managing aviation passenger demand with a frequent flyer levy

fellow travellers

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contents

abstract

This paper considers the feasibility of managing aviation passenger demand through a reformed taxation regime for flights. Specifically, it is supposed that Air Passenger Duty (APD) be repealed and replaced by a Frequent Flyer Levy (FFL), which would vary depending on the number of previous flights taken by an individual.

The research question is what such a tax regime should look like in order to achieve four goals: (i) prevent passenger demand from increasing more than 60% by 2050, as recommended by the Committee on Climate Change; (ii) be revenue neutral to the exchequer; (iii) obviate the need for new runway capacity; and (iv) reduce greenhouse gas emissions in line with a low probability of › 2°C warming.

The potential impact on businesses is also considered. It is found that a progressive tax on frequent flying could play a significant role in restraining demand for flights, while at the same time tending to distribute those flights more equally across the income spectrum.

introduction and motivation

Greenhouse gas emissions from aviation comprised 6% of the UK's total in 2011.[1] And demand for flights is expected to continue soaring, possibly increasing by 127% (i.e. more than doubling) between 2010 and 2050,[2] thus dramatically increasing the associated environmental damage. Consumer surveys also indicate that most people plan to fly as much or more in the future.[3]

However, while the cost of this environmental damage will be spread across the global population it is only a relatively small proportion of UK society that makes frequent use of air travel. It is estimated that only 15% of the population takes 70% of the flights,[4] while 55% of the population took no flights abroad whatsoever in 2013.[5] Even in terms of the global community, UK citizens are responsible for a disproportionate level of aviation emissions – per capita emissions from air travel are much higher in the UK than anywhere else in the world, and twice as high as in the USA.[6]

Unlike many other sectors, aviation is not expected to make absolute reductions in its emissions between now and 2050. The sector's allocation of the total UK carbon budget is expected to increase from 6% in 2011 to 25% in 2050.[7] A whole quarter of our limited allowance to emit greenhouse gases will be devoted to aviation. This situation is peculiar, therefore, in that a small number of beneficiaries are causing a substantial degree of environmental damage and yet not being asked to reduce that damage in absolute terms. This can be contrasted with, for example, the energy sector, whose beneficiaries are extremely diffuse (indeed, they are everyone) and will be required to undergo significant changes in the coming decades.

Despite this rather extreme situation, discussion of the potential to limit aviation emissions has focused on

only **15%** of the population takes **70%** of the flights increasing fuel efficiency, adopting lower-carbon biofuels and marginal technological substitutes such as better teleconferencing capabilities. There has been little to no discussion of options for actively restraining the number of flights. For example, the interim report of the Davies Commission[8] is quite clear that emissions from aviation will need to reduce and discusses a number of options for doing so, including greater fuel efficiency. Yet, despite this substantial discussion, the possibility that the number of flights might simply have to fall is not explicitly considered. We are failing to have an important debate.

In particular, this paper considers an option that is not currently on the table: fiscal policy. The aviation sector is particularly privileged in this regard – it is exempt from fuel duty and zero-rated for VAT. It has been argued that such treatment represents a significant public subsidy, putting other forms of transport at a competitive disadvantage.[9] In terms of absolute numbers, DfT's aviation forecasts show that the expected growth in flights by 2050 will come largely from short-haul rather than long-haul flights (a ratio of roughly 4:1) – these are exactly the flights for which alternative forms of transport, such as rail, are most feasible.

This paper considers the potential for a fiscal reform that aims to reduce the environmental impact of flights from the UK by reducing their total number while incentivising a more equitable distribution of those flights across the income spectrum. Specifically, it is hypothesised that Air Passenger Duty is repealed and replaced with a Frequent Flyer Levy that is zero for an individual's first outbound flight in each year and increases continually for each subsequent outbound flight. The research question is what such a tax regime should look like in order to achieve four goals:

i

Prevent passenger demand from increasing more than **60% by 2050**, as recommended by the **Committee on Climate Change**.

ii

Be revenue neutral to the exchequer

iii

Obviate the need for new runway capacity

iv

Reduce greenhouse gas emissions in line with a low probability of > 2°C warming.

The administrative practicalities of this reform are not considered at this stage.

data and modelling methodology

Data

The National Travel Survey dataset was downloaded from the UK Data Service for the years 2002-2010. This is an enormous data set with entries for nearly 200,000 individuals including their household income quintile, although most of the information relates to domestic journeys conducted by personal transport and terrestrial public transport, rather than aviation.

Two survey questions are of relevance. One question asks how frequently the respondent takes a domestic flight and a second asks how many times the respondent has taken an international flight out of the UK in the last 12 months. As such, the format of these questions is different. International flight survey responses are available for 2006-2008 only. In both cases, the respondent must answer by choosing a category, rather than giving an absolute number – e.g. someone might answer "12-53" when the true value is 37. This means that the average number of flights taken by each income group cannot be calculated as a precise value without some modifications. An imprecise fix is to convert the response category variables into a numerical variable by assuming an absolute value for each category. For the most part this is simple because the category only includes one number, but for the higher range of responses it is necessary to make a conversion, e.g. for international flights: "7-12" becomes 9.5; "13-52" becomes 33; and "53+" becomes 53. Choosing the mid-point of the range seems to be the least arbitrary option, although it might be expected that the true value is skewed towards the lower end of each category. This potentially adds a substantial, but unavoidable, degree of error to the analysis. However, since the large majority of responses are within lower single-number categories, the effect may not be so important.

The data is weighted using the sampling weights "W3" as recommended by the dataset guidance for individual level analysis.

Using statistical software the mean number of domestic and international flights taken by each income quintile per year is obtained. As expected there is a significant increase in flights taken along the income spectrum. Table 1 details these statistics.

table 1 - average number of flights taken by each income quintile
source: national travel survey

income quintile	average number int'l flights taken 2006-2008	average number domestic flights taken 2006-2008	total
Lowest real income	.45	.79	1.24
Second level	.60	.89	1.50
Third level	.85	1.05	1.90
Fourth level	1.20	1.27	2.47
Highest real income	2.55	2.10	4.65

NB these figures may not sum exactly due to rounding

Scaling these figures by the UK population in 2010 gives a total value of 148 mppa. This is very close to the actual figure for 2010 of 142 mppa (which is the sum of total UK domestic leisure and business, UK international leisure and UK international business), as reported by the Department for Transport.[10]

Modelling methodology

A standard approach to modelling the demand response of a change in fiscal policy is to multiply the percentage change in unit price caused by the change by the estimated price elasticity of demand. In this case such a simple approach is not possible since there is no single percentage change in unit price: the percentage change depends on how many flights have already been taken (i.e. the price of your 5th flight will increase much more than the price of your 3rd flight).

An alternative approach is necessary.

The approach taken breaks the demand for flights into a matrix of flight ranking by household income quintile, as illustrated in Table 2 for the base period of 2010.[11] This matrix illustrates, for example, that all income groups take at least one flight (domestic and international) on average and the average person in the lowest income group takes 0.24 of a second flight. This breakdown allows demand responses to be estimated for 1st, 2nd, 3rd, etc., flights individually (since the price change is different for each) at each income group.

table 2 - flight matrix for base period
2010

flight rank	1st	2nd	3rd	4th	5th	6th	Total
Lowest real income	1.00	0.24	0.00	0.00	0.00	0.00	1.24
Second level	1.00	0.50	0.00	0.00	0.00	0.00	1.50
Third level	1.00	0.90	0.00	0.00	0.00	0.00	1.90
Fourth level	1.00	1.00	0.47	0.00	0.00	0.00	2.47
Highest real income	1.00	1.00	1.00	1.00	0.65	0.00	4.65

The average cost of a flight fare is obtained from DfT's aviation forecasts.[12] This provides an average cost per flight (across international and domestic passengers) between 2008 and 2050, split by cost component, including Air Passenger Duty. No estimates were found for the average cost per flight at each income quintile (one would expect the lower quintiles to purchase cheaper flights on average). As such, the same average cost per flight is assumed for each income quintile – the sensitivity of the results to this assumption is tested below.

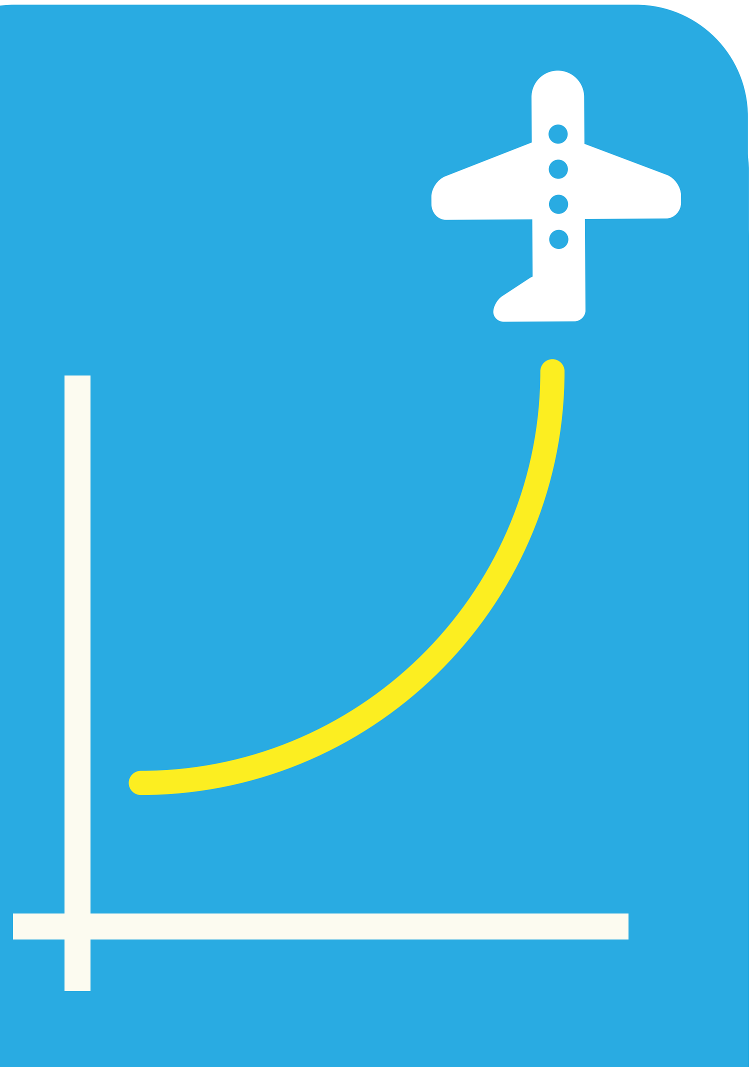
Since the price elasticity of demand might be expected to vary depending on both flight ranking and household income quintile, an elasticity matrix corresponding to the above flight matrix is assumed, illustrated in Table 3. DfT employs an overall price elasticity of demand of -0.6 for flights (an average across UK and foreign, business and leisure flights)[13] and this is placed in the matrix under the second flight at the third income level, highlighted below (based on the fact that the average income is contained in the third quintile and the average number of flights taken is between 1 and 2). -0.6 is also the value recommended in a study commissioned by IATA (an aviation industry group) for pan-national level changes (that is, when a 'set of routes (e.g., across a continent) experience an identical price change') such as the one hypothesised in this paper.[14] It is further assumed that elasticity is greater (further from zero) as flight ranking increases and as household income decreases, as illustrated below. These are somewhat arbitrary and the sensitivity of the results to these assumptions is tested below. The maximum range of elasticities is between -0.49 and -0.77 (the latter is for 9th flights taken by the lowest real income group).

After inputting a tax rate for each flight rank and calculating the resultant price per flight, a new matrix of percentage changes in price per flight is obtained, which can be multiplied by the elasticity matrix and used to obtain a new flight matrix. Comparing the original flight matrix with this new matrix gives the total expected change in demand for flights under a certain tax regime.

table 3 - matrix of price elasticities of demand

flight rank	1st	2nd	3rd	4th	5th	6th
Lowest real income	-0.69	-0.7	-0.71	-0.72	-0.73	-0.74
Second level	-0.64	-0.65	-0.66	-0.67	-0.68	-0.69
Third level	-0.59	-0.6	-0.61	-0.62	-0.63	-0.64
Fourth level	-0.54	-0.55	-0.56	-0.57	-0.58	-0.59
Highest real income	-0.49	-0.5	-0.51	-0.52	-0.53	-0.54

This procedure is repeated at four time periods – 2020, 2030, 2040 and 2050 – using DfT forecasts as a counterfactual in each case (i.e. the original flight matrix in each period is based on the forecasted growth in total flights from DfT aviation forecasts). For later periods the matrix is extended beyond the 6th degree (to a maximum of 9 flights) to accommodate the expected increase in flights person at the highest income quintile. Since these results are expressed in terms of changes in flight frequency per person, it is necessary to adjust for expected population growth (based on ONS forecasts)[15]. The counterfactual scenario from DfT already accounts for this impact.



results

(i) Preventing passenger demand from increasing more than 60% by 2050

The Committee on Climate Change has estimated that 'there is potential for aviation demand to increase while still meeting the Government's target [for reducing carbon emissions by 2050] – in the most likely scenario, a 60% increase in demand is allowed.'[16] It should be noted that this scenario makes assumptions regarding improvements in fuel efficiency, use of biofuels, carbon pricing, and increased use of videoconferencing and other forms of transport. Importantly, this allowable 60% increase in demand is relative to a 2005 base year. In the results that follow a 60% demand increase had been allowed from a base year of 2010, since this is the base year of the DfT forecasts used. Consequently, the results estimated correspond to some unknown figure slightly greater than 60% increase between 2005 and 2050.

Using the above methodology, the tax schedule in Table 4 and Figure 1 results in an increase in passenger demand between 2010 and 2050 of 60.4%. It is assumed that all tax rates increase by 5% each decade.[17] Clearly, there are a multitude of tax rate combinations that would result in such a total increase – this is but one example.

table 4 - tax schedule for scenario (i) in base period

flight rank	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Tax rate	£0	£20	£60	£135	£210	£270	£330	£380	£420

figure 1 - tax schedule for scenario (i) in base period

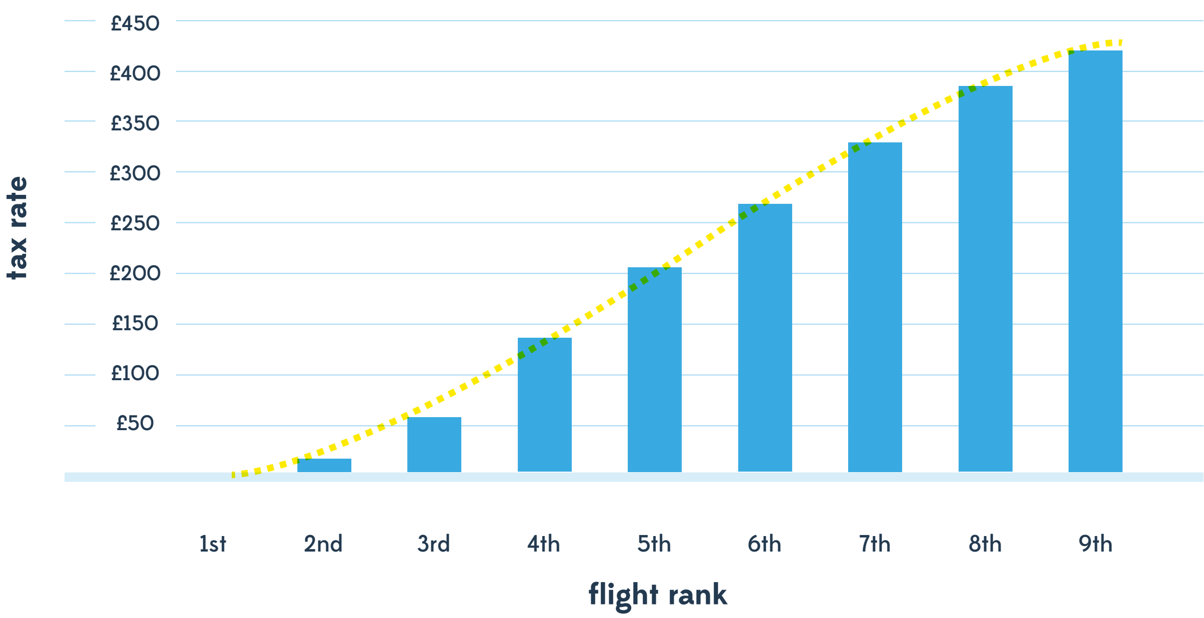
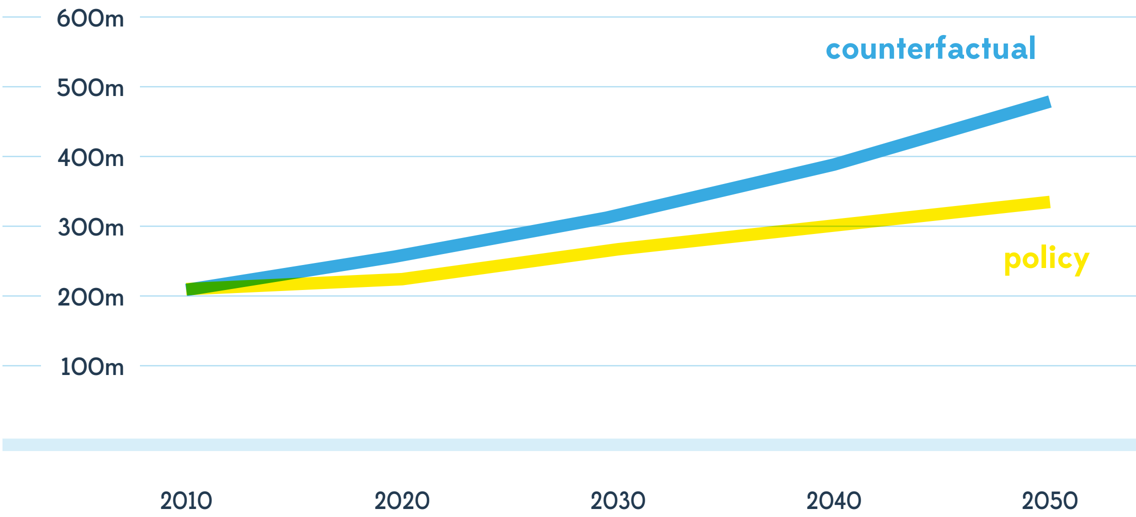


table 5 - total passenger volume for scenario (i)

total passengers (mppa)	**2010**	**2020**	**2030**	**2040**	**2050**
Counterfactual scenario	211	259	320	391	482
Policy scenario	211	230	268	306	338

Table 5 and Figure 2 illustrate the evolution of demand over time under this scenario. The counterfactual scenario is taken directly from DfT's unconstrained aviation forecasts and the policy scenario is calculated as described in the methodology section above.

figure 2 - total passenger volume for scenario (i)



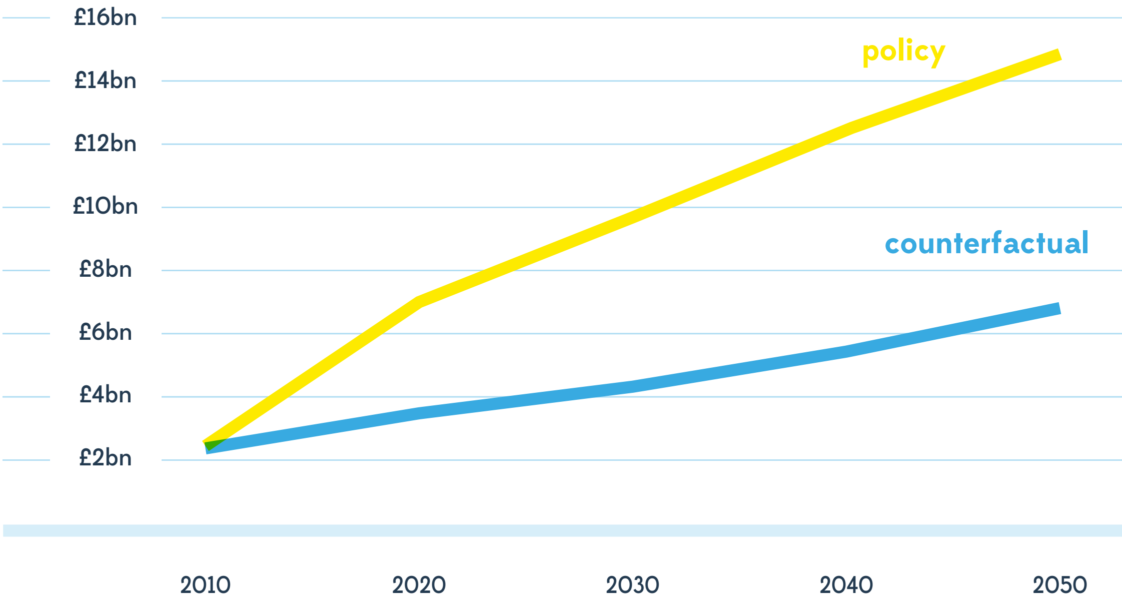
The policy scenario exhibits a 60.4% increase between 2010 and 2050, while the counterfactual scenario exhibits a 129.0% increase over the same period. Demand in the policy scenario is 30% lower in 2050 compared to the counterfactual.

Under this scenario, revenues to the exchequer are significantly greater in the policy scenario compared to the counterfactual, as illustrated in Table 6 and Figure 3.

table 6 - tax revenue for scenario (i)

tax revenue (millions)	**2010**	**2020**	**2030**	**2040**	**2050**
Counterfactual scenario	£2,280	£3,480	£4,347	£5,430	£6,890
Policy scenario	£2,280	£7,098	£9,703	£12,467	£14,955

figure 3 - tax revenue for scenario (i)



Tax rates have been specified up to the ninth flight. This is because the greatest average number of flights is 8.42 for the highest income group in 2050 under the counterfactual scenario. However, there will clearly be some number of individuals that take a tenth flight or more. Since the number of people at each flight frequency decreases as frequency increases (i.e. there are far fewer people taking 20 flights than 5 flights), the coverage of tax rates decreases beyond the ninth flight and therefore those rates become comparatively unimportant, though not necessarily negligible, for affecting behaviour. In principle, consistency would require that the tax rate continue to escalate with flight rank; however, a tax rate cannot be individually specified for all possible numbers of flights – there will need to be a limit beyond which the tax rate remains constant or increases at some automatically calculated rate (for example, each additional flight beyond the tenth is charged an additional fee of £50). The most appropriate limit is a practical question that the current data is not suited to answer.

(ii) Revenue neutrality to the exchequer

As demonstrated above, the tax schedule required to reduce passenger demand in line with CCC recommendations potentially creates large additional revenues to the exchequer. A question that follows is: how could a tax regime be designed so as to manage aviation demand while taking broadly the same level of revenue?

Using the above methodology, the tax schedule illustrated in Table 7 and Figure 4 results in a roughly neutral impact on exchequer revenues. It is assumed that all tax rates increase by 5% each decade.

table 7 - tax schedule for scenario (ii) in the base year

flight rank	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Tax rate	£0	£5	£15	£25	£35	£40	£45	£50	£55

figure 4 - tax schedule for scenario (ii) in the base year.

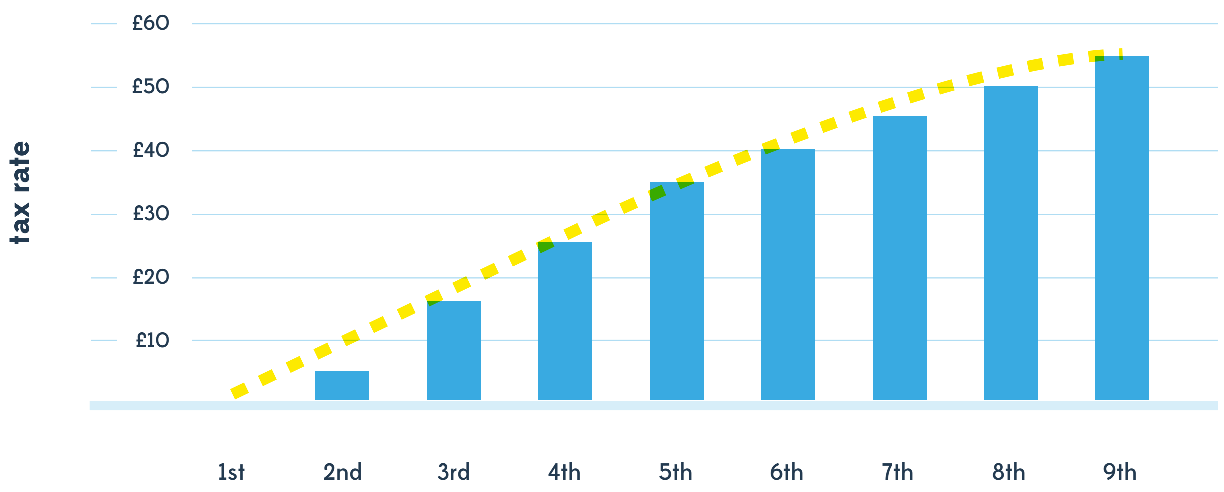


Table 8 illustrates the evolution of demand over time under this scenario. Again, the counterfactual scenario is taken directly from DfT's unconstrained aviation forecasts and the policy scenario is calculated as described in the methodology section above.

table 8 - total passenger volume for scenario (ii)

total passengers (mppa)	**2010**	**2020**	**2030**	**2040**	**2050**
Counterfactual scenario	211	259	320	391	482
Policy scenario	211	262	321	389	474

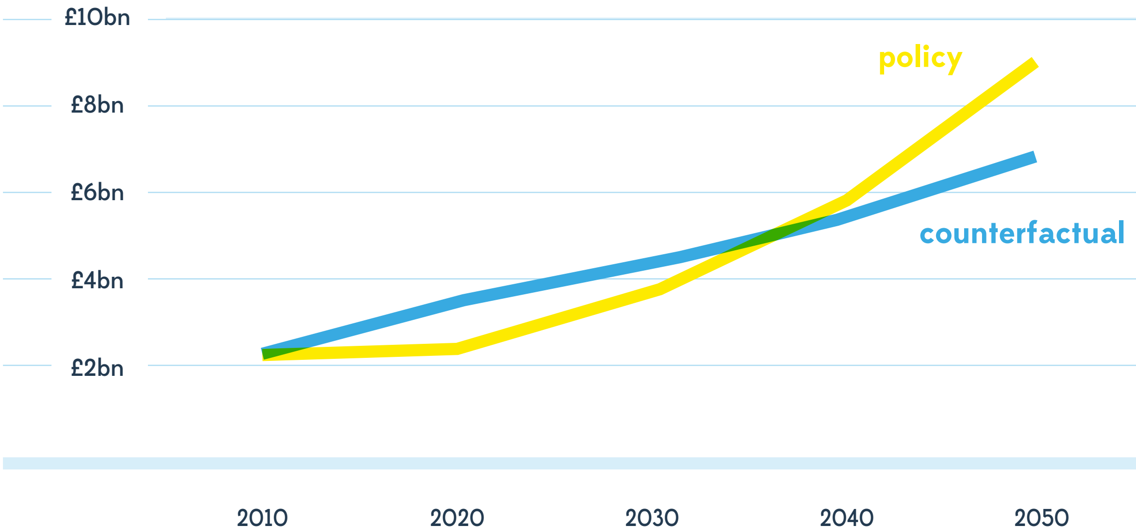
While this tax schedule still achieves a redistribution of flights down the income spectrum, it has a much weaker impact on total demand compared to scenario (i). The policy scenario exhibits a 124.9% increase between 2010 and 2050, while the counterfactual scenario exhibits a 129.0% increase over the same period. Demand in the policy scenario is 2% lower in 2050 compared to the counterfactual.

Under this scenario, revenues to the exchequer are similar in both scenarios over the full time period (though they differ somewhat in any single period), as illustrated in Table 9 and Figure 5.

table 9 - tax revenue for scenario (ii)

tax revenue (millions)	**2010**	**2020**	**2030**	**2040**	**2050**
Counterfactual scenario	£2,280	£3,480	£4,347	£5,430	£6,890
Policy scenario	£2,280	£2,389	£3,765	£5,757	£8,967

figure 5 - tax revenue for scenario (ii)



It should be noted that there are other ways of making this policy revenue neutral without changing the rate schedule, for example, some other tax could be reduced by an equivalent amount, or the revenues could be hypothecated towards making low-carbon transport more affordable by reducing the tax rates applied to them.

(iii) Obviating the need for new runway capacity

Under DfT's "constrained" aviation forecasts it is assumed that:

- 'no new runways are built in the UK;
- schemes already in the planning system and airport masterplans implemented by 2020;
- incremental growth to full potential long-term capacity by 2030 taking account of the airports' own longer term plans, physical site constraints and up 13% capacity gain (where possible) through operational and technological improvement;
- terminal capacity increased incrementally to service additional runway capacity; and
- no changes after 2030.'[18]

The resulting forecast is that passenger numbers will reach 445 mppa in 2050. It is assumed, therefore, that constraining passenger numbers to such a level by some means other than physical constraints would potentially obviate the need for significant extra capacity.

As shown in Table 5 above, scenario (i) constrains passenger demand significantly below the level of 445 mppa and is therefore consistent with this third objective. Scenario (ii) is not.

Using the above methodology, the tax schedule illustrated in Table 10 and Figure 6 is consistent with keeping passenger demand just below the level forecasted in DfT's "constrained" scenario. It is assumed that all tax rates increase by 5% each decade.

table 10 - tax schedule for scenario (iii) in the base year

flight rank	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Tax rate	£0	£10	£30	£50	£70	£90	£110	£130	£150

figure 6 - tax schedule for scenario (iii) in the base year.

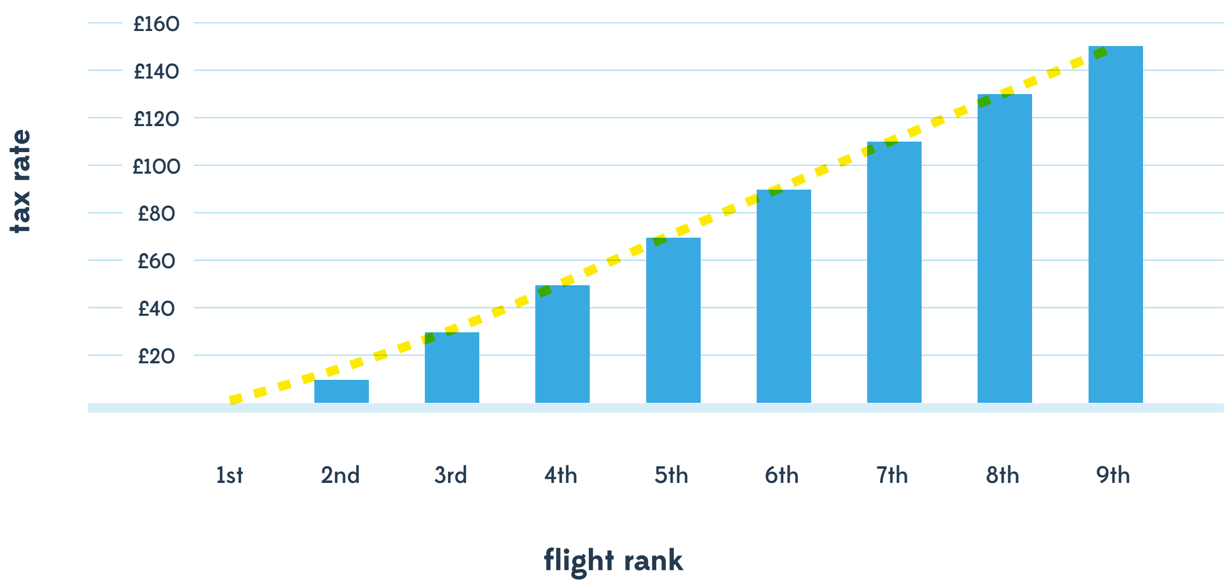
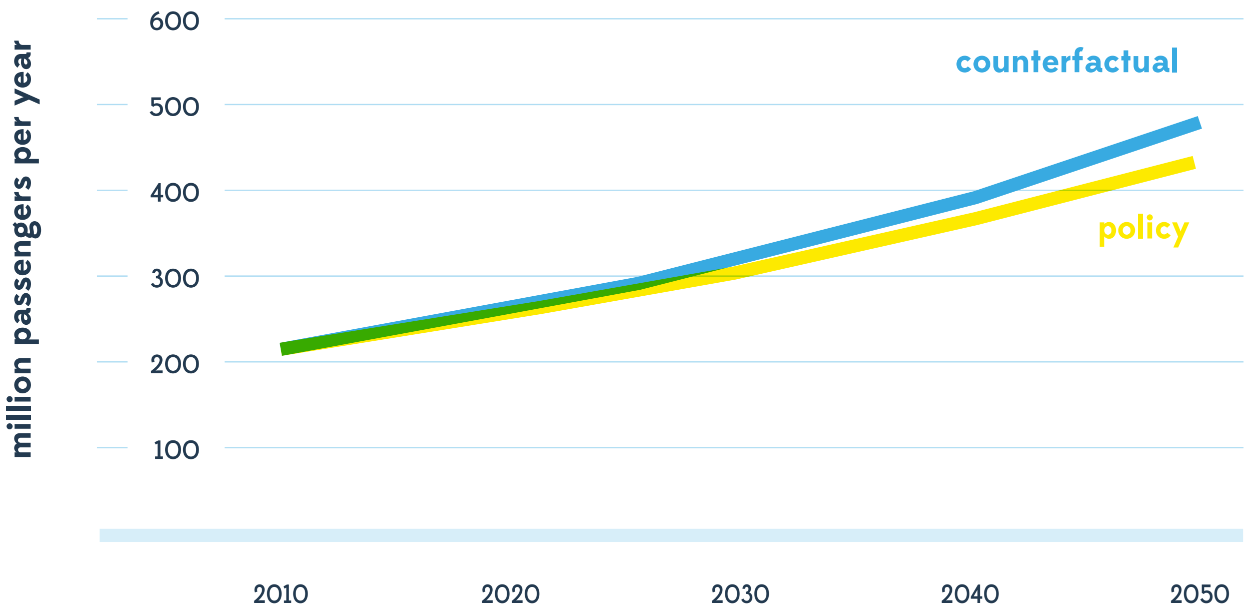


Table 11 and Figure 7 illustrate the evolution of demand over time under this scenario. The counterfactual scenario is taken directly from DfT's unconstrained aviation forecasts and the policy scenario is calculated as described in the methodology section above.

table 11 - total passenger volume for scenario (iii)

total passengers (mppa)	**2010**	**2020**	**2030**	**2040**	**2050**
Counterfactual scenario	211	259	320	391	482
Policy scenario	211	254	308	368	435

figure 7 - total passenger volume for scenario (iii)



The policy scenario exhibits a 106.8% increase between 2010 and 2050, while the counterfactual scenario exhibits a 129.0% increase over the same period. Demand in the policy scenario is 10% lower in 2050 compared to the counterfactual.

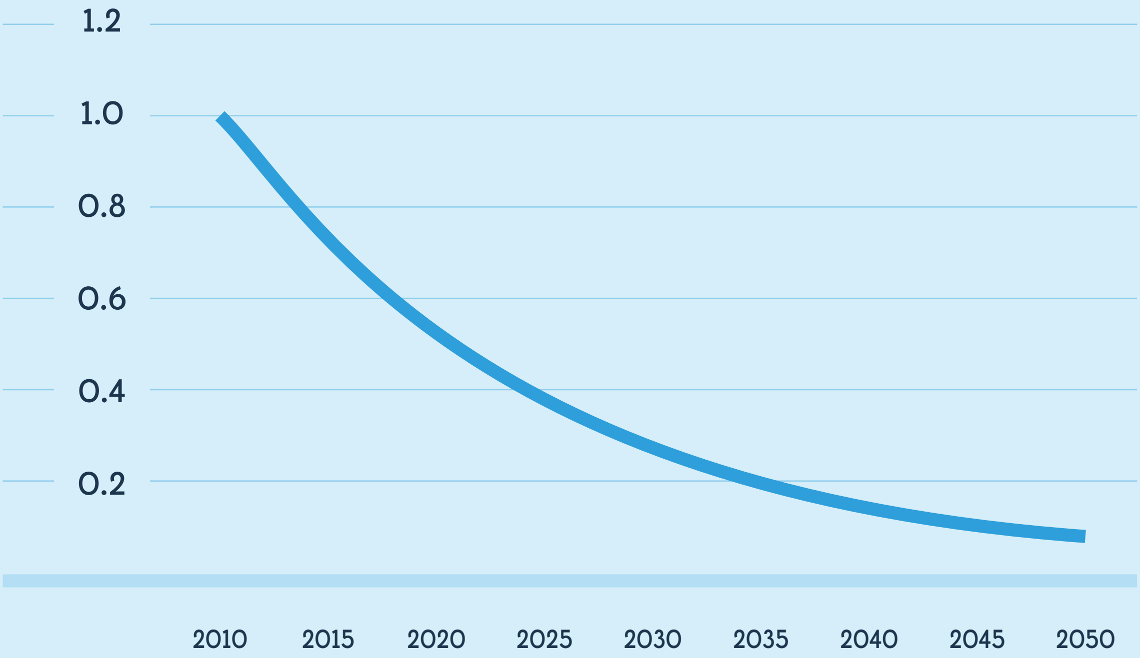
(iv) Reducing greenhouse gas emissions in line with a low probability of › 2°C warming

It has been argued that the UK's official target for reducing greenhouse gas emissions (80% in 2050 compared to 1990) is an insufficient contribution to achieving a reasonable likelihood of keeping temperature increases within +2°C, as committed to in the Copenhagen Accord. Anderson and Bows (2011)[19] illustrate this discord by modelling the necessary reductions in cumulative[20] emissions among Annex 1 countries (which includes the UK), given different pathways for non-Annex 1 countries. Their results imply that very rapid and immediate emissions reductions of 7-11% each year are necessary from Annex 1 countries to achieve an acceptable chance (approximately 37%) of not exceeding 2°C of warming.

This establishes a pathway of 7-11% annual reductions for the UK's total carbon budget. The allocation of that budget to the aviation industry must then be decided. Current forecasts would see aviation's allocation of the total carbon budget increase from around 6%[21] currently to 25% in 2050.[22] In part this reflects the relative lack of substitutes for aviation and aviation fuels[23] and in part it reflects special treatment of the aviation industry relative to others (which must pick up the slack by cutting emissions harder).

If the aviation industry were to take the same responsibility for emissions reductions as all other industries must (on average), this would imply an annual reduction in aviation emissions of 7-11%. Conservatively assuming only 7% annual reduction (implying greater reductions required in other sectors) and accounting for expected reductions in carbon intensity of 0.9% per year, as estimated by the CCC,[24] this implies the necessary pathway for total flight volume illustrated in Figure 8.

figure 8 - necessary flight volume pathway for 37% chance of < 2 degrees warming
(index, 2010=1.00)



In 2050 flight volumes would have to be 92% lower compared to 2010 under these assumptions. It seems clear that any single fiscal instrument such as the hypothesised Frequent Flyer Levy would be insufficient to effect such profound change – a much more radical approach would be necessary.

More broadly, this scenario clearly demonstrates the need for re-examining the adequacy of our existing targets and the degree to which we are willing to allow aviation to absorb a significant proportion of those targets.

Business Impacts

The proposed policy could potentially treat business flights in either of two ways.

Firstly, a system could be designed such that business flights face the same marginal rates of taxation as leisure flights. For example, a business might face a charge that depends on the ratio of total flights taken to total employees. The above results implicitly assume this scenario since the forecasts include both leisure and business flights and the calculations employ elasticities that account for the appropriate mix of business flights in the total. To get an idea of the demand response of business customers to this policy change, rather than the overall response, the average percentage change in flight costs for business customers is assumed to be between that for the lowest and highest income quintile, a range of +3% to +122% in 2050 in scenario (i).[25] Based on an elasticity of -0.2 for business passengers (as assumed by DfT) this implies a business demand response of between -0.5% and -24.5% in scenario (i). Intuitively, one might expect businesses that take very few flights per employee to benefit from this policy (since the first flight per employee becomes cheaper) and other businesses with a higher such ratio to reduce their demand. This impact is significantly less than the overall impact (-30% in 2050), as expected due to the lower elasticity.

A second option is to exempt businesses from the tax regime altogether, in which case the trajectory for business flights would remain slightly higher, as per DfT forecasts.[26] In order to still achieve the objectives described above it would be necessary to offset the increase in business passengers with a further decrease in leisure passengers. For a tentative understanding of the necessary change to the tax regime, it is assumed that, in this scenario, business passengers are taxed according to the previous APD regime. Thus, the trajectory of business passenger growth is assumed to be equal to that forecasted by DfT. Since we know the rough passenger numbers that satisfy a 60% increase by 2050, we can subtract business passengers from this figure to obtain the necessary trajectory of all other passengers. These trajectories are detailed in Table 12.

table 12 - passenger volumes in business exemption scenario

passenger volume	2010	2020	2030	2040	2050
Business flights as per counterfactual (mppa) (A)	43	56	70	86	104
60% increase total trajectory (B)	211	230	268	306	338
Necessary trajectory for other passengers (B − A)*	168	175	198	221	234

NB these figures may not sum exactly due to rounding

To obtain an example of a tax regime that results in this trajectory for other passengers the model described above is applied with the following changes: (a) the starting volume of passengers is 168 mppa, rather than 211 mppa; and (b) the elasticity matrix is centred around a value of -0.7 (which reflects leisure passenger price elasticity), rather than -0.6 (which reflects overall price elasticity). The resulting matrix is shown in Table 13.

table 13 - elasticity matrix for business exemption scenario

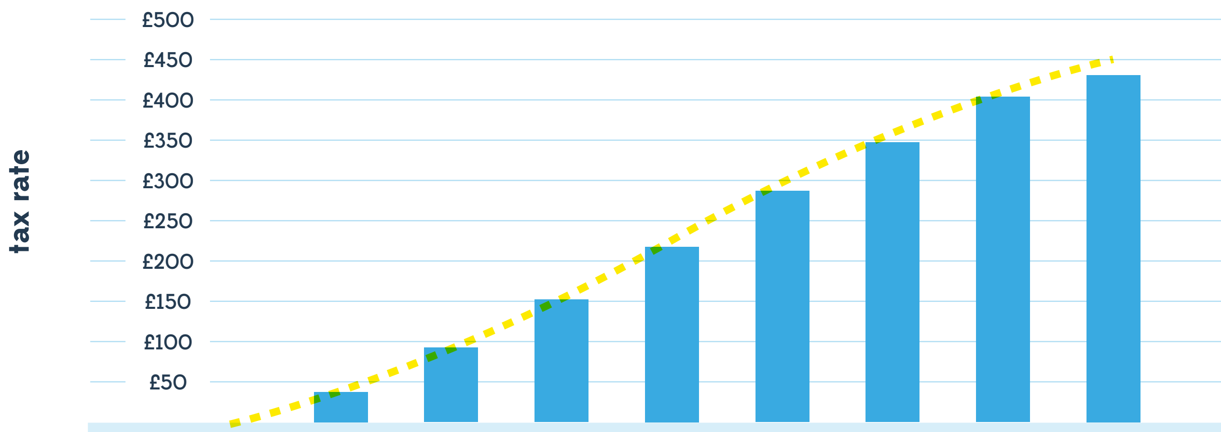
flight rank	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Lowest real income	-0.79	-0.8	-0.81	-0.82	-0.83	-0.84	-0.85	-0.86	-0.87
Second level	-0.74	-0.75	-0.76	-0.77	-0.78	-0.79	-0.8	-0.81	-0.82
Third level	-0.69	-0.7	-0.71	-0.72	-0.73	-0.74	-0.75	-0.76	-0.77
Fourth level	-0.64	-0.65	-0.66	-0.67	-0.68	-0.69	-0.7	-0.71	-0.72
Highest real income	-0.59	-0.6	-0.61	-0.62	-0.63	-0.64	-0.65	-0.66	-0.67

An example of a tax schedule that obtains the necessary trajectory above (i.e. passenger numbers in 2050 ≤ 234 mppa) is shown in Table 14 and Figure 9. It is assumed that all tax rates increase by 5% each decade.

table 14 - tax schedule for business exemption scenario in base period

flight rank	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Tax rate	£0	£40	£90	£155	£220	£290	£350	£405	£435

figure 9 - tax schedule for business exemption scenario in base period



The resulting overall trajectory is detailed in Table 15. Passenger numbers increase by 59.8% between 2010 and 2050 in the policy scenario.

table 15 - total passenger volume in business exemption scenario

total passengers (mppa)	2010	2020	2030	2040	2050
Counterfactual scenario	211	259	320	391	482
Policy scenario	211	223	262	302	336

sensitivity tests

There are two key assumptions made as part of this modelling that are tested for sensitivity. These are: (a) that 'other flight costs' (i.e. the cost of a flight excluding APD or FFL) are invariant with household income; (b) price elasticities of demand vary both by household income and by flight rank. The sensitivity of the results obtained to these assumptions is tested by changing them by a given percentage and observing the magnitude change in the results obtained.

(a) Other flight costs

The a priori expectation is that when lower income households purchase flights they will purchase cheaper flights on average compared to higher income households. However, in the absence of evidence to substantiate this expectation the same cost is applied across the income spectrum in the above analysis.

To take a large deviation from this assumption the costs are changed in the following way: for each time period analysed the third income quintile takes the average flight cost from DfT forecasts; the first quintile costs are 60% of that value, second quintile 80%, fourth quintile 120% and highest quintile 140%. To illustrate the change, this implies that in 2050 the average flight cost for the lowest income quintile is £96.25, while the cost for the highest quintile is more than double that at £224.57.

This changes the results of scenario (i) as follows:
the increase in demand between 2010 and 2050 in the policy scenario increases from +60.4% to +69.4%
the difference between the counterfactual and policy scenarios decreases from 30% to 26%

This is a considerable change in the assumptions and the resulting impact is significant, though not especially large. Since the true values of flight costs across the income spectrum are likely to lie in between the main assumptions and this sensitivity test, the two results might be interpreted as a range.

(b) Price elasticities of demand

In the main analysis price elasticities of demand are assumed to vary as described in the elasticity matrix detailed above. The rationale for these assumptions is described in the methodology section.

To test the possibility that price elasticities are in fact less variant than assumed, the entire elasticity matrix is set to -0.6, the DfT overall value. This changes the results of scenario (i) as follows:

the increase in demand between 2010 and 2050 in the policy scenario decreases from +60.4% to +57.8%
the difference between the counterfactual and policy scenarios increases from 30% to 31%

To test the extreme case in which behaviour is much less responsive to changes in the price of flights, it is assumed that no element of the elasticity matrix is greater (further from zero) than -0.6, while the higher income quintiles have a lower demand response, as illustrated in Table 16.

table 16 - elasticity matrix for sensitivity scenario

flight rank	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
Lowest real income	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Second level	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Third level	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
Fourth level	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Highest real income	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4

This changes the results of scenario (i) as follows:

- the increase in demand between 2010 and 2050 in the policy scenario increases from +60.4% to +69.5%

- the difference between the counterfactual and policy scenarios decreases from 30% to 26%

This is considered an extreme assumption – as such, the results obtained are similarly extreme. As with the previous sensitivity test, in response to relatively large changes in the assumptions, the results change significantly, but not with a particularly large magnitude.

discussion

These results provide some tentative ideas as to the magnitude of change required to the tax regime in order to achieve the four goals described above.

In the first three scenarios the tax schedule would change from one that is flat over the flight rank and relatively low (around £13 on average at present) in magnitude to one that increases steeply over the flight rank from a very low base (zero) to a high rate (though actually slightly lower than the very highest current rate of APD). In the policy scenarios considered the first flight that an individual takes becomes cheaper and the second flight is roughly similar (higher in scenario (i) and lower in scenario (ii)). Since the majority of flights that are taken are either a first or second flight (73% in 2010 and 50% in scenario (i) in 2050) a large proportion of flights will not become more expensive.

The impact of the policy is predominantly to discourage high flight frequency. Since it is the highest household income quintile that flies the most frequently, it is this group that is expected to change behaviour most significantly in response to the policy. Figure 10 illustrates the modelled change in flights taken per person by income quintile in 2050 for scenarios (i) and (ii). Notably, in scenario (ii) the majority of people actually slightly increase the number of flights they take, but this is offset by a larger reduction in flight frequency by higher income groups.

Even with this policy, which has the impact of reducing flight frequency, between 2010 and 2050 the number of flights taken per person would be expected to increase from 2.35 to 2.98 on average. Figure 11 illustrates the percentage of flights that are a first, second, third, etc. flight for 2010 and 2050 under policy scenario (i). Although the policy attenuates a trend it does not on average decrease flight frequency in absolute terms, only relative to the counterfactual trend.

The important result from this analysis is that, given the assumed elasticities and counterfactual forecasts, a progressive tax on frequent flying could play a significant role in restraining demand for flights, while at the same time tending to distribute those flights more equally across the income spectrum.

figure 10 - change in average number of flights taken by income quintile

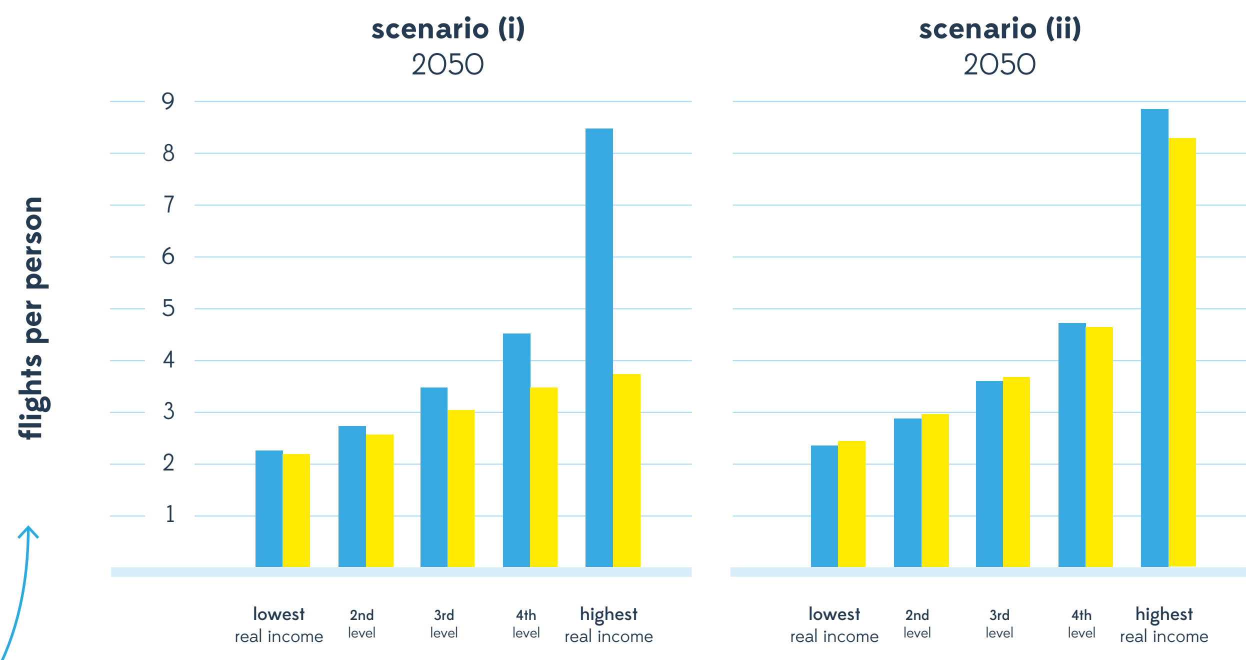
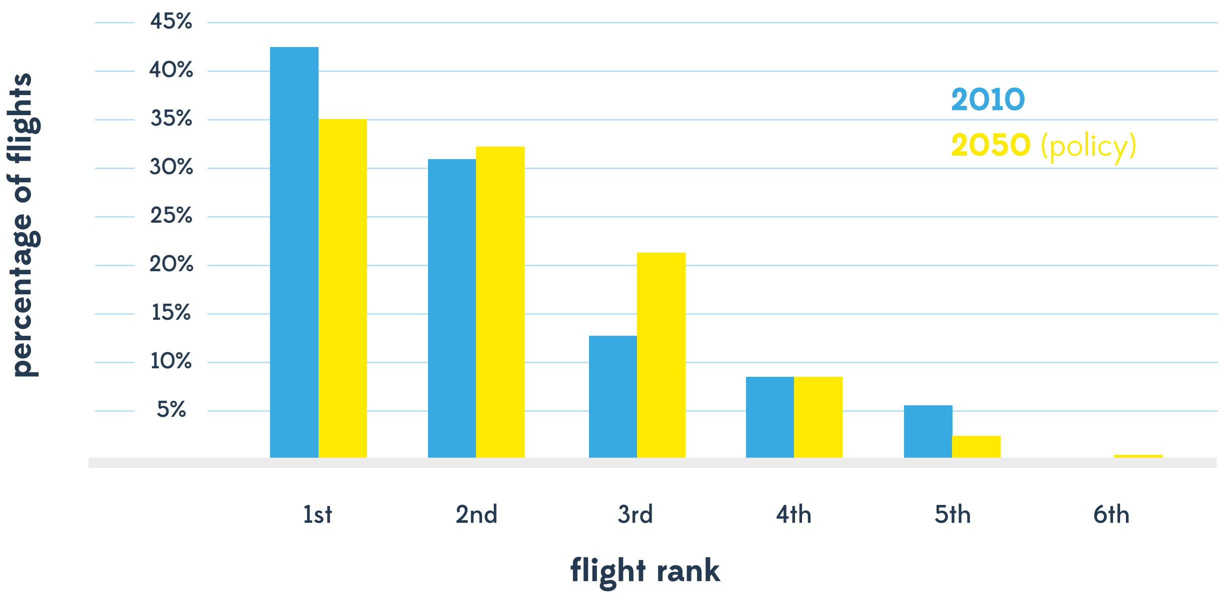


figure 11 - percentage of flights by flight rank



issues for further consideration

Data quality

As noted in the data and methodology section, the data set that has been used is highly imperfect. It contains information only on the frequency of flights taken by respondents. It does not capture purpose (i.e. business or leisure) or distance travelled.[27] What's more, the responses given are grouped in categories, so that analysis using absolute numbers requires arbitrary transformation of categories into single figures. As such, the data this modelling relies on is considered relatively poor and the results should be treated with suitable caution. However, rather than the precise figures that have been presented, the important result of this modelling is a test of feasibility. It has been shown that significant demand restraint in the aviation sector is possible with a change to tax rates that are not unfeasibly extreme.

In order to model more specific and nuanced outcomes of imposing such a regime it would be necessary to obtain a richer data set.

Applying the tax to non-UK residents

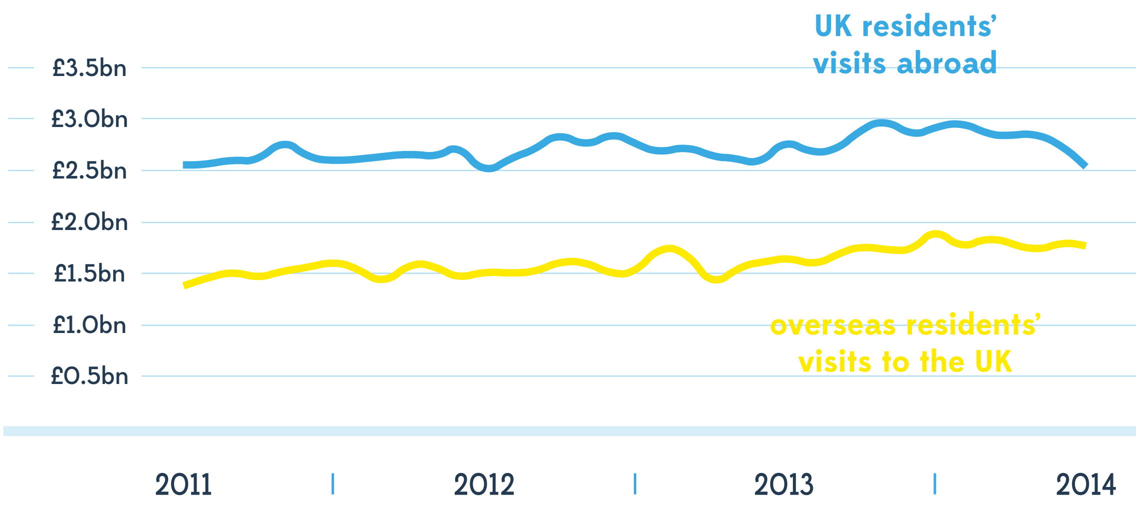
Practical implementation issues have not been thoroughly explored in this paper. A particularly important such issue is the question of residency. The impact of a Frequent Flyer Levy has been modelled based on data from UK survey respondents. Therefore, it is implicitly assumed that the tax can be designed in such a way that all passengers taking flights out of the UK respond in a similar way to UK residents (who comprise around two thirds of flights taken).[28]

Tourism

The tourism industry is particularly dependent on aviation to provide customers. As such, one concern with the hypothesised tax regime might be that this industry would disproportionately suffer. However, there are two clear reasons why the opposite may, in fact, be true:

1 The UK operates a significant "tourism deficit" – in other words, more money is removed from our economy by UK residents taking trips abroad than is brought in by foreign visitors.[29] As such, any measure that increases the tendency of residents to stay in the UK will reduce that deficit. Figure 12 shows the expenditure data[30] for both overseas visitors to the UK and UK visitors abroad, illustrating this deficit.

figure 12 - UK tourism deficit



2 The FFL penalises frequency of flying. UK residents may be quite likely to make a number of trips out of the country in any year, and would incur the associated cost. However, visitors to the UK are much less likely to make more than one such trip. As such, they will not be penalised to the same degree.

Waiting times and delays

An incidental benefit of reducing the volume of flights that pass through UK airports would be to significantly alleviate the problem of congestion, both in airport terminals and on runways, which may result at our current level of airport capacity. A lower throughput of passengers for a fixed air travel infrastructure could be expected to lead to significant improvements in customer satisfaction due to a lower likelihood of delay to any given flight and shorter waiting times for passing through check-in and security.

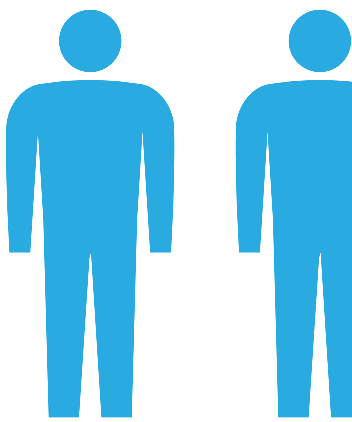
Tax revenues

The preceding analysis finds that, in the process of constraining passenger demand, significant tax revenues would accrue to the pubic purse. These taxes could be used to reduce tax rates in other areas of the economy, such as VAT or income taxes, with potentially beneficial effects. An alternative would be to use the increased revenues to further research in low-carbon substitutes for aviation fuel. If such research yielded successful results it would eventually remove the environmental requirement to constrain absolute demand for flights.

Uncertainty over the long term

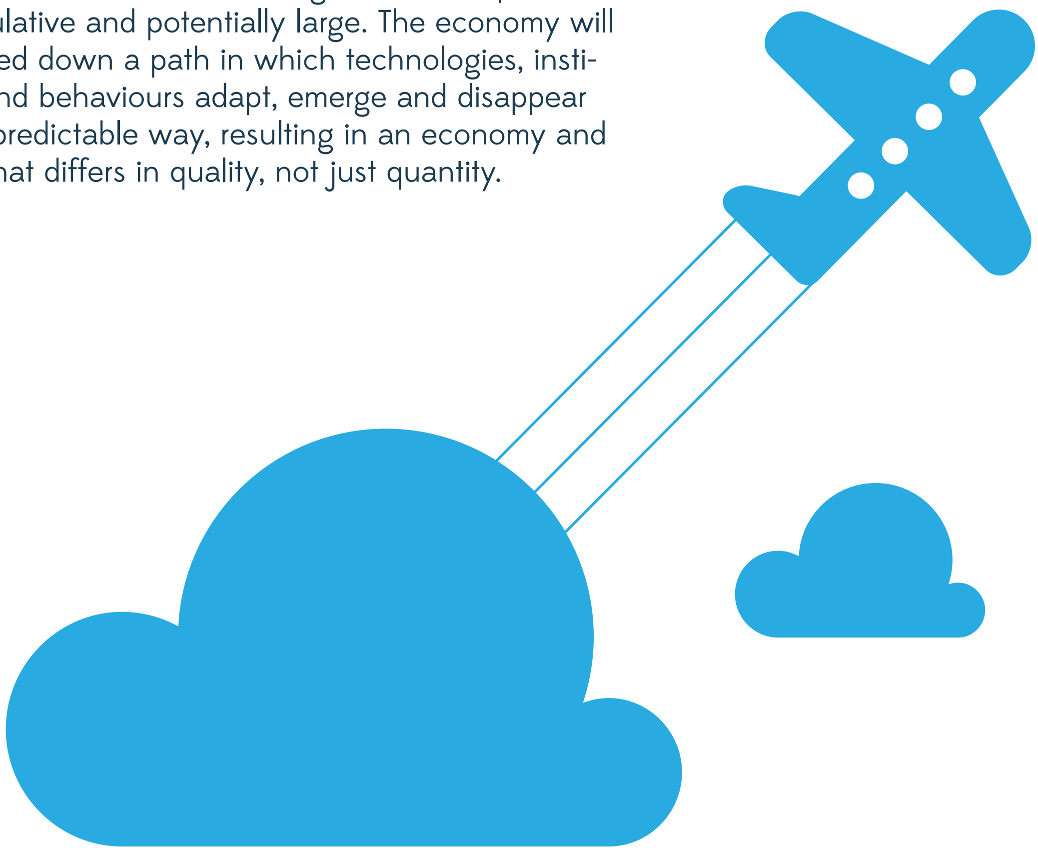
Long term impacts are inherently unpredictable because they are a result of random processes of trial and error, adaptive responses and path-dependent choices. There is a cumulative effect of innovation and research on the possibilities available in the long term.

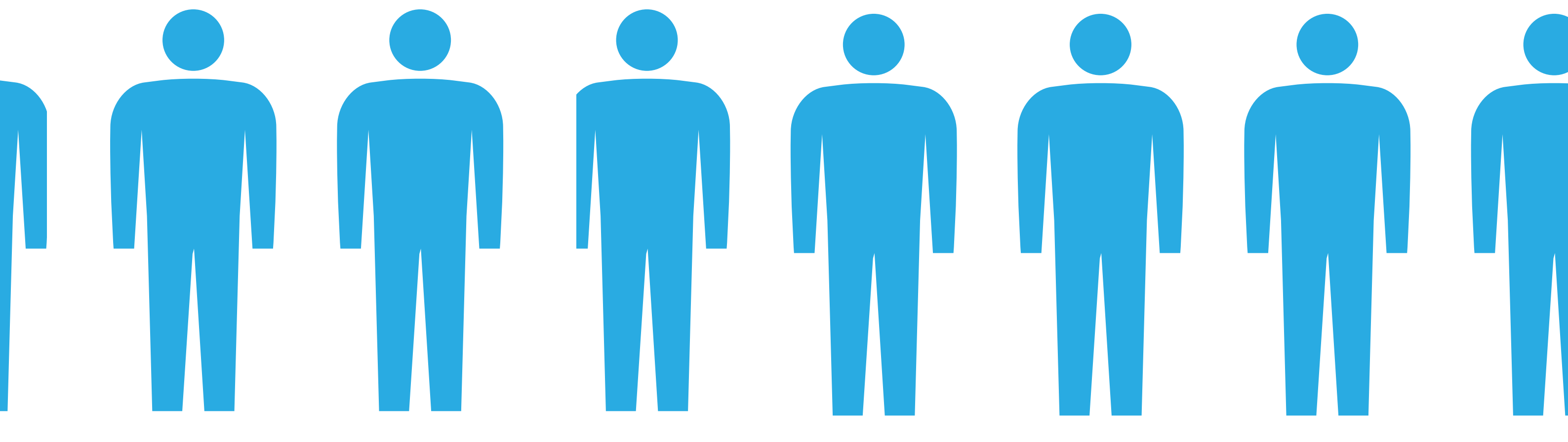
Putting in place a clear and long-term framework in the current day that provides the incentives to move towards a more grounded economy will cause gradual and cumulative changes in institutions and technologies. Such a change will re-orient the path of the economy in a way that could make existing aviation forecasts meaningless, or at least highly incomplete. It is not meaningful to think of the economy as having a single “optimal” path along which it ought to progress, with the government tasked with keeping it as close to



that path as possible. There are innumerable potential pathways, some of which will be objectively bad, but many of which might be considered good.

In a long-run scenario, the change in the number of flights taken resulting from the proposed policy reform is unknowable with any high degree of certainty. However, it is reasonable to expect that the reduction could be significantly greater than implied by a simplistic elasticity response estimate. The long-term consequences are cumulative and potentially large. The economy will be directed down a path in which technologies, institutions and behaviours adapt, emerge and disappear in an unpredictable way, resulting in an economy and society that differs in quality, not just quantity.





endnotes

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