



SEI Project Report

## **Generated User Benefits and the Heathrow Expansion: Understanding Consumer Surplus**

A report to Friends of the Earth England, Wales and Northern Ireland

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2008

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# **Generated User Benefits and the Heathrow Expansion: Understanding Consumer Surplus**

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## INTRODUCTION

The Department for Transport (DfT) has concluded, based on cost-benefit analysis, that more capacity at the UK's busiest airport will do the country more good than harm. The problems of relying on cost-benefit analysis to make important decisions about social welfare have been well documented in the literature: cost-benefit analysis does not take equity into consideration; costs and benefits to future generations are assumed to be of little consequence to today's decision makers; and *ad hoc* methods are used to assign money values to priceless environmental and social goods<sup>1</sup>. But in addition to these serious critiques, one of the little-noticed features of the DfT analysis is its absolute reliance on a highly abstract, unmeasurable benefit derived from economic theory: the so-called "consumer surplus" that Heathrow expansion is projected to generate over the next several decades, which is expected to outweigh its (less abstract and more easily measured) costs. The decision of whether or not to expand capacity at Heathrow Airport – by adding a new runway, changing to a noisier but higher-turnover mode of operation, and lifting legal limits on the number of flights – rests on DfT's estimation of consumer surplus, or "generated user benefits."

This report assesses the validity of the DfT's assumptions and reliance on consumer surplus theory.

DfT's (2007a) *UK Air Passenger Demand and CO<sub>2</sub> Forecasts* predicts that if demand for flights into and out of the UK were not constrained by limited airport capacity, the number of passengers would increase from 228 million passengers per year in 2005 to 460-540 million in 2030. These forecasts include the assumption that starting in 2010 UK airfare will include a carbon tax, to be gradually increased over ten years until it reaches the full cost of each flight's greenhouse gas emissions. DfT (2007a) estimates £4.4-5.2 billion in total net benefits (over and above costs) from adding a third runway at Heathrow Airport to open in 2020<sup>2</sup>. The total net benefits of switching Heathrow's existing runways to "mixed mode" operations (that is, allowing both runways to be used for arrivals and departures) from 2010 to 2020, lifting Heathrow's legal capacity limits in 2015, and adding a third runway in 2020 is estimated to be £5.4-6.2 billion<sup>3</sup>. Very similar scenarios in the DfT's (2007b) *Adding Capacity at Heathrow Airport – Public Consultation* have higher costs and benefits, but the same net benefits: £4.4-5.2 billion for adding a third runway, and £5.4-6.2 billion for mixed mode operations on the existing runways from 2010 to 2020, lifting the legal capacity limits in 2015, and adding a new runway in 2020<sup>4</sup>.

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1 See, for example, Ackerman (2008), Ackerman and Heinzerling (2004), and Stanton and Ackerman (2008).

2 DfT (2007a) p.78 Table 4.2: scenario s12s2 using Stansted R2 2015 as the base case.

3 DfT (2007a) p.78 Table 4.2: scenario s12s2mm2 using Stansted R2 2015 as the base case.

4 DfT (2007b) Annex B, p.126-130: Option 1 and Option 3, respectively.

The net benefit to be derived from the proposed Heathrow expansion, as estimated by DfT, is, therefore, on the order of £5 billion, in present value, accrued over the course of 60 or 70 years<sup>5</sup>. This net benefit, £5 billion, is the primary rationale for an enormous infrastructure project that will displace thousands of people from their homes, increase local noise and air pollution, and increase the UK's contribution to global climate change. Table 1 provides a breakdown of the various costs and benefits for two scenarios for Heathrow expansion<sup>6</sup>:

**Table 1: Breakdown of benefits, net present value (2006 £ in billions)**

Scenario (numbers of passengers)	s12s2	s12s2mm2
	Heathrow R3 (605,000 in 2020, rising to 702,000 in 2030)	Heathrow Mixed Mode (480,000 2010-2015 and 540,000 2015-2020), then R3 (605,000 2020, rising to 702,000 in 2030)
Generated Users	9	9
Existing users	neg	neg
Freight	neg	neg
Producers	5	5
Government	3	3
Noise disbenefits	neg	neg
User Benefits	-	2
Carbon Disbenefits	-5	-5
<b>Total Benefits</b>	<b>12.0</b>	<b>13.6</b>
<b>Total Costs</b>	<b>6.8 to 7.6</b>	<b>7.4 to 8.3</b>
<b>Net Benefits</b>	<b>4.4 to 5.2</b>	<b>5.4 to 6.2</b>

Source: DfT (2007a: 76-79) Tables 4.1, 4.2 and 4.3.

Notes from original Table 4.3: "'neg' means impact is estimated and non-zero, but rounds to zero"; "-" means that no impact is estimated"

In the first scenario, a third runway is added, opening in 2020; the result is £9 billion in generated user benefits and £12.0 billion in total benefits. In the second scenario, Heathrow's existing runways operate in mixed mode from 2010 to 2020, existing limits on the number of flights are lifted in 2015, and a third runway is added in 2020; the second scenario results in £9 billion in generated user benefits and £13.6 billion in total benefits. Both scenarios are dominated by the £9 billion in benefits to generated users- those who would fly more if airfare were cheaper and who may be attracted by Heathrow's added capacity, or those who would be forced by high prices at an unexpanded Heathrow to fly from more distant airports. The scale of these benefits to theoretical future users is very sensitive to the assumptions made (without

5 DfT (2007a: 76) uses an appraisal period of 60 years after project opening; DfT (2007b, Annex B: 143) uses a 70- year appraisal period.

6 Table 1 is based on DfT (2007a). DfT has published several estimates of the user benefits generated by Heathrow expansion. The results of the Heathrow Consultation (DfT 2007b) are not broken out by specific benefit; instead, the DfT's (2007a) earlier study, UK Air Passenger Demand and CO<sub>2</sub> Forecasts, is given as a source for the methodology. Differences in the DfT's (2007a) and (2007b) results are fully not explained in either text. The Heathrow Consultation's (2007b) Annex C seems to indicate that it uses a different methodology – developed by BAA – to forecast passenger demand and fleet mix (and not the methodology from UK Air Passenger Demand and CO<sub>2</sub> Forecasts cited in Annex B). According to Annex C the two methodologies give "broadly similar" results but the BAA results are used because they are more detailed: "The BAA forecasting system is designed both to inform strategic decision making within BAA, and to provide detailed forecast outputs for facility development and operational purposes. BAA's outputs can therefore include data such as daily schedules of departures and arrivals by aircraft type at Heathrow. DfT's forecasting system is designed primarily for the purpose of informing strategic aviation policy, and while it can provide some departure and arrival information at Heathrow, its outputs are less detailed than BAA's. As the noise and air quality modeling relies on detailed data, BAA's forecasts were the preferred source of the required inputs. However, DfT's forecasts were used throughout the modelling process as benchmarks to quality assure BAA's forecasts at the most detailed level possible."(p.204)

sufficient justification) regarding future airfare, consumers reactions to price changes, and available transportation alternatives. In both cases, were this category removed, costs would outweigh benefits. This report examines DfT's forecasts of the costs and benefits of expanding Heathrow Airport, with a particular focus on generated user benefits and consumer surplus.

## UNDERSTANDING GENERATED USER BENEFITS

In DfT's analyses of Heathrow expansion, generated user benefits are the value of those passenger flights that could not have occurred in the absence of increases to airport capacity. Benefits to these new passengers are measured as additions to "consumer surplus" or a windfall gain to consumers who value a good or service more highly than the price that they pay for it. Here, DfT predicts that airfare will be lower than the maximum that passengers would be willing to pay. With more flights available at a lower price, more passengers would be able to fly, and each new passenger flight would add to British welfare. Passengers' new, extra welfare is estimated as the difference between what they would be willing to pay to fly and the airfare they will actually have to pay. Consumer surplus plays a crucial role in DfT's evaluation of Heathrow expansion.

Generated user benefits are the additions to consumer surplus that result from new (as opposed to existing) passengers, and are measured as one-half the change in price multiplied by the change in the number of customers. Without a change in the number of customers, there is no change in consumer surplus. And without a drop in price, there is no increase in the number of customers. Most of the generated user benefits occur in the quarter-century after 2030. With no changes to Heathrow, the airport is at the limits of its capacity by 2030; with the proposed changes, it does not reach full capacity until well into the 2050s. Thus the largest impact of the proposals for expansion is forecast to occur between those two dates, when many more new ("generated") users can be accommodated with Heathrow expansion than without.

Consumer surplus, let alone "generated user benefits," is an obscurely abstract category that cannot be observed or measured, but there is only one reason that it can go up: the projected price must be going down. DfT's message here is nothing more or less than, "the benefit that justifies airport expansion is that we predict that prices will go down and therefore more people will enjoy more flying." Everything turns, therefore, on the strength or weakness of the prediction of falling prices.

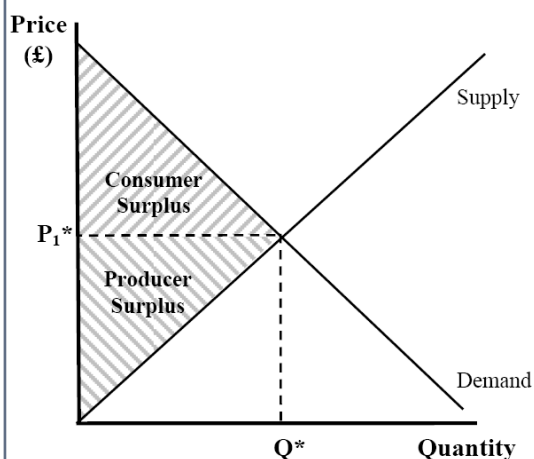
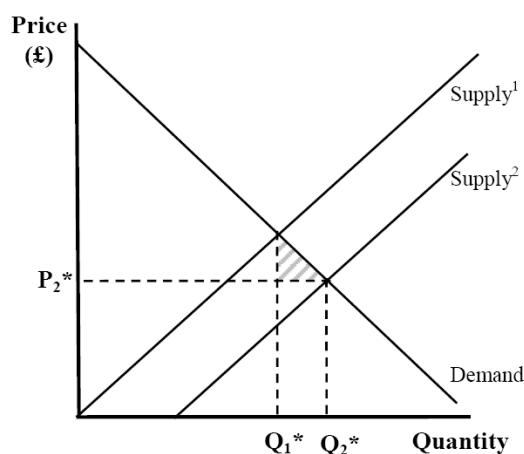
The consumer surplus resulting from Heathrow expansion is the difference between two immeasurable values: the most that we would pay for airfare at a future date, and the actual airfare on that same date. The existence of generated user benefits is, of course, very sensitive to both of these estimates. If demand for flights is smaller than the DfT expects, or if airfare is higher (due to increases in fuel prices, for example), then generated user benefits will be smaller, and so too will the total benefits of airport expansion. Even if demand and airfare could be forecast with perfect accuracy, however, these predictions will always be context specific: the demand for flights is strongly dependent on the existence of alternatives to flying. Of course, since consumer surplus is a theoretical construct that can never be observed there is no way to test its accuracy; we can only examine the assumptions used in making predictions about demand, airfare, and the available alternatives.

DfT's estimate of the future demand for flights is central to its prediction of net benefits from airport expansion. Demand estimates pair possible prices of airfare with the number of passengers predicted to fly at each price. These predictions rest on assumptions about how potential passengers react to changes in airfare and changes in their income. When airfare increases, does the British public keep buying tickets for the same number of flights, or is there a strong reduction in demand? If British incomes were to double over the next 30 years, would the number of airline tickets sold double as well? The sensitivity of buyers' decisions to changes in prices or income is called "elasticity." Note that there are two similar-sounding but distinct measures involved here, price elasticity and income elasticity.

*UK Air Passenger Demand and CO<sub>2</sub> Forecasts* (DfT 2007a: 17) states its assumed price and income elasticities explicitly. If prices fall by 1 percent, DfT expects demand among leisure passengers to increase by 1 percent and expects demand among business passengers to remain unchanged. (Note that in DfT's analysis the same elasticities apply to all prices changes, large or small, so according to these predictions a 20 percent decrease in prices would increase the demand for leisure flights by 20 percent and would change the demand for business flights not at all.) If income rises by 1 percent, DfT expects demand among leisure passengers to increase by 1.6 percent and demand among business passengers to increase by 1.5 percent.

**Box 1: An Economic Analysis of Consumer Surplus**

Consumer surplus is a windfall benefit to buyers who pay less than they would have been willing to pay. In the neo-classical economic model of supply and demand, supply is how much of a good sellers are willing to part with at a given price, and demand is how much buyers are both willing and able to purchase at a given price. Supply and demand curves give this information for a set of likely prices. Supply slopes upward because, in the short-run when investment decisions cannot be changed, the cost of making each new unit of a good is a little bit higher than the last unit (the idea here is that producers use of a fixed level of equipment gets more crowded and less efficient as more units of the good are required; in the long-run, when investment decisions easily can be changed, there is no reason to think that supply slopes upward). Demand slopes downward because as consumers buy more and more of the same good they become satiated and each additional unit of the good gives them a little bit less pleasure than the last. In this theoretical representation of a free market (that is, a market without government regulation and without the undue influence of powerful actors like monopolies), the market price is determined by the intersection of supply and demand.

**Figure 1: Consumer Surplus****Figure 2: Generated User Benefits**

All units of this good will be sold at the price  $P^*$ . But the demand curve indicates that consumers would have been willing to pay much more than  $P^*$  for first unit of the good purchased, and the second unit and so on up to  $Q^*$  units. Consumers' willingness to pay only reaches the low price of  $P^*$  at the intersection of the supply and demand curves. Consumer surplus is the area under the demand curve but above market price  $P^*$ . Similarly, producers receive a surplus whenever the market price is above the producers' reservation price (the price below which they would not sell). Producer surplus is the area above the supply curve but below market price  $P^*$ .

The predicted new user benefits generated by the expansion of Heathrow, £9 billion, rest on the untestable accuracy of these elasticities. It seems unlikely that demand for business flights is entirely insensitive to price changes, regardless of the scale or the direction of change. It also seems unlikely that an increase in British income will have the same impact on demand for airfare today as it will five years from now, or 20 years from now<sup>7</sup>. If incomes continue to increase, at some point the British public may be satiated with purchases of air travel: more of an enjoyable thing is not *always* better<sup>8</sup>.

Since consumer surplus is not directly observable, the magnitude of consumer surplus is dependent on the theoretical framework from which it is deduced. Any errors in projecting oil prices, future demand for air travel, or other factors can throw it off by a large (and again, unmeasurable) amount. If every piece of the calculation were reliable and unbiased, the resulting consumer surplus estimates might count as best guesses – with vast associated uncertainties. Sadly, the DfT calculation does not even rise to that standard. Instead, it has myriad defects.

7 According to DfT, "market maturity" has been factored into the forecasts; it reportedly "reduces the central demand forecast by 18%" (Annex B, section 1.24-1.27). No sensitivity analysis is offered for the assumptions underpinning this estimate.

8 For a discussion of how airline market maturity is likely to reduce the income elasticity of airfare over time see the Colin Buchanan and Partners (2006) study commissioned by the GLA.



## ESTIMATING GENERATED USER BENEFITS

DfT's methodology for estimating the costs and benefits of airport expansion takes the theory of consumer surplus and applies it to this real world problem by attempting to estimate future changes to airfare and passenger counts resulting from expanded airport capacity. These kinds of estimations are highly speculative and fraught with questionable assumptions. We discuss four such difficulties with estimation: uncertainty in predicting future demand; the inclusion of benefits to foreign travelers; and the DfT's choice of taking a "do nothing" scenario as their baseline.

### Demand projections are uncertain

DfT's predicted £9 billion in future generated user benefits from Heathrow expansion dwarfs the other benefit categories, as well as social costs. Perhaps the most important potential source of error that would tend to over-estimate generated user benefits is an inaccurate prediction of future airfare. DfT (2007a: 18-19) states the assumptions that it uses to forecast future fuel and non-fuel costs. Fuel costs are assumed to fall over time. Specifically, DfT's projected fuel prices follow the market price for a barrel of oil using what the report calls the Department of Trade and Industry's (DTI's) "central oil price projection": \$65 per barrel in 2006 and \$53 per barrel in 2030 (in 2004 dollars). These prices originate in the DTI's (2007: 332) *Meeting the Energy Challenge: A White Paper on Energy*, which includes this caveat: "Fuel price assumptions are intended to be illustrative scenarios to reflect uncertainty over the outturn of future prices in the modelling – they are not detailed forecasts or predictions of future prices."

World market prices for crude oil exceeded \$100 per barrel for the first time in February 2008. As of July 14, 2008, futures<sup>9</sup> for light, sweet crude oil (a good indicator of investors' current opinions about likely future prices) were trading at about \$140 a barrel for December 2016, the furthest distant future available. The market for oil futures for the period August 2008 to December 2016 never drops below \$140 a barrel<sup>10</sup>. The March 11, 2008 issue of the International Energy Agency's *Oil Market Report* comments that, "We are in an era of higher oil prices, and so if we look at \$100/bbl oil we have to do so with an understanding that prices are unlikely to return to levels seen in the early part of this decade." DfT's assumption that oil prices will fall over time is strangely out of step with common predictions for oil prices; even in November 2007, when DfT (2007a) was published, current oil prices had already reached \$87 a barrel<sup>11</sup>. The higher the assumed fuel costs, the lower the generated user benefits. DfT's analysis shows that using a slightly higher 2030 oil price of just \$80 a barrel in its forecasts would lower demand by 15 million passengers a year (DfT 2007a: 42).

Projected fuel costs also depend on DfT's assumptions regarding fuel efficiency. In both recent DfT reports (2007a, 2007b) fuel efficiency depends on the types of airplanes that will arrive and depart Heathrow in the future, or the "fleet mix." The process of estimating overall fuel efficiency and its impact on airfare is complex and, perhaps for that reason, not entirely transparent in either report. In general, DfT assumes that aircraft will become more fuel efficient over time. The fleet mix is an area of controversy regarding the scope of airport operators' influence over the DfT's economic analysis of Heathrow expansion<sup>12</sup>.

Non-fuel costs are assumed to follow recent trends, with costs falling but at a rate that slows over time. In the DfT's (2007a: 18-19) methodology, non-fuel costs for short-haul and domestic flights fall 4-5 percent each year until 2010. The annual rate of decline is 2.4 percent from 2010 until 2015 and then 1.9 percent until 2020; after 2020, non-fuel costs remain constant. For longhaul flights, annual reductions in non-fuel costs are assumed to be 3 percent until 2010, then 1.6 percent until 2015, 1.1 percent until 2020,

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9 A "future" or "futures contract" is a financial instrument that obligates the buyer to purchase a given amount of a good on a given date in the future for a given price. If oil futures are trading at \$100 a barrel for a "delivery date" eight years from now, investors must believe with some confidence that oil will be trading for more than \$100 a barrel on when that date comes to pass.

10 From the New York Mercantile Exchange website, <http://www.nymex.com>.

11 U.S. Energy Information Administration, Short-Term Energy Outlook, "Refiner Average Acquisition Cost" for November 2007, <http://www.eia.doe.gov/oiaf/forecasting.html>, published April 8, 2008.

12 Marie Woolf and Jon Ungoed-Thomas (2008) "Evidence fix led to third runway being approved." The Sunday Times 9 March 2008.

and constant thereafter<sup>13</sup>. According to the DfT (2007a: 18), non-fuel costs for flights into and out of the UK have fallen 5 percent per year (adjusted for inflation) over the last five years in part because of the expansion of budget airlines. The scale of generated user benefits predicted from Heathrow expansion relies on the continuing decline of these costs. If the recent drop in non-fuel costs was a one-time change, resulting from the introduction of budget airlines, then those cost categories may not continue to decline – and generated user benefits will be reduced.

### **Benefits to foreign travelers are counted**

Another important concern with DfT's demand predictions regards the types of new passengers who will be generated as demand increases. A study of South East airport expansion commissioned by the GLA (Colin Buchanan and Partners 2006) argues that a large proportion of the increased demand will come from international passengers making transfers in UK airports (called "interliners") on their way to other international destinations. Currently, 30 percent of Heathrow passengers are just changing planes on their way to another destination<sup>14</sup>. These interliners are included in DfT's (2007a: 9) predictions of future demand, but it is difficult to see how increasing the number of international interliners adds to British welfare in any way except by increasing airlines' and airports' profits. Similarly, the GLA study points out that despite HM Treasury guidelines to the contrary, the DfT's accounting of benefits from airport expansion includes benefits to foreign tourists and business travelers<sup>15</sup>.

### **Doing nothing is taken as the baseline**

Consumer surplus is completely scenario-dependent. In an analysis with the wrong scenario assumptions, the generated user benefits will be wrong as well. In particular, if an alternative such as Heathrow expansion is not compared to the next best alternative, its benefits will be exaggerated. (In the extreme, if the only alternatives are "my new policy" or economic collapse, almost any policy looks good. But those are not usually the only alternatives.) DfT's (2007a, 2007b) economic analyses give us the necessary criterion for making a decision about Heathrow expansion, but only in a very circumscribed sense. The costs and benefits of Heathrow expansion are, implicitly, compared to the status quo. The projected £9 billion in generated user benefits are the difference between this category of benefits without Heathrow expansion and the corresponding category with Heathrow expansion. Even if it is the case that net benefits can be gained by expanding Heathrow rather than doing nothing, it does not follow that expansion is the best possible plan for the British people. Any decision regarding airport expansion should be based on a comparison to other attractive alternatives, not to inaction.

One alternative is airport expansion elsewhere in the South East. Other airports may have fewer people living in proximity who would be displaced or who would suffer from greater noise and air pollution in the event of an expansion. DfT's (2007a) forecasts of suppressed demand for each of the South East airports is based in part on the current availability and speed of ground transportation, public and private. Better rail connections to other South East airports could reduce Heathrow's desirability in comparison (Boon et al. 2008).

A systematic implementation of institutional measures to make the most of existing airport capacity is another viable alternative to Heathrow expansion. Limiting the number of short-haul flights and international to international transfer (switching planes) and transit (remaining on the same plane) passengers would free up space for more passengers who are coming to, or going from, the UK but cannot get to their destination by train. These limits could be implemented by setting quotas on the number of short-haul and international to international flights, or by increasing charges on these flights. A system of charges that gave preference to larger planes and higher load factors (the share of occupied seats on a plane) would have a similar effect (Boon et al. 2008; Colin Buchanan and Partners 2006). The much-discussed alternative

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<sup>13</sup> These are reductions in real costs, adjusted for inflation.

<sup>14</sup> According to DfT (2007a: 113), out of a total 68 million Heathrow passengers in 2005, 20 million were international to international interliners.

<sup>15</sup> Colin Buchanan and Partners (2006) critique refers to DfT (2003) White Paper, *The Future of Air Transport*, but DfT (2007a: 9) also includes benefits to foreign tourists and business travelers. According to the GLA study, removing benefits to non-UK residents reduces the total benefits estimated in DfT (2003) by 25 percent.

of a “green tax shift” – such as an increase in taxes on carbon, offset by a decrease in taxes on wages and salaries – could have a similar effect, reducing demand for aviation and thus postponing or eliminating the need for airport expansion.

A better rail system – within the UK, and connecting the UK to Paris and Amsterdam, and from there to the rest of the EU – is another alternative worth comparing to airport expansion. Trains emit far less carbon dioxide per passenger than planes, and as the British rail fleet continues to retire older train models (and especially diesel engines) and reform its electricity generation mix (away from coal-fired generation) trains will pull ahead of planes in terms of their contribution to local air quality as well. Nineteen percent of Heathrow passengers are taking short-haul flights to locations that are already serviced by trains (Watkiss et al. 2001; Greengauge21 2006; DfT 2007e). Recent improvements in videoconferencing technology may also reduce the demand for increased business flights (WWF 2008). Finally, another alternative to Heathrow expansion is a national preference for a cleaner environment and an insurance plan against the worst risks of climate change – even if it means flying less. An economic analysis of this alternative would need to set a value on the importance that the British public places on a clean environment, over and above the costs to those directly exposed to local pollution.

### Estimating Generated User Benefits: Summary

Many of the assumptions used to estimate the generated user benefits of Heathrow expansion – high future income elasticities for airfare, low fuel and non-fuel prices, high fuel efficiency, the inclusion of interliners and foreign travelers in generated user benefits, no additional investments in rail transit – tend to increase the projected benefits of airport expansion. Positive net benefits from airport expansion depend on large generated user benefits; it may be that these benefits are over-estimated, but there is no way to verify the accuracy of the predictions. Among these assumptions, only fuel costs, non-fuel costs, and fuel efficiency were subjected to sensitivity tests in DfT (2007a: 37-42). The sensitivity to the price of oil is particularly noteworthy: raising oil prices to just \$80 a barrel decreased demand by 3 percent, while lowering oil prices to \$25 a barrel increased demand by 4 percent. As of this writing, of course, the price of oil is far above \$80 a barrel; if such prices persist, the demand for air travel will be noticeably reduced. DfT’s sensitivity analyses examined changes to only one assumption at a time; in reality, changes could occur in multiple assumptions, causing even greater uncertainties. The interaction of multiple sensitivity analyses may be more than additive, and cannot be simply calculated from the singlefactor sensitivity analyses offered by DfT.

DfT’s projections of future benefits rely on the assumption that airfare will be cheaper and demand for air travel will be larger in the future. This approach seems a far cry from the DfT’s (2007d) rejection of ambitious “predict and provide” expansions of transportation infrastructure in favor of a setting strategic targets while keeping a primary goal of environmental sustainability, as discussed in *Towards a Sustainable Transport System: Supporting Economic Growth in a Low Carbon World*:

*The Government’s other aviation priority over the period to 2014 will be delivery of the sustainable framework for the development of airports capacity set out in 2003 in The Future of Air Transport White Paper. This rejects a ‘predict and provide’ approach and sets a 30- year strategy to address the global and local environmental challenges, whilst allowing some growth in capacity, particularly in the congested south east of England.(p.14)*

Proposal for Heathrow expansion are based not on current needs, but on future projected needs, and seem like the antithesis of the environmentally accountable policy published just a month earlier than DfT (2007a).

## OTHER BENEFITS ESTIMATED IN DFT’S ANALYSIS OF HEATHROW EXPANSION

Generated user benefits are the largest but not the only category of benefits from airport expansion estimated by DfT. This section sets out three other categories of benefits – benefits to government, to existing users, and to producers.

### Benefits to government

Government benefits from Heathrow expansion amount to £3 billion in both scenarios presented above in Table 1. The *Heathrow Consultation* (DfT 2007b: 144) explains that government benefits are: “Benefits from additional revenues from Air Passenger Duty (APD) resulting from increased numbers of air passengers

using the new capacity, where these arise from newly ‘induced’ demand.” The detailed explanation of methodology found in DfT (2007a: 123-124) shows the increase in tax revenues counting as a government benefit and the same amount counting as part of the cost of carbon (or, more accurately, as a disbenefit, since it is subtracted from total benefits, not added to total costs)<sup>16</sup>.

DfT assumes that tax revenue, or APD, generated by Heathrow expansion will offset carbon costs. DfT (2007a: 19) states that “revenues from Air Passenger Duty (APD) should count as part of the aviation industry’s contribution to meeting its climate change goals.” The DfT’s *Consultations on the Emissions Cost Assessment* (2007c: 23) explains this policy in detail:

*In common with other taxes, APD revenue is not hypothecated towards any particular spending commitment but provides resources for the Government’s priorities, including public transport and the environment. Nevertheless, because this tax is directly related to the activity that creates the emissions - passenger air travel – it can be interpreted as having a role to play in covering climate change costs and can also reduce the climate change impact of air travel through demand reduction. APD also plays a valuable role in ensuring that passengers understand and acknowledge the environmental costs of their actions. APD is of course not a perfect instrument for doing this because it does not correlate exactly with the climate change impacts of flying.*

To this end, the APD was doubled in February 2007 with the express goal of acting as an incentive to reduce the greenhouse gas emissions resulting from air transit<sup>17</sup>.

The higher the taxes on air transit, the higher the effective price faced by passengers. Increases to the APD act as a disincentive to flying; the revenue collected can also be viewed as offsetting the social cost of carbon emissions, especially if it were used to compensate those who suffer the costs of climate change, at home or abroad (instead of going into the general exchequer as is currently the case). There is, however, a missing piece of this puzzle that is not represented in the DfT’s model: The airline industry receives government subsidies, in the form of lower taxes than those paid by other industries. Just as taxes increase the effective price faced by passengers, subsidies decrease the effective price. Government subsidies – estimated at £9 billion per year in several reports<sup>18</sup> – act as an incentive to flying by lowering the price of tickets. APD revenues of £1 billion or £2 billion<sup>19</sup> would need to be increased by several-fold just to offset subsidies received by the airline industry, and even more to then act as a net disincentive to flying.

In short, the benefits to government identified by DfT are reasonable in the context of costbenefit analysis. However, this analysis omits the offsetting government subsidies to airports and airlines, which are a cost to government; in fact, these omitted costs are several times as large as DfT’s projected benefits.

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16 DfT (2007a) reports zero carbon disbenefits from adding the third runway, and a value less than £0.5 billion to be subtracted as a carbon disbenefit from the scenario that combines mixed mode operations, the removal of capacity limits, and the third runway. In contrast, DfT (2007b) reports £4.8 billion in carbon costs from a third runway and £5.0 billion from the full set of expansion measures. (The Heathrow Consultation reports both more costs and more benefits than DfT 2007a, but net benefits are identical for the two reports.) DfT’s (2007a: 123) explanation of methodology suggests that carbon costs will be greater than airport tax revenues, but the breakdown by benefit category suggests the opposite. If DfT has included a tax equal to the full cost of carbon, then the prediction that the increased capacity from adding a third runway will result in no additional emissions of carbon whatsoever is either an error or the manifestation of surprisingly optimistic assumptions regarding fuel efficiency. DfT (2007a: 6, 2007b: 138) take the full cost of carbon to be the DEFRA shadow price of carbon, £19/tCO<sub>2</sub> in 2000, increasing by 2 percent each year. The amount of carbon emitted by planes is multiplied by a radiative forcing multiple of 1.9 in DfT (2007a: 125) calculations.

17 Chapman, James (2006) “Brown doubles tax on flights in effort to combat global warming.” Daily Mail 4 December 2006; Chesshyre, Tom (2007) “Don’t take any chances.” The Times (London) 27 January 2007.

18 See Sewill (2003, 2005), and Friends of the Earth press release, “UK taxpayers ‘subsidise’ airlines by 300 each every year,” 13 March 2006.

19 See Sewill (2003, 2005). APD revenues were £1 billion each year before the February 2007 doubling in rates.

**Box 2: An Economic Analysis of Taxes and Subsidies**

In the DfT's (2007a: 123) model of the market for flights, supply is not the simple, upward sloping line shown in section 2 above. Instead, the supply curve has a horizontal portion and a vertical portion, as shown in Figure 3 below. In the horizontal section of the supply curve, airlines' costs per passenger are the same regardless of the number of tickets that they sell. The 90-degree turn in the supply curve occurs when the sale of flights hits the constraint of limited airport capacity. Thereafter, the supply curve is vertical: no matter how high the price offered, airlines cannot sell more flights. In this model, a small tax or airport duty has no effect on the market price or the number of flights sold; its sole effect is to reduce producer surplus (the windfall gain to producers that can be observed above the supply curve but below the market price  $P^*$ ).

For a tax to have a disincentive effect on the number of flights purchased, it would have to be larger than the difference between the horizontal section of the supply curve and the market price (and therefore take away all of producer surplus and some consumer surplus). In Figure 4, potential passengers face price  $P^{2*}$  after the tax; only  $Q^{2*}$  number of passengers are willing to fly at that price. Note that the loss of all producer surplus is not the loss of all producer profits: the supply curve represents the producer's reservation price at each possible amount of goods that could be sold, and the reservation price includes the minimum amount of profit that the producer is willing to accept.

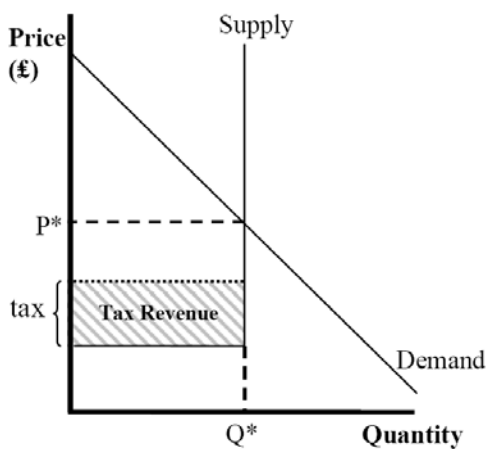


Figure 3: Tax Shown in DfT (2007a)

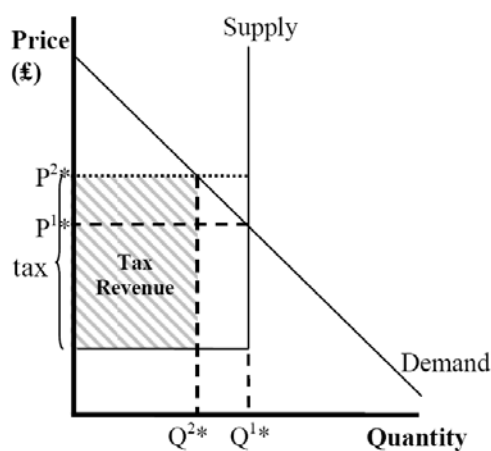


Figure 4: Tax with Disincentive Effect

**Benefits to Existing Users**

DfT (2007a) forecasts two additional, smaller categories of user benefits from Heathrow expansion: one is called “user benefits” and the other “existing user benefits” (see Table 1 above). DfT (2007a) estimates no user benefits from the addition of a third runway, but £2 billion in user benefits from the scenario that includes mixed mode operations and lowering Heathrow's capacity limits. User benefits are the reduction in costs to existing passengers that comes from more frequent flights, but neither of DfT's (2007a, 2007b) recent reports give a clear accounting of the method of estimating these benefits<sup>20</sup>. It should be noted that user benefits are not the extra consumer surplus that existing passengers receive from lower airfare. DfT (2007a: 124) explains that lower prices are a gain in existing users' consumer surplus but a loss to producers' surplus; these two effects cancel one another out and, therefore, are left out of total benefits and total costs (see the box below on transfers from producer to consumer surplus for a fuller explanation).

Existing user benefits were positive, but less than £0.5 billion for both scenarios (see Table 1). If more flights are added to the same destinations, existing users of air transport would benefit from a reduction of delays<sup>21</sup>. Curiously, DfT's (2007a: 126-127) method for estimating these benefits relies on the assumption that passengers with flexible tickets arrive at the airport at random times and board the next flight to their destination. By this logic, flexible ticket holders wait one-half the average time between flights. Existing user benefits are estimated by assigning a money value per hour to reductions in waiting time (or reductions in one-half the average time between flights to the same destination). These benefits accrue only to the 16

20 See DfT (2007a) p.73 and p.124 for definitions of user benefits.

21 See DfT (2007a) p.73-74 for a definition of existing user benefits.

percent of business travelers and 8 percent of leisure passengers who hold flexible tickets.

The value of time assigned to reductions in waiting time is not made explicit in either of the most recent DfT reports (2007a, 2007b). In a GLA-commissioned critique of the DfT's 2003 *Future of Air Transport* White Paper, Colin Buchanan and Partners' (2006) tracked down the DfT's value of time assumptions in another, earlier report: £62 per hour for business travelers and one-half that value, £31 per hour, for leisure travelers<sup>22</sup>. According to the GLA report, DfT based these values on wages, which are high because 80 percent of business travelers were assumed to be high-level management.

The GLA report compares DfT's assumed value of time for air travel to DfT's own published guidance for setting a value of time in road and rail assessments: £22 per hour during work time, and £4 per hour for commuting<sup>23</sup>. Air transit assessments for the European Union use values of time for three categories of passengers: £32-43 per hour for business travelers; £19-22 per hour for "personal convenience" travelers; and £14-16 for tourism<sup>24</sup>. DfT's value of time for air transit is high in comparison to both its own guidance for road and rail transit, and to values used in EU assessments. The GLA report also raises the issue of whether or not time spent in air transit is necessarily wasted. For example, many business travelers work – on laptops or on the phone – while waiting for a plane.

### Producer Benefits

According to DfT (2007b, Annex B: 144), "Airport operators and associated businesses may enjoy increased profits from capacity expansion arising from new passengers using Heathrow." Both scenarios for Heathrow expansion shown in Table 1 result in £5 billion in producer benefits. These benefits are additions to producer surplus, or the windfall profit that producers get when the market price is more than the minimum necessary to persuade them to sell their good. Additions to producer surplus may result from the additional flights sold when airport capacity expands.

After generated user benefits, producer benefits are the largest share of total benefits from Heathrow expansion. An important criticism of economic analyses based on the size of net benefits is that corporate profits are weighed against social costs. If, for example, the social costs of a given project were £100 trillion, but the corporate profits generated were £101 trillion, positive net benefits of £1 trillion would indicate that this project was in the public interest. This should not be mistaken for any promise on the part of the corporation to offset social costs by means of direct compensation, charitable contributions, or private investments in public goods – no such promise is implied. In cost-benefit analysis only the size of net benefits matters; who receives the benefits and who suffers the costs is immaterial.

### DO GENERATED USER BENEFITS MATTER?

Consumer surplus and generated user benefits exist in the realm of theoretical economics: they may be measured in pounds, but they will never appear in a bank account or on a balance sheet. How real are these benefits? Are they something that can or should be balanced against more tangible costs like airport construction or damage from pollution?

#### Are generated user benefits real or theoretical?

Generated user benefits are as real as any other subjective measurement of human welfare (like the benefits to existing users that DfT counts as part of Heathrow expansion's total benefits – see Table 1 and the discussion in the previous section) *if and only if* the context out of which they are drawn actually comes to pass. If leisure travelers are as sensitive to changes in airfare as the DfT predicts, if the British have a virtually insatiable desire for leisure air travel, if oil prices plummet, if significant advances are made in airplane efficiency, and if non-fuel costs continue to fall over time *then* the predicted number of new

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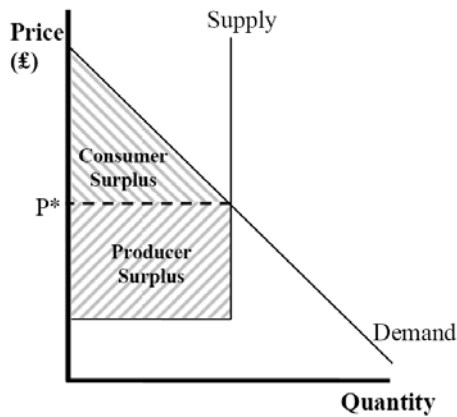
22 These values date from 1999, from a Halcrow report commissioned by DfT, and are assumed to grow with the value of real per capita GDP.

23 From DfT's Transport Analysis Guidance Website (webTAG).

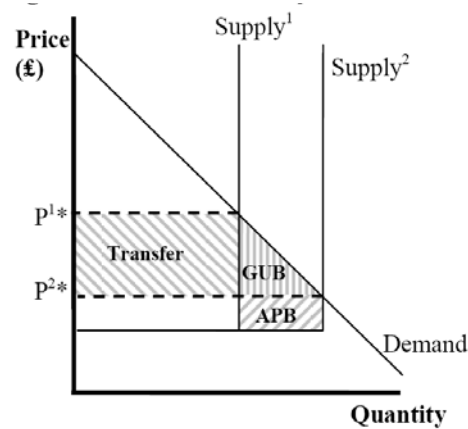
24 From the European Organization for the Safety of Air Navigation (EUROCONTROL), as cited in Colin Buchanan and Partners (2006) in 2005 euros. Converted to British pounds using the 6/1/05 exchange rate of 0.67760; "Historical Currency Exchange Rates," <http://www.oanda.com>.

**Box 3: Transfers from Producer to Consumer Surplus**

Consider the same model of the market for flights introduced in Box 2, and used in Figures 3 and 4 above. The supply curve has a horizontal section before capacity is reached, and a vertical section when the sale of flights hits the constraint of limited airport capacity. In this model, airport expansion implies a transfer from producer to consumer surplus, as illustrated in Figures 5 and 6.



**Figure 5: Constrained Supply**



**Figure 6: Transfer of Surplus**

When airport capacity is expanded, supply shifts to the right, but there is still a vertical portion of the supply curve representing the new, larger capacity limit of the airports. With a larger possible supply of flights, demand now meets supply at a lower price. Part of what used to be the producer surplus (between the old market price  $P^{1*}$  and the new market price  $P^{2*}$  – this area is labeled “transfer” in Figure 6) is now part of consumer surplus. There is also a new addition to consumer surplus – below the demand curve, over the market price  $P^{2*}$ , and between the old and new supply curves – the generated user benefits (GUB), and a new addition to producer surplus – above the supply curve, below the market price, and between the old and new supply curves – the added producer benefits (APB). DfT counts additions to both consumer and producer surplus towards the total benefits of airport expansion. Since increased supply results in a loss to producer surplus but a gain of equal size to consumer surplus, the transfer is simply left out of both costs and benefits. This practice has no effect on net benefits, but does increase the size of the ratio of benefits to costs that DfT presents as evidence of how strongly benefits outweigh costs.

passengers will be generated, and these passengers will pay less for airfare than they would have been willing to pay. In short, the results of DfT’s economic analyses are scenario specific: The context of consumer surplus predictions is critical to these benefits’ eventual fulfillment.

In addition to the characteristics determining the demand for and price of flights, the scenario in which £9 billion of user benefits is generated also depends on implicit assumptions about the set of available alternatives to air travel. Price and income elasticities (the way that consumers react to changes in prices or changes in their income) are especially sensitive to the existence of alternatives.

In the case of air travel these alternatives may be different modes of transport: DfT’s projections assume no additions to the British rail system beyond those already planned. Demand for flights, however, is very much dependent on the price, speed, reliability and availability of rail. Public investment in the rail system would make travel by train cheaper, faster, more dependable and easier to access. Improvements to rail service might reduce demand for flights, thereby reducing predicted generated user benefits. Alternatives to leisure air travel can also take the form of spending money on other kinds of goods and services; many forms of consumption may serve as substitutes for a vacation. It is also possible that the British public might, on principle, wish to choose a cleaner environment as an alternative to cheaper and more abundant flights.

### Ethical Implications of Generated User Benefits

The inclusion of generated user benefits in DfT’s analysis also raises some ethical issues. Because DfT is using a cost-benefit analysis framework, benefits are considered net of costs. This means that generated user benefits are being weighed against real costs to real people – like damages from climate change, or air and noise pollution. The expansion of Heathrow airport will benefit two groups of people: air transit

passengers and investors in the aviation industry. DfT (2007a, 2007b) makes no attempt to quantify any broader effect on the British economy, and, indeed, any wider economic impacts would need to be compared to the same kinds of effects stemming from other uses of the same income. If Heathrow is not expanded, British consumers would spend their money on other goods and services, which would have their own ripple effects in the economy: creating jobs and increasing the overall amount of economic activity<sup>25</sup>. More flights purchased as a result of Heathrow expansion would no doubt create some jobs and benefit some British businesses, but so too would other uses of consumer spending.

Most British air passengers belong to the upper and middle classes. On average in the UK, people in social classes A, B and C1 (that is, the upper and middle classes) take four times as many flights each year as those in social classes C2, D and E (the working class and the poor). Only 11 percent of international leisure passengers come from the two poorest social classes; in comparison, 20 percent of domestic UK tourists come from social classes D and E. On budget airlines, 75 percent of passengers come from social classes A, B and C1 (Bishop and Grayling 2003: 64-65). Even if airfare were to fall dramatically, there is no reason to believe that other costs of vacation travel – hotels, restaurants, ground transportation, time off from work – would follow suit. It seems likely that most of the suppressed demand for air travel projected by the DfT comes from richer members of society. Business travelers also represent the richer segments of British society. Among business travelers, DfT assumes that the vast majority belongs to upper management and assigns a value of £62 per hour to their time.

The second group of beneficiaries from Heathrow expansion would be investors in the aviation industry – owners and stock-holders of airlines and airports, as well as investors in airport-based shops and restaurants. Like air passengers, aviation owners and stock-holders come from the richest social classes. It is difficult to see how Heathrow expansion would bring any benefits to the British working class and poor, except perhaps in generating more employment in runway construction, at airlines, and in airport shops. Of course, increased employment might be generated instead in other places and sectors if different investment decisions were made.

The expansion of Heathrow will generate additional carbon dioxide emissions, contributing to climate change worldwide. Beyond this global impact, however, the people who would bear the brunt of the costs of Heathrow expansion live in the communities closest to the airport. In Sipson – the proposed location for the third runway – just 5 percent of the population is classified as having higher managerial or professional occupations, compared to 9 percent for the larger local authority of Hillingdon – which includes Sipson and several other neighborhoods close to Heathrow – and 12 percent for London as a whole<sup>26</sup>. A large share of Sipson's population, 22 percent, perform jobs that are classified by the Census as routine or semi-routine – primarily manual labor. (For comparison, 38 percent of Kensington and Chelsea residents belong to social classes A and B – higher and intermediate managerial, administrative and professional workers. The same statistic is 24 percent for Heathrow's neighbors in Hillingdon.)

The residents of neighborhoods closest to Heathrow Airport do not own airlines or airports, or even significant stock holdings in the aviation industry. While no doubt some of Heathrow's closest neighbors fly for leisure, the majority do not. Very few of the people who would bear the greatest and most immediate social and environmental costs of Heathrow expansion stand to benefit from more frequent flights or bigger aviation profits. This simple fact is a clear illustration of the greatest weakness of decision making based on the size of a project's net benefits: costs and benefits will not be experienced by the same people, and there is little reason to hope that those who benefit will generously compensate those who suffer. In this context, balancing context-specific potential future generated user benefits against the real environmental and social costs of Heathrow expansion seem inequitable and difficult to justify as advances in the overall British welfare. These problems once again call into question the appropriateness of cost-benefit analysis as a tool for decision making, especially where costs and benefits are not likely to be experienced by the same people.

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25 The Colin Buchanan and Partners (2006) report for the GLA discusses this argument at length.

26 Office of National Statistics, "Neighborhood Statistics," from the 2001 Census. Sipson statistics are for the "lower layer super output area" Hillingdon 031B.



## CONCLUSIONS AND POLICY RECOMMENDATIONS

The expansion of Heathrow Airport is controversial. It involves costs that are irreversible: damage to health from noise and air pollution, destruction of homes and loss of community and higher emissions of the greenhouse gases that contribute to climate change. The evaluation tools used to sort out whether or not expansion is in the public interest have been flawed. Cheaper flights and airport profits are not a currency that can be exchanged for health, peace and quiet, or a better future climate. It is no wonder that communities nearby the airport or under its flight paths are up in arms<sup>27</sup>: whatever net benefits could be eked out of more flights to and from Heathrow will not line the pockets of those most affected by noise, air pollution, and the disruption of established communities.

The greatest share of these benefits is attributed to generated users, or new passengers attracted by lower airfare. DfT optimistically projects that with airport expansion many new passengers will be attracted to Heathrow by lower fares in quarter century after 2030 (when Heathrow would otherwise be at full capacity and facing rapidly increasing fares). The result of DfT's analysis – positive net benefits from Heathrow expansion – is highly dependent on these generated user benefits, which appear to be the least robust of DfT's estimated benefits: they rely on projections of the future demand for and price of flights, based on questionable assumptions. Moreover, these benefits are a theoretical construct, and cannot be directly observed; there is no empirical measurement that yields the size of the consumer surplus resulting from airport expansion (or any other policy). Yet this unmeasurable quantity is the linchpin of the whole analysis: Without generated user benefits, costs of Heathrow expansion would outweigh benefits by £3-5 billion.

It stands to reason that this sort of economic analysis is best performed by someone with no interest in its outcome, a neutral by-stander or a government agency interested only in the public good. We cannot expect perfect accuracy in forecasting future costs and benefits, or in assigning monetary values to priceless environmental goods, but we should expect that any errors that over-estimate the net benefits of airport expansion will be balanced out by errors that underestimate net benefits. If instead the researchers performing the analysis had, as it were, a horse in the race, an obvious concern would be that all errors would point in the same direction (e.g., more benefits, fewer costs) creating a bias in favor of airport expansion. The British public would have to be on guard for this kind of bias if, for example, the owners of Heathrow Airport had a hand in preparing the economic analysis of Heathrow expansion<sup>28</sup>.

Errors in DfT's economic analyses are to be expected: Any projection of future conditions relies on educated guesses. We can expect very little certainty from projections reaching 60 or 70 years into the future. The important question, then, is whether or not – in the light of recent revelations concerning its surprising communications with BAA during the preparation of the *Heathrow Consultation* – DfT has provided an impartial accounting of the costs and benefits of Heathrow expansion. Are the most apparent errors in favor of Heathrow expansion balanced out by errors in opposition to expansion?

Many of the problems with DfT's methodology discussed in this report result in obvious biases affecting the resultant projected net benefits. This report cannot claim to provide a comprehensive critique of DfT (2007a, 2007b), nor are the authors of this report clairvoyant: we cannot predict the events or conditions of the next 70 years. That being said, nearly all of the problems discussed here bias net benefits in the same direction – in favor of airport expansion<sup>29</sup>. Benefits of expansion are over-estimated by high future income elasticities for airfare, the inclusion of interliners and foreign travelers in generated user benefits, low fuel

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27 See Byers, David and agencies (2008) "Greenpeace protesters arrested over major Heathrow security breach." Times Online 25 February 2008; Robertson, David (2008) "Tempus: Terminal decline." Times Online 27 February 2008; Webster, Ben (2007) "Heathrow is defeated in its attempt to ban environmental campaigners." Times Online 7 August 2007.

28 On the allegations that DfT collaborated with BAA, the owner of Heathrow Airport, in preparing the *Heathrow Consultation* see: Marie Woolf and Jon Ungoed-Thomas (2008) "Evidence fix led to third runway being approved." The Sunday Times 9 March 2008; Jon Ungoed-Thomas (2008) "Labour's flying club lobbies for BAA." The Sunday Times 16 March 2008; Gilligan, Andrew (2008) "BAA 'rigged figures' to hide airport delays: A crisis looms on the ground and in the air." The Sunday Times 24 February 2008.

29 The sole exception is the assumption that businesses do not react to falling airfare by buying more flights.

and non-fuel prices, high fuel efficiency, the assumption of no additional investments in rail transit, and high values assigned to passengers' waiting time. Net benefits are then placed in the most advantageous possible light by comparing them to the status quo, rather than to alternatives like better use of existing capacity or investment in the British rail system.

It is the recommendation of this report that the positive and negative effects of Heathrow expansion, and of several alternatives to airport expansion, be reexamined by disinterested researchers, well-insulated from parties with strong interests for or against expansion. This new analysis should take special care to include costs and benefits that are difficult to monetize, and should present results in a way that highlights the distribution of costs and benefits across the British public. Considering the size of the project and the irreversibility of its consequences, a full and accurate accounting of impacts is essential before any decision-making process can go forward.

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