30 OCTOBER 2018

A CRITIQUE OF PUBLISHED REPORTS REGARDING SCARCITY RENTS AT HEATHROW AIRPORT

A REPORT FOR THE CIVIL AVIATION AUTHORITY

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Glossary

ASA	Air Service Agreement
BA	British Airways
CAA	The Civil Aviation Authority
Frontier Report	Competition & Choice 2017 – A report prepared for Heathrow, Frontier Economics, December 2017
FTI	FTI Consulting LLP
FTI Consulting	FTI Consulting LLP
HAHL	Heathrow Airport Holdings Limited
HAL	Heathrow Airport Limited
IAG	International Consolidated Airlines Group SA
IAG Response	Economic regulation of capacity expansion at Heathrow: policy update and consultation (CAP 1658) Response, IAG, July 2018
LCC	Low cost carrier
LHR	London Heathrow
OD	Origin-destination
OLS	Ordinary Least Squares
RAB	Regulatory Asset Base
RPP	Revenue Per Passenger
The Commission	The Airports Commission
VFR	Visiting friends/relatives

Executive summary

1.1 In economic theory, scarcity rents are 'surplus' profits that arise from a constraint on capacity. In a competitive market, forces of supply and demand act so that the price of a good is equal to its cost of production. However, producers of a good can sustainably price goods above cost if there is an external constraint on the volume of goods which can be sold.

1.2 At an airport, scarcity rents could arise from a scarcity of capacity (that is, a scarcity of airport slots). If scarcity rents exist and are currently captured by airlines, then an increase in capacity should (all else equal) result in a decrease in ticket prices. This transfers value from airlines to consumers. Whilst the addition of a third runway at Heathrow Airport is estimated to have significant wider economic impacts, this transfer of value was one of the key stated rationales for the UK Government's decision on the expansion of Heathrow Airport.[1]

1.3 The existence of scarcity rents at Heathrow Airport is a matter of debate between Heathrow Airport Limited ("HAL"), the operator and owner of Heathrow Airport, and many of the airlines which use the airport.

1.4 Frontier Economics (on behalf of HAL) published a report in December 2017 which, among other issues, assessed the level of scarcity rents at Heathrow. More recently, as part of the Civil Aviation Authority's ("CAA's") ongoing consultation on the future regulatory framework for Heathrow Airport, International Consolidated Airlines Group SA ("IAG") has critiqued the work of Frontier Economic, disputing the existence of scarcity rents at Heathrow.

1.5 The CAA wishes to progress the debate on this issue and has asked FTI Consulting to critique the analysis put forward by both Frontier and IAG. Below, we summarise:

- our views on the Frontier Report;
- our views on the IAG Response; and
- our overall conclusions and views on where further work is required.

[1] Airports Commission (July 2015) Final Report, ¶7.22 - ¶7.54.

The Frontier Report

1.6 With respect to scarcity rents, the Frontier Report's key conclusion is that *"if Heathrow were expanded today, ticket fares would decrease by 23% relative to other London airports as a result of removing the capacity constraint"*.[2]

1.7 This conclusion is based on econometric analysis which finds that after accounting for certain other variables, ticket prices at Heathrow are 23% higher than at other airports in London.

1.8 Frontier's econometric analysis follows a widely-used technique called ordinary least squares ("OLS") regression, where the objective is to isolate the causal impact of multiple independent factors on a single dependent factor.

1.9 While the Frontier Report makes relevant arguments, some issues with the analysis and data used suggest that scarcity rents may be larger or smaller than Frontier states.

1.10 The econometric analysis underpinning the estimated scarcity rent of 23% (that is, that ticket prices are on average 23% higher at Heathrow compared to other London airports due to Heathrow's capacity constraint) suffers from several shortcomings, and in particular:

- The residual approach used assumes that all differences in price other than those reflected in the regression model can be attributed to scarcity rents.[3] The 23% 'scarcity rent' premium may reflect Heathrow-specific elements (such as its more or less convenient travel links, actual and/or perceived differences in the quality of the airport, etc.).[4]
- Aggregated data is used, which means that the fares on the least busy routes have a greater impact on the coefficient estimates than the busiest routes.[5]

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2 Frontier Report, pp 5.

3 See ¶5.10.

4 See ¶4.9 - ¶4.13.

5 See ¶5.15 - ¶5.16.

- The analysis likely suffers from omitted variable bias, where relevant explanatory variables are missing from an econometric model. For example, Frontier's econometric models fail to account for differences in within-airport route competition. Routes that are serviced by more carriers at a single airport are likely to see more price competition than routes serviced by fewer or even a single carrier. Therefore, without controlling for within-airport route competition, differences in annual average fares across airports may be overly attributed to excess demand.[6]
- Some coefficients appear unstable, indicating that the coefficient estimates could be biased in at least some of these model specifications.[7]

1.11 In addition to the above, we have concerns that the conclusion reflects an assumption that the expansion completely removes the capacity constraint. We would also note that the Frontier Report does not discuss that the aero charges (per passenger) may change as a result of expansion. At this early stage, it is not possible to be definitive on how the aero charges per passenger would change post expansion, but it is likely that this would have an impact on post-expansion ticket prices.[8]

1.12 Notwithstanding the above, we do still consider that Frontier's analysis makes a valuable contribution to the debate around scarcity rents at Heathrow airport and makes valid arguments that are worth further consideration.

The IAG Response

1.13 The IAG Response suggests that scarcity rents do not exist as they are competed away at Heathrow through airlines switching to serving capacity constrained routes. In other words, IAG argue that whilst Heathrow is running at full capacity, the Frontier Report fails to consider route competition between airlines, which are incentivised to use slots on high-profit/high load factor routes where there is vigorous competition, in turn reducing airlines' ability to generate scarcity rents. However, this argument does not consider the network effects of an airline serving multiple routes at a hub like Heathrow and the disincentive for an airline to switch away from a route that is already capacity constrained.[9]

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6 See ¶5.29 - ¶5.33.

7 See ¶5.41 - ¶5.42.

8 See ¶4.22 - ¶4.23.

9 See ¶6.10 - ¶6.18.

1.14 The IAG Response presents several arguments based on the financial position and market valuations of HAL and IAG, but these do not represent compelling evidence on the existence or absence of scarcity rents at Heathrow Airport. This is because the financial position and market valuations of both firms are likely to reflect a wide variety of factors (such as possible investor preferences for regulated assets, the cost efficiency of both firms, etc.).[10]

1.15 The IAG Response appears to simultaneously argue that scarcity rents:

- do not exist as the capacity constraint at Heathrow is expressed in monetary terms; and
- must accrue to HAL rather than airlines because HAL's (unobservable) market value is far more favourable than IAG's.

1.16 It is not clear how both arguments can simultaneously hold.

1.17 With respect to the econometric analysis, the IAG Response touches on the omitted relevant variables from the Frontier Report. However, in other respects, the IAG Response reflects a misunderstanding of the details of the econometric analyses in the Frontier Report and fails to make a persuasive case for any bias in the results.[11]

Conclusions

1.18 In our view, the Frontier Report reflects a substantial econometric analysis. This analysis, whilst sound in many respects, suffers from some deficiencies that cast doubt on the accuracy of the 23% scarcity rent premium identified. Further, it appears to us that Frontier have not fully considered the relationship between the result of their econometric analysis and the real-world impact on ticket prices if Heathrow were to be expanded.

1.19 The IAG Response correctly attempts to contextualise Frontier's results. We agree that the outputs of econometric analysis need to be tested and considered in the context of the market dynamics. However, we do not agree with IAG's view that airlines currently compete with one another on a route-by-route basis, as described by the IAG Response, such that scarcity rents are competed away.

[10] See ¶6.22 - ¶6.28.

[11] See ¶5.43 - ¶5.49.

1.20 IAG's analysis of the financial position of HAL and IAG is misguided in our view, as the evidence provided for this seems to be unverifiable. Moreover, the IAG Response does not sufficiently justify its assumption that the trading multiples of airports and airlines are driven by scarcity rents, rather than other market forces that typically affect market valuations.

1.21 Further consideration of the quantum of scarcity rents at Heathrow, through more detailed econometric analysis, may be valuable. Such an analysis might consider:

- specifying the dependent variable at a more granular level, that is, at the level of individual flight tickets;
- controlling for a wider range of explanatory variables, including (but not limited to) variables accounting for passenger preferences for flying from Heathrow, and differences in within-airport route competition; and
- performing further and more detailed diagnostic tests of the relevant regression specifications.

1.22 Given the way that Heathrow is regulated, it seems unlikely to us that scarcity rents could be accrued by Heathrow. However, the factors that could potentially inhibit ticket prices from falling as far as any identified scarcity rent premium – such as the extent to which a third runway at Heathrow would eliminate scarcity at Heathrow, or the role played by the nature of competition between airports and airlines, might be considered further.

2. Introduction

2.1 This report is prepared by FTI Consulting LLP ("FTI") on behalf of the Civil Aviation Authority ("CAA"). It critiques the economic rationale and econometric analyses contained in two published documents that consider the impact on prices paid by passengers using Heathrow Airport if a third runway were to be constructed. The two documents are:

- a report produced by **Frontier Economics**, published in December 2017, entitled *"Competition & Choice 2017 – A report prepared for Heathrow"* (the "Frontier Report");[12] and
- a consultation response produced by **International Consolidated Airlines Group SA** ("IAG"), submitted to the CAA in July 2018, entitled *"Economic regulation of capacity expansion at Heathrow: policy update and consultation (CAP 1658) Response"* (the "IAG Response").[13]

2.2 In this section, we set out the background to the issue and the purpose and structure of this report.

Background

2.3 In October 2016 the UK Government, informed by the conclusions of the Airports Commission ("the Commission"),[14] selected the Heathrow North-West Runway as its preferred option to expand airport capacity in the South-East of England.

2.4 The Commission's recommendation was partially based on its conclusion that, despite the need for aero charges (paid by airlines to the airport, to cover the costs of the airport) to increase to pay for the costs of expansion, the costs of tickets from Heathrow (paid by passengers to airlines) would not rise.[15]

[12] Available on the CAA website.

[13] Available on the CAA website.

[14] Airports Commission: Final Report (2015).

[15] Airports Commission: Final Report (2015), pp 120.

2.5 This, the Commission argued, was due to the elevated profits earned from airlines' operations at Heathrow arising from the fact that capacity is constrained at the airports. These elevated profits, the Commission concluded, would be eroded if capacity becomes unconstrained (with the addition of a third runway). These profits, known as 'scarcity rents', are described in further detail in Section 3 below.

2.6 The expansion of Heathrow is expected to be delivered by Heathrow Airport Limited ("HAL"). HAL is the operating subsidiary of Heathrow Airport Holdings Limited ("HAHL"), which is itself owned by FGP Topco Limited, a consortium owned and led by the infrastructure specialist Ferrovial S.A. (25.00%), Qatar Investment Authority (20.00%), Caisse de dépôt et placement du Québec (CDPQ) (12.62%), GIC (11.20%), Alinda Capital Partners of the United States (11.18%), China Investment Corporation (10.00%) and Universities Superannuation Scheme (10.00%).[16]

2.7 HAL is regulated by the CAA, which determines the maximum aero charges HAL is allowed to levy on airlines. Since the selection of Heathrow as the preferred option to expand airport capacity in the South-East of England, the CAA has begun to develop the economic regulatory framework for HAL that would underpin the expansion programme. During this time, the CAA has engaged with interested parties regarding this framework, against a backdrop of wider regulatory debate.

2.8 The Frontier Report, commissioned by HAL and published in December 2017, estimates the level of scarcity rents at Heathrow with an emphasis on comparison with Gatwick Airport.

2.9 The IAG Response was produced by IAG which is the sixth largest airline group in the world, based on revenue. It is the parent company of British Airways ("BA"), Aer Lingus, Iberia and Vueling.[17]

Purpose of this report

2.10 Both the Frontier Report and the IAG Response discuss the issue of scarcity rents at Heathrow (in addition to other topics).

2.11 The CAA have asked FTI to consider the merits and shortcomings of each report on the issue of scarcity rents, with the aim of progressing the debate on this issue and pointing to future areas of investigation.

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16 Heathrow – Company information; Capital IQ: Heathrow Airport Holdings Limited – Private Company Profile; Capital IQ: Heathrow Airport Limited – Private Company Profile.

17 Available on IAG – About Us.

2.12 This report sets out our findings. It comments only on both documents insofar as they address scarcity rents. For the avoidance of doubt, this report is not intended to comment on the merits of expanding airport capacity at Heathrow.

Restrictions and limitations to the scope of our work

2.13 This report has been prepared solely for the purpose described above.

2.14 FTI accepts no liability or duty of care to any person other than the CAA for the content of the report and disclaims all responsibility for the consequences of any person other than the CAA acting or refraining to act in reliance on the report or for any decisions made or not made which are based upon the report.

2.15 This report contains information obtained or derived from a variety of sources. FTI has not sought to establish the reliability of those sources or verified the information provided.

2.16 No representation or warranty of any kind (whether express or implied) is given by FTI to any person as to the accuracy or completeness of this report.

2.17 This report is based on information available to FTI at the time of writing of the report and does not take into account any new information which becomes known to us after the date of the report. We accept no responsibility for updating the report or informing any recipient of the report of any such new information.

Structure of the rest of this report

2.18 The remainder of this report is structured as follows:

- Section 3 briefly describes the theory behind scarcity rents and its application to airports;
- Section 4 summarises and critiques Frontier's evidence on the size of the scarcity rents at Heathrow airport;
- Section 5 contains a detailed commentary on the econometric analysis in the Frontier Report (including IAG's comments on the same);
- Section 6 summarises the key arguments advanced by the IAG Response and outlines several critiques of those arguments; and
- Section 7 concludes.

2.19 This report also includes an appendix that summarises the key regression model used in the Frontier Report.

3. Theoretical background on scarcity rents

3.1 This section provides some theoretical background on the concept of scarcity rents, and its application to airport capacity.

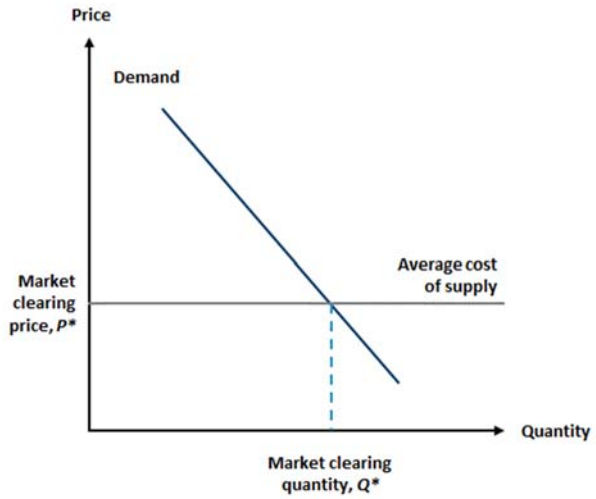
Scarcity rents

3.2 In traditional economic theory, 'rent' is the difference between the price paid for a good and the cost of producing it.[18] The cost of producing a good includes amounts paid for any labour, capital, raw materials and a reasonable level of profits. Rent is therefore a return earned in excess of normal profits. The existence of economic rents can sometimes be indicative of a market failure.

3.3 *Scarcity* rents exist when capacity constraints prevent the market from achieving its equilibrium price and quantity.

3.4 Suppose a generic market, with a downward sloping demand curve and a flat supply curve.[19] As illustrated in Figure 3-1 below, the market clearing equilibrium is given by quantity *Q** and price *P**.

Figure 3-1: Generic market diagram with market clearing equilibrium



[18] Not to be confused with the income from hiring out land or other durable goods.

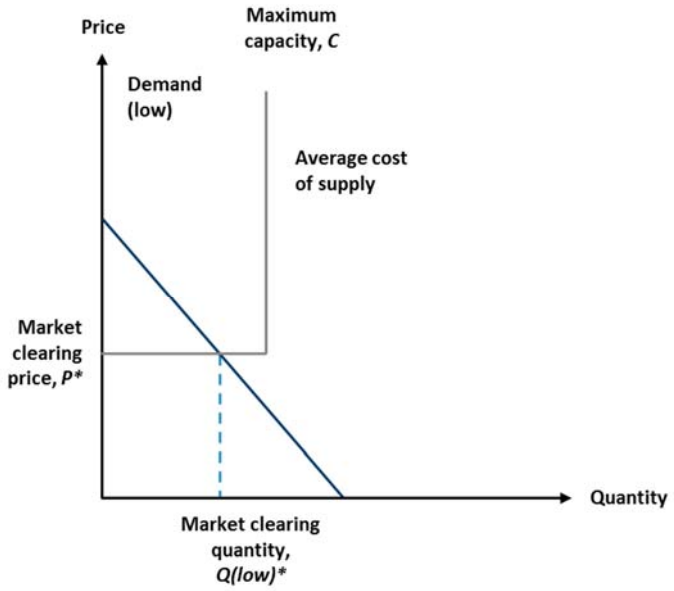
[19] In practice, a market with a more typical upward sloping supply curve will produce the same conclusions, but a flat supply curve is used here for ease of illustration.

3.5 Suppose further that some maximum capacity *C* exists, such that the quantity supplied in the market cannot increase beyond *C*. This capacity constraint could be the result of limited space or resources to produce the good, government regulation, etc.

3.6 The constraint can in fact be considered a 'kink' in the supply curve where the cost of supply beyond the constraint is essentially infinite.

3.7 The effect of this constraint on the market clearing price depends on the demand curve. If the market clearing quantity is below the capacity constraint, then the market clearing price would be the same as if there were no constraint. This is illustrated in Figure 3-2 below.

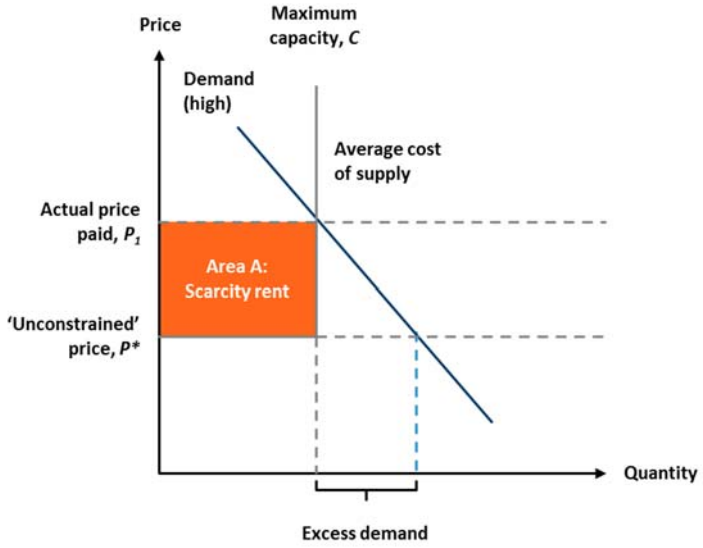
Figure 3-2: Effect of capacity constraint on market equilibrium



3.8 However, if there is greater demand,[20] a sufficient shift *in* the demand curve (that is, demand for the product increasing for reasons other than price alone) will cause prices to rise above the average cost of supply curve, creating a scarcity rent. This is illustrated in Figure 3-3 below.

[20] By this, we mean demand for the product increasing for reasons other than price alone. This can be represented by a shift in the demand curve.

Figure 3-3: Effect of capacity constraint on market equilibrium



3.9 The capacity constraint *C* means demand at the price *P** exists that cannot be met.[21] As such, producers increase the price from *P** to P_1 to constrain demand to the maximum quantity supplied, *C*. This results in an excess profit, designated by Area A, that would not have been earned by producers in the absence of the capacity constraint. This Area A is the scarcity rent.[22]

Application to airports

3.10 In practice, most industries have value chains, where the final good or service purchased by the consumer has passed through multiple firms, each adding some value to the final product. Therefore, if scarcity rents exist, there is a secondary question of which party in the value chain those scarcity rents accrue to.

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21 Note the 'Excess demand' noted in Figure 3-3 above is the difference between the demand that is met (at the actual price paid) and the demand that would have been met in the absence of the capacity constraint.

22 The nature of competition between airlines, and indeed of competition between airports, is complex. It is not the intention of this report to characterise the nature of competition between airlines, or between airports, as perfectly competitive or otherwise. The demand and supply diagrams used in this report are intended to be purely illustrative. They are intentionally constructed in the form as above to be similar to the format used in the Frontier Report and in other reports on the subject of scarcity rents.

3.11 In the context of Heathrow Airport (and indeed airports in the UK in general), the generic case described above is more complex. Heathrow Airport is operated by HAL and provides airlines with airport slots in exchange for payments in the form of aero charges per passenger. Airlines in turn provide passengers with flights in exchange for air fares. This relationship is illustrated in Figure 3-4 below.

Figure 3-4: Relationship between airport, airlines and passengers

3.12 We would note that there is of course a distinction between 'seats' on an aircraft and 'slots' on a runway. Passengers purchase *seats*, whereas the direct constraint in the market is on the *slots* available to airlines. In our view, neither the Frontier Report nor the IAG Response sufficiently addresses this distinction, and it remains an area where further work may be required.

4. Frontier's evidence on the existence and size of scarcity rents

4.1 With respect to scarcity rents, the conclusion of the Frontier Report is that *"if Heathrow were expanded today, ticket fares would decrease by 23% relative to other London airports as a result of removing the capacity constraint"*.[23]

4.2 This conclusions rests on two main propositions:

- that the scarcity rent is 23%; and
- that relieving the capacity constraint at Heathrow will reduce prices by the full amount of this estimated scarcity rent.

4.3 In this section, we explore both propositions. This section is structured as follows:

- First, we summarise the econometric analysis Frontier used to estimate the size of the scarcity rent at Heathrow, and then explain why Frontier's approach may not have correctly estimated the size of scarcity rents at Heathrow (a further and more detailed examination of the econometric issues in the Frontier Report is provided in Section 5).
- Second, we comment on the implicit assumptions that Frontier are making with regards to the overall effect of the expansion on ticket prices (even if they are correct in their assessment of the size of scarcity rent).

Econometric analysis and the size of scarcity rents

4.4 The Frontier Report uses ordinary least squares ("OLS") regressions to estimate the scarcity rent at Heathrow. OLS regressions are used to isolate the causal impact of multiple independent factors on a single dependent factor. This subsection first summarises the Frontier Report's econometric methodology, then explains why it may not have accurately estimated the size of the scarcity rent at Heathrow.

[23] Frontier Report, pp 5.

The methodology in the Frontier Report

4.5 Using 2016 data on estimated revenue per passenger ("RPP") from a collection of routes, the Frontier Report regresses RPP for outgoing origin-destination ("OD") trips on:[24]

- the distance of the route;
- whether or not the route was a long-haul route;
- the number of other flights to the same destination at the same airport;
- the number of other flights to the same destination from other airports;
- the proportion of business passengers on the route;
- the proportion of passengers visiting friends and family travelling on the route;
- the proportion of passengers that are transfer passengers;
- the proportion of passengers flying on low cost carriers on that route; and
- whether or not the route was from Heathrow airport.

4.6 The full regression specification and results are summarised in Appendix 1.

4.7 The Frontier Report takes a 'residual approach' to estimating scarcity rents. This approach regresses ticket prices on both identified relevant factors, and on airport dummy variables. After controlling for all other variables, Frontier argues, the coefficient on each airport dummy variable must be the scarcity rent. In other words, Frontier have not measured scarcity rents directly but have instead identified a price premium at Heathrow and attributed this wholly to the existence of scarcity rents.

4.8 Using this analysis, the Frontier Report concludes that, holding all other variables constant, flights from Heathrow were, on average, 23% higher than at other London airports. It states that this 23% premium represents the scarcity rent at Heathrow, which would be eroded (leading to lower ticket prices) if capacity was increased.[25]

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[24] Outgoing origin-destination trips are those for which the airport of interest is the originating airport (not the final destination) and excludes all those trips involving transfers and layovers at either originating or destination airports.

[25] Frontier Report, pp 5.

Comments on the size of the scarcity rent

4.9 As noted above, Frontier have identified a price premium at Heathrow and attributed this to scarcity rents. However, in practice, there are many airport-specific reasons why ticket prices might be higher at one airport than another that are unrelated to capacity constraints.

4.10 First, passengers may have a preference for flying from Heathrow, perhaps due to:

- its location (for example, transport links that make travel into and from central London more convenient);
- actual and/or perceived differences in the quality of the airport (for example, queue times for security and check-in, quality of service of staff, choice of shops, etc.); and/or
- any number of other Heathrow-specific factors.

4.11 Second, there may be additional costs of operating at Heathrow that are not captured in the aero charge that Frontier controls for.

4.12 In an ideal world, an econometric model should be capable of distinguishing between the impact of all these effects on ticket prices.

4.13 The 'residual approach' referred to above ignores the possibility that passengers may simply perceive specific airports in England to provide a superior service, be in a more convenient location, etc. compared to others. Thus, the 'Heathrow effect' measured by Frontier may comprise the sum of multiple effects: the possible scarcity rent, and any number of the Heathrow-specific factors identified above. If these factors, all else being equal, reflect a higher willingness to pay for flights at Heathrow, Frontier's 'Heathrow effect' may have over-estimated the scarcity rent. Equivalently, if these factors reflect a lower willingness to pay for flights at Heathrow, Frontier's 'Heathrow effect' may have under-estimated the scarcity rent.

4.14 This econometric issue (and others) are elaborated on and detailed further in Section 5 below.

Comments on the effect on ticket prices

4.15 The Frontier Report explains that, when capacity is constrained, prices must be adjusted upwards in order to equate quantity demanded with quantity supplied.

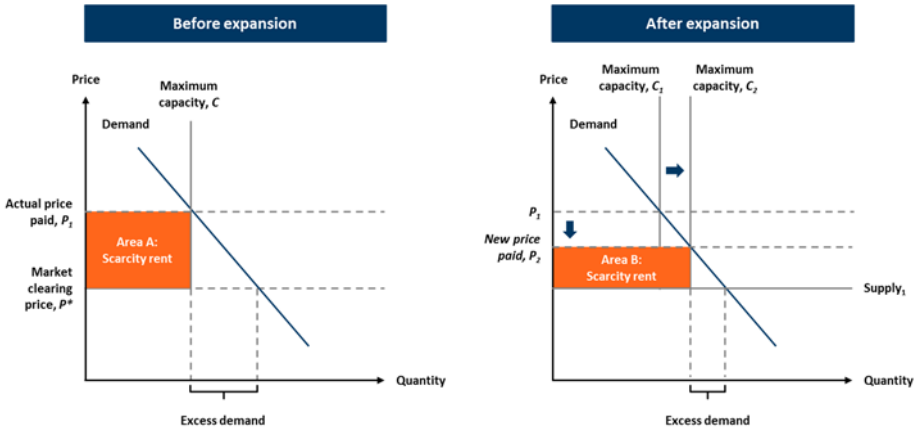
4.16 However, as Frontier note, when an airport is regulated (such as Heathrow or Gatwick), the aero charges cannot be adjusted in the same way, as they are fixed by the regulator. Therefore, the only party (in the value chain described above) that is free to adjust prices is airlines.

4.17 Indeed, the Frontier Report states that *"airports cannot adjust their pricing to ensure that demand equals supply in the constrained case"*.[26] It further states that *"competition in the airline market plays an important role in adjusting prices so that demand equals supply"*[27] and that "*the restricted capacity leads to rising ticket prices so as to match passenger numbers to the seats available"*.[28]

4.18 The Frontier Report notes that the size of the scarcity rent depends on excess demand and the extent to which there is competition from other airports.

4.19 The Frontier Report then offers the theoretical conclusion that *"if the capacity constraint is removed, new airlines can enter existing routes and this increase in airline competition ensures that prices fall"*.[29] This is illustrated in Figure 4-1 below. As the capacity constraint is relieved (shifted to the right), excess demand falls, allowing the price to fall from P_1 to P_2.

Figure 4-1: Illustration of Frontier Report's view of capacity expansion



26 Frontier Report, pp 21. Emphasis added.

27 Ibid.

28 Ibid.

29 Ibid.

4.20 Whilst we would agree that prices will theoretically fall as the capacity constraint is relieved, we note that Frontier conclude that, post expansion, ticket prices would in aggregate fall by the *entire* amount of the estimated scarcity rent. In our view, this would only be true if:

- the capacity expansion completely clears the capacity constraint; and
- the average aero charge faced by airlines stays at the same level.

4.21 We discuss each below.

Expansion completely removes capacity constraint

4.22 The Frontier Report's conclusion assumes that Heathrow's planned expansion will eliminate the current capacity constraints at Heathrow. If instead expansion only relieves some proportion of the capacity constraint, ticket prices will not fall by the full amount of the scarcity rent. Airlines will continue to earn scarcity rents, albeit less.

Cost of expansion per incremental passenger is sufficiently small

4.23 In relation to ticket prices, the Frontier Report does not discuss the effects of the costs of expansion.[30] Assuming HAL delivers the expansion, the cost of the potential Heathrow expansion would be added into HAL's RAB, increasing the amount it can recover from airlines. However, the passenger numbers would also rise, meaning that the overall impact on the average aero charge per passenger is ambiguous. At this early stage, it is not possible to be definitive on how this metric would change post expansion (it is, of course, hugely dependent on the costs of expansion, the regulatory framework, and the change in passenger numbers). We would simply note that Frontier's conclusion assumes no change to average aero charges per passenger. If the aero charge per passenger rises because of expansion, ticket prices will not fall by the full amount of the previously identified scarcity rent. Conversely, if the aero charge per passenger falls, ticket prices may (but not necessarily will) fall more than the identified scarcity rent.

[30] Aside from the following comment: *"the cost to passengers of Heathrow expansion could be offset in only eight years by alleviating the congestion premium"* (sic) – Frontier Report, pp 28.

Effect on individual ticket prices

4.24 In its theoretical discussion of scarcity rents, the Frontier Report inherently considers Heathrow airport to be a single market. With numerous airlines operating out of Heathrow, and not all airlines serving the same routes, air travel to and from Heathrow is perhaps more accurately represented as a collection of individual markets.[31] Each airline, and indeed each city-pair, is likely to have a unique cost to serve, and therefore a unique supply curve. Moreover, the overall capacity constraint at Heathrow is likely to affect each city-pair differently. For example, on some routes there might be no capacity constraint and the prevailing price is equivalent to the market clearing price. On these city-pairs there would be no scarcity rents. On other city-pairs, the capacity constraint may be more severe, and on these there would be very high scarcity rents.

4.25 Therefore, even if the overall average effect of expansion is a reduction in ticket prices, it is likely that capacity expansion will affect ticket prices differentially depending on the city-pair and it is even possible that some may increase whilst others decrease.

[31] CAA (January 2014) CAP1133 – Market power determination in relation to Heathrow Airport – Appendix D, ¶D91 - ¶D92.

5. Commentary on econometric analysis

5.1 As noted above, the Frontier Report estimates scarcity rents through econometric analysis. Econometric analysis is not an 'absolute' exercise – it requires judgment, and conclusions have to be drawn in the context of the available data and hypotheses which are being tested. It seems to us that the Frontier Report is primarily focused on exploring how scarcity rents differ between Heathrow and Gatwick.

5.2 Notwithstanding this, we consider the analysis is not sufficiently robust to draw the conclusions that scarcity rents – the typical fare premium to other London airports due to capacity constraints – at *Heathrow* are 23%. In this section we explain why, by setting out our critique of Frontier's analysis.

5.3 As well as providing this critique, we also comment on IAG's response to Frontier's econometric analysis, and then finally outline how the econometric analysis could be performed in an 'ideal world' with no restrictions on data or resources, and with the specific aim of estimating scarcity rents at Heathrow.

Econometric analysis in the Frontier Report

5.4 Frontier's econometric analysis of the 'congestion premium' at Heathrow airport is not sufficiently robust. A major limitation of the econometric analysis is the absence of any diagnostic test results for the model specifications it estimates. Frontier has not demonstrated that its model specifications are robust to an array of modelling issues that can cause unreliable coefficient estimates.

5.5 Frontier uses aggregated data of individual passenger data for OD routes for London airports and for European hub airports. Observations in the dependent variable are the annual average fare (in 2016) for each OD route for each airport. Frontier explains that only those OD routes with at least 10,000 passengers annually are included in the dataset. The busiest OD route for London Heathrow is approximately 3 million passengers annually.[32]

[32] LHR-DBX, available on Eurostat website. See avia_par_uk database, sum of columns 2017Q1 to 2017Q4.

5.6 The explanatory variables used in the econometric modelling include: route distance; long haul or short haul identifiers; number of flights on the route from the same airport and other airports in the dataset; proportion of passengers travelling for business; proportion using the route for a transfer; proportion flying on low-cost carriers; and dummy variables for departure airports. The models are estimated using OLS.[33]

5.7 Frontier finds London Heathrow's 'congestion premium' – the typical fare premium due to capacity constraints – ranges from 15.0% to 35.7%. Frontier estimates the 'congestion premium' using the departure airport dummy variables. That is, Frontier's approach does not directly estimate the 'congestion premium', but rather it is inferred from the remainder of the dependent variable that is not explained by the explanatory variables included in the models. Therefore, it is likely that the 'congestion premium' estimate is inaccurate if the coefficient estimates of any of the other explanatory variables are inaccurate.

5.8 Frontier provide coefficient estimates for a range of model specifications for a 'European airport' dataset and a 'London airport' dataset in results tables in the appendices of the Frontier Report.[34] The results tables also include 1%, 5% and 10% confidence level ranges for the statistical significance of the coefficient estimates.

5.9 In the sub-sections below, we comment on different aspects of Frontier's econometric analysis.

Residual approach

5.10 The Frontier Report takes a 'residual approach' to estimating scarcity rents. [35] As explained above, this approach is to regress ticket prices on all possible relevant factors, and on airport dummy variables. After controlling for all other variables, Frontier argues, the coefficient on each airport dummy variable must be the scarcity rent.

[33] See Appendix 1 for further details.

[34] Frontier Report, Annex A, Figures 50 to 53.

[35] Not to be confused with the residual error term that is a standard feature of linear regression analysis.

5.11 However, this approach ignores the possibility that passengers may simply perceive specific airports in England to provide a better or worse service, be in a more or less convenient location, etc. compared to others. Therefore, the coefficients on each airport's dummy variable in Frontier's analysis may capture both the effect of the said airport's capacity constraint *and* perceived differences between the airports that are unrelated to capacity constraints. That is to say, the airport dummy variables may have captured multiple additional effects as well as scarcity rents.

Effect of biased coefficient estimates

5.12 Frontier's econometric models attempt to unbiasedly estimate the 'true' impact of each explanatory variable (e.g., flight distance) on the dependent variable (flight ticket price). However, there are several reasons to suspect that the coefficient estimates from the Frontier econometric models are biased away from the 'true' values.

5.13 Biased coefficient estimates assign an incorrect impact to the explanatory variables; and with biased coefficient estimates, the remainder of the dependent variable, which Frontier interprets as the 'congestion premium', will be also be biased.

5.14 Biased coefficient estimates can be caused by a range of issues described further below and can be assessed using diagnostic tests following the model estimation. Biased coefficient estimate can, to some degree of certainty, also be inferred by trends in the estimates across related econometric models.

Estimation approach using aggregated data

5.15 Frontier has used the annual average fare (for 2016) per OD route as the dependent variable and uses OLS to estimate the coefficients for these models. OLS treats each observation with equal weight, but each observation of the dependent variable is an aggregation using a different number of total passengers for each observation. The fares on the least busy routes impart a greater individual impact on the model results than fares on the busiest routes; e.g. the fares for a route comprised of 10,000 total fares will each have a 300x greater impact on the model results than the fares for a route comprised of 3,000,000 total fares. Therefore, Frontier's results are biased to the extent that the fares on the least busy routes have a greater impact on the coefficient estimates than the busiest routes.

5.16 A weighted regression using the total number of passengers for each route would have corrected for this bias. For example, the average of the ten integers from 1 to 10 is 5.5. However, given that the average of the nine integers from 2 to 10 is 6.0, the unweighted average of 1 (the remaining integer not initially included) and 6.0 is 3.5: a biased result. But a weighted average using the number of integers underlying each value, results in a weighted average of 1 and 6.0 of 5.5.[36]

Diagnostic testing

5.17 Frontier have not provided results for post-estimation testing that assesses the 'correctness' of each model. Following estimation of a model's coefficients, it is common practice to run diagnostic tests, which is to assess the reliability of the coefficient estimates. Diagnostic testing includes testing the functional form of the explanatory variables, model specification (omitted variables and redundant variables as described above), data measurement errors and outlier analysis, heteroskedasticity and multi-collinearity. These issues can lead to biased coefficient estimates and/or biased statistical significance. It is common practice to provide diagnostic test results; however, the Frontier report has not done so.

Heteroskedasticity

5.18 Heteroskedasticity is the presence of changing variances across the error terms of an econometric model. Heteroskedasticity does not bias the point estimates of explanatory variables but can bias the standard errors, so that inference on the statistical significance of explanatory variables is biased. Estimation techniques can correct for the effect of heteroskedasticity on the standard errors of explanatory variables and these techniques produce heteroskedasticity-robust standard errors.

5.19 Frontier provides its results with and without heteroskedasticity-robust standard errors. There is little change in the statistical significance of explanatory variables in Frontier's models when comparing across the same model specifications estimated with and without robust standard errors. This suggests that there is little heteroskedasticity present in the Frontier models.

5.20 The Frontier models include explanatory variables that are statistically insignificant with and without controlling for heteroskedasticity. Possible implications of statistically insignificant variables are described further below.

[36] That is, (1/10)*1 + (9/10)*6.0 = 5.5.

Functional form

5.21 Functional form describes the relationship between the explanatory variables and a dependent variable, e.g. linear-to-linear, logarithmic-to-linear, or logarithmic-to-logarithmic. A specification of the functional form is required before OLS estimation. Imposing functional forms that do not reflect the actual interaction of explanatory variables and a dependent variable will cause biased coefficient estimates for the functional form used.

5.22 Frontier has considered the relevant functional form of the explanatory variables when specifying its models by looking at two-dimensional scatterplots of some explanatory variables and the dependent variable.[37]

5.23 However, formal testing of a chosen functional form can objectively measure the appropriateness of a chosen functional form based on the results of the estimation. Frontier have not provided any results of diagnostic tests of its chosen functional forms.

5.24 An inappropriate functional form causes omitted variable bias and unreliable coefficient estimates. Without diagnostic testing of the functional form, it is not possible to determine that Frontier's chosen functional form is appropriate and that the coefficient estimates are reliable.

Measurement errors and outlier analysis

5.25 Frontier has chosen to include explanatory variables in its models that are not statistically significant (whether controlling for heteroskedasticity or not). Measurement error is a possible explanation for a lack of statistical significance of an explanatory variable that is thought to impact a dependent variable.

5.26 Measurement errors in the dataset can lead to biased coefficient estimates and large standard errors. The Frontier Report suggests that the data has been inspected in 2-dimensional charts, which can reveal significant, simple measurement errors. However, Frontier has not provided any results of formal measurement error testing. If one or more variables suffer from measurement error, where the size of the error is correlated with the value of the variable, then the coefficient estimate will suffer from attenuation bias. This causes downwards biased coefficient estimates.

5.27 Therefore, given that Frontier's approach measures the 'congestion premium' as the remainder of the dependent variable not explained by the other explanatory variables, attenuation bias in any of the explanatory variables could lead to an inaccurate estimation of the 'congestion premium'.

[37] Frontier Report, Annex A, Figures 48 and 49.

5.28 Outlier analysis is a related diagnostic testing procedure that is typically performed after an econometric model is estimated. Outliers are extreme values that can be due to measurement error but can also be accurate measurements of sampling from the tail of the random variable's distribution. Outliers can have a major effect on coefficient estimates. Frontier does not indicate whether it has tested for outliers that may have major effects on the coefficient estimates.

Omitted and redundant explanatory variables

5.29 Omitted variables can cause coefficient estimates for the variables included in the model to be biased away from the actual value, because the included variables capture some of the explanatory effect of the missing explanatory variables.

5.30 For example, suppose ticket prices are affected by the flight's destination and the airline operating the flight only. A correct regression specification would therefore be:

$$Ticket\ price = a + \beta_1 Destination + \beta_2 Airline + \varepsilon$$

5.31 Suppose further that, in error, one excluded the airline variable from the regression specification. The resulting coefficient on the destination variable would therefore capture both: (i) the effect of destination; and (ii) some of the effect of the airline, on ticket prices. This would also cause the error term to be correlated with the dependent variable. The overall effect is that the destination coefficient would no longer be the best, linear, unbiased estimator of the effect of destination on ticket prices.

5.32 Thus, when specifying the regression, one must ensure the full range of control variables is included, as the omission of any relevant variable biases all other variables that have been included. This is known as 'omitted relevant variable bias'.

5.33 Frontier's econometric analysis likely suffers from omitted variable bias. For example, Frontier's econometric models fail to account for differences in within-airport route competition. Routes that are serviced by more carriers at a single airport are likely to see more price competition than routes serviced by fewer or even a single carrier. Therefore, without controlling for within-airport route competition, differences in annual average fares across airports may be overly attributed to excess demand.

5.34 Frontier's econometric analysis also includes explanatory variables that are not statistically significant whether adjusting or not adjusting for heteroskedasticity. Typically, variables that are not statistically significant should be removed from a model because any common variance they share with the other explanatory variables may be wrongly attributed to them. This would bias the coefficient estimates of the redundant variables and the associated explanatory variables.

5.35 An alternative explanation for the lack of significance of explanatory variables is a high degree of common variance between two or more explanatory variables, such that the estimation can only poorly identify the coefficient estimates leading to large standard errors on the coefficients of those variables. This is called multicollinearity and causes coefficient estimates to be unreliable and the standard errors to be too large. Multicollinearity can be due to two or more variables varying to a large extent in the same way or, more typically, varying very little across the dataset.

5.36 Frontier states that its regression models suffer from multicollinearity and considers this may reduce the 'congestion premium' estimate using the London Heathrow dummy variable.[38]

5.37 Multicollinearity is expected to make coefficient estimates unreliable, which may increase or decrease the 'congestion premium' estimate. For example, the inclusion of the 'Transfer' variable in the models, using the European airports dataset,[39] increases the coefficient estimate of the London Heathrow dummy variable.

Model specification using nested models

5.38 Two or more econometric models are said to be 'nested' models where all-but-one of the models are subsets of the remaining 'primary' model; that is, the subset models are run on the same dataset and the same dependent variable using the same estimation technique but using a subset of the explanatory variables from the primary model.

5.39 There is a greater level of comparability between nested models than across non-nested models. Indeed, it is possible to test for a 'preferred model' within nested models because it is possible to isolate the additional explanatory power of the additional explanatory variables and to test whether the additional explanatory power is sufficiently large to justify the inclusion of the additional variables.

[38] Frontier Report, pp 29.

[39] Frontier Report, Annex A, Figure 53.

5.40 Frontier present the coefficient estimates of several nested models, however, they do not provide diagnostic test results to determine which models are superior.

Coefficient stability

5.41 Assessing the stability of variable coefficients across different model specifications and data samples is a non-formal assessment method. Nonetheless, such assessments can help to focus on potential issues in the models.

5.42 For example, the 'business' variable used in the models estimated on the 'London airport' datasets show coefficient estimates of 1.15 to 1.70 (significant at 10% to 5% confidence levels using robust standard errors) for long haul routes and coefficient estimates of 0.62 to 0.65 (all significant at the 1% confidence level) for short haul routes.[40] However, the coefficient estimates for the 'business' variable using the combined dataset of long haul and short haul routes are significantly lower than estimated in either of the separate datasets at between 0.21 and 0.28 (with statistical significance ranging from significant at the 5% confidence level to insignificant at the 10% confidence level). This strongly indicates that the coefficient estimates are biased in at least some of these model specifications, which is expected to lead to a biased 'congestion premium' estimate.

IAG's comments on Frontier's econometric analysis

5.43 The IAG Response critiques the econometric methodology in the Frontier Report. Many of IAG's comments address similar issues to those set out above, such as the apparent omitted relevant variables[41] and the statistical insignificance of certain results.[42]

5.44 Further, the IAG Response comments that the data used by the Frontier Report may not be suitable for its analysis. For example, it remarks that IATA fare data may not be representative of the majority of air travel bookings.[43] If it is true that the IATA fare data relies on *"traditional travel agency booking"*, but that *"direct/online bookings"* now represent the majority of air travel bookings,[44] then IAG would be correct to criticise Frontier's analysis on this basis.

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40 Frontier Report, Figure 52.

41 IAG Response, Appendix A, Annex, ¶33 and ¶37.

42 IAG Response, Appendix A, Annex, ¶41.

43 IAG Response, Appendix A, ¶36.

44 Ibid. We have not independently verified this.

5.45 However, for completeness, we would note two instances where we consider IAG's criticism is not as well-founded.

5.46 First, the IAG Response states that "*airfares using in FE's* [Frontier Economics] *analysis of LHR are based on 172 observations, which is just 0.036% of the approximately 480,000 annual arrivals and departures*."[45] It is not clear which specific analysis in the Frontier Report the IAG Response is referring to. It is possible that IAG is referring to the Frontier Report's regression results.[46]

5.47 The second column of Figure 50 of the Frontier Report represents a regression specification that has 172 observations, each representing average revenues per passenger in 2016 on a given route. However, this is a regression of flights from Heathrow only. In fact, the Frontier Report's conclusion of a scarcity rent of 23.3% is based on the regression specification in the seventh column from the left of Figure 50. This regression includes both long haul and short haul routes from all London airports in 2016 and is based on 645 observations.

5.48 The IAG Response compares the number of observations in the Frontier Report's analysis to the number of arrivals and departures at Heathrow, suggesting that the analysis is performed over an unreasonably small proportion of flights at Heathrow. However, each observation in Frontier's analysis represents a route, not a single flight, as suggested by the IAG Response (although this was not entirely clear in the Frontier Report).

5.49 Second, the IAG Response states that *"FE goes on to further admit that the results of its analysis are not statistically significant"*.[47] While not every variable in the Frontier Report's regressions is statistically significant, the coefficient on the Heathrow dummy variable is stated to be statistically significant at the 1% level. [48,49] While we agree that the inclusion of statistically insignificant explanatory variables may be problematic (see ¶5.34), it is not the case that all of Frontier's results are statistically insignificant.

45 IAG Response, Appendix A, ¶32.

46 Frontier Report, Annex A, Figure 50.

47 IAG Response, Appendix A, Annex, ¶41.

48 Frontier Report, Annex A, Figure 50.

49 On its regression that includes both long haul and short haul flights and all London airports, which the Frontier Report uses as its estimate of scarcity rents at Heathrow.

'Ideal world' analysis

5.50 In an 'ideal world', one would calculate the average value of scarcity rents by modelling ticket prices (the dependent variable) for individual flights (for example, the flight BA558 from Heathrow to Rome) averaged over a time unit (for example, monthly), controlling for all other factors that affect them (the control variables). The effect of these factors must be controlled for to obtain a reliable measure of the effect of scarcity on ticket prices. Control factors are discussed below.

5.51 In our view, it is particularly important not to confuse the effect of scarcity linked to full utilisation of available slots with the effect of scarcity linked to seat availability on an individual flight.

5.52 We therefore consider that an analysis of load factors on individual flights and routes should precede and inform the model specification phase of the analysis.

Control variables

5.53 Relevant control variables are factors that are likely to affect price levels, independently of the capacity constraints at the airport that drive scarcity rents. On the supply side, these could be (but not limited to):

- airport charges;
- fuel prices;
- flight distance; and
- competition levels.

5.54 On the demand side, these could be (but not limited to):

- the destination airport;
- time/day of departure;
- passenger income; and
- airport-specific factors unrelated to capacity constraints.[50]

5.55 In addition to the factors identified above, the length of time before the date of departure that a flight is booked also affects the price of an air ticket. In general, the closer to the date of departure a flight is booked, the more expensive it is likely to be, although the relationship can be complex and non-linear.

[50] See ¶5.11 above.

Modifications to Frontier's analysis

5.56 Frontier's analysis could be updated to specify the dependent variable at a much more granular level, that is to say, using data at the ticket price level, rather than aggregated at a route level.

5.57 Further control variables, such as those specified above should also be included in Frontier's analysis, to avoid omitted relevant variable bias. Further diagnostic testing (such as those described in ¶5.17 above) would be necessary, and the model specification adjusted depending on the result of the post-estimation testing. The diagnostic tests would be run again, and this iterative process would continue until the most 'correct' model could be specified.

Practical constraints

5.58 In practice, gathering a sufficient quantity and granulation of data to control for all of the above factors is likely to be difficult. Practitioners are likely to have to make simplifying assumptions and make use of various proxies for some or all of the variables listed above.

6. IAG's critique of the Frontier Report

6.1 Appendix A of the IAG Response is a direct critique of the Frontier Report. Its arguments can be summarised as follows:

- scarcity rents at Heathrow do not exist, because there is competition for capacity at the most profitable slots, leading to any rents being competed away on those slots; and
- the market value of HAL's stocks and BA's lack of profitability mean that any scarcity rents that do exist accrue to Heathrow, not airlines.

6.2 In this section, we comment on these arguments as set out in the IAG Response.

Scarcity rents are competed away

6.3 The IAG Response disagrees that capacity constraints at Heathrow lead to higher prices levied by airlines on passengers than would be the case if capacity was unconstrained. It points to the ability of (and incentive for) airlines to switch their slots to serving more profitable routes and compete against each other. This assumes a given airline has the right to operate on the particular route in question.[51]

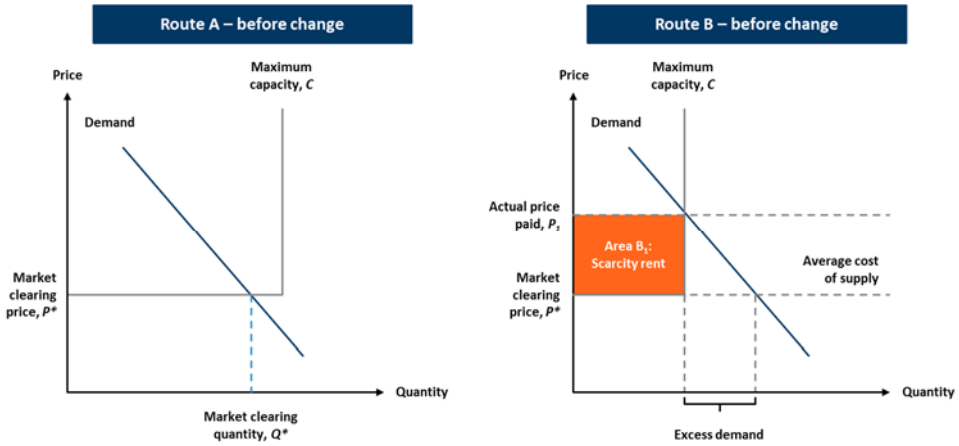
6.4 The IAG Response considers that, because airlines are able to control the quantity of seats serving a given route, any scarcity rents will be competed away by airlines switching an increasing number of slots to serve capacity constrained routes. In other words, if a given route were capable of producing scarcity rents then other airlines would shift their seats away from a less profitable route and toward the capacity constrained route, in order to earn the observed scarcity rents. Eventually, as supply for the capacity constrained route increases, prices will fall, and thus the scarcity rents will be competed away.

6.5 This is illustrated in Figure 6-1 and Figure 6-2 below.

6.6 Suppose two airlines: Airline A and Airline B, both of which only have one aircraft (both aircraft and airlines are homogenous). In Figure 6-1 below, Route A is served by Airline A, and is not capacity constrained. Therefore, no scarcity rents are earned on Route A. Route B is served by Airline B, and is capacity constrained, allowing Airline B to earn scarcity rents of Area B_1.

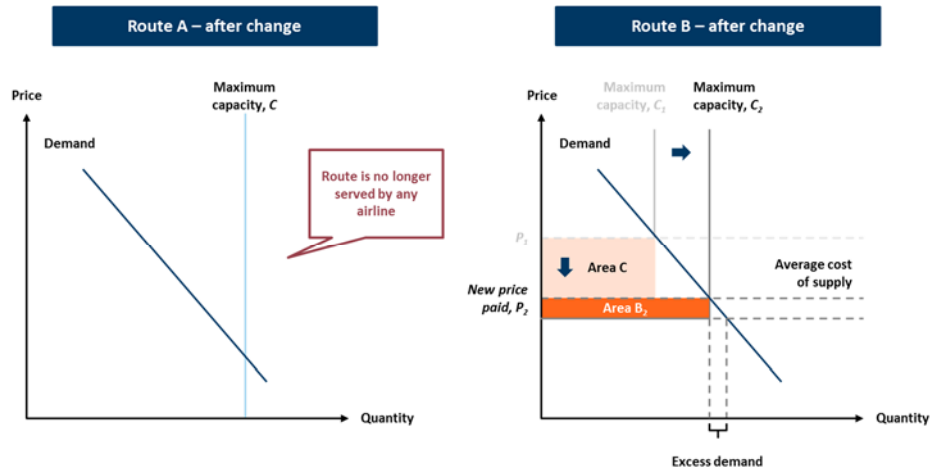
[51] IAG Response, Appendix A, pp 15, FN28.

Figure 6-1: Illustration of IAG Response, before change



6.7 Observing scarcity rents being earned at Route B, Airline A would switch its capacity away from Route A to Route B. This shifts the capacity constraint from C_1 to C_2, which reduces the total amount of scarcity rent available to both parties. The scarcity rent on Route B has now fallen by Area C, and each airline earns half of Area B_2 in scarcity rents. Generalised to the Heathrow case with multiple airlines and multiple routes, IAG argues that all routes will eventually have their scarcity rents competed away, and some routes will eventually go unserved.

Figure 6-2: Illustration of IAG Response, after change



6.8 IAG's argument is essentially that capacity constraints at Heathrow are manifested as a reduction in consumer choice, as airlines shift seat capacity to more capacity constrained flights.

6.9 However, we consider there are two issues which IAG does not appear to have considered:

- airlines are likely to benefit from the network effects of serving multiple routes; and
- airlines will not have an incentive to switch away from routes that already have capacity constraints.

Network effects

6.10 Airlines are likely to gain from the network effects associated with serving multiple routes. Suppose a given airline has two slots, and can choose to assign:

- both slots to serve Route A (for example, JFK – Heathrow);
- both slots to serve Route B (for example, Heathrow – Hong Kong International Airport); or
- one slot to each of Route A and Route B.

6.11 Network economies of scale can be said to exist when an airline that operates on both Route A and Route B (Airline 1) faces more favourable demand or cost conditions than two other airlines (Airline 2 and Airline 3) serving Routes A and B separately.[52] Airline 1 could time its Route A and Route B flights such that a passenger intending to fly both routes (in the example above, from JFK to Hong Kong via Heathrow) would be more likely to purchase tickets from Airline 1, rather than purchase one ticket from Airline 2 and one ticket from Airline 3. Airline 1 could also schedule its Route A flights at times that would be unpopular for Route B passengers, allowing it to optimise its flight schedules.[53]

6.12 Airline 1 therefore gains an advantage from serving both Route A and Route B. Even if, say, Airline 1 observes that Route A has higher scarcity rents associated, then it may not choose to switch both slots to Route A since it would lose the benefits of the network effects described above. Therefore, it is unlikely that airlines at Heathrow would make their route allocation decisions based only on consideration of scarcity rents on each route. Indeed, it is likely that airlines at Heathrow (and in general) make their route allocation decisions based on a variety of factors that affect profitability, and not simply on the scarcity rents on each route.

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52 Pustay, Michael W. (1980) Airline Competition and Network Effects.

53 Ibid. Note that the logic still holds true even if airlines work together in an alliance.

6.13 We understand from discussions with the CAA that airlines themselves are constrained in route choice. While there are some regions which have adopted a more liberal approach to market access in air services (such as the intra-EU single aviation market, or the EU-US agreement that any EU or US airline can serve any route between the EU and US), the international norm is for countries to agree air services bilaterally. We further understand that these Air Services Agreements ("ASAs") vary greatly in the restrictions they place on market access. Virtually all confine access to airlines which are majority owned and controlled by nationals of each country (hence the prevalence of single national 'flag' carriers in some markets). The most illiberal ASAs restrict: (i) the number of airlines that each side can designate; (ii) the routes they can fly; (iii) the frequency at which they can operate; and (iv) the fares they can charge. In such markets, therefore, an airline may not be able to serve a route even if it wished to.[54]

Routes that are currently constrained

6.14 IAG's worked example of an airline deciding to switch from one route to another fails to consider if its initial route was capacity constrained in the first place.

6.15 Suppose Airline 1, operating on Route A, observes large scarcity rents being earned by Airline 2 on Route B, due to Route B's capacity constraint. Following IAG's logic, Airline 1 has an incentive to shift its capacity to serve Route B, competing away the scarcity rents earned by Airline 2.

6.16 However, suppose Route A is similarly capacity constrained, and therefore earns some scarcity rents. If the *whole* scarcity rent at Route A is greater than the *proportion* of the scarcity rent it is likely to earn at Route B, Airline 1 has no incentive to switch to Route B.

6.17 One could generalise this example (and continuing to follow IAG's logic of quantity competition) to Heathrow's case of many airlines and many routes. In principle, in equilibrium, the scarcity rents on each route would equalize.

6.18 Therefore, scarcity rents can exist even when airlines are free to choose which routes to operate on if the airport in aggregate is capacity-constrained.

[54] As an example, we understand from the CAA that the London to Cairo route is served by just two airlines: British Airways (daily) and Egyptair (twice daily). The ASA limits airlines of each side to no more than 14 round-trip services per week. Therefore, new entry on this route is currently confined to an airline designated by the UK (which must be EU-owned and controlled) operating up to seven services per week.

Scarcity rents accrue to airports rather than airlines

6.19 The IAG Response claims that *"shares in HAL (reportedly) currently trade at a significant premium to RAB equity, while those in IAG currently trade at a discount to assets and at around 50% of the FTSE valuation"*.[55] The IAG Response suggests that, as HAL appears to be seen to be far more valuable than IAG to shareholders, it must be the case that any scarcity rents that do exist at Heathrow accrue to HAL rather than to airlines. It claims that *"interested shareholders undoubtedly recognise the economic reality of LHR* [London Heathrow]*, it is those of HAL (not airlines) who collect a congestion premium."*[56]

6.20 Further, the IAG Report also argues that if scarcity rents accrue to IAG, then the elimination of those same scarcity rents (as measured by the Frontier Report) would bankrupt IAG. The conclusion drawn is that IAG cannot be earning a scarcity premium currently.

Inconsistency of arguments

6.21 It appears to us that the principal argument in the IAG Response as a whole is that scarcity rents do not exist, and that the capacity constraint at Heathrow is not expressed in monetary terms, but in a reduction in passenger choice.[57] However, the suggestion that scarcity rents accrue to HAL – "*it is* [shareholders of] *HAL who collect a congestion premium*"[58] would of course be inconsistent with this position.[59]

Trading premiums of HAL shares

6.22 It is difficult to assess the meaning of IAG's comments on the supposed premium at which HAL's shares trade over RAB equity without more information. HAL is a privately-owned company and its shares are not publicly traded. HAL shares therefore do not have an observable market value in the same way as those of IAG.

6.23 To the extent that IAG's conclusions are based on some information on a particular transaction in HAL's shares that is known to IAG, then more information on this transaction would be required to comment further on IAG's assertions.

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55 IAG Response, Appendix A, ¶25.

56 IAG Response, Appendix A, ¶26.

57 IAG Response, Appendix A, 'HAL does not understand the economics of LHR'.

58 IAG Response, Appendix A, ¶26.

59 IAG Response, Appendix A, 'HAL does not act like a commercial business'.

6.24 However, we would note that, even if there were some observable prices for transactions in HAL shares, then those transactions would need to be carefully considered, and limited conclusions could be drawn from a very small number of transactions. This is because, as a private company, HAL's shares are not traded in a liquid public market, and the transactions may therefore only reflect the particular appetites of a few buyers and sellers.

6.25 We note that in 2014 HAL sold Airport Holdings NDH1, a holding company that owns and operates the airports in Glasgow, Aberdeen and Southampton.[60,61] As this transaction was unrelated to Heathrow airport, it is not clear how this transaction is a relevant comparable to IAG's market valuations. Transfers in this asset are unlikely to be relevant to the value of Heathrow.[62]

6.26 Notwithstanding all of the above, we consider that a simple consideration of trading premiums would not, in and of itself, suggest that economic rents were being earned by HAL.

Effect on BA of the removal of scarcity rents

6.27 IAG further notes that the removal of the fare premium (which IAG and the Frontier Report both assume is the scarcity rent per passenger) implied by the Frontier Report of £59/passenger would result in BA making an operating loss of GBP 483m. This is illustrated in Table 6-1 below.

Table 6-1: Effect of the removal of scarcity rents on BA

	Values	Values GBPm
BA pre-tax trading profits before expansion *[A]*		1,700
Scarcity rents per passenger *[B]*	GBP 59/passenger	
Total BA passengers in 2017 *[C]*	37 million	
Implied BA scarcity rents *[D] = [B] x [C]*		(2,183)
BA pre-tax trading profits after expansion *[E] = [A] – [D]*		**(483)**

Sources: IAG Response, Appendix A, ¶27.

60 Capital IQ – Heathrow Airport Holdings Limited – Dec 2014 Transaction Details.

61 Airport Holdings NDH1 Annual Report, 31 December 2016; Airport Holdings NDH1 Annual Report, 31 December 2014.

62 We would note that many regulated assets in the UK attract high equity valuations, because the stability of those returns is highly valued especially by international investors and by investors seeking long-term stable returns (such as pension funds). This is a function of the well-regarded regulatory environment, rather than of the profit level per se of the companies.

6.28 However, even if IAG was 'unprofitable' on any particular measure, it would not necessarily imply it was not accruing scarcity rents at Heathrow. For example, operations at other airports could be loss-making, or the value of the scarcity rents could be captured by other parts of the airline operation value chain (for example, support services, pilot wages, etc.) or could even be absorbed by inefficiency.

7. Conclusions

7.1 The Frontier Report and the IAG Response represent viewpoints in the context of ongoing engagement between the CAA and stakeholders. We consider that both documents have merits and present arguments that are worth further consideration. However, both documents contain flaws which, in our view, undermine confidence in the robustness of their conclusions. In this section, we conclude on the key drawbacks of each report, before highlighting where we consider further work needs to be conducted.

Frontier Report

7.2 With respect to scarcity rents, the Frontier Report's key conclusion is that *"if Heathrow were expanded today, ticket fares would decrease by 23% relative to other London airports as a result of removing the capacity constraint"*.[63]

7.3 Our overall view is that the analysis in the Frontier Report does not definitively support that conclusion.

7.4 Firstly, this is because the econometric analysis underpinning the estimated scarcity rent of 23% suffers from several shortcomings, and in particular:

- The residual approach used implicitly assumes that all differences in price other than those reflected in the regression model can be attributed to scarcity rents.
- Aggregated data is used, which means that the fares on the least busy routes have a greater impact on the coefficient estimates than the busiest routes.
- The analysis likely suffers from omitted variable bias, where relevant explanatory variables are missing from an econometric model. For example, Frontier's econometric models fail to account for differences in within-airport route competition.
- Some coefficients appear unstable, indicating that the coefficient estimates are biased in at least some of these model specifications.

[63] Frontier Report, pp 5.

7.5 In addition to the above, we have concerns that Frontier simply assume that whatever the scarcity rent identified, ticket prices will fall by the same amount. This relies on two other assumptions, which the Frontier Report does not discuss:

- First, that expansion completely removes the capacity constraint. The Frontier Report's conclusion assumes that Heathrow's planned expansion will eliminate the current capacity constraints at Heathrow.
- Second, that aero charges (per passenger) do not change as a result of expansion. At this early stage, it is not possible to be definitive on how the aero charges per passenger would change post expansion, but is of course likely that this would have an impact on post-expansion ticket prices.

IAG Response

7.6 The IAG Response suggests that scarcity rents are competed away at Heathrow through airlines switching to serving capacity constrained routes. However, this argument fails to consider the network effects of an airline serving multiple routes at a hub like Heathrow and the disincentive for an airline to switch away from a route that is already capacity constrained.

7.7 The IAG Response also puts forward two apparently contradictory arguments:

- scarcity rents do not exist as the capacity constraint at Heathrow is expressed in monetary terms; and
- scarcity rents do exist, but accrue to HAL rather than airlines.

7.8 In terms of the possibility of scarcity rents existing, but accruing to airlines, IAG's response does not in our view present compelling evidence. For both airlines and HAL, the financial position alone cannot provide strong evidence either way on scarcity rents.

Areas of further investigation

7.9 Our view is that scarcity rents can, in principle, apply to airports although further detailed work may be required to quantify them with more confidence, given (i) the complexity of the market; and (ii) the drawbacks identified in Frontier's analysis.

7.10 Further work might consider:

- specifying the dependent variable at a more granular level, that is, at the level of individual flight ticket;

- controlling for a wider range of explanatory variables, including (but not limited to) variables accounting for passenger preferences for flying from different airports, and differences in within-airport route competition; and
- performing further and more detailed diagnostic tests of the relevant regression specifications.

7.11 Given the way that Heathrow is regulated, it seems unlikely to us that scarcity rents could be accrued by Heathrow. However, the factors that could potentially inhibit ticket prices from falling as far as any identified scarcity rent premium – such as the extent to which a third runway at Heathrow would eliminate scarcity at Heathrow, or the role played by the nature of competition between airports and airlines – might also be considered further.

Appendix 1 Frontier Report main regression specification and results

A1.1 This appendix summarises the Frontier Report's main regression specification and results. Note that several different regression specifications are presented in the Frontier Report (as is the standard approach for econometric analysis).

$$ln(Fare)_i = a + \beta_1 Distance_i + \beta_2 Long\ haul + \beta_3 ln(Frequency\_Own)_i + \beta_4 ln(Frequency\_Other)_i + \beta_5 Business_i + \beta_6 VFR_i + \beta_7 Transfer_i + \beta_8 LCC_i + \beta_9 LHR_i + \varepsilon$$

A1.2 The variables and the results are summarised in Table A1-1 below.

Table A1-1: Frontier model specification

Variable	Interpretation	Coefficient estimated
Distance	Holding everything else constant, an increase in distance of one nautical mile will increase the price by β_1%.	0.000306***
Long haul	Holding everything else constant, on average, the fare for long haul flights is β_2% higher than the fare for short haul flights.	0.269**
Frequency_Own	Holding everything else constant, a 1% increase in the number of flights to the same destination at the same airport is associated with a β_3% increase in fare.	0.0306*
Frequency_Other	Holding everything else constant, a 1% increase in the number of flights to the same destination at other airports is associated with a β_4% increase in fare.	-0.00182
Business	Holding everything else constant, a one percentage point increase in business passengers on this route is associated with a fare increase of β_5%.	0.215
VFR	Holding everything else constant, a one percentage point increase in passengers who visit friends and relatives on this route is associated with a fare increase of β_6%.	-0.203***

Variable	Interpretation	Coefficient estimated
Transfer	Holding everything else constant, a one percentage point increase in transfer passengers on this route is associated with a fare increase of β_7%.	0.411**
LCC	Holding everything else constant, a one percentage point increase in passengers who fly with low cost carriers on this route is associated with a fare increase of β_8%.	-0.382***
LHR	Holding everything else constant, on average, the fare for a flight on this route from Heathrow is β_9% more expensive than the same flight from the other airports in the sample.	**0.233*** **

*Notes: *** the result is statistically significant at the 1% level. ** significant at the 5% level. * significant at the 10% level*
Source: Frontier Report, Annex A, pp 64, Figure 50.