is extensive interdependence among air travel markets in the domestic airline industry and that, because of important economic cross subsidization of air routes, many air travel markets cannot stand on their own but must be supported by other markets (1, 2, 3, 4). Deregulation, the argument continues, would result in "cream-skimming," the collapse of the cross-subsidy system, and wholesale abandonment of service. From the point of view of this paper, the primary significance of this argument is in its assertion that, if existing cross subsidization among the routes of a particular carrier were removed by some external force, that removal would result in wide-scale abandonment by the carrier of points currently served. If such abandonment by carriers is not the result of an external removal of supposed interdependence among markets, then the argument loses its significance and need not be considered an important issue in regulatory reform.

Opponents of regulatory reform have argued that extensive cross subsidization currently exists between and among markets (or points served by particular carriers) and that the removal of cross subsidization would mean an end to profits that are necessary to support marginal service to marginal points served and would thus destroy a national, integrated system of air service. Inherent in this argument is the belief that (a) many of the markets served are not independent markets that can stand on their own two feet but rather interdependent markets; (b) service to one market is dependent on service to other markets; and (c) reduced profits for a more profitable market mean reduced service to less profitable markets. Opponents have also argued that larger markets are the most profitable and that smaller markets are either less profitable or lose money. It has been argued in both instances that, because of the inherent economics of the interrelated markets, profit reductions or increased competitiveness in the larger markets would preclude service to the smaller markets (5). The argument would be true from an economic standpoint if (a) extensive cross subsidization does exist and if profits, particularly excess profits, from larger markets are being consciously used to provide service—whether as a result of public interest objectives of private carrier managements or by regulatory fiat—to unprofitable smaller markets whose services are unrelated to the profits in the larger markets; and (b) larger markets are more profitable, by their nature or rate structure, than smaller markets.

During the lengthy Civil Aeronautics Board (CAB) investigation of domestic passenger fares, a deliberate attempt was made to remove any existing cross subsidization inherent in the regulated rates of the domestic 48-state passenger fare structure. Since the CAB decision, air passenger fares have been adjusted to remove cross subsidization. Shorter haul fares have been increased more rapidly than have longer haul passenger fares in an attempt by CAB to remove what was regarded as historic, inherent cross subsidization.

It is the position of this paper that economic interdependence among markets may or may not qualify as economic cross subsidization under the traditional definition. Market conditions are examined in which interdependence among markets may exist as a result of the natural conditions of the marketplace or markets may be linked by law or by regulatory fiat. (For example, many certificates of public convenience and necessity in the domestic airline industry require that market A be served only if market B is served.) The main purposes of this study are to explore the natural interrelationships among various markets for air service and, specifically, to question whether regulated circumstances or unregulated competitive circumstances are likely to lead to greater incentives for airlines to serve medium-sized and smaller air travel markets.

ECONOMIC THEORY OF CROSS SUBSIDIZATION

In its most general sense, economic cross subsidization exists when there is interdependence of markets, i.e., when individual markets are not independent. The traditional economic concept of cross subsidization is based on the idea that profits from services rendered in larger markets are used by the supplier to directly subsidize services in smaller markets that are less profitable or unprofitable and that the services performed in the smaller markets have no direct economic relation to the services performed in the larger, profitable markets.

Accountants and economists do not agree about when and where the traditional concept of cross subsidization occurs in a particular market. Two important economic thresholds at which cross-subsidization begins are those points at which (a) the immediate service in a market fails to cover the fully allocated economic costs of providing the service, including a return on the required capital investment; and (b) the variable costs of providing a service are not being covered by the revenues from the service in that market. The important accounting definition involved in each of these economic thresholds is of course variable costs. Variable costs are defined here as including only those costs that vary immediately and directly with the particular service being provided in the particular market. In other words, the second threshold begins when out-of-pocket costs of providing the market service are not being exceeded by market revenues from that service in that market.

In the development of airline management strategies, there are several reasons why management would voluntarily provide service in a market even though service revenues are not covering fully allocated economic costs: (a) The future looks better than the present; (b) revenues in one market are related to revenues in another market; (c) a competitor is close to suspending service and the market would be economically attractive if that occurred; and (d) externalities such as aircraft positioning needs and maintenance needs, or employee benefit requirements, such as free, first-class travel for airline employees on various types of passes, may be achieved through the service.

Cross subsidization is not unique to air passenger transportation. The concept of the interdependence of markets is widely recognized in many regulated and unregulated industries. For example, as demand in higher education shifts toward more occupationally related courses, an assistant professor teaching an accounting course to 200 students may often cross subsidize an assistant professor of languages tutoring individual students. Although the accounting professor may receive \$4000/year more than the language professor, this does not cover the differential contribution that the two make to the operation of the university.

For example, some private universities are currently charging tuition at the universal rate of \$100/credit hour, and all undergraduate courses are usually priced similarly for the same number of course hours per week. Thus the accounting course generates \$80 000 in revenue (200 × 4 credit hours × \$100) against the language course at \$400. Even considering the cost of the larger room needed for the accounting course, if there exists the universal pricing scheme common in higher education coupled with a nearly universal salary scheme and everything else is held constant, cross subsidization exists between the two courses and the university's revenue-cost situation. This is a simple example in that the direct costs of providing the language course are not being covered by the \$400 in revenue that the course earns.

A more complex situation develops if there are 10 students in the language course and the resulting \$4000 in revenues covers all direct or variable costs of offering the course. If the accepted definition is that no cross subsidy exists if revenues in a particular market cover the direct costs of providing the service, then in this instance no cross subsidy exists. Merely covering all direct costs of offering the course, however, does not help to replace the room the course is taught in, operate the library where language students study and listen to tapes, maintain the cafeteria, or support the football team that attracted the students to the university in the first place. In simple accounting terms, there is no contribution to overhead.

Natural market relations that result in cross subsidization evolve from conditions of complementarity and relatively high cross elasticity of demand. Two goods are said to be complementary if the purchase of one is directly related to the purchase of the other, e.g., cameras and film and razors and blades. In the case of cameras, the market structure is such that one dominant firm is able to earn the majority of profits from either instant or regular film. The demand for film and film developing is directly related to the number of cameras in circulation and in use and the time of year. Whether or not film-related profits are covering or cross subsidizing camera marketing costs need not be determined if what is known in marketing as product-line pricing is considered. In this case, one item is viewed as a necessary accessory or condition of sale of another item in the same product line and no arbitrary allocation of further economic costs is made. In the context of oligopolistic marketing strategies, this cross subsidization is a rational procedure under certain conditions. In particular, the economic losses associated with the cross-subsidized product (razors or cameras) could be more than recovered by the excess or economic profits earned on additional sales of the subsidizing product (razor blades or film).

When this rationale for cross subsidization is translated into the terms of the air service market, cross subsidization might be said to exist under the following conditions. If excess profits are earned in dense and medium or long-haul markets, it is rational for carriers to provide net loss service for smaller points connecting into the major markets to obtain a competitive advantage in selling longer haul seats to passengers originating at the smaller points. Presumably the loss incurred in serving the smaller points is more than offset by excess profits earned on the sale of tickets to small-point traffic traveling beyond in the longer hauls. By using the razor-razor blade analogy, one can go on to suggest the possibility of abandonment of smaller points in a price-competitive air service market. Clearly, if the market for razor blades were such that a manufacturer was unable to obtain a price for the basic product greater than that required to offset economic cost, the economic incentive to cross subsidize the complementary product, razors or cameras, would evaporate and the price of razors or cameras would increase. In air service markets, it might be suggested that straightforward, discretionary fare flexibility with relatively free entry into markets would cause long-haul excess profits to be bid away in a competitive process. It might also be argued that, as a result, the economic incentive to cross subsidize small points would evaporate and fares at small points would increase. Add to this the fact that the fare increase would be so great as to reduce demand below minimum service levels at many small points, and the result is clearly abandonment (that is, abandonment of air services as they are presently provided by certificated carriers, which, of course, does not preclude the existence of such alternative services as commuter airlines).

A typical industry expression of this line of reasoning might be stated as follows: The X-to-Y long haul is where our system earns its profits and, if all the profits are bid away by new entrants lowering prices, we will have to stop serving small points and concentrate on the long haul. This analysis by analogy leads to a false conclusion. Intermarket relations observed in air transportation are largely distinct and unique (with the possible exception of telecommunications) and are not primarily related to the existence of excess profits in any market. The cross-subsidization analysis, at least as outlined above, does not hold in domestic air transportation. The analysis centers on the proper allocation of costs and revenues among markets and points served and partially on the definition of the product. Cost allocation is fairly straightforward and is primarily dependent on the time horizon of the analysis. Appropriate revenue allocation is the basic source of confusion.

In the short run, it is conceivable that a carrier will provide service in a market or to a point whose marginal contribution to system revenue just offsets the additional short-run costs associated with providing that service. In other words, short-run services might be provided even if those services do not make an appropriate contribution to the cost of the capital used to provide the service. This may happen if the carrier simply has no better use for the capital equipment and is not able to sell it in the marketplace at a price that reflects his or her perception of the long-run value of that capital in the system. Because the focus of this analysis is the conditions for abandonment of service to a point or a market, such a short-run view of costs is not entirely appropriate.

If a carrier is not able in the long run to recover the costs of all capital equipment, his or her stock of equipment will decline through simple attrition unless the carrier is willing to continue to obtain capital at a net loss. Therefore, a point or a market that does not cover the marginal costs of capital associated with providing service may receive service for a period of time but in the long run will be abandoned. Thus, for purposes of this analysis, it is assumed that points and markets whose marginal contribution to system revenues does not cover or exceed the marginal contribution to system costs, including capital, will eventually be subject to abandonment.

REVENUE ALLOCATION BY MARKET AND POINT

Market interrelationships are highly complex with regard to revenue. The following example will serve to establish the principle of intermarket relations and its significance for market-by-market and point-by-point allocation of revenues.

During 1976, Eastern Airlines provided three daily flights from Macon, Georgia, to Atlanta (6). One flight continued on from Atlanta to Baltimore and then to Hartford, Connecticut. Suppose Eastern typically carries 50 passengers from Macon to Atlanta and that 21 of those fly on to Baltimore or Hartford. Clearly, Eastern has a substantial competitive advantage in selling Atlanta to Baltimore or Hartford tickets to those 21 passengers flying on from Macon.

For simplicity, it will be assumed here that all passengers choose to continue on Eastern. From the evidence, it would seem extremely unlikely that a passenger would get off one plane and on to another even if he or she were able to reduce connecting time as a result. It would also seem likely that the through and beyond flight would minimize connecting times. Carriers contend that they are able to control a substantial portion, if not all, of connecting traffic to points they serve. Whether or not single-plane service is offered from a smaller point to a major hub and beyond to a final destination, the carrier providing the feeder service has a greater advantage over competitors in carrying a connecting passenger to a beyond area point. With the development of satellite terminals segregated by carrier rather than destinations or lengths of haul, the inherent advantages to a carrier of providing feeder service to on-line connecting passengers have increased. Further advantages have been gained by use of the "sterile concourse" concept of airport security, to the extent that it is a major project for a passenger on an incoming carrier to change carriers at a major air hub.

Eastern, in 1974, provided about $^3/_7$ of the available seats and flights from Atlanta to Baltimore. If Eastern did not fly to Macon, one would roughly expect that, at best, only 9 ($^3/_7 \times 21$) of the 21 passengers would fly Eastern to Baltimore. If the 21 passengers had flown to Atlanta by another carrier providing connecting or through service to Baltimore, much fewer than 9 would be expected to continue on Eastern. Clearly, the ticket revenues from these additional 12 to 21 passengers would not be earned by Eastern unless the Macon service was provided. To properly evaluate the marginal system contribution of the Macon-Atlanta flight, these ticket revenues must be added to the revenues directly earned from Macon-Atlanta service.

The apparent Atlanta-Baltimore revenue, which properly should be allocated to Macon-Atlanta service, must also be offset by the local Atlanta-Baltimore passengers displaced. It cannot be assumed that, because an average 40 to 45 percent of the Atlanta-Baltimore seats are empty (i.e., a 55 to 60 percent load factor), the n through passengers will fill seats that would otherwise be empty. There is a probability distribution about the mean load factor and mean number of through passengers so that at specific points in time the through passenger may displace a local Atlanta-Baltimore passenger or, alternatively, the through or connecting passenger might not be able to obtain a seat on the appropriate Eastern flight.

Therefore, the a priori expected intermarket revenue (IR) that should accrue to the Macon-Atlanta service for a given through or connecting passenger may be expressed as

$$IR = \delta \times F[1 - p(LF)] \tag{1}$$

where

δ = probability that the through or connecting flight provided by the same carrier will be the preferred flight for the through or connecting passenger (assuming δ = 1),
F = long-haul fare, and
$p(LF)$ = probability that the marginal through or connecting passenger will not displace a long-haul origin-and-destination passenger [this frequency function is taken to vary with load factor (LF)].

It should be noted that the number of passengers on a flight is LF $\times$ capacity.

The total expected revenue from those passengers continuing to Baltimore that should be allocated against the Macon-Atlanta flight may be expressed as

$$IR = F \int_{N}^{N+n} p(x)dx \tag{2}$$

where N = expected or mean number of long-haul origin-and-destination passengers and n = expected number of through or connecting passengers available from the incoming short-haul flights over and above the carrier's expected share, i.e., those passengers that would be distributed among other competing carriers providing service on the long haul if short-haul service were not provided. [The frequency function has simply been transformed to be an equivalent function of number of passengers (LF = x/capacity); capacity of the aircraft is here considered a constant.]

$\int_N^{N+n} p(x)dx$ is the expected net gain in the number of passengers flying from Atlanta to Baltimore, related to the Macon service. On a marginal basis, these passengers and the associated ticket revenues accrue to the airline because and only because the Macon-Atlanta service is provided. If that service were stopped, this intermarket revenue and the revenue from the direct Macon-Atlanta ticket would be lost to the carrier. Except for minor costs associated with in-flight services provided to Macon-Atlanta-Baltimore passengers on the Atlanta-Baltimore haul (such costs are not dealt with here), there are no additional costs associated with the intermarket revenues.

Clearly, service to Macon may be profitable for the system even though direct revenues do not offset the fully allocated costs of that service. Further, an unsophisticated observer could contend that the profits derived from service between major centers are supporting the whole system. Analyzed on a simple market-by-market or segment-by-segment basis, that would appear to be the case. Eastern's Atlanta-Baltimore segment runs a load factor of $[\int_N^{N+n} p(x)dx]$/capacity, whereas hypothetical competitors not providing Macon service would run a load factor of N/capacity, assuming this N/capacity is the break-even level established by either a regulated or unregulated market dynamic (i.e., flight frequency competition versus flight frequency and price competition).

Because the Atlanta-Baltimore market for Eastern achieves a higher than break-even load factor, partially because of feeder traffic from Macon, an unsophisticated observer might argue that the lucrative hub-to-hub market supports the whole system and is the source of the profits that support the rest of the carrier's system. Yet, as the above analysis demonstrates, if the feeder markets are dropped as unprofitable (if direct ticket revenues do not cover fully allocated costs), the apparent excess profits in the hub-to-hub market will evaporate.

The design of major air hubs such as Atlanta, where both Delta and Eastern "marry" large numbers of passengers from various origins seeking service to a common destination, is such that changing planes on line (i.e., changing from one plane to another plane of the same airline) is made simple. The respective carriers make a great effort to control on-line connecting traffic by carefully timing connecting flights, using adjacent terminal gates for related flights, and in some cases holding longer haul connecting flights for feeder flights that arrive late. All major domestic airlines have major connecting hubs where they vigorously solicit the business of on-line and interline connecting passengers.

COMPETITION VERSUS REGULATION

The simple market structure developed in the previous section can be used as a tool to examine potential reduction of service at small or feeder points as a consequence of deregulation. For these purposes, deregulation is defined as a condition characterized by complete carrier discretion with regard to fares, flight frequency, and entry and exit.

Carriers and others contend that allowing free entry into lucrative long-haul markets will destroy an integrated (interrelated) air service network. In the example of market interrelation given above, however, no such outcome can be observed.

Entry into the long-haul market of itself can potentially affect the long-haul market share (represented by N in Equation 2). If, irrespective of profit potential, additional capacity (additional flights and additional available seat miles) were allocated to the market by new entry, the expected number of long-haul origin-and-destination passengers carried on a typical flight would fall. All other things being equal, this would increase the likelihood that Macon-Atlanta beyond passengers would fill otherwise empty seats; i.e., $\int_N^{N+n} p(x)dx$ increases if N decreases and n remains the same. The amount of revenue that should be allocated to the feeder route would thereby increase. The portion of Macon originating passengers that Eastern would be expected to carry without providing Macon-Atlanta service would also fall. Under the initial entry-protected regulated conditions, it was assumed that, if no Macon-Atlanta service was provided, passengers originating at Macon would travel to Atlanta by other transport modes and be distributed to air carriers by the percentage of flights or available seat miles in the long-haul market. Thus, without providing the Macon-Atlanta service (assuming it to be monopoly service), Eastern would normally be expected, if no one else serves Macon, to carry

$$(EFL/TFL)MACBAL \tag{3}$$

where

EFL = number of Eastern flights from Atlanta to Baltimore,
TFL = total number of flights in the market, and
MACBAL = Macon-Baltimore passengers.

The additional number of passengers gained by providing the service is

$$n = MACBAL - (EFL/TFL)MACBAL \tag{4}$$

If Eastern's proportion of long-haul flights or available seats declines, the number of additional Macon-Baltimore passengers obtained by Eastern because Macon-Atlanta service exists increases. Under these conditions (denoted by the superscript), revenue allocated to Macon-Atlanta service, expressed as

$$IR^1 = F\int_{N^1}^{N^1+n^1} p(x)dx \tag{5}$$

clearly increases, and the Macon-Atlanta service is more profitable from the carrier's point of view.

Of course, if the original equilibrium capacity provided in the market achieved break-even load factors for the typical equipment, it is also clear that average load factors for the long-haul origins and destinations, or for carriers only serving the long-haul market, will have fallen below the break-even point on a fully allocated basis (given the fare level). Logically, from a long-run point of view, one might ask why such entry would occur. Such entry is postulated here to establish the point that it does not reduce but rather increases the advantages offered a carrier that provides feeder services. Given that such feeder service, with properly allocated revenues, at least covered fully allocated costs in an entry-protected environment, its allocated revenues would increase under the entry conditions considered above. The feeder service in this context is in danger only to the extent that long-haul service is in danger. Given that long-haul service continued to exist, the incentives related to short-haul service would continue as long as the short haul continued to feed the long haul.

Although this scenario represents the viewpoint of many carriers it seems highly likely that air fares will decline in high-density, long-haul markets if a deregulated regime is introduced. Clearly, if fares fall, expected intermarket revenues allocated to feeder routes could conceivably fall as follows:

$$IR = F\int_{N+n}^{n} p(x)dx \tag{6}$$

This circumstance is examined more specifically below.

The final point that should be made here is that intermarket support is not financed by excess profits in long-haul markets but could tend to increase when long-haul markets become less profitable. The more competitive the high-density, long-haul routes become as a result of open entry, the greater will be the market advantage to carriers who control feeder passenger traffic from smaller hubs. In addition, whether or not intermarket allocated revenues decline or increase is not directly related to whether or not more capacity is provided in an unregulated environment as opposed to a regulated environment but rather to whether or not fares decline or increase. Under current conditions of intensive economic regulation and strongly restricted competition, the value of attracting both on-line and interline connecting traffic to a particular carrier at a major traffic hub is apparent.

Because, under the current regulatory scheme, prices as well as market entry and exit are tightly controlled, airlines today are limited in attracting and attempting to control connecting passengers. The carriers have, however, been able to offer both common fares and joint fares, which in effect offer price discounts designed to do two things in the marketplace: (a) attract connecting-passenger revenue (fares) for travel to beyond-area points and (b) prevent freeloading by carefully enforced provisos that preclude stopovers at intermediate points between longer haul origins and destinations.

For example, Macon and Atlanta could have a common fare as an origin for a passenger en route to Boston. The practical implication of this pricing scheme is that the Macon passenger is carried from Macon to Atlanta for free on the enforced conditions that he or she (a) continues on to Boston and further and (b) does not stop over in Atlanta on the way to Boston, except as required by the airlines to marry traffic (separate the origins and destinations) and to switch to the optimal flight equipment for the longer haul, higher density portion of the total trip.

A joint fare is an airline fare offered in air travel markets that involve an intermediate stop between a passenger's origin and final destination. A joint fare usually involves an interline connection or a change in airlines, although not necessarily a change in aircraft, and a reduction in price from the sum of the local or flight-segment fares. The typical purposes of joint fares are to (a) stimulate passenger traffic between the origin and destination by offering a lower fare between the two points than would otherwise be offered and (b) attempt to control the connecting-passenger revenue earned on the longer haul from hub to hub. In effect, a joint fare is a price discount that is given to a connecting passenger on the leg of a longer journey but is not given to a passenger having a local origin and destination, e.g., a Macon-Atlanta passenger.

The longer haul passenger is given a joint fare on the condition that additional revenues are to be paid by that passenger during the particular single-ticket trip in question. In the case of a common fare between Macon and Atlanta to Boston, the Macon-Boston passenger would be "given" the flight to Atlanta and the flight from Atlanta to Macon on the return trip on the condition that the longer haul revenue is captured by the carrier providing the Atlanta-Macon service. Both common-point fares and joint fares have provisos, or artificial barriers, that preclude freeloading. A freeloader in this case would be a passenger taking advantage of the discounted, or free, Macon-Atlanta air service without paying the airline additional revenue for a longer haul flight segment that is part of the Macon-Atlanta trip.

PRICE-COMPETITIVE OLIGOPOLY

An extremely static analysis applied to the example market structure would suggest that intermarket allocated revenue would fall under competitive conditions of price and entry that result in fare reductions. Obviously IR in Equation 2 declines in proportion to any decline in the fare level (F). However, a lower fare also implies a higher break-even load factor (N/C); more precisely, the number of passengers per flight required to break even increases. If planes generally fly with fewer empty seats, this would mean that the likelihood that through passengers will fill empty seats declines {the definite integral $[\int_N^{N+n} p(x)dx]$ declines}. Thus, the intermarket allocated revenue declines both because the fare revenue received from passengers flying to a beyond area declines and because through and beyond passengers more frequently displace local, long-haul origin-and-destination passengers.

If, however, one assumes that fares are reduced, it is unreasonable to suppose that passenger traffic, specifically Macon-Baltimore traffic, is totally inelastic with respect to fare levels. Further, given a price-service competitive market (deregulated) as opposed to a service competitive market (regulated), it is not clear that equipment configuration will continue to resemble today's service-oriented mode. Aircraft may be reconfigured to make more seats available and dispense with service facilities that take up valuable space, such as kitchen facilities on flights providing meals. This has been the experience with the service provided by intrastate carriers (i.e., low fares and high load factors). This means that, in an environment competitive with respect to price, even if lower fares cause the break-even passenger load to increase, the average number of empty seats available for connecting traffic may not decrease.

In determining the elasticity condition that results in zero change or an increase in intermarket revenues, the revenues associated with marginal feeder or short-haul service may be expressed as

$$R = F_{ab} \int_N^{N+P_{mb}} p(x)dx + F_{ma}P_{ma} + F_{ma} \int_N^{N+P_{mb}} p(x)dx \qquad (7)$$

where

- F_{ab} = long-haul fare (Atlanta to Baltimore);
- N = expected or break-even level of long-haul passengers;
- $p(x)$ = density function indicating the probability that a flight with an average of x passengers will have at least one empty seat;
- F_{ma} = short-haul fare (Macon to Atlanta, assumed constant);
- P_{ma} = local short-haul passengers (Macon to Atlanta); and
- P_{ab} = passengers traveling over both the long and short haul (Macon to Baltimore).

The question is how the revenue allocated to the short-haul, or feed, segment is affected by a reduction in the long-haul fare:

$$dR/dF_{ab} = \int_N^{N+P_{mb}} p(x)dx + F_{ab}\, p(N + P_{mb})(dP_{mb}/dF_{ab}) + F_{ma}\, p(N + P_{mb})(dP_{mb}/dF_{ab}) \qquad (8)$$

The conditions under which such revenues do not decrease as a result of a fare decrease may be obtained by setting

$$dR/dF_{ab} \leqslant 0 \qquad (9)$$

or

$$+F_{ab}\, p(N + P_{mb})(dP_{mb}/dF_{ab}) + F_{ma}\, p(N + P_{mb})(dP_{mb}/dF_{ab}) + \int_N^{N+P_{mb}} p(x)dx \leqslant 0 \qquad (10)$$

$$F_{ab}\, p(N + P_{mb})(dP_{mb}/dF_{ab}) + F_{ma}\, p(N + P_{mb})(dP_{mb}/dF_{ab}) \leqslant -\int_N^{N+P_{mb}} p(x)dx \leqslant 0 \qquad (11)$$

$$dP_{mb}/dF_{ab} \leqslant -\int_N^{N+P_{mb}} p(x)dx \Big/ [F_{ab}\, p(N + P_{mb}) + F_{ma}\, p(N + P_{mb})] \qquad (12)$$

$$dP_{mb}F_{ab}/dF_{ab}P_{mb} \leqslant (-F_{ab}/F_{ab} + F_{ma}) \times \left[\int_N^{N+P_{mb}} p(x)dx \Big/ P_{mb}\, p(N + P_{mb})\right] \qquad (13)$$

$$E \leqslant -F_{ab}/(F_{ab} + F_{ma}) \left[\int_N^{N+P_{mb}} p(x)dx \Big/ P_{mb}\, p(N + P_{mb})\right] \qquad (14)$$

This expression is similar to that derived previously except for the term in brackets on the right, which the simplifying assumptions used earlier defined as equal to unity. This term is the ratio of the average probability that the short-haul connecting passenger will not displace a local long-haul passenger to that probability for the last short-haul connecting passenger. Given that the probability that a flight with an average of x passengers will have at least one empty seat [p(x)] declines as x increases, the term in parentheses should be greater than one, which would imply that market elasticities must be somewhat higher than previously suggested, all other things being equal, to compensate for long-haul fare reductions.

The simplified condition of elasticity is

$$E \leqslant -F_1/(F_2 + F_{ma}) \qquad (15)$$

where

- E = Macon-Baltimore price elasticity,
- F_1 = initial fare, and
- F_2 = deregulated fare.

By setting $F_1 = F_2$ one can determine the point elasticity required for revenues allocated to the short haul to increase or remain the same. For example, if the short-haul fare is 25 percent of the long-haul fare,

$$E \leqslant -F/(F + 0.25F) \qquad (16)$$

or $E \leq -0.8$. Any market that has an elasticity of -0.8 or less will observe an increase in revenue allocated to the short haul for a unit reduction in the long-haul fare. Conversely, for any market having elasticity greater than 0.8, revenues allocated to short-haul service will decline. Alternatively, if the elasticity is -1, allocated revenues will increase regardless of how small the short-haul fare is relative to the long haul:

$$-1 \leqslant -F/(F + F_{ma}) \qquad (17)$$

$$-F - F_{ma} \leqslant -F \qquad (18)$$

$$F_{ma} \geqslant 0 \qquad (19)$$

Any assumption that such allocated revenues will decline in the price and entry competition could only be justified in relation to specific empirical or a priori hypotheses concerning specific market conditions. In particular, to suggest a reduction in revenues allocated to short levels, one must specifically assume a decline in long-haul fare levels plus low price elasticity of demand. In intrastate markets, low fares have coincided with high price elasticity.

SUMMARY AND CONCLUSIONS

This analysis has considered smaller air service points whose profitability to a carrier might be marginal or nearly marginal even with allocated intermarket revenues. It has been implicitly assumed that such markets would support only one carrier. (Macon is in fact served by two federally certificated carriers, Delta and Eastern, which between them fly several daily flights.) For larger points—small or medium hubs—the principle of intermarket relations remains the same but the profits accruing from traffic to beyond areas lead carriers to compete for these revenues. It is thus conceivable that a medium hub providing a great deal of feed traffic might receive extensive service even though many of the segments served from that hub do not directly generate enough revenue to cover fully allocated accounting costs.

The clear result of current pricing strategy in the competition for feeder traffic is the existence of joint fares and common-point fares. The reason for these pricing practices is, of course, to encourage feeder traffic from short-haul markets to long-haul markets.

As a result of the analysis we have concluded that

1. Determining whether or not economic cross subsidization exists between or among one or a group of markets and one or another group of markets is more an issue of revenue allocation between and among the respective markets than it is an issue of allocation costs;
2. The economic threshold where cross subsidization begins in a particular market is as much related to the definition of the product as it is to the definition or allocation of accounting costs;
3. The domestic airline business is somewhat unique in that profits from hub-to-hub service in large-volume markets are partly a function of service from the origins and destinations to smaller hubs in beyond areas (the telecommunications industry is conceptually similar);
4. Current joint fares and common fares, both of which reduce the costs of on-line connecting and interline connecting passengers traveling from smaller points over large hub-to-hub service, provide ample evidence of the value in larger markets of the passenger revenue that is a function of service to smaller points; and
5. On-line and interline connecting passengers clearly are highly valued under the current conditions of limited competition and intensive regulation; the value of these passengers will undoubtdely increase conditions of greater competition and less economic regulation (as a result, because an even more intensive effort will be made to control the flow of connecting passengers at major hubs, extensive abandonment of smaller hubs will not occur).

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Allocating Highway Program Costs to Washington State Highway Users

Dennis Neuzil, Transportation Development Associates, Inc., Seattle

This paper analyzes a Washington State highway cost-allocation study that determined road-user cost responsibilities for support of the state-aided highway program at both the state and local levels. The study used an incremental cost-allocation model for over 350 individual highway user subclasses correlated with vehicle type, use class, power type, and registered gross vehicle weight. Cost responsibilities for alternative funding programs were compared with user tax payments to assess equity performance. There is considerable variance among vehicle classes in the degree to which tax payments meet cost responsibility. The automobile consistently fails to meet its cost responsibility, trucks generally attain measures of equity comparable to that of the automobile, and intercity buses generate the lowest level of tax payment relative to cost responsibility. Equity performance among trucks varies with engine power type and use class; commercial-class and gasoline-powered trucks generally attain the highest equity levels. Cost responsibility for heavier vehicle subclasses varies significantly with changes in budget composition. The proportion of the budget devoted to construction—and in particular to pavement—is a prime factor. The sensitivity of the results to allocation model variations and input data is also addressed.

In the state of Washington, as throughout the nation, mounting highway construction and maintenance costs, heavier trucks, and the impact on revenue flow stemming from energy shortages and rising fuel costs have gen-