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Subject consumer surplus BCA methodology

As promised, attached is the proposed consumer surplus approach in evaluating both existing and new passenger benefits under the OMP BCA. Look forward to discussing with you.

1509 Economic Framework 27July05 (FB revised).doc

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ECONOMIC FRAMEWORK FOR ESTIMATING AIRPORT PROJECT BENEFITS

This memorandum provides information on how to apply economic principles to the estimation of airport project benefits. It focuses specifically on projects that enhance the capacity of the airports to process additional traffic and passengers. The methodology is briefly outlined in Appendix C, Section C.2 of: **FAA Airport Benefit – Cost Analysis Guidance** (December 15, 1999). In the appendix, the Guidance document suggests the use of consumer surplus as the appropriate measure of the benefits of a project. This is defined as the difference between what consumers must pay for a given level of service and what they would be willing to pay. In passenger transportation markets, the concept of full price of travel (FPT) includes the money price plus an increment representing the value of transportation time.

The rationale for this measure of consumer surplus in passenger transportation markets is straightforward. Consumer invests both money and time when consuming a transportation service. The rational consumer would purchase the service only in the event that the value (or consumer surplus) of the service exceeded both the money fare and the value of time.

In an airport context, the benefits of an airport expansion project might result in additional consumer benefits to both existing passengers and incremental passengers who would be able to utilize the facility as a result of the expansion. This is illustrated

in the following exhibit, which was copied directly from page C-4 of the Guidance document. It shows a circumstance at an airport where congestion costs are rising rapidly. This is reflected in the very steep supply curves (S and S′). In the base case (before an investment is made), total passengers equal the amount Q, and the full price of travel is P. The consumer surplus in the base case would be the triangle P a D.

Exhibit 1

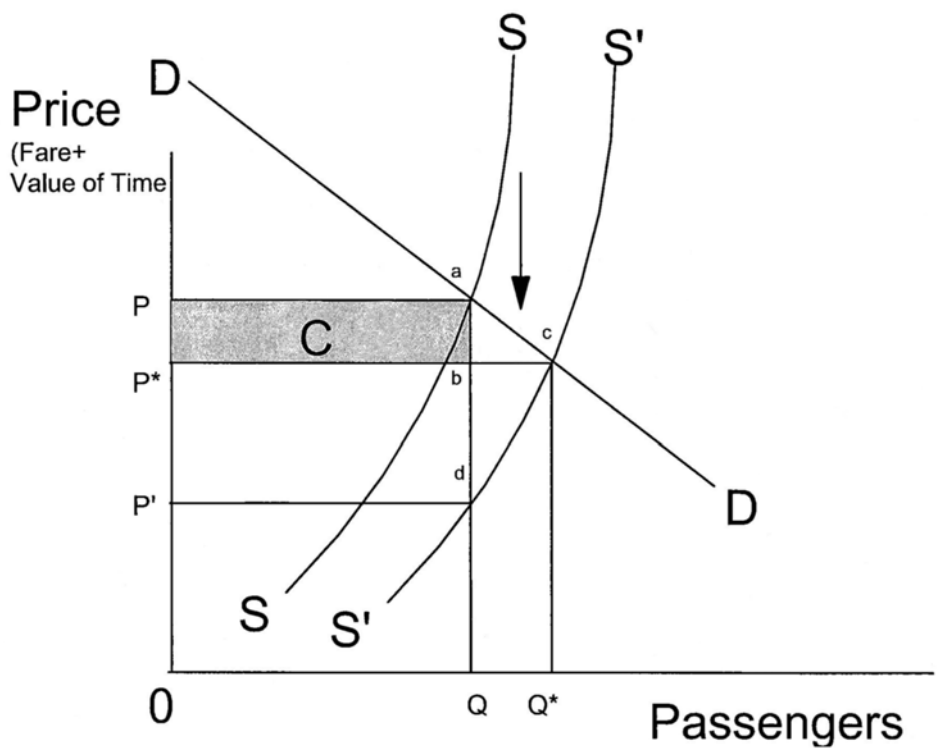


Figure C.2: Consumer Surplus With Radical Delay

Now suppose that an infrastructure program is undertaken so that the supply curve shifts to the right to S′. The infrastructure program makes it possible to provide service to passengers at a lower full price of travel at any level of demand (Q). For example, if demand at the airport remained at the initial base case equilibrium of Q, the

cost to providing service would fall from P to P′—a very large reduction in the full price of travel which could be made up of both the reduction in the money fare (due to the lower cost of operating at the airport) and reduced travel time. But, as is typical in most markets, when there is additional supply (S′) in the market place, and the price is falling, a new and higher equilibrium level of output will be reached (Q*). As a consequence, the new equilibrium price of travel with the additional infrastructure is P*.

It is important to note that as a result of the infrastructure improvement, **both** existing and new passengers gain consumer surplus. The gain to existing passengers is measured by the rectangle P P* b a. The consumer surplus realized by new passengers is described by the triangle a b c. The total benefits of the infrastructure project will be described by the polygon P P* c a. The existing passengers are better off because the full price of travel has fallen. Because the full price of travel has fallen, additional passengers can be accommodated at the facility. The benefits reflect changes in money fare and/or service time.

UNDERLYING ASSUMPTIONS PER THE GUIDANCE DOCUMENT

It is important to note that on page C-1, the Guidance document provides an important set of assumptions that are to be made in undertaking the analysis. Essentially, the assumptions are that airline markets are competitive so consumers realize the full benefits of reductions in both money fare and travel time that result from airport infrastructure projects. This means that by measuring consumer surplus in the

way described immediately above, we will have captured all of the local benefits of the infrastructure projects. To the extent there are other benefits in the National Aviation System, these would not be captured using the consumer surplus measure described immediately above.

THEORY AND PRACTICE

The theoretical underpinnings for the measure of benefits (consumer surplus including value of time) discussed in the Guidance document is well established in the economics literature. Much of this literature was first developed in urban transportation to address the problem of deriving optimal tolls and investment guidelines in the presence of congestion on urban roads. The literature can be traced to the early work of Ellet (1840), DuPuit (1849), Pigou (1912), and Knight (1924) and also parallels the development of peak-load pricing in the public utility literature (Boiteux, 1949). Mohring and Harwitz (1962) developed the first formalized treatment of an optimal investment/pricing framework. The analytical framework demonstrates that optimal investment will occur when the marginal costs of an additional unit of investment in a facility (e.g., an airport) just equals the marginal value of the benefits to the users of the facility (including the money price and the value of time).

Morrison (1983) estimated a set of landing fees and investment levels for congested airports in the United States using this framework. The Department of Transportation utilized the same model to estimate consumer benefits in its own High Density Rule Study (1995).

More generally, most of the economic work on the effects of airline deregulation are based upon models that measure consumer benefits using the full price of travel framework (see, for example Morrison and Winston, 1986, 1989 and 1995).

APPLICATION TO AIRPORT EXPANSION PROJECTS

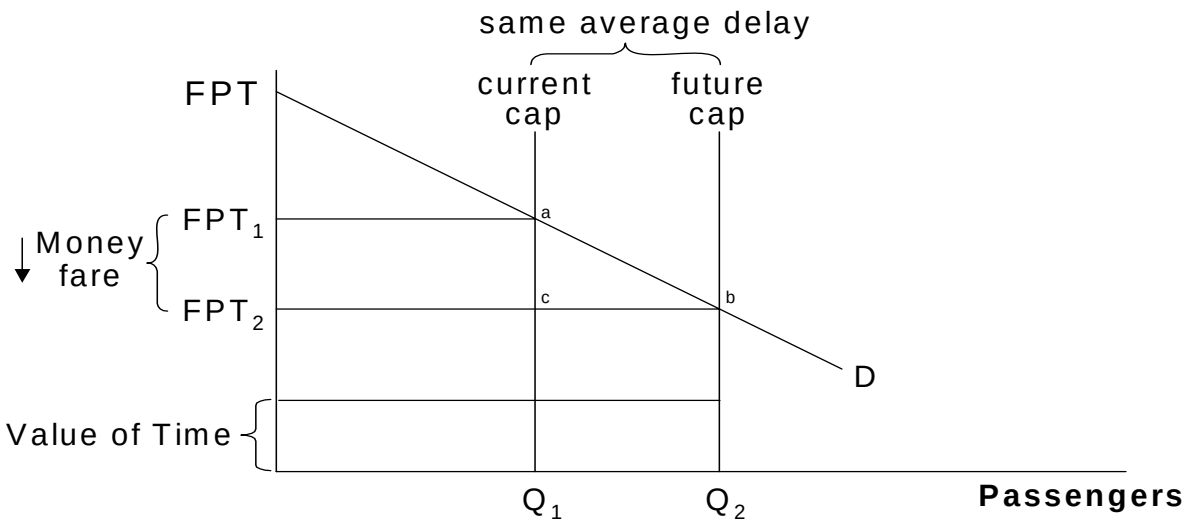
One of the most important applications of this economic framework would be at airports that exhibit substantial congestion, including those that are slot constrained. At these airports, because demand exceeds available capacity by a wide margin, incremental expansions may result in increases in the number of passengers, but only modest reductions in observed delays. In these circumstances, it is important to value both the benefits to additional passengers and the benefits to existing passengers of the expansion using the framework described above.

To illustrate this problem, refer to Exhibit 2. Here, the base case shows Q_1 passengers and a full price of travel of FPT_1. There is a cap established at the airport that results in operations and passengers at levels below those that would otherwise be demanded. Now suppose there is an expansion project which, when it is completed, results in additional passengers being accommodated at the facility (Q_2) but at identical average delay. In this case, the expansion will have resulted in a reduction in the full price of travel. But because the delay experience in the two examples is identical (and because we are assuming that taxi and en route time are identical in the two cases), the value of time at the two equilibrium levels will be identical. As a consequence, the reduction in the full price of travel will have to have been brought about by a reduction

in the money fare. That is, in order to induce additional demand, airlines would have to reduce their fares below the levels that would otherwise obtain without the project.

Exhibit 2

When Delay is Equal in Base Case and Scenario Cases



From an economics standpoint, this outcome makes sense. In order to induce additional demand, the full price of travel will have to decline. So, in cases where delay experience would be identical in both the base and scenario cases, the money price would have to decline to induce additional passengers to use the facility. The expansion has made possible the additional passenger output, but the incremental capacity will only be fully utilized if it is produced at a lower full price of travel.

Although Exhibit 2 has been used to describe consumer surplus gains that result from an expansion project that may take several years to complete and where delay ultimately returns to its base case level, the same type of analysis can be applied to year-by-year comparisons of the full price of travel with and without the expansion project. In other words, Q_1 and FPT_1 could refer to the base case in, say, Year 5 if no project were

undertaken, while Q_2 and FPT_2 could represent the expected results from Year 5 of the expansion project. In this context, the net consumer gain from the project in Year 5 would be the area FPT_1 a b FPT_2.

To make an analysis such as the one illustrated in Exhibit 2 operational, one needs to collect data that is typically available to analysts undertaking a benefit-cost study for the subject project. One such approach that is based on the year-by-year comparison method is illustrated in Exhibit 3. The analysis would be undertaken over the economic life of the project—typically 20 years. The analyst would construct both base and scenario cases in each year. From simulation models for the base case, one can collect information on the expected average travel time for passengers in each year of the analysis (column 1). Multiplying the average travel time by the FAA's prescribed value of time for passengers (column 2) results in an estimate of the base case value of travel time (column 3). To this, the analyst would add the average segment money fare for the airport (column 4) to develop a base case full price of travel. The analyst would also need a constrained passenger forecast reflecting the continuation of the cap in the base case (column 6).

Exhibit 3

Estimating Consumer Benefits Due to Infrastructure Expansion at a Congested Airport

	Base Case						Scenario Case		Benefit Calculations			
	1	2	3	4	5	6	7	8	9	10	11	12
	Average Travel Time per Operation (minutes)	Value of Time per Minute	Base Case Value of Travel Time	AverageSegment Money Fare	Base Case Full Price of Travel	Base Case Total Passengers (millions)	Scenario Total Passengers (millions): TAF unconstrained	Scenario Full Price of Travel	Benefits to Existing Passengers ($ mil)	Benefits to Incremental Pax ($ mil)	Total Benefits ($ Mil)	PV of Total Benefits @ 7%
Source	Simulation Studies	FAA Critical Values	(1) x (2)	DB1a Database	(3) + (4)	TAF Constrained	Unconstrained TAF [1]	See Footnote [2]	((5)-(8))*(6)	0.5*((5)-(8))*((7)-(6))	(9)+ (10)	PV in Year 20XX
Year 1												
2												
3												
-												
-												
20												

1. The unconstrained TAF would be used up to the point where congestion reaches levels beyond which airlines are unwilling to schedule added flights.

2. Col 8: -Col (5) *(1+x)/(1-x) where x = elasticity of demand * (col 7 + col 6)/(col 7 - col 6).
Recommended values for elasticity of demand for these analyses can be found in the Guidance document on page C.2.

For the scenario case, the analyst would need an unconstrained forecast of passenger demand (column 7). In the case illustrated in Exhibit 2, demand would rise each year until the point where the expected delays per passenger would be identical in both the scenario and base cases. After that point, demand in the scenario case would be capped. Using the equation illustrated in Footnote 2 of Exhibit 3, the analyst would then derive the scenario full price of travel.

The consumer benefits in each year could then be developed in a straightforward manner by computing the area of the polygon FPT_1 a b FPT_2. These would then be discounted at a seven percent discount rate (per the Guidance document) to derive an estimate of total benefits over the investment life of the project in constant year dollars. These total benefits would then be compared to an estimate of the present value of total costs to determine whether the project was cost-beneficial.

Sensitivity Studies

Ideally, the preceding analysis would be developed in an integrated way. For example, both the base case and scenario case demand forecasts would reflect consumers' reactions to the average expected delay and money price levels that will likely obtain in the future. But, often, demand forecasts in airport benefit-cost studies are either based on or taken directly from FAA Terminal Area Forecasts, which are typically unconstrained forecasts that do not directly take into account price elasticities or expected changes in the full price of travel. Regardless of the source of the forecast, it is useful to test the robustness of the results against relevant range values for the key parameters in the analysis. These are illustrated in Exhibit 4.

Exhibit 4

Sensitivities

1. Check the plausibility of the value of time and the money fare in the scenario case.
2. Evaluate the range of elasticities of demand over which the project is cost beneficial.
3. Evaluate the range of future demand in the scenario case over which the project is cost beneficial
4. Make alternative assumptions about future money fare levels and assess the effect on the project.

For example, the analyst will want to check on the plausibility of the value of time and the money fare in the scenario case. In the example illustrated above in Exhibit 2, the expected average delay will be identical in both cases. In such a circumstance, the full price of travel will only fall if the money fare falls. The analyst should assess whether

the expected reduction in the money fare is plausible given market circumstances and experience.

Likewise, the analyst should assess the range of elasticities of demand over which the project remains cost-beneficial. Ideally, the outcome of the analysis will not be altered within the range prescribed in the Guidance document. That is, if a project were cost-beneficial at the average elasticities of demand shown in the Guidance document, the robustness of the results would be stronger if the same outcome were to occur throughout the whole range shown in the Guidance document.

Another approach that an analyst might take in evaluating the robustness of the results would be to assess the range of demand levels in the scenario case over which the project remains robust. To the extent that a project remains cost-beneficial at lower levels of demand in the scenario case than are projected in TAF or another independent forecasts, the resulting outcome is more robust.

Finally, the analyst might be concerned with future money fares in both the base and scenario cases. Since deregulation, average yield (fare divided by average stage length) has fallen continuously at approximately one percent per year. The analyst could make similar assumptions about the future and determine if the implied reduction in money fares in the scenario case remain plausible.

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