Thanks for nothing essay

The paper starts by setting out the theoretical background regarding the identification and measurement of project benefits. It then presents a practical approach to measure such benefits in projects involving the expansion of passenger capacity and, subsequently, those aimed at expanding aircraft capacity. Projects for the freight market and the estimation of airport costs are both treated separately. Keywords: airports, cost-benefit analysis, infrastructure, transport JEL codes: D61, H43, H54, R41

The authors gratefully acknowledge comments by M. Hansen (Institute of Transportation Studies, U. C. Berkeley), by M. Turro, P. Boeuf and A. Lynch from the European Investment Bank (EIB) and by participants at the EIB internal seminar on cost-benefit analysis of airport infrastructure investment. The views presented in this paper are those of the authors and do not necessarily reflect those of the EIB or institutions to whom the authors are affiliated. 1. Introduction

The main issues in the economic evaluation of airport projects are common to all cost-benefit analysis of major transport investments. The basic comparison of social benefits and costs and the criteria and procedures to avoid errors and biases are not significantly different: the definition of the base case; the identification and measurement of relevant effects; the use of appropriate parameter values; and the prevention of double or triple counting (see for example: Adler, 1987; Mackie and Preston, 1998; Boardman et al, 1996; and Gramlich, 1990)

Airport investments are centers of thriving retailing activity, and projects with a sound financial performance might not be considered as good from a broader economic perspective. This paper is concerned with the cost-benefit analysis of airport infrastructure. The principle underlying the paper is that airport investments are to be assessed as transport infrastructure improvements aimed at addressing a demand for transportation.

The analysis should therefore focus on the impact of the investment on the generalized cost of travel for the users and on the costs of supplying the transportation service, including both airport and airline costs. The methodology proposed in this paper is aimed to help the practical application of cost-benefit analysis for a project analyst facing limited availability of data and a short period of time for issuing an opinion, a situation faced by many analysts in government and international agencies.

Also, the political context within which project appraisal is carried out in practice and the uncertainties it is subject to (see Turro, 1999) can make a quick, low cost assessment valuable. The emphasis is placed in the consistency of decision criteria across projects as to whether a given project is a “ good” or “ bad” investment, rather than on the detailed accuracy of the estimates of project returns. The approach must be workable, meaning both that it must be pragmatic about data availability, and that it must be consistent with the limited resources usually available for project appraisal.

When the full appraisal option is not possible (a full cost-benefit analysis with surveys of local conditions) the approach to be followed has to rely on data readily available from the majority of airport operators. There are significant differences in data availability across promoters of airport projects, and the methodology should be sufficiently flexible to allow application across projects in order to ensure consistency of decision making.

This paper does not deal with safety, security or environmental impacts, and it is conceived for “ incremental projects”. Strategic projects with broader objectives like “ social and economic cohesion” or “ national competitiveness” with controversial indirect effects are not suitable for conventional cost-benefit analysis and are prone to overestimating net social benefits (see for example Phang, 2002; van Exel et al, 2002) The paper does not pretend to measure strategic investments based on the presumed impact of the investment on the regional economy.

Evaluating airport investments in terms of maximizing regional development would require a comparison of the regional impact of airport investment with investment in other sectors, such as manufacturing, education or health. In any case, it should be noted that the economic return of the project provides, in most cases, a good indication of the project’s impact on the regional economy. This is because the willingness to pay for travel reflects the gross economic benefit generated by the trip. 1] Revenues from non-aviation activities – mainly retailing, but also land rental for other industrial activities, should not be counted as economic benefits resulting from the airport investment[2]. However, estimating such revenues is necessary in the appraisal process to estimate the financial return of the project and to gauge the necessary adjustments to aeronautical charges in the airport following project implementation. Sections 2 and 3 provide the theoretical basis for the appraisal framework subsequently proposed.

Section 2 is concerned with the theory of economic evaluation of airport projects, and section 3 with the theory for the measurement of the various benefits. Sections 4 to 7 are concerned with the practical application of the framework. Section 4 and 5 address appraisal of landside and airside investments, respectively. Section 6 deals with the special case of freight transport. Section 7 addresses the estimation of airport operating costs. Finally, section 8 draws some concluding remarks about the approach presented. 2.

The economic evaluation of airport projects The economic rationale of public investment decisions concerning whether a project should be implemented, or which projects should be selected subject to a given budget constraint, requires identifying and measuring the benefits and costs during the life of the project and calculating the net present value of this flow of net benefits. An essential element in evaluating the economic benefits of a project is the definition of the alternative to the project, the “ without project” scenario.

There are two elements in this respect. Firstly, what would happen to existing infrastructure. In the case of repair projects, which involve bringing existing infrastructure back into normal operative conditions, the “ without project” scenario would be that no further investments are made and that the airport will progressively degrade into inoperability. If the project consists of capacity expansion, then the “ without project” scenario should include all necessary investments to maintain operative the existing level of capacity.

The second element is the institutional constraints present in the market. These may involve government, airport or airline policies which would place additional conditions on the definition of the “ with project” and “ without project” scenarios. For example, faced with runway constraints, an airline dominating an airport may not want to increase aircraft size and may prefer to let yields rise instead. There may also be environmental constraints, as when there is a cap on aircraft movements below the notional capacity of a runway.

These constraints are very much project-specific, and the project analyst must incorporate them into the evaluation exercise accordingly, by making ad hoc adjustments to the scenarios. 2. 1. Economic benefits of airport infrastructure The economic benefits derived from investment in airport infrastructure cannot be identified with the revenues obtained by the airport authority and retailing firms with commercial operations in the airports. Airport infrastructure devoted to meet transportation demand can be divided into landside and airside.

Normally, airside involves infrastructure beyond security check points, where only passengers or authorised personnel can access. Landside involves infrastructure before that. For the purposes of this paper, airside is taken to mean infrastructure to process aircraft; whereas landside would involve infrastructure to process passengers or cargo. This latter division is more meaningful in the current context, as it draws the line by type of economic impact, as will be seen further down in the paper. Airside projects are geared to increase the capacity of the airport to handle aircraft movements.

Projects involve new runways or the widening or lengthening of existing ones; taxiways to increase the capacity of existing runways; apron space to expand aircraft parking capacity; or aircraft traffic control at the airport or in the airport's vicinity. Landside projects aim at expanding the airport's capacity to handle passenger and freight. Projects could involve expanding capacity of cargo or passenger terminals; improving access to terminals through parking facilities or rail stations; and enhancing product quality through increased use of jetways to access aircraft. 3] Projects can involve any combination of these items or, ultimately, the construction of entirely new airports.

The sources of benefits of investing in landside capacity are threefold. Firstly, the avoidance of traffic being diverted to alternative travel arrangements that impose additional generalised cost of transportation to the passenger or freight customer. Secondly, by relieving congestion in terminals, passenger or freight process – or throughput – time is reduced, hence contributing further to a decrease in the generalised cost of travel. And thirdly, in the case of investing on contact stands (i. e. hose equipped with jetways) in passenger terminals, comfort to passengers is increased by avoiding bus trips or walks to and from remote aircraft stands. Investment on the airside will produce two potential benefits. First, enhanced airside capacity will enable an increase in the frequency of departure and range of routes from the airport. This will yield the benefit of reducing the frequency delay,[4] as well as potentially the trip duration, both of which contributing to a reduction in the generalised cost of transport. Second, airside investments may speed the processing time for aircraft, reducing operating costs to airlines.

The benefits derived from airside and landside projects can be summarized into four categories: first, reductions in travel, access and waiting time; secondly, improvements in service reliability and predictability; thirdly, reduction in operating costs; and finally, increases in traffic. Regarding reduction in travel, access and waiting time, infrastructure investments may lead to faster or more frequent services, or to alleviate congestion, or to generate some network effects. The final effects translate into lower generalized cost of travel.

When capacity is not enough to match demand at a given level of prices, it may happen that investment in additional capacity would not alleviate congestion, but accommodate latent demand for that particular airport, which was previously served at a less convenient alternative. This is the concept of scarcity (Starkie, 1988; Nash and Samson, 1999) useful to account for the important fact of ex ante matching of supply and demand through administrative procedures. Scarcity applies to transport infrastructure with non-random entry and where the different operators have access to the system through a coordinated scheme.

Theoretically, demand cannot exceed capacity. Unattended demand at given prices is reflected in scarcity. Nevertheless, with tight schedules, system overloads due to flight delays generate congestion as the required rescheduling to accommodate the delayed flights impose changes in departing or arrival times for other flights. Scarcity is possible without congestion when the airport authority is not charging a market clearing price for the available slots and the number of slots give enough slack to accommodate timing problems without system overloads.

Investment in transport infrastructure can improve service reliability and predictability and this is converted in lower generalised costs for travellers or lower operating costs for firms using air transport services. Other projects allow the introduction of more efficient technologies or facilitate a better use of those in use, resulting in a reduction in operating costs (lower cost per seat associated with more efficient aircrafts, handling equipment, etc.) Finally, the reduction in costs for passengers and firms could lead to an increase in traffic.

The degree of market power in the airline industry and other economic activities directly affected by the project will determine who is the final beneficiary of the cost saving or the increase in frequency or service reliability. When markets are competitive, producer surplus remains unchanged. Passengers and consumers served by companies benefiting from the cost reduction will increase their surpluses through lower prices and higher levels of service. However, this is not always the case with the airport authority which enjoys some market power by being the only provider of aeronautical services within a given area.

Such an operator, once the project has been implemented, has to set prices above avoidable costs to recover the investment. There are two ways of approaching the economic appraisal exercise: the social surplus approach, and the resource use or resource cost approach. The social surplus approach consists of the direct calculation of changes in consumer and producer surpluses. This requires identifying changes in prices, costs and revenues with and without the new airport infrastructure. The alternative approach to estimating the economic benefit of the project consists in looking at the changes in real resources, ignoring transfers.

Even in the case of positive airport authority surplus it is possible to concentrate in resource costs as shown below. So, instead of looking at the changes in social surplus, we focus measurement in real resource costs changes ignoring revenues from existing traffic. In this approach one should take especial care when changes in quality occur, and with the treatment of taxes and incremental revenue in generated traffic. When markets are competitive and incremental revenues equal incremental costs for airlines and other firms, it is possible to measure the benefits of enerated traffic by measuring the savings in resource costs. In the case of taxes, this shortcut is also feasible as long as there is a general indirect taxation in the rest of the economy. The net increase in tax paid to the government could be too insignificant to justify further effort (Abelson and Hensher, 2001). The resource cost approach does not account for quality changes (e. g. comfort) and additional measurement should be made to avoid the understatement of user benefits when significant quality changes are part of the project.

The measurement of benefits and costs requires estimating airport demand for the project life. Let us assume that the base demand level is known and equal to q0 and the annual growth rate is ?. The annual airport demand for airport, assuming no changes in generalised costs is: [pic] (4) It is worth noting that Qt is the number of users willing to pay, at the existing price, for the use of the airport in year t, and qt0 and qt1 in (2) and (3) are the equilibrium quantities in year t without and with the investment.

We assume that the evaluating agency knows the annual demand growth and needs to work out the equilibrium quantities to estimate the change in social surplus (or resource cost). 3. Identification of benefits from airport infrastructure investment 3. 1 Benefits without rationing Assuming that the market is competitive and leaving aside the measurement of service reliability and predictability, the economic benefit of the investment can be determined through the reduction in resource costs. Let us consider a project in airport infrastructure which implies a reduction in total trip time (? 1- ? 0), and assume that prices do not change. Figure 1.

Users benefits Figure 1 represents the stylized case of this type of investment, in landside infrastructure, which eventually leads to higher capacity. Generalized costs and willingness to pay for airport services are measured in the vertical axis and the demand per unit of time (e. g. hour, peak period, day or year) in the horizontal axis. Initial capacity allows attending a maximum of qa users per period of time at a constant generalized cost equal to g0. The average generalized cost function C shows that once the critical level qa is reached, a new increase in traffic is only possible, within existing capacity, at a higher average cost.

Initially the airport demand in a particular period of time has an imperfect substitute (another less convenient flight, airport or mode of transport) available at a generalized cost of g1, higher than g0) nevertheless, as demand is D0, all the users willing to pay g0 will be attended. Demand growth is expected to be equal to ? and according to (4) the level of demand in the following period is Qt. Depending on which cost (go or g1) applies, Qt would be fully attended at the project airport (Qt= qd), or partially at this airport (Qt= qb) with some deviated traffic to second best alternatives (qc-qb) and some deterred traffic (qd-qc).

Scarcity without the project results in some deviated traffic to second best alternatives (qc-qb) and some deterred traffic (qd-qc). The comparison with and without the project leads to the following benefits: Benefits to current users are equal to (g’- g0)qb, strictly lower than without administrative rationing. Benefits from avoided diversion costs are equal to (qc-qb) (g1-g0), which are strictly higher than those reflected in figure 1 as (qc-qb) is now strictly higher[7]. User benefits from generated traffic are similar.

The comparison between the situations reflected in figures 1 and 2 also shows the interesting possibility of improving the results without implementing the project when congestion is above the optimal level. A Pareto improvement results without the project through a rationing of capacity. Another insight from the comparison of figures 1 and 2 is that the benefits of the airport infrastructure project appear to be substantially higher in figure 1 than in figure 2, highlighting the importance of a clear definition of the base case. Figure 2.

User benefits with administrative rationing of capacity 3. 3 Capacity constraint During the lifetime of the project it might occur that demand in some year t is above the baseline identified in figure 1 with a generalized cost equal to g0. This is a quite realistic case during a typical project life of 15 or 20 years. Figure 3 illustrates a situation during the project life, in which demand Qt cannot be met at a constant cost g0 but at a higher cost, due to the presence of congestion. This could happen because of indivisibilities in airport investment.

It may be optimal not to invest in additional capacity during some years, and hence the case represented in figure 3 is compatible with the assumption of perfect information on demand. Figure 3. User benefits with administrative rationing and congestion In this case, benefits from capacity expansion are lower than those described in figure 1. The reduction in the generalized cost of using the airport is now lower and so is the generated traffic. The generalized cost for existing traffic remains at g’. Benefits come from diversion costs avoided, equal to (g1-g’)(qe-qb). No deterred traffic exists in this case.

Project benefits are definitely lower when supply and demand conditions are similar to those represented in figure 3: lower demand at equilibrium and smaller cost reduction. The graphical analysis shows the user benefits we have to measure to work out whether the investment is socially profitable: time savings for existing passengers, diversion cost avoided and the consumer surplus of generated travel. We have assumed that the economic effects of the investment were limited to user time savings and therefore leaving the producer surpluses of airport authority, airlines and other firms constant.

Investment in airport infrastructure can change operating costs and revenue of airport authority, airlines and other firms, so we need to generalize the previous graphical analysis based in the resource cost approach to the case of a positive airport authority surplus. For simplicity, we keep the assumption that cost reduction accruing to airlines will finally benefit consumers through lower prices. Without rationing, from (2) and (3), and disaggregating existing and generated traffic, the change in social surplus with the project in year t s equal to: [pic] (5) Given that[pic], and rearranging (5), social surplus can be expressed as: [pic] (6) Following (6) the benefit of the project for current users is equal to total time cost savings. In the case of generated passengers, only half of that amount should be accounted for, plus the average of ex ante and ex post airport charge per trip. Time diversion cost savings are treated in (6) as existing traffic (conditions in figure 1) and the full difference in trip time applies[8].

With rationing, condition (6) has to be modified to account for possible differences in time savings between existing and diverted traffic, as happens to be the case in figures 2 and 3. The conditions prevailing in figure 2 requires to calculate the first term of (6) twice, one for existing traffic and another for deviated traffic. With figure (3) the calculus is straightforward as the same time saving apply for all traffic and no deterred traffic exists. 3. 4 Additional considerations for airside investments An increase in airport capacity in terms of the aircraft movements it can handle has three effects.

Firstly, it enables an increase in the potential passenger and freight capacity. Secondly, it makes it possible to increase flight frequency, benefiting all passengers traveling through the airport. These benefits result from the greater choice of departure time, and consist of reductions in the " frequency delay", which is the difference between the passengers' preferred departure time and the nearest departure time available. [9] Thirdly, for a given amount of traffic as frequency increases there can be a change in the average size of aircrafts using the airport. This has implications for airline operating costs because larger aircraft re, to a certain extent, cheaper to operate on a per seat basis than smaller aircraft[10]. Figure 4. Benefits from airside investment Indivisibilities in airport expansions imply that runway capacity cannot increase linearly with traffic. As a runway handles more passengers, it will eventually have to handle larger aircraft. When a new runway is built, two effects may bring about reductions in average aircraft size. Firstly, airlines would tend to compete for time sensitive business travelers by increasing flight frequency, which will tend to take place with smaller aircraft.

Secondly, new airlines will enter the airport, developing new routes, also normally with smaller aircraft. Should a new runway not be built, airlines will be forced to operate with bigger aircraft in order to accommodate growing traffic. Hence, the decision to invest in a new runway will have to consider the possible trade off between, on the one hand, reduced frequency delay at a higher cost per seat if the runway is built and, on the other hand, keeping frequency delay constant at a lower cost per seat if the runway is not built.

This trade-off is illustrated in Figure 4. The left-hand vertical axis measures currency units and the right hand-side vertical axis the inverse of average aircraft size (AS). The horizontal axis measures departure frequency. The marginal frequency delay schedule (FD) denotes the inverse relationship between departure frequency and generalized cost. An increase in the value of time would shift the schedule upwards. The marginal airport costs schedule (Ca) denotes constant returns to scale. The marginal total cost schedule (C) includes both airport and aircraft costs.

With respect to the right hand side vertical axis, C reflects the inverse relationship between departure frequency and aircraft size and, with respect to the left hand side vertical axis C reflects the direct relationship between departure frequency and unit cost per seat. When total traffic grows, for a given level of frequency, aircraft size will have to increase, reducing marginal cost per seat, rotating the C curve downwards, clockwise[11]. In the example illustrated in figure 4, runway 1 has a capacity for aircraft movements of f1.

Building a second runway would enable an increase in frequency to f2. At f1 the cost imposed on the passenger by the frequency delay is fd1, higher than marginal operating costs of c1. Airlines hence have an incentive to increase frequency at the expense of aircraft size, as passenger willingness to pay for en extra frequency is higher than the marginal cost associated with reducing aircraft size. Equilibrium would be reached at point b, where frequency is f’ and where fd’ is equal to c’. The benefits of building a new runway, enabling an increase in departure frequency, will be equal to the area abd.

Moreover, the passing of time will bring about two effects: traffic grows, shifting the C schedule downwards; and the value of time increases with growing income, shifting the FD schedule upwards. These two effects would expand the area abd from all of its three corners, meaning that the benefit of building a new runway increases with time. The economic returns from investing on a new runway are determined by the present value of the future stream of benefits as determined by the area abd in each year, and by the present value of the capital investment required for the new runway.

Until point b exceeds the capacity of runway 2, there will be no benefit from building a third runway. 4. Applied measurement of benefits from investment in airport landside 4. 1 Expansion of landside capacity Airport infrastructure usage experiences marked peaks and troughs, which follow time of day, day of the week and month of the year patterns. Figure 5 provides an indication of the degree of variability of capacity requirements placed on airport infrastructure throughout the year. It displays the Flow Distribution Curve (FDC) for a hypothetical typical airport.

The FDC ranks all 8, 760 hours of the year by passenger throughput. Figure 5. Flow Distribution Curve for a hypothetical airport This pattern of demand means that the terminal is underused for a significant portion of time. In principle, terminal capacity could be increased – and a more economically efficient operation could be achieved – by flattening the FDC, for instance through pricing policy. Airport charges should differ between peak and off-peak periods either through a differentiated pricing system or by a market-driven slot allocation.

In practice, almost always a flat charge is applied, increasing the peaks in demand above efficient levels[12]. Terminals are designed to be able to process a target hourly throughput with a given level of service. The objective is to strike a balance between the need to address traffic peaks, and the need to minimize unused capacity during throughput troughs. This implies that the terminal needs to supply a level of service that is acceptable “ most of the time”. There is not a single criterion to set the hourly throughput target for terminal design.

Some alternatives include: • the Standard Busy Rate, taken to be the thirtieth busiest hour; • the fortieth busiest hour; • the 5% Busy Hour Rate, defined as the throughput level which the 5% of passengers traveling during the busiest hours find as a minimum throughput level in the terminal (see Figure 1, where the area under the FDC and left of the doted line corresponds to 5% of total traffic); and • measures of the type “ busiest hour in the second busiest month”. At the target level of throughput, a standard of service is defined.

The Airports Council International (ACI) and the International Air Transport Association (IATA) have defined a scale of service standards, in terms of space available per occupant at various locations in the terminal. These standards are shown on Table 1. Trespassing the minimum limits imposed by level E would take the terminal to level F, considered as “ system breakdown”. It is important to underline that the actual capacity of the terminal in terms of passenger throughput per hour is determined by the maximum capacity of the “ weakest point” along the passenger processing chain.