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"American Airlines' Propeller STOL Transport Economic Risk Analysis"

When American Airlines evaluated STOL Transports, we received 13 proposals for our state-of-the-art-technology Propelled STOL Transport (PST) that could be available by 1975. We evaluated these, cut the list back to 3 airplanes on which we did a detailed risk analysis. It is this risk analysis I'm going to talk about today. The studies that have been made by various people on market demand and modal split did not provide the information that American needed, because they started off with assumtions that people would pay a certain fare premium for STOL, and then calculated the size of the market. American had no doubts whatever that there was a large market. Their question was, "Would passengers pay a STOL premium fare?" The real question was completely opposite from the data that was provided. Furthermore we wanted to look at specific rather than hypothetical areas and hypothetical airplanes, because we were afraid that you would end up with hypothetical people and hypothetical profits that way. We felt that

STOL was necessary in the New York area because the demand was for the city center operation rather than for an RTOL operation at the suburban airports. Furthermore we had reason to believe that you could put a city center STOLport in Manhattan, although not in Chelsea. The Chelsea reaction was not because it was a city center STOLport, but because it was a residential STOLport. There is an area at Hunters Point, on the East River (Queens) that is not a residential area and could be expected to have no community reaction against a STOLport. We looked at the market share: I'll explain later how we got this. Where we had numbers with a fair amount of confidence, we used those numbers. Where there was uncertainty we used a probability analysis. For instance, we determined a most likely value for the O&D market, a pessimistic value and an optimistic value. In the analysis 80% of the data came from the most likely level, 10% from the pessimistic and 10% from the optimistic. We looked at the spares cost in a similar probablistic fashion. Other uncertain economic factors were the size of the O&D market, the direct operating cost, and the indirect operating costs. Values of which we were confident or were fixed values were fare levels, the available seat miles offered, the aircraft cost, the aircraft resale value, the investment tax credit rate and the interest rate. We assumed 50% equity, and financing for 50% at a 10% interest rate. These were fully allocated costs. We developed the internal rate of return on investment. We used internal rate of return because we felt it was more representative of the actual profit and loss of the operation. The usual measure, return on investment, has to assume a certain depreciation rate of the aircraft, but internal rate of return is a function of discounted cash flow. It tells you whether you are making profits this year or next year and is therefore of more interest. We ran 3 airplanes (the Canadair CL-246, the McDonell 188 and the DeHavilland DHC-7) through the computer 100 times each, on a Monte Carlo risk analysis. Monte Carlo is a type of gambling procedure where the computer with random access selects values that you give it. It can select these values with certain probabilities. In this case it was directed to select 80% of the O&D share out of the most likely value and 10% out of each of the pessimistic and optimistic. You never know whether it is going to pick a number from

527

the top here and the bottom there or something else, but in the long run you end up with a probability distribution which shows that the probability of making a certain expected internal rate of return is predictable. The 10% bound indicated that 90% of the cases were above this value and therefore there was a 90% probability of making this level of internal rate of return, or better. We plotted a mean and the 10th and 90th percentile. This was plotted versus fare premium over CTOL, and number of seats offered.

Now, I will discuss some of the input functions. There was a typical mission profile. You start the engine in Washington. There was a fixed climb and maneuver to get on the flight path below 1500 feet, then climb and cruise, a 5 minute hold at 5000 feet which was a delay factor built in, and then landing at New York. There was a 10 minute time in New York, no refueling, just change passengers, and takeoff, and climb. And return to Washinton, five minutes hold and either descend and land or divert. There was a half hour spent on the ground here to service the airplane for the round trip. The total non-cruise allowances were 10 minutes regardless of where you flew. The initial assumption was that there would be two STOLports in Manhattan, one downtown STOLport and one in the suburbs. Immediately it was discovered that since no one really wanted to go to the suburbs the airplanes would be empty, and therefore the STOL airplane would have to deadhead over to the suburban STOLport. Even if it is a 10 minute flight over there, if you have a 10 minute system time, it becomes a 20 minute flight to the other STOLport. If the time from Washington to New York was roughly 40 minutes of flying plus 10 minutes system time, or a 50 minute total flight, and if we add the other 20 minutes deadhead, the total is 70 minutes of cost time but only 40 minutes of revenue time. This is right back where we started now with the 70 minute block time scale for B-727s between New York and Washington. Thus we assumed that there would only be one city center STOLport in New York and one in Washington. The range is 180 nautical miles between New York and Washington. We set up a schedule with these airplanes by chasing tail members back and forth between New York and Washington. We assumed that there would be no market sensitivity due to the frequency because the frequencies

529

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were from every half hour, every 20 minutes, every 15 minutes and every 10 minutes; and because of this very high frequency no one really cared whether they missed one airplane or not.

We calculated realistic block speeds, realistic winds and temperatures for takeoff and landing performance. The ground distance each way was 180 nautical miles. We used the highest speed cruise because fuel cost was of no consequence; time was more valuable. The 85% probability winds for the winter and for the summer were known. Because of the effect of winds on cruise performance you do not subtract 24 knots if you are going downwind, you can only subtract a certain portion of it. There's a Boeing analysis that we used for this. We ended up with equivalent air distances. These then are reflected in the times. For the DHC-7, the block time was 70 minutes (and this includes the 10 minute system time) from New York to Washington and 59 minutes from Washington to New York. We used the winter winds because this is conservative, providing the greater cycle time. If you look at the actual times, then the DHC-7 would depart from the Washington STOLport and it would arrive

530

in New York City 59 minutes later. It has to stay on the ground a minimum of 10 minutes. It ended up staying on the ground 11 minutes here which was fine. Now, if it had arrived at 61 minutes instead of 59 minutes, it would have had to stay on the ground a whole cycle and could not have left at 70 minutes, for example; it would have to wait over. Similarly, it ended back at Washington after 140 minutes elapsed time, 30 minutes later it could leave at 170 minutes. If this happened to turn out to be 9 o'clock for example, it could leave at 9:30 and it would be the 9:30 flight. If it happened to arrive at 9:05, it could not leave at 9:30, it would have to leave at 10 o'clock, so there was wasted time. This shows the effect that just a small difference in cruise speed can have on the value of an airplane in its productive time and utilization. This is quite important.

Looking at the market, we tried to determine where the market was coming from. We did not assume any market generation or any market stimulation. We figured that from New Jersey, roughly 25% of the people would fly from Newark, perhaps 25% of the people would keep going to LaGuardia. No one was going to go out to Kennedy to fly

531

to Washington; but 50% would probably go to the STOLport in Manhattan. From Manhattan we figured no one would go to Newark, 10% to La Guardia, none to Kennedy, but 90% would go to the STOLport in Manhattan and so on across. Remember, 90% is the probable value. Looking at the optimistic value everyone in Manhattan would go to the STOLport, and pessimistically only 2/3 would go. We did a similar thing for the Washington area and when we got through, we added these things up. Furthermore, based on the market data, more people fly from New York down to Washington then go from Washington up to New York. Perhaps, this is because in Washington we say if you want to talk to us, come in and see us. At any rate, we figured 2/3 of the people were originating from Manhattan and only 1/3 from Washington, and so this means that we ended up with about 60% of the people who wanted to fly using the STOLports, optimistically 70% and pessimistically only 43%.

The Pan Am fare sensitivity assumption input into the CAB Norhteast corridor VTOL investigation says that STOL will capture 83% of the market at a CTOL fare but only 45% of the market at a CTOL fare plus a $7.00 premium. We did not necessarily agree with this but we did not have anything better to use, so we used it. If you extrapolate historical market data you will find that in 1975, supposedly 4 million people will be flying between New York and Washington. American was a little more conservative than that. They said instead of using this 9% growth rate we will use a 4% growth rate. We predicted 2.8 million. Now, at the 83% penetration that would move the probable STOL to 2.3 million at a CTOL fare. Using the data from above about who would actually go to the STOLports for the mean dropped it down to 60%. We have the optimistic case and the pessimistic case also.

Market assessment is a pretty slippery thing to get hold of, but using the fare sensitivity then we could determine the size of the market vs. the people who pay the fare. There is another factor here which we did not put in. That was the inelasticity because of convenience. People may pay a $2, $4 or $6 premium to save some time. We ignored this to be conservative. Also, this is just the air fare which does not take into consideration any savings which the traveller might have from higher cab fares going to airports further away.

533

Looking at the costs, we used the CAB in 1970 dollars. We did not look at 1975 dollars because we felt that if you start looking at 1975, you have to figure out not only the inflation and the cost but also the increased air fares themselves and then what is the dollar worth then to the traveler. We felt that if it could be made profitable in 1970, then it would be similarily profitable in 1975.

We did not use American Airlines' usual overhead burden. We set this up as either a subsidiary airline or a separate airline entirely. The STOL costs had no bearing on the American Airlines costs other than just as a point of departure. The pilots' salaries are conservative in that they are the levels of the BAC-111 pilots, which would be high for a DHC-7. We felt that if the source of the pilots was American Airlines, the pilot would have to make at least as much salary as he was making already. On direct maintenance, we did not accept the numbers of the manufacturer. Instead, our maintenance people looked at the airplane, system by system, and compared it to the Electra on which we had operational data and determined the relative complexity. This then

534

gave them a basis on which they could esitmate the direct maintenance and maintenance labor overhead.

On depreciation, we did not use the CAB rate but estimated how long we could use the airplane and what would they be worth when we sold it. We felt that if these airplanes were available in 1975, they would have a useful life of only 5 years, because we would have to sell them as soon as the jet STOL's came in, for competitive reasons. We felt that the DHC-7 would have a very high resale value based on the Twin Otter experience and with discussions with 3rd level operators and so, we felt that a 5 year depreciation to 50% was reasonable for that airplane. That approximated the CAB allowance for a 4 engine turbo prop of 12 years to 5%. On the other aircraft, however, because they are more complex, the 3rd levels could not be counted on to buy them. The market there would be in South American countries where they need an aircraft that has high performance for operation in the mountains and we felt that a million and a half was all these people could afford. Those aircraft were the McDonell 188, and the Canadair CL-246. They were depreciated in 5 years to 1½ million dollars, which was a

535

variable rate depending on their initial cost, but was roughly double the CAB rate.

Now this was not what you normally see for DOC, this was cash DOC because this is cash flow accounting. The depreciation is added later so the total of $353/ block hour is not the total DOC. You have to add the depreciation, which varies from 130 to 137 dollars/block hour for the DHC-7, depending on its utilization. Utilization varied because we were flying on different frequencies. You could add the cash DOC and depreciation for a total DOC of roughly $500/ hour.

Looking at the indirect operating costs, this is an annual cost, not per hour. There are certain things that are a function of just getting started. The stewardess training for example, and the advertising and publicity. Our marketing people felt that it took quite a bit of advertising to let anybody know you are around, so there was a big initial effort. For the recurring cost, some things were fixed, some things were a function of the round trips per day and the number of passengers per aircraft. We came up then with an indirect operating cost in dollars per year in a formula to which we added a 10% contingency factor. These factors were all figured out based on the specific type of operation that was being considered. For example, with the food, there were savings because we were only loading one end. The type of service provided was not meal service but rather liquor, which would be sold, and soft drinks and coffee; very austere service. Furthermore, a savings was realized because there was no baggage checking. If you provide baggage checking for one then you must have someone there to handle all of the baggage and you then have the whole system. There would be room on the airplane for someone to put his bag, but no baggage checking. Landing fees were based on an analysis of STOLports which we had made and felt that a 65¢ per passenger was reasonable.

What did all of this come up to be? Looking at the internal rate of return as a function of the annual seats and the flight frequency, it looked like Figure 10. The numbers in parentheses are the load factors. We restricted load factors to greater than 45% and less than 80%, 80% is a little high, but the American Airlines' Jet Express average load factor between New York and Washington is 70%. We felt that since this was running back and forth, and since we had the option with this high frequency of cutting out a flight, or a round trip at off peak times, we could maintain a higher load factor. 80% was the cutoff point. The value of the internal rate of return (IRR) that you see is a little bit higher than you see normally for return on investment (ROI). ROI is not directly relatable and not really convertible. If you have a 10 to 12% ROI you might say that that is roughly equivalent to maybe 24 or 26% IRR, but you have to be cautious because it is not really the same thing. Note that the size of the market varies and that we have airplanes of different sizes in here competing in a way. This method of analysis was able to handle this. Figure 11 is the internal rate of return vs. the fare premium. There is a 10th percentile line probability of making at least this return on the investment. The large spread was caused by the fact that there was considerable variation in the pessimistic and optimistic values that were put into the analysis. The little numbers in parentheses are the load factors, 44% up to 74%. This shows that even with the conservative costs, the DHC-7 had a 90% probability of breaking even at a CTOL fare. This is quite interesting. If you charge a little fare premium then you can make more but it starts dropping off at a higher level. The question comes up of course then, what happens if you cut fares; does IRR continue to increase? This would of course be interesting. Figure 11 shows the data for the DHC-7. The CL-246 was above this and the McDonell 188 was below this. This was mainly caused by the input costs for the airplanes.

Now this is where the economic analysis stops but that is not where the decision process stops, because other factors enter into it. The McDonnell 188 and CL-246 could not go into production on the basis of this one market. These airplanes will not be available because there is not enough justification. The DHC-7 is likely to go into production and therefore could be available, but this is not the size of airplane nor the image that American Airlines wanted to get involved in. If you put on a very conservative hat and look at the return on investments and the money that is already obligated for DC10s and the B-747s, it just does not make sense to buy a prop airplane. Therefore, the decision was made to terminate further study of the propeller STOL transport and concentrate on maintaining the option for jet STOL operation when it is available in the '80's. If I were a regional carrier, or someone who can offer this type of airplane, I think that the airplane would work and be very good. At American Airlines it did not work for us and so I recommended against.

The next step would be to look at a jet STOL transport and run through this same type of analysis. The prop airplanes were small, they were too small for the market. The jet STOL would be a much better size.

540

STOL RISK ANALYSIS

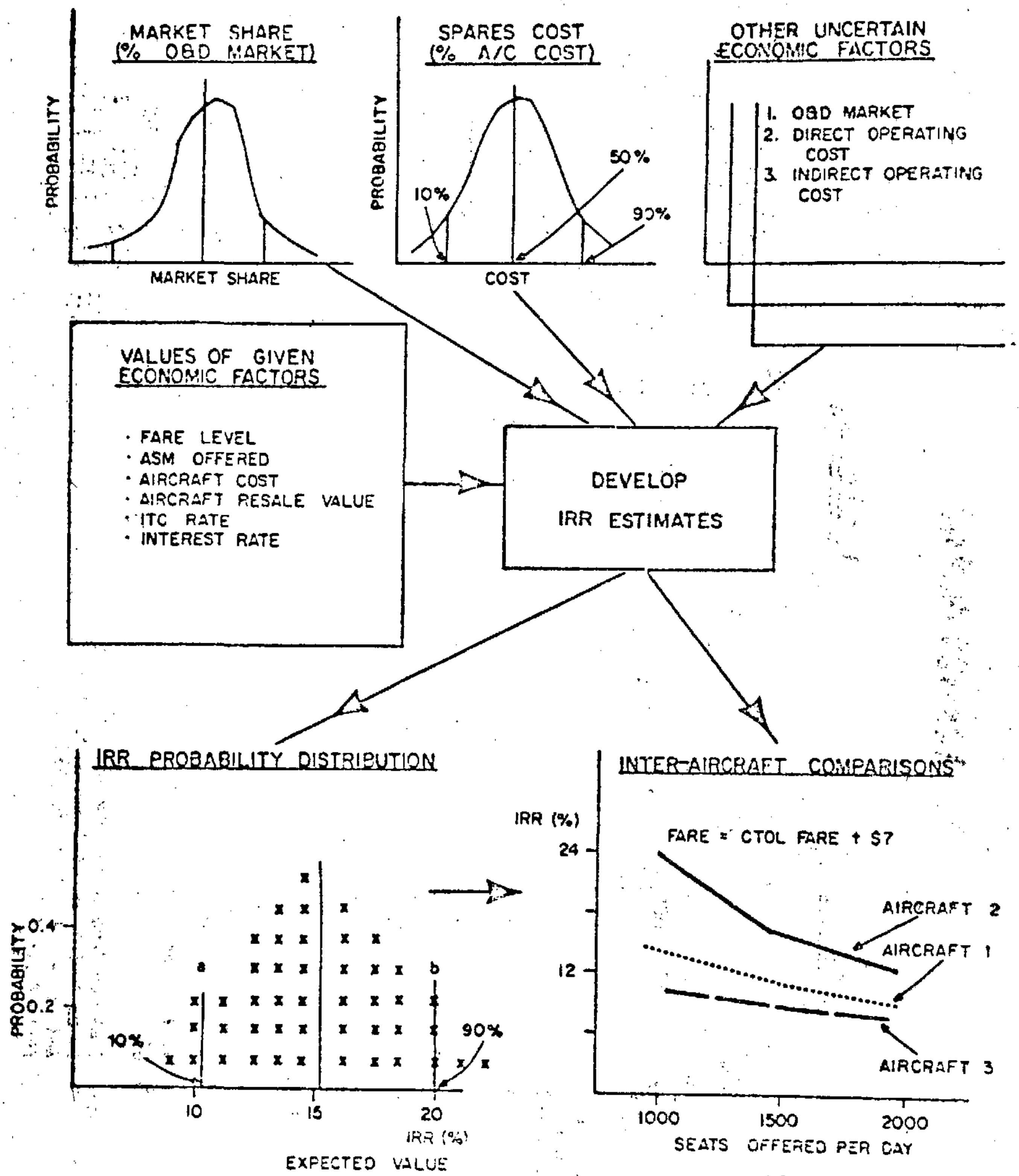

Figure 1

MISSION PROFILE

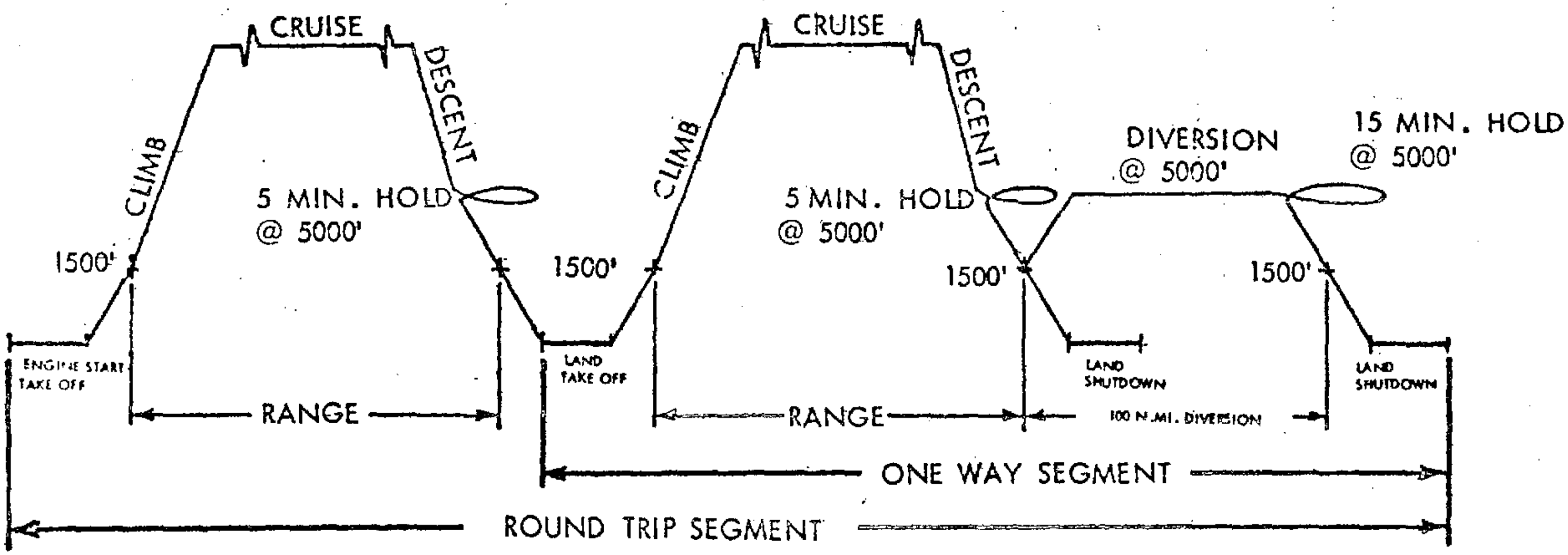

Figure 2

Allowances:

1 minute	-	Takeoff
5 minutes	-	Ground delay
1 minute	-	Climb maneuvering @ 1500'
2 minutes	-	Approach man. land & taxi in
10 minutes		

Note: 5 minute congestion hold at 5000' is used to figure fuel reserves only, and it is not used to compute block fuel or block time.

542

Missions:

I. Round Trip Segment (unrefueled)

(a) Range = 180 n.mi. (DCA-NYC-DCA)
(b) Range = 50 n.mi.

II. One Way Segment

(c) Range = 50 n.mi.
(d) Range = 100 n.mi.
(e) Range = 200 n.mi.
(f) Range = 300 n.mi.

EQUIVALENT AIR DISTANCES

	DHC-7
Ground distance (DCA-NYC) each way - n.mi.	180
High speed cruise true airspeed - knots	235
85% January winds (NYC-DCA) - knots	-44
(DCA-NYC) - knots	+6
85% Summer winds (NYC-DCA) - knots	-24
(DCA-NYC) - knots	-1
Equivalent Air Distances:	
Winter NYC-DCA	221
DCA-NYC	176
Summer NYC-DCA	200
DCA-NYC	181

Figure 3

PST BLOCK TIMES

		DHC-7
Winter	NYC-DCA - minutes	70
	DCA-NYC - minutes	59
Summer	NYC-DCA - minutes	65
	DCA-NYC - minutes	60

Figure 4

PST SCHEDULE TIMES
(Accumulative Minutes)

545

	DHC-7
Depart DCA	0
Arrive NYC	59
Depart NYC	70
Arrive DCA	140
Depart DCA	170
(repetitive cycles)	(etc.)

Figure 5

1975 PST MARKET SHARE @ CTOL FARE

DCA-NYC-DCA

		From: New Jersey	Manhattan	New York & Conn.	Long Island	TOTAL
NEW YORK	EWR	25%	0	0	0	6%
	LGA	25%	10%	34%	50%	30%
	JFK	0	0	0	0	0
	STOL (Probable)	50%	90%	66%	50%	64%
	STOL (Optimistic)	60%	100%	75%	60%	74%
	STOL (Pessimistic)	30%	66%	50%	35%	45%

		From: Virginia	Washington	TOTAL
WASHINGTON	DCA	90%	10%	50%
	STOL (Probable)	10%	90%	50%
	STOL (Optimistic)	20%	100%	60%
	STOL (Pessimistic)	0	80%	40%

Assume About 2/3 of Total O&D From NYC:

Probable	1/3	(64 + 64 + 50)	=	59	say:	60%
Optimistic	1/3	(74 + 74 + 60)	=	69.3	say:	70%
Pessimistic	1/3	(45 + 45 + 40)	=	43.3	say:	43%

Figure 6

546

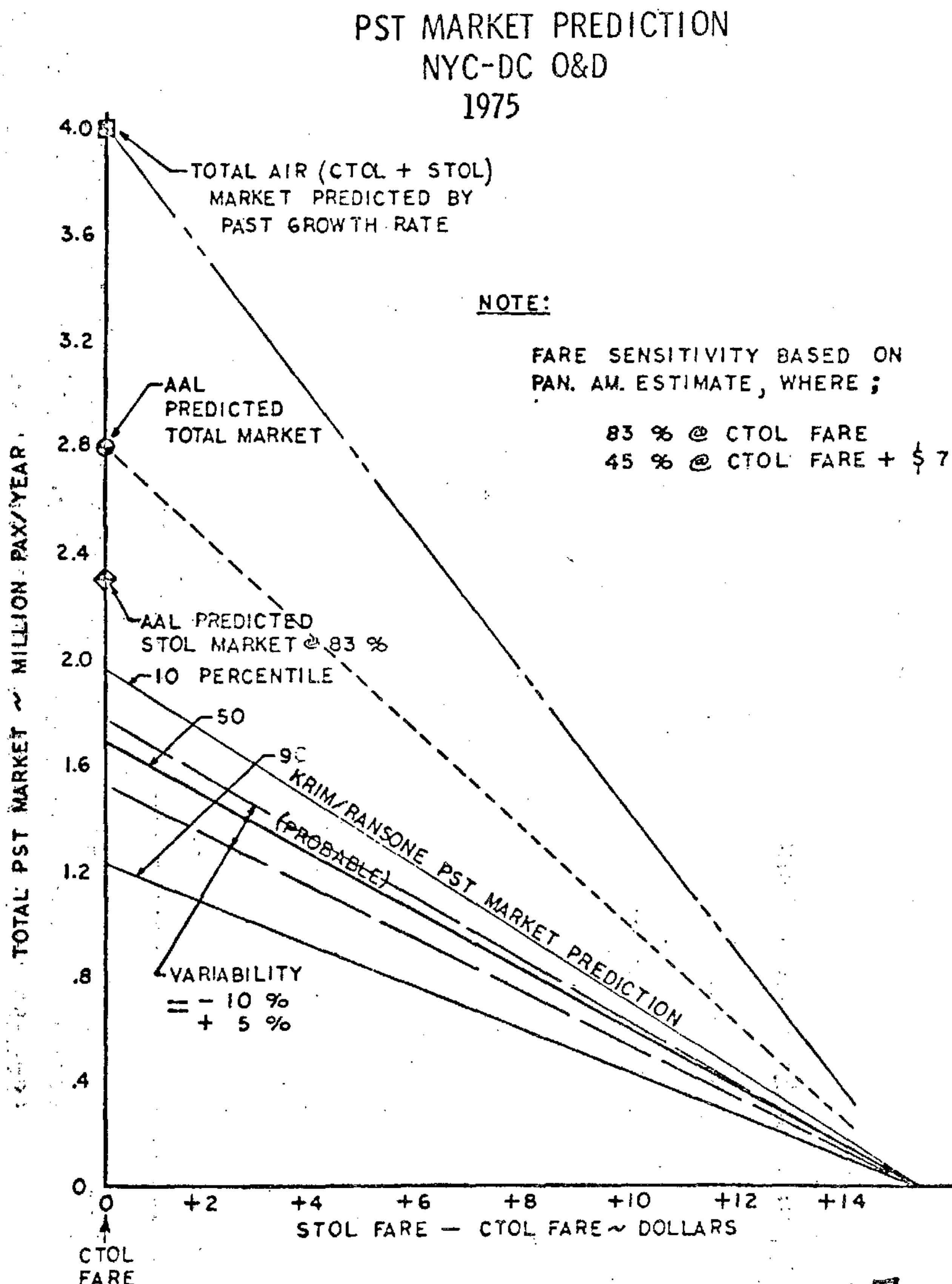
PST MARKET PREDICTION
NYC-DC O&D
1975
TOTAL AIR (CTOL + STOL) MARKET PREDICTED BY PAST GROWTH RATE
NOTE:
FARE SENSITIVITY BASED ON PAN. AM. ESTIMATE, WHERE ;
83 % @ CTOL FARE
45 % @ CTOL FARE + $ 7
AAL PREDICTED TOTAL MARKET
AAL PREDICTED STOL MARKET @ 83 %
10 PERCENTILE
50
90
KRIM/RANSONE PST MARKET PREDICTION
(PROBABLE)
VARIABILITY = − 10 % + 5 %
TOTAL PST MARKET ~ MILLION PAX/YEAR
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
.8
.4
0
0
+2
+4
+6
+8
+10
+12
+14
STOL FARE — CTOL FARE ~ DOLLARS
CTOL FARE

Figure 7

PST DIRECT OPERATING COST
(1970 $ @ 200 n. mi. Stage Length)

	DHC-7
5100 - Flying Operations	
2 pilots	82
Fuel & Oil	33
Insurance (@ $7.70 per $ mil flyaway cost)	17
5200 - Direct Maintenance (60% labor)	106
5300 - Maintenance Burden (1.8 x maint. labor)	115
7000 - Depreciation and Amortization	— — —
Total Cash DOC - $/block hour	353

Note: Depreciation was added separately during the risk analysis since it was a function of aircraft utilization. It varied from $130/B.H. to $137/B.H. for the DHC-7

Figure 8

PST INDIRECT OPERATING COST

(Annual Cost in 1970 $)

Item	One time	Recurring (add 10% contingency)		
		Fixed	f (R.T. / day)	f (R.T. / day) (Pax / aircraft)
5500 -				
Stewardesses			6,730	
Stew. Training	2,460 (R.T. / day)			
Stew. Uniforms			409	
Pax Food				206.50
Pax Supplies				111.30
6100 -				
Aircraft Servicing		29,750	3,660	
Landing Fees				429.00
Facilities Costs				169.00
6200 -				
Traffic Handling		5,040		184.50
6300 -				
Servicing Admin.		62,000		
6500 -				
Res. & Sales				67.40
6600 -				
Adv. & Publicity	350,000			
6800 -				
G&A (Public Liability)		35,000		
Total IOC - $/year	$350,000 + $2,460 (R.T. / day)	$131,790	$10,799 (R.T. / day)	$1167.70 (R.T. / day) (Pax / aircraft)

Figure 9

DHC-7 VARIATION IN IRR AND ITS RISK WITH CHANGES IN CAPACITY OFFERED AT TWO LEVELS OF FARE PREMIUM AND MARKET SIZE

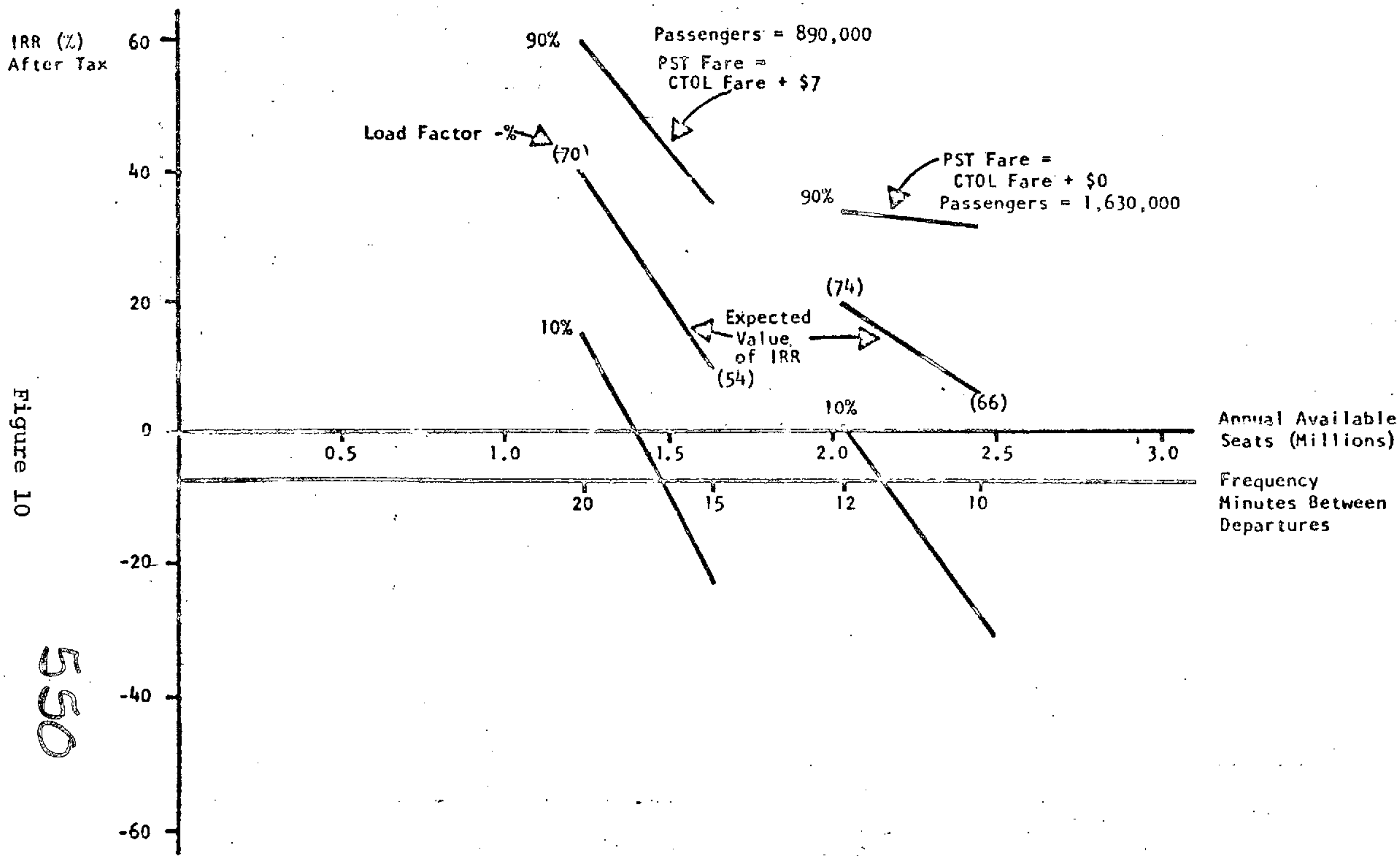

Figure 10

DHC-7 VARIATION IN IRR AND ITS RISK WITH CHANGES IN FARE PREMIUM
(Available Seats Fixed at 2,040,000 Annually)

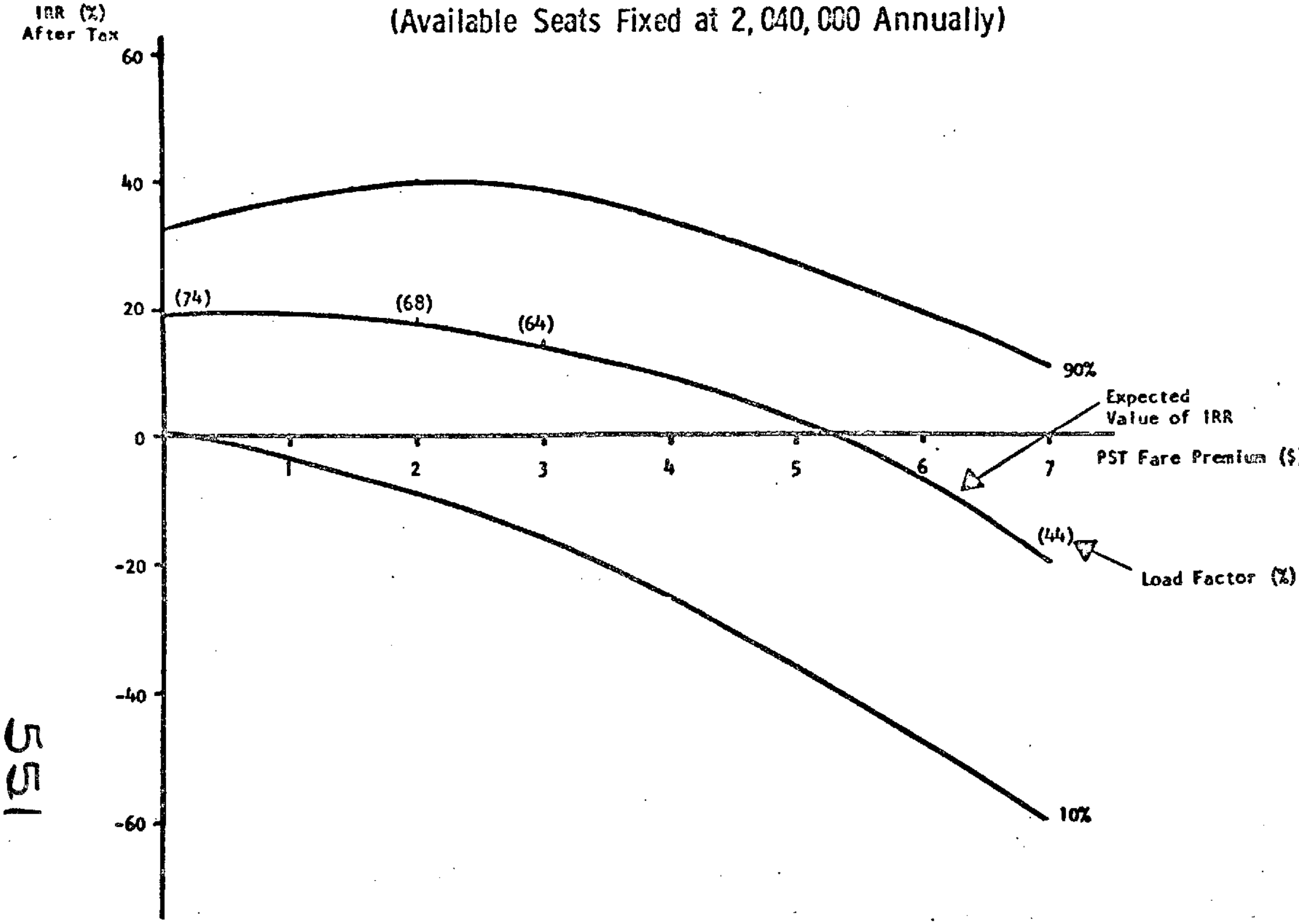

Figure 11