



UNIVERSITY OF LEEDS

Independent Peer Review of Recent Research on the Existence of Scarcity Rents at Heathrow

FINAL REPORT

Richard Batley, Phill Wheat & Peter Mackie

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1 NON-TECHNICAL SUMMARY

This report documents a review on the topic of scarcity rents at Heathrow. The background is that several reports and papers have been written by and for various parties in which there is not a meeting of minds on this subject, and the CAA has therefore sought an independent opinion of this body of work. The review is organised around a series of questions, and cites various academic papers and consultants reports relevant to the arguments.

1.1 What are scarcity rents?

Scarcity rents are excess profits caused by capacity limits, typically slot restrictions at airports. Consider a situation in which capacity utilisation at an airport serving a city region is close to its limits and demand is growing over time. Assume that there are no close substitutes for the airport. Ultimately, as capacity limits are approached, demand will need to be rationed to available capacity. This rationing could be by quantity, but in Western economies will be by price. The scarcity rent is the excess of the market clearing price over the uncongested price. Who receives this rent depends on the regulatory regime facing the various parties such as the airport, the airlines and the Government, including who has the property rights to the slots.

1.2 Why do scarcity rents matter?

They matter for several reasons. The regulator (CAA) is charged with protecting the interests of consumers, so if prices rise sharply in real terms because of scarcity, this affects their remit. Government, in considering the case for new capacity, needs to estimate the balance of effects on prices of the reduction or elimination of scarcity rents versus any increase in aero charges required in order to fund the capacity enhancement.

1.3 Is scarcity the only source of rent to the airport/airline system?

No. The fundamental source of rent is market power. There are economic and historical reasons why hubs are an efficient way of creating connectivity through interchange. This is likely to be associated with small group competition in particular markets possibly with entry barriers. Marketing phenomena such as frequent flyer points, travel agent commissions, ownership of slots and gates are supporting factors. But slot scarcity accentuates market power, operating in conjunction with the other market factors, often referred to as hub dominance. Given that different sub-markets have different elasticities, slot scarcity is likely to push the shape of what is provided at a hub in the direction of the least elastic traffics with the highest mark-ups. A corollary is that if new capacity is brought on-stream, the shape of the service provision at the hub will change.

1.4 Are scarcity rents directly observable?

No. It follows from the above that scarcity rents are an element in an overall economic system and are not directly observable. But that does not mean they do not exist; it means that they need to be observed indirectly, and that precision is problematic. But that is true of much modelling and forecasting within the transportation sector.

1.5 How might scarcity rents be observed?

There seem to be four possible avenues. The first is to observe what is happening in the secondary slot market and convert that into an equivalent price per seat. What seems clear is that there are very different values by time of day/week, so at the very least it is not credible to say that there is no scarcity value of a Mon-Fri morning arrival/departure slot pair at Heathrow. However, the secondary market is relatively thin and whether the reported trade values are representative of the value of all slots in a particular time period is open to question.

The second is to observe price differences for city-pairs between congested and uncongested airports. Again, this is a useful thing to try to do, but there are multivariate problems – ideally we want to control for differences in the traffic composition (journey purpose, class of travel, flexibility of ticket etc.), differences in the airlines' offers (seat pitch, meals, frequent flyer points etc.), differences in the access costs to the airports, differences in aero charges, congestion costs and turnaround times. We believe that price differences are the outcome of an amalgam of effects rather than a pure scarcity rent.

The third is to do some kind of accounting study of airline balance sheets. Airlines clearly 'own' valuable property at capacity constrained airports, and how they handle that in their accounts is of interest. Specifically, if airlines view scarce slots as tradeable assets, then this has implications for the calculation of equivalent price premia.

The fourth is to examine the dynamic interaction between demand and supply across relevant airport networks, and infer the equilibrium 'shadow price' arising at any given airport which needs to impose a price premium to match demand with available capacity.

1.6 Does economic theory suggest there could be a scarcity rent at Heathrow?

The papers we have read conjecture that the marginal cost curve for Air Traffic Movements (ATMs) is a reverse L shape, given fixed infrastructure capacity, permitted times of operation etc. However, we feel that there is a lack of clarity concerning short vs. long run properties of the cost function. In practical terms, we would conjecture that there are three relevant permutations:

- Plane size/route structure fixed and infrastructure fixed – which we would characterise as the very short run
- Plane size/route structure variable, infrastructure fixed – short run
- All factors variable – long run

Thus, in the short run, we might expect there to be more of a three-part curve – the uncongested section, an upward sloping section where more movements can be handled at the expense of increased queues, delays and turnaround times, and a vertical section given technology, departure intervals, approach controls etc. Airlines supply ATMs but sell seats. In the vicinity of capacity for ATMs, a number of behaviours make seats a bit more elastic than ATMs – larger planes replace smaller on given routes, frequencies on thick routes with wide bodies displace frequencies on thinner routes with narrow bodies, load factors increase as

travellers accept less preferred departure times. So until every departure out of Heathrow is a full A380, there can be some seat growth without ATM growth, assuming terminal facilities, gates and the availability of aircraft are not the ultimate constraining factors.

So we see the realistic short run marginal cost (SRMC) curve as strongly upward sloping as capacity is approached – but not literally vertical. This suggests that scarcity rents are likely to vary quite appreciably by time of day/week and by ticket type. Presenting a single average number (£x per seat) could be very misleading in terms of the pattern of impact, even if arithmetically correct. Moreover, most of the burden of adjustment to exogenous demand growth has to be taken on the price side, so even if scarcity rents are low today, they might grow quite quickly. In this context, the crucial moving parts are the shape of the SRMC per seat curve and the demand/supply interaction at Heathrow (which depends partly on what is offered at other London airports and the degree of substitutability in the system). But overall, we think theory supports the notion that in airports where utilisation is 99% of rated capacity, scarcity rents of some scale are likely to arise.

1.7 To whom does any such scarcity rent accrue?

In principle, the rents could accrue to some combination of Government, airport operator and airlines, depending on who ‘owns’ the slots and whether/how the airport is regulated. In London, Heathrow is a regulated entity so aero charges are set on the basis of a permitted revenue yield relative to the Regulated Asset Base. So the airport operator is not able to increase aero charges so as to cream off the scarcity rent as they would in an unregulated environment.

That does not mean that the airport operator may not enjoy rents of other kinds. For example, if the RAB is set too high, or can be manipulated, or the permitted yield per unit of RAB is set too high, or there is regulatory lag which takes time to adjust the formula as traffic grows, then the airport operator will receive rents or supernormal profits. Whether economic regulation of Heathrow and Gatwick is efficient is beyond our brief. But if there are rents to the airport operator, they are not scarcity rents.

We conclude therefore that any scarcity rents accrue to the airlines as ‘owners’ of the valuable property. This is why, albeit in a thin market, slots at London Heathrow (LHR) are willingly exchanged for money. So then the question must be confronted *‘If airlines benefit from these scarcity rents, why aren’t they highly profitable?’*. One answer could be that the scarcity rents might not be very large, no more than a few pounds per passenger on average at the present day. Another is that some of the rents might be accruing not to the airline firm/shareholders but for example to existing and legacy labour through terms and conditions and pension commitments. A further answer could be that above-average profits on some routes may be offset by less profitable routes elsewhere within a given airline network. Some of the answers might be found by studies of the cost-side rather than the demand-side. Network airlines offer a product which is differentiated from point-to-point airlines and incur costs in order to do so. In assessing evidence for rents, price differences (and changes in) should be adjusted for cost differences (and changes in).

1.8 Does the empirical evidence suggest there could be a scarcity rent? How reliable is this evidence?

Both Frontier (2019) and SEO/Cranfield (2017) are pieces of work which should be taken seriously, and should form part of the evidence base on which informed judgement should be made. However, these studies are not without their limitations, key among which are the following:

- The fares data is average route revenue, when ideally, finer resolution by time of day, business/economy etc. is desirable.
- The SEO/Cranfield approach of representing scarcity rents by a measured variable (capacity) is useful in separating out the influence of this factor from other unexplained factors. We prefer this approach to Frontier's use of airport specific dummy variables.
- Notwithstanding the previous point, the representation of capacity within both Frontier (2019) and SEO/Cranfield (2017) is overly simplistic, and we believe that there is scope to significantly strengthen this.
- There is a clear advantage in using panel data rather than cross-sectional; if further work is done, we would consider the use of a panel with airport-specific effects constant over time.
- The fares data is travel agency ticket sales data which only accounts for about half the market, although there is some adjustment of the raw data to reflect sales across all channels. It would be prudent to commission a detailed audit of this data to determine fitness for purpose.

We agree with the approach taken by Frontier (2019) in adopting a triangulation approach built around analysis of fares data, analysis of slot trading including their accounting treatment, and shadow cost approaches such as NAPAM. The value-added comes from interrogating each of the approaches in the light of the others.

1.9 What would happen to the rent if capacity were increased?

It is clear from theory that, if capacity is increased, rent will reduce, all else equal. However, in order to quantify this, the practical challenge is to forecast forward from the analysed position in the base year, say 2018, to the position in 2030 and 2040 during the life of the airport system both with and without enhanced capacity. Building a more secure description of the base year is one thing; using the model in predictive mode is another.

1.10 Recommendations

How to move forward from the position reached in summer 2019 is partially dependent on the timelines and decision points within which the scarcity rents issue is being addressed. But we think the following commissions could be considered by the regulator:

- Further work to enhance the existing regression analysis by Frontier (2019) by better treatment of congestion and capacity as outlined in section 6.3.
- A review and audit of the fares data, its representativeness of the market as a whole, and its fitness for purpose in this application, together with any recommendations for improved data, relevant disaggregation and validation.

- A small scoping study to assess the scope for re-couching the econometric model in terms of generalised cost rather than fare, especially with a view to achieving better representation of supply-side responses to congestion.
- Further work on the airline cost side to help determine whether price differences are partly a reflection of cost differences.

Alongside these suggestions for further commissioned work, the core of the way forward lies in policy work to develop the triangulation approach used by Frontier (2019) and described in Chapter 6. It would be useful if the fares approach and the analysis of the slot market were taken forward. More attention could be given to the insights from the NAPAM model since this incorporates demand/supply interaction which is helpful in representing what happens close to capacity. A crucial question for policy is how to forecast scarcity rents forward to 2030 and 2040. Sound judgement and interpretation of the different strands of evidence and their robustness will be essential.

2 INTRODUCTION

Our review is organised around the following questions, each of which accounts for one of the following chapters in the report:

- Chapter 3: Given the current regulatory regime in the UK, does theory suggest that there could be a scarcity rent at Heathrow?
- Chapter 4: Does the empirical evidence from fares analysis suggest that there could be a scarcity rent?
- Chapter 5: To whom does any such rent accrue?
- Chapter 6: What can be done to strengthen analysis of scarcity rent at Heathrow?
- Chapter 7: Combining theory and evidence, what do the findings tell us in terms of understanding the concept of scarcity rents and their existence at Heathrow?

Annex A extracts key arguments directly from the various consultants reports and offers a brief response to each such argument. Annex B is a technical annex relating to Chapter 3.

The context of this report is as follows. The Airports Commission¹ recommended to Government that a third runway and associated works should be constructed at Heathrow to expand capacity. The economic case consisted of the following components:

- The benefits to passengers in terms of lower air fares and improved accessibility to the air transport system relative to the Do-Minimum;
- The impacts on the wider economy;
- The environmental and local area impacts;
- The effects on airlines of reduced scarcity rents especially at Heathrow but also in the future at Gatwick;
- The capital and running costs of the capacity and the way this would be ultimately funded via aero charges.

The Civil Aviation Authority is the economic regulator for Heathrow and Gatwick. Its core remit is to consider the interests of air passengers in the regulatory decisions it makes, most obviously on the setting of aero charges now and over time and specifically the way in which the CAPEX for Runway 3 etc. is to be incorporated into the Regulated Asset Base (RAB).

In principle, there are two categories of passengers who will be affected by the new capacity at Heathrow. LHR is a constrained airport operating at over 99% of available runway capacity.

¹ The Airports Commission (2015) 'Final Report'. Available at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/440316/airports-commission-final-report.pdf

Providing more capacity will enable increased frequencies and new routes. This will divert some passengers who prefer LHR but are squeezed out by capacity constraints and generate some new traffic which would not otherwise fly. The relevant elasticities and response properties within DfT's aviation modelling suite² are what drive the forecasts of this induced traffic. That is not the subject of this report, but is an important element in the overall cost-benefit analysis.

The other group affected by the new capacity is existing passengers using Heathrow. Potentially, there are two countervailing effects on them (leaving to one side any surface access improvements). Firstly, air passengers as a group will need to fund the capital expenditure over its life through aero charges. Secondly, there are argued to be scarcity rents at congested airports, of which LHR is one (see for example Starkie (2008)³). Supposing this to be the case, the additional capacity would increase competition and ticket prices would fall. The relative sizes of these two effects determine whether from a fares point of view passengers stand to gain or lose. There may also be non-fare effects on passengers and in a traffic growth environment the balance between the two effects could be expected to change over time.

In its Final Report, the Airports Commission (2015)⁴ judged that capacity expansion would not impact upon passenger fares, as the increase in airport charges resulting from expansion would not be passed through to passengers by airlines (p120). Over the period 2017-19, several key stakeholders have commissioned reports on this topic, summarised as follows:

- 2017: Heathrow Airport Limited (HAL) commissioned Frontier Economics to produce a report entitled *'Competition and Choice 2017 – A Report Prepared for Heathrow'*⁵. This report included an econometric analysis of airline fares and used the results of that analysis to conclude that fares would *'decrease by 23% relative to other London airports as a result of removing the capacity constraint'*.
- International Airlines Group (IAG) responded with a critique of the Frontier (2017) report and their own assessment of the impact of capacity constraint at Heathrow airport⁶.

² DfT (2017) UK Aviation Forecasts, available at: <https://www.gov.uk/government/publications/uk-aviation-forecasts-2017>

³ Starkie, D. (2008) Aviation Markets. IEA Studies in Competition and Regulatory Reform, Ashgate (especially Chapter 5 on 'Reforming Airport Regulation'.

⁴ Airports Commission (2015) Final Report, available at: <https://www.gov.uk/government/publications/airports-commission-final-report>

⁵ Frontier Economics (2017) 'Competition and Choice 2017 – A Report Prepared for Heathrow'. Available at: https://www.caa.co.uk/uploadedFiles/CAA/Content/Accordion/Standard_Content/Commercial/Airports/HAL%20-%20Frontier%20Competition%20and%20Choice.pdf

⁶ Letter to Stephen Gifford, Consumer & Markets Group, Civil Aviation Authority, dated 6th July 2018, available at:

- 2018: CAA commissioned FTI to produce a report '*A Critique of Published Reports Regarding Scarcity Rents at Heathrow Airport*'⁷, which assessed the economic rationale and econometric analyses within the Frontier (2017) report and the IAG response. This report also identified areas where additional analysis could further illuminate these issues.
- 2018: IAG released a subsequent report entitled '*The Effect of Congestion at Heathrow Airport – Comments on Frontier and FTI Reports*'⁸ by RBB Economics. The report commented on the earlier Frontier (2017) and FTI (2018) reports, arguing that an increase in the cost of congestion was unlikely to cause ticket prices to increase. The report did not however present definitive evidence on the existence or scale of scarcity rents.
- 2019: HAL commissioned Frontier Economics to undertake a further study '*Estimating the Congestion Premium at Heathrow*'⁹. Instead of focussing upon econometric analysis as per their 2017 report, Frontier broadened their scope to incorporate two further analyses – namely: a) analysis of demand/supply interaction and the shadow price needed to 'choke off' excess demand and b) analysis of slot prices – and then sought to 'triangulate' between the three approaches.
- 2019: CAA commissioned FTI to undertake a further study '*Scarcity rents and slot prices at Heathrow Airport*', which is still in progress. This work employs data on the reported prices of slots traded in the secondary market at Heathrow airport as an 'indicator' of the level of scarcity rents.

Whilst the aforementioned portfolio of studies is the focus of our review, we also draw substantively on three further studies, namely:

- Airports Commission (2015) '*A Note from Expert Advisors, Prof. Peter Mackie and Mr Brian Pearce, on key issues considering the Airports Commission Economic Case*'¹⁰.

https://www.caa.co.uk/uploadedFiles/CAA/Content/Accordion/Standard_Content/Commercial/Airports/Files/IAG%20CAP1658%20response%20FINAL.pdf

⁷ FTI Consulting (2018) '*A Critique of Published Reports Regarding Scarcity Rents at Heathrow Airport*'. Report to CAA. Available at: <http://publicapps.caa.co.uk/docs/33/CAP1722b%20FTI%20Consulting%20-%20Report%20to%20CAA%20on%20Scarcity%20Rents%20-%20Final%20-%2030%20October%202018.pdf>

⁸ RBB Economics (2018) '*The effect of congestion at Heathrow Airport – Comments on Frontier and FTI reports*'. Report to IAG.

⁹ Frontier Economics (2019) '*Estimating the Congestion Premium at Heathrow*'. Available at: https://www.caa.co.uk/uploadedFiles/CAA/Content/Accordion/Standard_Content/Commercial/Airports/H7/Estimating%20the%20congestion%20premium%20at%20Heathrow.pdf

¹⁰ Airports Commission (2015) '*A Note from Expert Advisors, Prof. Peter Mackie and Mr Brian Pearce, on key issues considering the Airports Commission Economic Case*'. Available at:

This note summarised some of the key issues of relevance to the Economic Case for airport expansion. On scarcity rents, the note concluded: *'Our view is that the assumptions concerning the working of the market for slots and the transfer of scarcity rents between producers and consumers produce CBA results which are a little conservative. It is vital to remember that the Do-Minimum reference case is a journey into the unknown and it is inherently more difficult to predict the behaviour of the actors in highly constrained conditions than in what, over the appraisal period, is broadly a facilitation strategy designed to accommodate demand growth'* (p3).

- Another report commissioned by the Airports Commission from SEO Economic Research (2015) *'Expanding Airport Capacity: Competition, Connectivity and Welfare: Discussion of Options for Gatwick and Heathrow'*¹¹ also deserves attention. This report argued that airlines at Gatwick and in particular at Heathrow generate scarcity rents due to excess demand and price capping of charges. Furthermore, the report showed that these scarcity rents would increase in the future under a Do-Minimum scenario, because excess demand would increase further if no additional airport capacity were to become available. The study assumed that any increases in aero charges would be absorbed by the airlines through reduction in airline scarcity rents.
- Last but not least, SEO & Cranfield University (2017) *'The impact of airport capacity constraints on air fares'*¹² conducted econometric analysis to investigate whether air fares were higher at airports subject to excess demand. They concluded that: *'...higher levels of capacity utilisation are indeed associated with higher air fares, all other things being equal. We estimate this total additional fare premium at congested European airports at €2.1 billion today. Airport capacity shortages in Europe are becoming increasingly severe. Based on EUROCONTROL's 'Challenges of Growth' forecasts, the total fare premium levied by airlines at congested airports is projected to reach € 6.3 billion by 2035'* (page i).

Across the 2017-19 reports, there is very little symmetry of views between the airport operator (HAL) and the main airline operator (IAG) at Heathrow. Consultants for HAL argue that there is evidence from ticket prices of appreciable scarcity rents enjoyed by airlines at LHR. Consultants for IAG argue that the analysis is flawed, and IAG argue that there are no scarcity rents or alternatively if there are, they accrue to the airport operator, not the airline. There is also disagreement over the size of the change in aero charges required to fund the scheme.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/438981/economy-expert-panelist-wider-economic-impacts-review.pdf

¹¹ SEO Economics (2015) Expanding Airport Capacity: Competition, Connectivity and Welfare – Discussion of Options for Gatwick and Heathrow. Report to the ITF of the OCED. Available at: https://www.itf-oecd.org/sites/default/files/docs/15cspa_airports-discussion-options.pdf

¹² SEO Amsterdam Economics & Cranfield Centre for Air Transport Management (2017) The impact of airport capacity constraints on air fares. Report for ACI EUROPE.

To help shed light on the relative merits of these competing arguments, the CAA has commissioned ITS Leeds to provide a commentary on the various reports, give a view, and suggest ways forward. To be clear about the scope of our work, we have been asked to consider the issues from two standpoints:

- 1) from the standpoint of economic theory;
- 2) from the standpoint of empirical analysis, focussing especially on econometric analysis of fares data.

It should be acknowledged that some of the aforementioned reports bring to bear other forms of empirical analysis, namely analysis of the secondary slot market, analysis of demand/supply interaction and the shadow price of capacity, and analysis of airline/airport balance sheet position. These alternative empirical analyses will be referred to at various junctures in our report, but detailed review falls outside our terms of reference.

3 GIVEN THE CURRENT REGULATORY REGIME IN THE UK, DOES THEORY SUGGEST THAT THERE COULD BE A SCARCITY RENT AT HEATHROW?

This chapter draws upon technical concepts from economic theory to consider whether there could be a scarcity rent at Heathrow. It should be emphasised that this chapter represents an ‘in principle’ discussion – even if the theoretical argument is made that a rent could arise, it does not necessarily follow that a rent will manifest ‘in practice’. The latter will be the concern of subsequent chapters of this report.

3.1 Comments on the theoretical framework presented by Frontier and FTI

The Frontier (2017) and FTI (2018) reports present a simplified and highly stylised representation of the market for seats on competing routes A and B operated by different airlines from a capacity-constrained airport such as Heathrow¹³, whereby:

- Demand is linear and downward sloping; it should be acknowledged that linearity is a common expositional simplification, but is unlikely to hold in practice.
- Short run marginal costs are constant (implying that $MC=AC$); again, this seems a reasonable expositional simplification, although in practice it is possible that the supply function could to some extent be upward sloping, and that MC could deviate from AC. In the context of LHR, MC will comprise operating costs directly incurred by airlines plus taxes and charges imposed by Government and the regulator respectively.
- At some quantity, supply is subject to a hard (vertical) constraint, which in the present context will be dictated by the availability of slots, planes and the size of those planes. Again this construct would seem reasonable in terms of expositional convenience, although in practice it is possible that the constraint could be more graduated, reflecting some degree of supply-side flexibility in managing capacity (we will return to this point below).
- Routes A and B represent separate sub-markets subject to different capacity constraints.

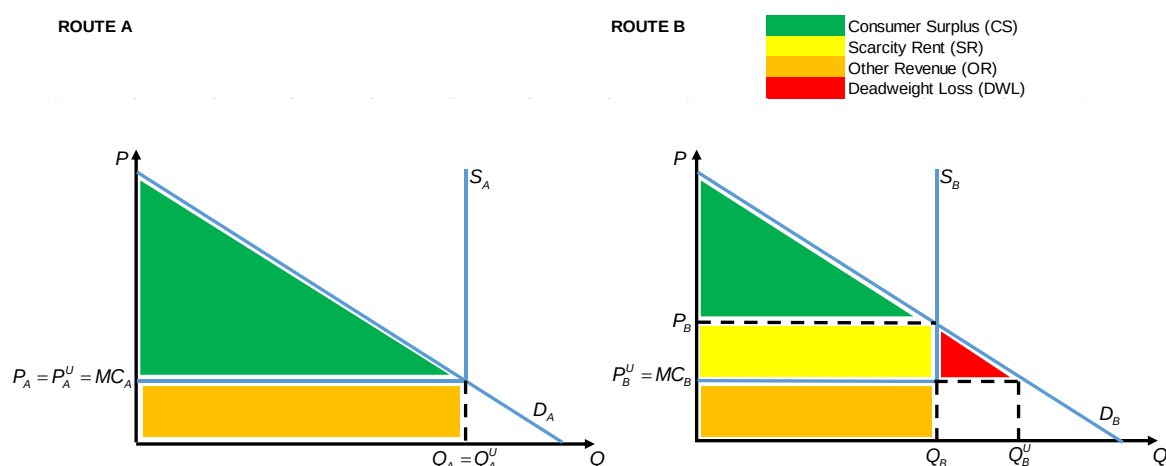
The essence of this is illustrated in Figure 3.1 below. Whereas the Frontier (2017) and FTI (2018) reports employ such diagrams to illustrate the prevalence and scale of scarcity rent, here we show the broader welfare impact on all relevant economic agents¹⁴. That is to say,

¹³ This stylised representation is also consistent with that shown in Appendix A of TAG Unit A5.2 Aviation Appraisal, available at: <https://www.gov.uk/government/publications/webtag-tag-unit-a5-2-aviation-appraisal-may-2018>

¹⁴ Appendix A of DfT TAG Unit A5.2 ‘Aviation Appraisal’ adopts a similar breakdown of welfare agents, available at: <https://www.gov.uk/government/publications/webtag-tag-unit-a5-2-aviation-appraisal-may-2018>

we also show the existence/scale of consumer surplus¹⁵, other producer revenue¹⁶ and deadweight loss¹⁷. Box 1 provides a broad definition of the concept of ‘rent’; whereas the Frontier and FTI reports attributed this rent entirely to scarcity of supply at Heathrow, it is possible that other factors may contribute to this rent, and we will return to this point later.

Figure 3.1: Two routes with different properties in terms of capacity constraint



For both routes, the price/output combination is determined where demand and supply intersect. On Route A, the unconstrained demand Q_A^U coincides with the equilibrium demand Q_A , and this generates both consumer surplus and producer revenue. By contrast, on Route B, the unconstrained demand Q_B^U exceeds capacity, such that supply is constrained at the equilibrium demand Q_B , and this additionally generates scarcity rent (since the equilibrium price P_B is above marginal cost) and deadweight loss (since there is a loss in efficiency relative to the perfectly competitive outcome where the airline prices at MC).

The purpose of showing the broader welfare impact is to highlight that the incidence and scale of any scarcity rent will inter-play with other components of welfare – namely other producer revenue, consumer surplus and deadweight loss.

¹⁵ ‘Consumer surplus’ is the excess of willingness-to-pay for a given quantity of a good over its price.

¹⁶ This is revenue which exactly covers the cost of supplying a given quantity of a good.

¹⁷ ‘Deadweight loss’ is the loss of economic efficiency that arises when the free market equilibrium for a good is not achieved.

Box 3.1: Definition of Rent

$$\text{Rent} = (\text{Market-Clearing Price} - \text{Marginal Cost}) * \text{Market-Clearing Quantity}$$

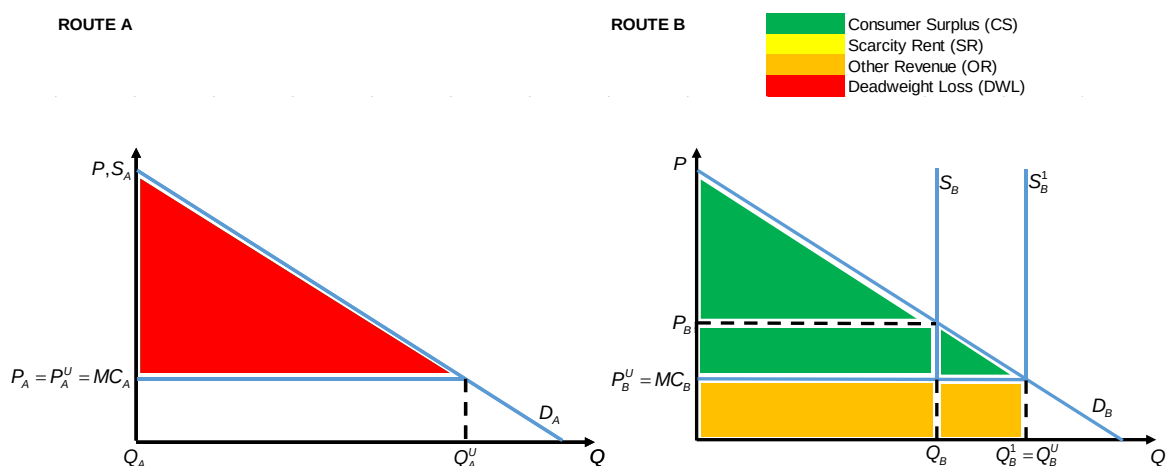
Figure 3.2 is a progression from Figure 3.1, which is presented in the FTI (2018) report. Here, the airline operating Route A observes the existence of scarcity rent in Route B, and responds by switching capacity from A to B. However, the overall level of capacity available to both airlines remains fixed, and this might therefore be seen as a short run position.

It follows that Route A is no longer served, such that substantial deadweight loss now arises in this sub-market. Turning to the second sub-market, the additional capacity redirected to Route B stimulates a rightward shift in the supply function from S_B to S_B^1 , such that unconstrained demand now coincides with capacity¹⁸. Relative to Route B in Figure 3.1, it can be seen that both the scarcity rent and deadweight loss are now absorbed within consumer surplus, such that the latter increases. Since quantity increases but price falls relative to Figure 3.1, the net impact on producer revenue will be an empirical question.

The welfare changes from Figure 3.1 can be summarised:

- Route A: consumer surplus is eliminated and deadweight loss arises
- Route B: consumer surplus increases, both deadweight loss and scarcity rent are eliminated, and other revenue increases – the net impact on the airline will be given by the increase in other revenue minus the loss of scarcity rent

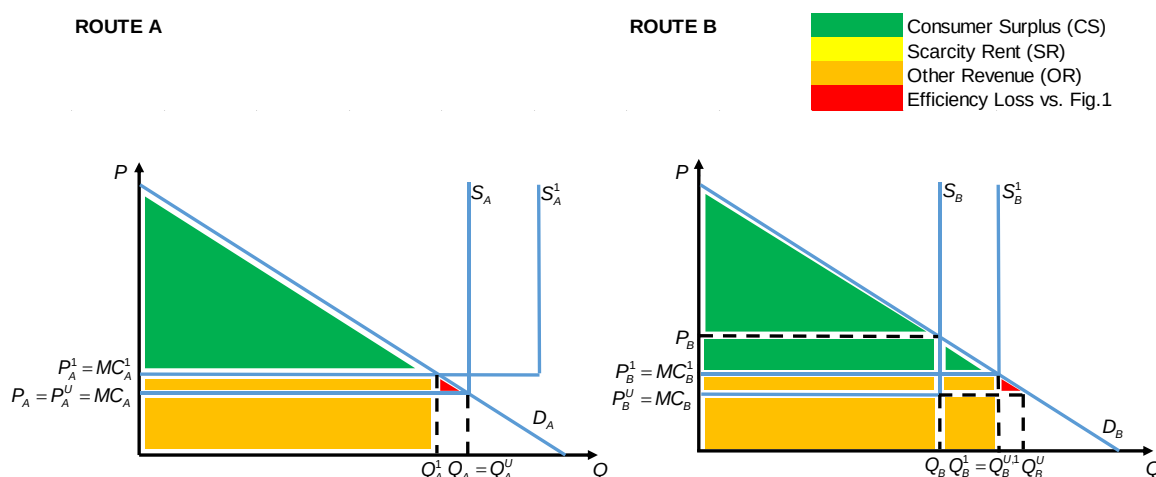
Figure 3.2: Concentration around route facing capacity constraint



¹⁸ Here we assume that the redirection of capacity to Route B incurs no additional marginal cost. If it did, then the supply function would shift upwards as well as rightwards (see Figure 3).

Figure 3.3 is an alternative progression from Figure 3.1, which we introduce to show the potential impact of increasing airport capacity in the long run. In contrast to the short run response in Figure 3.2 where capacity is transferred from Route A to Route B, here the supply functions for *both* Routes A and B (i.e. S_A^1 and S_B^1) shift rightwards – such that both airlines exploit the release of new capacity. Furthermore, both supply functions are shown as shifting upwards to reflect increased aero charges – since at Heathrow these charges include a contribution towards the cost of runway expansion (see Box 3.2).

Figure 3.3: Off-setting of rent by the costs of providing additional capacity



The welfare changes from Figure 3.1 can be summarised:

- Route A: consumer surplus is reduced and deadweight loss arises – the net impact on other revenue (and the airline's welfare position more generally) will depend on whether, in revenue terms, the increase in price offsets the reduction in quantity.
- Route B: consumer surplus increases, deadweight loss is reduced, scarcity rent is eliminated, and other revenue increases – the net impact on the airline will be given by the increase in other revenue minus the loss of scarcity rent.

It should again be stressed that these outcomes are illustrative – the precise outcomes in terms of price, quantity and the various components of welfare will depend upon the differentials between the market clearing price/quantities and those that would arise in the unconstrained situation. However, this figure illustrates the relevant mechanics of demand and supply response to capacity increase.

Box 3.2: Definition of aeronautical charges at Heathrow

'Airport charges and passenger volumes', taken from Heathrow company website (<https://www.heathrow.com/company/company-news-and-information/economic-regulation/airport-charges-and-passenger-volumes>)

The level of airport charges that Heathrow levies each year is in accordance to the CAA's pricing formula, which is part of the CAA's decision for the Q6 period of Economic Regulation at Heathrow from April 2014. The formula set by the CAA determines the level Heathrow cannot exceed in charging its airline on a per passenger basis (passenger only), which is also referred to as the 'maximum allowable yield'. The maximum allowable yield is set following a period of formal consultation with the Heathrow airline community.

Heathrow Airport is also subject to the Airport Charges Regulation 2011, which was transposed into UK law from a European Directive for its member states. This regulation aims to ensure a common framework for regulating airport charges, which includes consultation and transparency of information when setting airport charges.

The CAA formula for the maximum allowable yield is calculated by taking the following into account:

- *Retail Price Index = April RPI is used*
- *Value of X = Fixed at -1.5%*
- *Cumulative Development factor = Adjusts the maximum allowable yield to reflect the cumulative changes associated with development CAPEX projects*
- *Capital triggers = Reduction in the maximum allowable yield when the airport has not achieved particular capital investment project milestones*
- *Bonus = Airport can earn a bonus if it exceeds targets for certain service quality measures*
- *Correction factor = Corrects for any under/overrecovery of actual airport charges against the maximum allowable yield*
- *Business rates factor = Adjusts the maximum allowable yield in 2018 to reflect any change in the actual revaluation of business rates undertaken by the Valuation Office Agency 2017 compared to the regulatory allowance*

The maximum allowable yield is then converted to an estimated total revenue that Heathrow can recover. This is estimated by using a forecast for total passengers (i.e. maximum allowable yield multiplied by total passenger numbers).

The total revenue from airport charges is then recovered from Heathrow's structure of airport charges.

The structure of airport charges has been subject to formal consultation with the Heathrow airline community and has resulted in the total airport charges revenue being recovered through three categories; Landing Charges, Departing Passenger Charges and Aircraft Parking Charges. The three categories (excluding ANS) represent 21%, 75% and 4% of the total airport charges revenue respectively.

In our view, an important distinction which does not come through clearly in the Frontier (2017) and FTI (2018) reports is that between the short and long runs. More specifically, we would conjecture that, in practice, three permutations are relevant:

- Plane size/route structure fixed and infrastructure fixed – which we would characterise as the ‘**very short run**’;
- Plane size/route structure variable, infrastructure fixed – ‘**short run**’;
- All factors variable – ‘**long run**’.

Trusting that the above typology is meaningful in operational terms, then the previous diagrams can be interpreted such that:

- Figure 3.1 shows the very short run, since all aspects of supply are fixed.
- Figure 3.2 shows the short run, since route structure is varied but infrastructure is fixed;
- Figure 3.3 shows the long run, whereby SRMC shifts right on both routes, and for each such route the LRMC will in principle be given by the envelope of the two SRMCs

Within this typology, it might be noted that, where infrastructure is fixed, there will be the opportunity to optimise usage of this capacity – but this will serve only to equalise rents over opportunities within time slots, rather than eliminate rents altogether.

It is perhaps obvious that the market for air travel is not one market but a series of overlapping sub-markets with different characteristics and elasticity properties. For example, the sub-market for Mediterranean destinations might be a relatively large group in nature and involve competition between airports as well as airlines, while the long distance city-pair sub-market might tend to be a small group. Devices such as frequent flier programmes, agent commission structures and slot dominance at congested airports are argued to influence market competitiveness (Levine, 1987)¹⁹. The market conditions facing holiday travellers wishing to go to Malaga in two months’ time and a business traveller wishing to go to Mexico City next Monday are probably quite different. Against this background, the nature of the interaction between Routes A and B from a capacity-constrained airport such as Heathrow could be quite different depending on the characteristics of their respective sub-markets.

3.2 Additional insights from the Cournot model

Diagrammatic representation of the problem at hand can be a very powerful tool, but inevitably calls for a degree of simplification in the description of the problem. However, even if we acknowledge and accept the need for some expositional simplification, we feel that the Frontier (2017) and FTI (2018) reports – and IAG’s response – overlook a key feature of the problem. This is because the framework as outlined does not account for the competitive structure of the market of interest – a point which is also made by SEO/Cranfield (2017) .

¹⁹ Levine, M.E. (1987) Airline Competition in Deregulated Markets: Theory, Firm Strategy and Public Policy. Yale Journal on Regulation, 4, pp.393-494.

3.2.1 Theoretical rationale

Reflecting upon the structure that prevails in the case of Heathrow, we are drawn to the well-established theoretical finding by Kreps & Scheinkman (1983)²⁰ that, in a capacity (i.e. fixed slot capacity) then price game with efficient consumer rationing (i.e. yield management of aircraft seats) and with linear demand and constant MC, the chosen capacity will be equivalent to that which arises in a standard Cournot model²¹.

Adding recent empirical evidence to these considerations, Lijesen & Behrens (2017)²² investigated whether alternative city- or airport-pairs are viable substitutes and the extent to which they impact upon airline competition between the UK and continental Europe. Using monthly airline-route seat capacity levels, Lijesen & Behrens estimated airlines' strategic reaction to competitors' capacity levels, including competitors on other routes. They found that *'the vast majority of the city-pair markets is less competitive than a symmetric Cournot duopoly'* (p11). This finding contrasts (to some extent) with Koopmans & Lieshout (2016)²³ – cited by SEO/Cranfield (2017) – whose analysis encompassed all city-pairs worldwide (as opposed to focussing on the UK), and concluded that *'most aviation markets can be described as oligopolies with product differentiation'* (p5).

Reconciling these theoretical and empirical insights, our view is that the competitive structure of most UK sub-markets probably falls somewhere between monopoly and Cournot – but possibly with monopolistic competition arising in some sub-markets accessible to new entrants (especially low cost carriers). Moreover, in any of these cases, there is good reason to believe that the market clearing price will be above MC – such that scarcity rent of some scale will in principle arise. In practice, however, it is quite likely that – even at a heavily congested airport such as Heathrow – any scarcity rent will arise to different degrees across different city-pairs, at different times of day, and at different points in the year. That is to say, scarcity rent will apply in a variable fashion across Heathrow's slot portfolio.

3.2.2 Diagrammatic illustration

Building upon our theoretical assertion that scarcity rent could arise at Heathrow, we now introduce a further diagram of our own, Figure 3.4, which we believe better reflects the prevailing competitive structure. Note that rather than compare two routes (which might be

²⁰ Kreps, D.M & Scheinkman, J.A. (1983) Quantity Precommitment and Bertrand Competition Yielding Cournot Outcomes. The Bell Journal of Economics, 14 (2), pp.326-337.

²¹ The 'Cournot model' presents an industry structure where a small number of companies (a pair of companies in the standard presentation) compete on the quantity of output produced, but these quantities are determined independently and simultaneously.

²² Lijesen, M. & Behrens, C. (2017) The spatial scope of airline competition. Transportation Research Part E, 99, pp.1-13.

²³ Koopmans & Lieshout (2016) Airline cost changes: to what extent are they passed through to the passenger? Journal of Air Transport Management, 53, pp.1-11.