Distributing Air Cargo in the Baltimore-Washington Region

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The planning of air cargo terminal systems requires accurate forecasts of demand, particularly of the impact of points of cargo origin and destination on demand. A methodology for this problem should meet three criteria if it is to be useful for airport planning. It must use low-cost and generally available data; it must be based on cargo shipper and receiver behavior; and it must allow for the transferability of results required for general forecasting. This paper describes a methodology based on econometric analysis of data from a number of small geographic areas within the Baltimore-Washington region. Tests of the method were performed by the Maryland Department of Transportation as part of a Maryland Aviation System Plan designed to address the current status of all aviation facilities in the state and to prepare recommendations for any required expansion or development. This case study suggests that the method is a useful tool for forecasting the arrival and departure of air cargo within the region but that it is not necessarily adequate for testing whether policy changes affect demand.

The forecast of intraurban commodity distribution is central to an understanding of the locations of future cargo generation and consumption. (In the following, "cargo" refers to all freight, mail, and express shipments by air.) Yet, recent goods-movement studies emphasize the significant absence of data bases and rudimentary record keeping necessary for forecasting growth and for understanding the implications of the forecasts for fixed facility development.

According to one federally sponsored project (1, p. 9), "little is known at this time about the intra-urban flow of goods. Neither adequate theory, nor models, nor hypotheses detailing activity linkages within urban areas exist. Thus there is no base from which the design of empirical studies of goods movement can be systematically derived." Unless proper record keeping is established for ongoing intraurban commodity distribution, the potential increases for preparing inaccurate projections and developing imprecise assessments of transportation externalities such as land use, industrial location, regional taxation, and environmental disamenities.

The purpose of the present paper is to summarize the results of a two-day survey methodology that forecast air cargo generation for 78 geographic areas in the Baltimore-Washington region. Although air cargo transportation is often recognized as an interurban commodity transportation phenomenon, the intraurban surface haul of air cargo before and after actual air transportation is central to successful and timely movement. So important is the truck haul of air cargo that it was the subject of considerable study, particularly in the middle and late 1960s.

Brewer was often found using the phrase "chaos on the ground" when describing the surface transportation of air cargo (2, 3). It was his contention that the surface transportation and ground handling of air cargo could account for as much as 40-80 percent of total in-transit time.

Commodities transported by air are typically of high value per unit weight. Examples include electronic equipment, perishable foods, nonmechanical equipment, replacement parts for operating machinery, and printed matter. One would have expected the airlines to devote extensive research efforts toward the analysis of the intraurban and surface haul of air cargo. But available research is scarce.

In addition to Brewer's work, there are at least two other studies that address the air cargo issue. Reeher and Dwyer examined the air-truck network serving the Baltimore-Washington region (4). They sought to reveal the relationships among airport air cargo market areas, air carrier operating schedules, motor carrier operations, rate-setting behavior, and intraurban commodity flows. While no previous study had presented in such a comprehensive fashion the numerous variables affecting the surface movement of air cargo, the Reeher and Dwyer study suffered from the absence of an adequate cargo movement data base.

Tomassoni and Weissbrod (5) extended the work of Reeher and Dwyer by suggesting that, within multiairport environments, market area competition is easily determinable by plotting surface haul cartage rates set by local trucking agencies to and from the airports. Accordingly, they identified three types of market areas—exempt, indifferent, and preferred—within the same Baltimore-Washington regional study area. Exempt market areas were defined as locations within a 40-km (25-mile) radius of the airport or the city limits of the air carrier's certificated route point (6). Indifferent areas were classified as areas with no preference of airport use. Preferred market areas were described as areas with a clear preference for one airport over another when measured in terms of motor carrier freight rates.

Despite the insights provided by these two research teams, neither was able to examine in geographic depth the places of air cargo origination and destination due to the absence of an adequate cargo movement data base. It was evident that the next major study of air cargo in the region should begin to develop the information background needed to describe the existing transportation of air cargo and to provide the framework for projections of forecast demand.

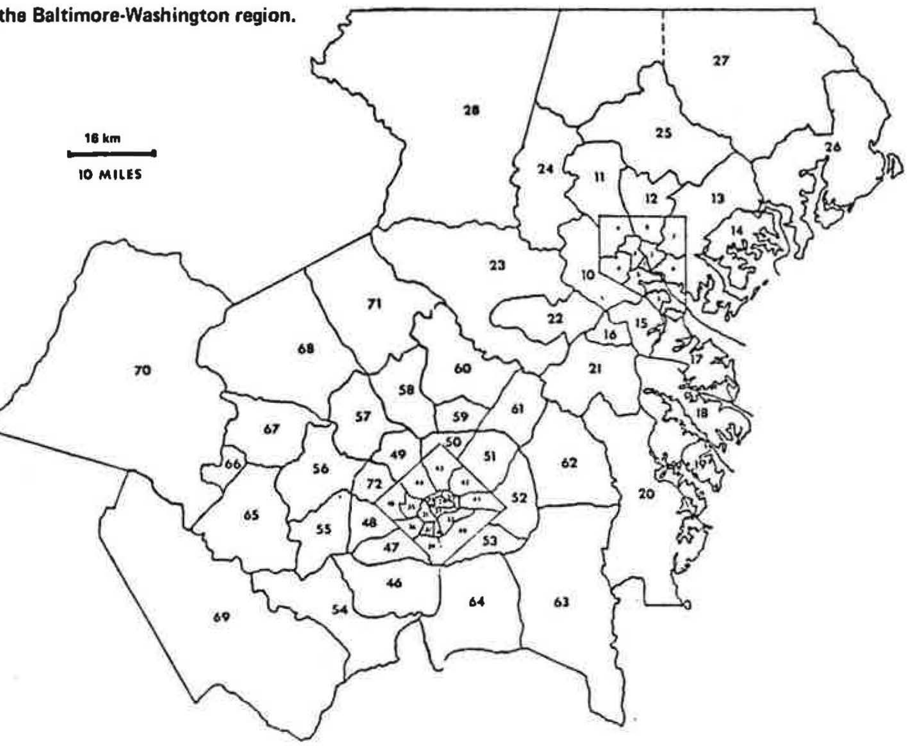
MARYLAND AVIATION SYSTEM PLAN

Mindful of the need for more sophistocated commodity movement data, the staff of the Maryland Department of Transportation included, as part of their statewide aviation system plan, an extensive treatment of air cargo flow. Efforts were initiated to "identify and examine the structure, operations, and quantity" of domestic air cargo originating from the three airports Baltimore-Washington International (BWI), Dulles International (IAD), and Washington National (DCA) (7).

The Airports

BWI, IAD, and DCA form an important multiairport air cargo system. The market area served by these three airports extends roughly north to Harrisburg, northwest to Cumberland, southwest to Roanoke, south to Elizabeth City, east to the Delmarva peninsula, and northeast to Aberdeen. Handling more than 11.5 Gg (12 700 tons) of enplaning cargo in 1976, these regional

Figure 1. Zones within the Baltimore-Washington region.



airports together accounted for 2.28 percent of all domestically enplaned cargo (8).

The historical development and current position of the airports can be described as follows. The first airport of recognized significance to be constructed in the region was Washington National following a decree set forth by President Roosevelt in the late 1930s. Federal funds were allocated and DCA was completed in 1941 at a distance of only 6.5 km (4 miles) from the Washington, D.C., central business district. Though dominating the transportation of cargo until only recently, the increased demand for air cargo (9) and the associated growth in surface vehicle movement has led to serious on-airport vehicle congestion problems. This, combined with its obsolete 1393-m^2 (15 000-ft^2) air cargo building, has forced cargo-handling activity to relocate in dispersed hangar areas and has decreased incentive to ship air cargo via DCA.

The second airport to be constructed in the region was the Baltimore-Washington International Airport, then known as Friendship International. Christened in 1951 by President Truman, BWI is located 16 km (10 miles) south of Baltimore's central business district and only 32.3 km (20 miles) north of the District's mall area. BWI is currently experiencing an unprecedented rate of modernization and expansion of terminal facilities, cargo handling areas, airline schedules, and marketing efforts. The state-owned and state-operated 10 219 m^2 (110 000 ft^2) of air cargo facility and the airline-owned rampside cargo structures accounting for an additional 5946 m^2 (64 000 ft^2) allow BWI to claim the greatest regional freight-handling ability.

Indeed, by late 1976, BWI began to handle more air cargo than DCA for the first time in the region's history. Moreover, since motor carriers are not subject to the continued on-airport congestion that they would experience at Washington National, terminal delays are reduced, and truck and driver operating times can be more effectively utilized.

These observations, together with the capability to increase cargo warehousing space to more than 27 871 m^2 (300 000 ft^2), make it apparent that BWI has a major advantage in air cargo and has the incentive to obtain as large as possible a percentage share of the region's total air cargo market.

Completing the facilities is Dulles International Airport, dedicated in 1962 by John F. Kennedy on an expansive semirural Virginia plot some 38.6 km (24 miles) from downtown Washington, D.C. Constructed in large part in response to the then growing congestion at DCA, IAD has attracted long-haul aircraft schedules that are restricted from use out of DCA. Obstacles in the form of lengthy highway access times from the District, access road closed to truck traffic because of structural design, and limited aircraft schedules have limited air cargo use at Dulles.

The Survey

To assess the amount and types of air cargo originating in the region, a two-day, 100 percent sample of surface haul airway bills was obtained from the four major air cargo forwarders (10). These forwarders were Air Cargo International (ACI), Emery Air Freight, Airborne Freight Corporation, and Railway Express Association (REA) Air Express (now defunct). A total of 2178 shipments were surveyed.

From the airway bills the following information was coded for each shipment: name of forwarder, place of cargo origination, airport in the region used to ship the cargo, destination airport, number of pieces in shipment, total weight of shipment, and date. The region was subdivided into 78 analysis zones (Figure 1), of which 6 were used to describe nonregional points of origination.

The total cost of the air cargo survey including survey distribution, computer coding, and expansion to annual figures came to approximately $5000. With a total of 2178 survey shipments recorded, the average cost of each survey item came to about $2.30.

Table 1. Air cargo forwarder survey results.

Forwarder	Shipments to Airports BWI	DCA-IAD	Total	Percentage of Total
REA Air Express	283	598	881	40
Airborne Air Freight	183	161	344	16
Air Cargo, Inc.	181	79	260	12
Emery Air Freight	277	416	693	32
Total	924	1254	2178	100

Table 2. Air cargo forwarder survey weights.

Airport	Forwarder	Number of Samples	Total Sample Weight (kg)	Average Weight per Sample (kg)
BWI	REA Air Express	283	4 283	15.1
	Airborne Air Freight	183	8 355	45.7
	Air Cargo, Inc.	181	20 957	115.8
	Emery Air Freight	277	14 482	53.3
	Subtotal	924	48 077	57.5
DCA-IAD	REA Air Express	598	9 695	16.2
	Airborne Air Freight	161	7 257	45.1
	Air Cargo, Inc.	79	8 508	107.3
	Emery Air Freight	416	12 303	29.6
	Subtotal	1254	37 763	50.0
	Total	2178	85 840	39.4

Note: 1 kg = 2.2 lb.

Results

Of the total sample, REA accounted for 40 percent of the total, Emery was represented by 32 percent, Airborne Freight Corporation by 16 percent, and ACI by 12 percent (Table 1). The samples accounted for a total weight of 85 840 kg (189 252 lb) or an average weight of 39.4 kg (86.9 lb) per shipment (Table 2). ACI handled the largest average weight per shipment in deliveries to BWI as well as DCA and IAD.

Factoring and Forecasts

The total cargo originating in each zone during the two-day period was then expanded proportionately to annual totals during the survey year. Two sources of annual air cargo volume data were used to find the proper expansion factors: Maryland Department of Transportation's State Aviation Administration Comparative Summary of Activity (June 1973-June 1974) and the Federal Aviation Administration's National Capital Airports Activity Reports for Dulles International and Washington National Airports (July 1973-June 1974). Both of these data sources break down the air cargo activity into enplaning and deplaning cargo by type, i.e., mail, freight (domestic-international), and express. The expansion factor was calculated by simply dividing the annual kilograms by the survey kilograms.

Forecasts of 1985 and 1995 cargo origination were then developed based on demographic forecasts supplied by the Baltimore Regional Planning Council and the Washington Council of Governments. The forecasts were controlled by a macroforecast for the region as a share of the national forecast.

Distribution of Cargo to Air Destinations

The forecast for originating cargo was then distributed to leading domestic destinations by using the Simat, Hellisen, and Eichner air passenger distribution model. Aircraft belly capacity was determined for various aircraft types. A 65 percent load factor was assumed, and a certain percentage of cargo capacity was eliminated for use as luggage space.

The originating cargo demand was calculated for each of the three regional airports and from each of the 78 zones based on accessibility measures from the air passenger portion of the state system plan (9). Cargo was distributed to the closest airport, but DCA was limited to shorter trips. Final output displayed total cargo from each aviation analysis zone to each of the three airports.

CONCLUSIONS

This paper has attempted to summarize the results of a two-day survey that forecast air cargo generation for the Baltimore-Washington region. Some questions that must be raised and carefully considered, before accurate evaluations of air cargo origination are possible, are

1. Which points generate most air cargo?
2. Which commodities are produced at generating points?
3. Are local airports providing airlines with adequate cargo storage capacity at or near the airport? If not, is this reducing the amount and/or type of cargo shipped through the airport?
4. When a survey is used, is consideration given to sampling cargo destined for the local airport(s)?
5. Can an ongoing record-keeping system of air cargo flows be established?
6. What are the identifiable market areas surrounding a particular airport?

This list could be greatly expanded. What is at issue is the relative importance of gathering this information, the cost of such a study, and the final use to which the information could be profitably put. It seems at least plausible to conclude from the results of this study that, placed in the hands of the proper marketing experts, the type of study conducted by the Maryland Department of Transportation could prove useful in expanding cargo movement by air through local air carrier airports.

This paper has not in any way attempted to describe in comprehensive detail the procedures and final forecasts resulting from the study. Those interested in obtaining more background information are asked to contact the Maryland Department of Transportation.

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Abridgment

Commuter Rail Diversion Model

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Over the past two decades commuter railroads, in general, have been experiencing declines in ridership that have led to a rather stable but low level of ridership. Alternative action therefore must be taken to recoup financial losses. These losses can be offset by reducing or eliminating commuter service, by obtaining outside funding, or by increasing commutation rates or the entire fare structure.

Railroads requesting a commuter fare increase either make no effort to determine the number of people diverted to other modes of transportation as a result of the fare increase or come up with unrealistic figures. Outside of a few general models for transit diversion in relation to fare increases (1, 2), little has been done to determine the relationship between fare increases and ridership for rail transit, not to mention commuter railroads.

The problem of not having a model that measures passenger diversion attributable to a given fare increase for commuter railroads is significant. Not only is the diversion figure important in the economic analysis of a fare increase, it is a key factor in determining environmental and transportation impacts of commuter service. Government policy in recent years has been advocating mass transportation as a mitigating measure to traffic congestion and hazardous levels of air pollution and more recently to energy consumption. Economically, an accurate diversion figure is needed to project passenger revenues and to determine whether, in fact, the fare increase is the solution.

The general objective of this paper is to present a model developed to determine the diversion of commuter rail users as a direct result of a fare increase and to compare this with other transit diversion models (3). Also, the model should be easy to understand because many of its users will be nontechnical people, many of whom represent railroads or transit agencies in a legal capacity. Therefore, the simplistic model resulting from the limited scope of this research will be beneficial. On the other hand, the model must be accurate enough to provide the user with a reasonable estimate of the diversion so that the resulting impacts on transportation, the environment, and revenues can be determined.

CHICAGO MODEL

A model for Chicago, developed by the Interstate Commerce Commission (4), determined the functional relationship between the diversion of commuter rail passenger traffic to other modes of transportation and commuter fare increases by analyzing data provided by the six Chicago area commuter railroads. These data included monthly revenue passenger volumes for a period of at least 52 months that dated as far back as 1969 and rate increases that occurred during the same period. A computerized forecasting program (with seasonal variation capabilities) was used to determine the historic trend of each railroad with respect to growth or decline.

The linear function that resulted from the regression analysis is

$$Y = 0.52(X) - 3.68 \quad (1)$$

where X is greater than 7 percent and

X = fare increase in percent and
Y = diversion of passenger traffic in percent.

The relationship is graphically represented in Figure 1.

The analysis also revealed that there is no significant diversion for an increase in fares averaging 7 percent or less. For fare increases of greater than 7 percent, there is an expected 0.5 percent diversion for each additional 1 percent increase in fares in excess of 7 percent. For example, if a railroad increased its fares an average of 13 percent, it can expect a diversion of passenger traffic to other modes of transportation of approximately 3 percent.