THE COMPETITIVE EFFECTS OF MERGERS ACROSS HUB-AND-SPOKE NETWORKS

by

Heather E Coles

CCR Working Paper CCR 03-3

Abstract

This paper examines the effect of mergers across airline hub-and-spoke networks, on traffic levels, consumer surplus and the profit of competing airlines. Previous research has concentrated on the benefits such mergers provide for interline passengers and typically show that consumer welfare rises. This paper illustrates how tractable changes in the level and nature of competition can reverse the welfare implications even when interline passengers benefit. The model fits the proposed BA/AA alliance and provides some interesting insight into the European and US Competition Commission's findings, and the likely consumer welfare implications of this proposed 'virtual merger'.

JEL classification: L0; L2; L4; L5; L9.
Keywords: Alliance; Mergers: Codesharing; Hub-and-spoke network.

Acknowledgements:
I would like to thank Morten Hviid, Stephen Davies and Begoña Garcia Mariñoso for guidance and helpful comments on an earlier draft. I would also like to thank Adrian Majumdar, Trevor Smedley and David Bachelor, for providing me with an insight into the airline industry and useful feedback. Financial support from the ESRC is gratefully acknowledged.

Contact details: Heather E Coles, School of Economics and Social Studies, University of East Anglia, Norwich, NR4 7TJ, United Kingdom. Email: h.coles@paston.co.uk

ISSN 1473-8473

The competitive effects of mergers across hub-and-spoke networks

1. Introduction

The recent globalisation and liberalisation of air transport has led to dramatic industry changes. Two of the most significant have been the airlines' reorganisation of their route structures into hub-and-spoke networks, and the growing number of international airline alliances and mergers. By developing hub-and-spoke networks, airlines have been able to exploit the economies of traffic density that arise from funnelling passengers through a hub, rather than providing a point-to-point service. Whilst international mergers and alliances have allowed airlines to extend their network reach without operating additional flights. This provides them with the opportunity to enter those new markets, which were either not economical to operate on their own or where they lacked the authority to do so.

The initial motivation for this paper stemmed from the proposed British Airways and American Airlines (BA/AA) 'virtual merger', which would have unified the largest airlines in Europe and in the World. These two parties if combined, would be nearly 70% larger than their nearest rival, United Airlines. Despite the growing importance of such mergers, there has been very little research into their competitive effects. The principal model (Brueckner 2001a), which has been used to provide support for BA/AA, focuses on the horizontal double marginalisation problem, which can arise in the independent pricing of complementary goods[1]. A hub-and-spoke network with monopoly spokes and initial interhub[2] competition is developed, and according to the model, the carriers' non-cooperative sub-fare choices in the interline[3] market generate negative pricing externalities. For example, in the absence of a merger each airline, in the Cournot fashion, chooses the quantity for its portion of the journey without taking into account the effect that this quantity has on the demand for complementary sections of the journey, and on other airlines' profits. Post merger this double monopoly markup is removed,

[1] Connecting flights can be viewed as complementary goods which, post merger, an airline can bundle together and sell as one good.
[2] Interhub passengers travel between the hub cities.
[3] Interline passengers are those whose journey requires them to travel with more that one airline.

culminating in lower fares and increased traffic. With constant marginal costs the alliance has no effect in the spoke markets but the reduction in competition raises interhub fares. The attractiveness of the merger critically depends on this horizontal double marginalisation in the interline market. Emphasis is placed on the benefits awarded to interline passengers, rather than on the costs to interhub passengers. This fits well with US-style hubs, which are designed primarily to attract connecting passengers. Many of these hubs are located in cities that are not major destinations in their own right and therefore most passengers are interline. The theoretical models of Brueckner therefore suit these markets, but they do not capture the essential features of European hubs and the market for transatlantic travel. In contrast to US-style hubs, European hubs, such as Heathrow, are important destinations in their own right and thus attract a high proportion of direct, interhub traffic[4].

The aim of this paper is to illustrate that by changing the competition in the spoke and interline markets - in order to best capture the essential features of transatlantic travel - the anti-competitive effects are enhanced. There can still be benefits to interline passengers (when the double marginalisation problem exists), but crucially, the costs to all other passengers that arise from a change in the market structure, and the merged airlines' ability to capture a larger share of the interline market, consume these.

As suggested, the model best represents the market for transatlantic travel and differs from previous models in two distinct respects. First, the airlines do not have a monopoly in their US domestic or European spoke markets, either side of the transatlantic gateway. The US and European hub cites, in the transatlantic market, tend to be major destinations and therefore the spoke routes are served by more than one airline. Following the deregulation of the US domestic, and European airline industries, there has been an increase in the number of carriers serving such routes. Despite some industry consolidation, there has been a dramatic increase in the number of low-cost airlines in

[4] For example the estimated proportion of interhub (point-to-point) passengers at Heathrow, Gatwick and Stansted is 66%, 69% and 95% respectively (CAA Survey 1996, summarised in OECD report 2000, p187).

these markets[5]. The second change relates to the nature of competition in the interline markets, without the merger. Brueckner (2001) assumes that passengers in these markets always travel as far as possible with their home carrier. This is not a realistic assumption. It is possible that passengers located in Edinburgh who wish to travel to Kansas City, for example, could purchase tickets to travel with British Midland from Edinburgh to Heathrow and with AA from Heathrow to Kansas City. These passengers are not restricted to buying a ticket to fly with BA from Edinburgh to Chicago and from Chicago to Kansas City with another US domestic carrier. Although passengers may have some preference for their home carrier, it is unrealistic to assume that they do not consider other carriers, operating in the same markets, when they purchase tickets. In particular, the decline of many flag carriers and the liberalisation of air travel, has facilitated the purchase of seats on 'foreign' carriers. Relaxing this assumption introduces competition, without the merger, into the interline market. This competition results in higher equilibrium traffic levels and therefore reduces the merger's benefit to interline passengers. With these changes to the level and nature of competition, following the merger there is a fall in total consumer surplus. The policy implications of this model, with respect to Brueckner's, are therefore reversed.

The organisation of the paper is as follows: in the subsequent section the proposed model for mergers across hub-and-spoke networks is formalised, in order to develop solutions with and without the merger – the results of which are summarised in sections 3 to 6. The results depend on assumptions made with respect to competition in the spoke and interline markets. In the first case (section 3) competition from n-1 carriers is introduced in the spoke markets only, in the second (section 4), this is coupled with competition in the interline markets. The final case is an asymmetric one (section 5) – with one monopoly and one competitive spoke. US spokes, in general, are less competitive than European ones, and on occasion local monopolies, a feature captured in this asymmetric case. Section 6 finally culminates in a conclusion of remarks and policy implications.

[5] Even if low-cost carriers don't fly the exact the same route, they impose a competitive constraint when flying to a neighbouring airport, close to the hub city.

2. The model

Figure 1 (below) shows the model's network structure:

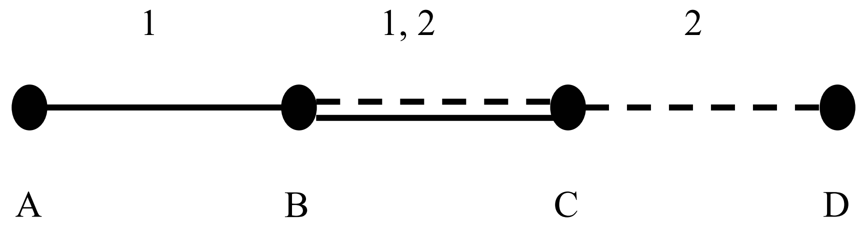


Figure 1: Network Structure

The hub airports are located at cities B and C, AB and CD are the spoke routes. BC therefore represents the transatlantic gateway and the endpoints A and D are cities behind and beyond the gateway. Without a merger, airline 1 uses city B (in the US) as her hub and operates routes AB, BA, AC, CA, BC and CB. Airline 2 uses city C (in Europe) as her hub and operates routes CD, DC, BD, DB, CB and BC. The number of airlines operating in the domestic US or European spoke markets (AB, BA, CD and DC) is varied in the analysis below, in some cases the airlines face competition, in others they have a monopoly. Without a merger, passengers in the interline (AD and DA) markets must change airlines at one of the hub airports, since neither of the two airlines fly over the entire network.

A more realistic network structure would have more than one spoke route. However, given the symmetry of the network structure, irrespective of the number of spokes, the same four distinct passenger types arise, who wish to travel:

- Along the spokes (domestic or European routes AB, BA, CD and DC).
- Across the transatlantic gateway (short international routes BC and CB).
- Between an endpoint and the opposite hub (medium international routes AC, CA, BD and DB).
- Between the two endpoints (long international routes AD and DA).

With the effect of the merger on each of these separate markets determined, the impact of a change in the number of endpoints and spoke routes is considered in the conclusion.

The approach of the model is to examine the competitive effects of the merger, which arise from a change in the number of airlines competing. It is assumed that differences in convenience, between the pre-merger interline flight AD, where the passengers must change airlines, and the post-merger flight AD, where passengers can fly the entire journey with one airline do not affect the demand for travel in this market. For whilst there is the potential for service (efficiency) improvements, such as offering the consumer a more seamless travel experience, these improvements in effect can be made without the airlines merging[6]. With and without the merger the airlines are assumed to compete a la Cournot, therefore the model considers only the unilateral effects. Since the merged airline has a monopoly in all markets, apart from the spoke markets – where the same number of airlines compete, the possibility of coordinated effects is not important[7].

The model is developed under the assumption that all demand for travel is round-trip. The inverse demand function in each city pair market is given by $P(Q_{ij}) = a - b_{ij}Q_{ij}$, where Q_{ij} is the total round-trip traffic originating at city i and flying to city j, and $P(Q_{ij})$ is the total fare for round-trip travel between the city pair. Despite the previous assumption, the order of the cities in the market designation is important. This is because some domestic and international markets face demand from interline passengers, who are changing airlines and purchasing separate tickets for separate flights[8]. The parameter b_{ij} includes a measure of the market size[9] (the total number of passengers located at i wishing to travel to j), as the market size increases, b_{ij} decreases. Although the demand function is identical for all city pair markets, the parameter b_{ij} varies to reflect differences

[6] For example, BA and AA and already negotiate and achieve this through their limited 'Oneworld' alliance.

[7] However if the model where extended so that there were initially three airlines serving the international gateway, the possibility of coordinated effects should be considered. Coordinated interaction is particularly likely in the airline industry give the high degree of price transparency and multi-market contact.

[8] For example, if it is assumed that passengers travel as far as possible with their home carrier, without the merger, the roundtrip AC market will be larger that the CA market, since all the passengers located at A wishing to travel to D will purchase a roundtrip ticket for the flight AC. No interline passengers will purchase a roundtrip ticket from C to travel to A. In the same manner the DB market will be larger than the BD market.

[9] For derivation of this see Appendix 1.

in the market size. Aside from the merger simply reducing, or in some cases eliminating competition, often it reduces a city pair market size[10]. This fall causes a reduction in the equilibrium quantity (Q), and given that quantity and price are inversely related, the equilibrium price for travel increases, and consumer surplus is reduced[11].

Importantly airlines must recognize the possibility of fare arbitrage. When airline 1, for example, is setting her quantity in the AC market, she should be sure that the fare satisfies the constraint: $P_{AC} \leq P_{AB} + P_{BC}$. If this constraint is not satisfied then a passenger could fly more cheaply by purchasing two separate tickets for the AB and BC sections of the journey rather than purchasing one ticket from airline 1 for the entire 'through' journey. If this constraint is not satisfied airline 1 would face no demand in the AC market. Similar constraints must also be satisfied in the interline markets. In the interline market satisfaction of the arbitrage constraint is directly related to the double marginalisation problem (this is illustrated in the following section). If the interline arbitrage constraint is satisfied, then without the merger there is a double monopoly markup, and interline passengers benefit from the merger.

It is assumed that on each route there are constant marginal costs, indicating that the technology exhibits constant returns to scale or density. The marginal cost for each route depends on the route's traffic density (Q). The marginal cost for operating domestic or European sections of the network (such as AB or CD) is given by c_D, whilst the marginal cost of operation in short international markets (BC or CB) and in medium international markets (such as AC or BD) are given by c_{SI} and c_{MI}. Following the merger the marginal cost of flying over the entire network, the longest possible flight, is given by c_{LI}. As the length of the flight increases so do marginal costs, and therefore

[10] For example, following the merger, the merged airline (provided the arbitrage constraints are satisfied), can capture the entire interline market, this reduces the size of the medium international and domestic markets, which previously carried interline passengers.

[11] However, the analysis deals with linear demand and evaluates at an optimum, therefore although the equilibrium quantity falls, there is no price change, but this is not a general result. Given that the quantity (Q), and the consumer surplus falls with the merger, it is fair to argue that prices would, in general, rise.

$c_D < c_{SI} < c_{MI} < c_{LI}$[12]. The implications of relaxing the constant returns to scale assumption are discussed in the conclusion.

Where airlines compete it is assumed that they do so in a Cournot fashion. Cournot competition has emerged as the standard for airline industry research. The Kreps-Sheinkman (1983) argument is often put forward to support its use, since airlines can be seen as competing in a two stage fashion, where they first set quantity by scheduling flights (capacity), and later set prices to fill up their seats. There are, however, problems associated with the use of Cournot. In the interline market, in particular, where medium international and domestic flights are complementary products, purchased in fixed proportions, a quantity based approach cannot be used. This is because in a non-cooperative Cournot game, the airlines cannot simultaneously choose the same quantities. When the airlines have a monopoly in their respective medium international and domestic markets this problem can be solved by a move to price competition. Brueckner (2001a) argues that this is legitimate, since when there is no competition price and quantity are equivalent decision variables. As stressed in the introduction, the aim of this paper is to highlight that although the merger benefits interline passengers, the costs to all other passengers are likely to outweigh these. In much of the analysis below without the merger, the airlines face competition, and therefore price competition in the interline market cannot be introduced, since with Bertrand price setting, prices would fall to marginal costs and the equilibrium outcome would be both unrealistic and very different from the Cournot one. Instead, it is assumed that airlines operating in the medium international and domestic markets that serve interline passengers cannot differentiate between interline and local passengers[13]. Interline passengers simply increase the market size and pay the local fare. Each airline therefore, in the Cournot fashion, sets quantity without considering the effect that the resulting fare has on interline demand, where passengers must purchase two tickets. This makes the total fare for interline travel very high – a feature that reinforces the results. By allowing the total interline fare, without

---

[12] The cost structure imposed allows for the realisation of economies of scale when an airline flies over more than one section of the network, by setting $c_{LI} < c_{MI} + c_D$.

[13] Local passengers are those who purchase just one ticket for roundtrip travel between a city pair, unlike interline passengers who need to purchase two separate tickets.

the merger, to be as high as possible, the model allows for the largest possible gain in consumer surplus. If the loss in consumer surplus in other markets is large enough to outweigh this excessive interline gain, then the proposition that total consumer surplus falls with the merger is robust.

3. Symmetric case 1: no competition in the interline markets, competition in the spoke markets.

The network structure for both symmetric cases is illustrated in figure 2 below:

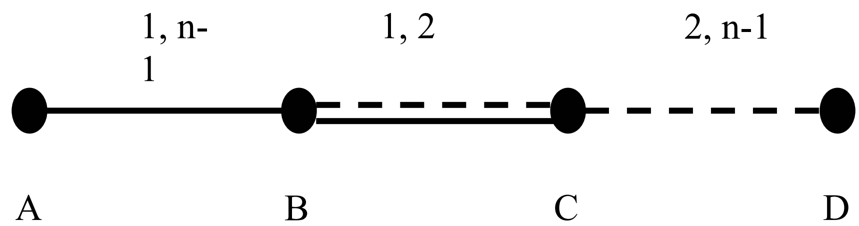


Figure 2: network structure for symmetric cases

There is no competition in the interline market - passengers are assumed to travel as far as possible with their home airline[14]. Those passengers originating at A wishing to travel to D, are assumed to travel the AC section with airline 1 and then switch to one of the n carriers operating in the CD spoke for the last section of their journey. The reverse is true of all passengers located at D wishing to travel to A. They are assumed to travel the DB section with airline 2 and switch to one of the n carriers operating in the AB section for their final flight.

3.1 Non-merger equilibrium

There are n-1 airlines competing with airline 1 in the AB (BA) spoke market and n-1 airlines competing with airline 2 in the CD (DC) spoke market. The symmetry of the

[14] It should be appreciated that this assumption applies only to those passengers in the interline market and not to those in the short or medium international markets.

network structure, and the assumption that passengers travel as far as possible with their home carrier, gives rise to 5 distinct types of markets:

1. AB and DC, these markets only include those passengers who wish to travel between the city pair.
2. BA and CD, these markets include all the passengers who wish to travel between the city pair, and all the interline passengers who purchase tickets in these markets.
3. BC and CB, these markets only include the passengers who wish to fly between the two hub cities.
4. CA and BD, these markets only include those passengers who wish to fly between the city pair.
5. AC and DB, these markets include all the passengers who wish to fly between the city pair, and all the interline passengers who purchase tickets in these markets.

The key difference between the interline markets (AD and DA) and medium international markets (AC, CA, BD and DB) is that without a merger, interline passengers must purchase separate tickets from the two airlines. Their total fare is the sum of these. Provided that the arbitrage constraints are satisfied this is not the case in the medium international markets (AC, CA, BD and DB). Here passengers can purchase one ticket for their entire journey, and therefore unlike the demand from interline passengers, their demand does not need to be taken into account in other markets.

In both the non-merger and merger case the equilibrium for airline 1 is analogous to the equilibrium outcome for airline 2, and therefore the model needs only to be solved for airline 1 in the AB, BA, CA, AC and AD markets.

<u>AB market:</u>

Airline 1 competes with n-1 airlines in this market, the inverse demand function is denoted by:

$$P_{AB} = a - b_{AB*}(q^1_{AB} + (n-1)q^i_{AB})$$

Where q^i_{AB} represents the quantity of each of the other n-1 carriers, the profit function for airline 1 is:

$$\pi^1_{AB} = q^1_{AB}(a - b_{AB*}(q^1_{AB} + (n-1)q^i_{AB}) - c_D)$$

The profit function for airline i, from the n-1 airlines is:

$$\pi^{i}_{AB} = q^{i}_{AB}(a - b_{AB^*}(q^{i}_{AB} + q^{1}_{AB} + (n-1)q^{rest}_{AB}) - c_D)$$

The best responses are given by:

$$q^{1}_{AB} = \frac{1}{2b_{AB^*}}(a - b_{AB^*}(n-1)q^{i}_{AB} - c_D)$$

$$q^{i}_{AB} = \frac{1}{2b_{AB^*}}(a - b_{AB^*}(q^{1}_{AB} + (n-2)q^{rest}_{AB}) - c_D)$$

Given the symmetry of the n airlines, $q^{1}_{AB} = q^{i}_{AB} = q^{rest}_{AB}$ and therefore solving for q^{1}_{AB} and q^{i}_{AB} yields the classic Cournot solutions:

$$q^{1}_{AB}{*} = q^{i}_{AB}{*} = \frac{a - c_D}{b_{AB^*}(n+1)} \tag{1.1}$$

$$Q_{AB}{*} = \frac{n(a - c_D)}{b_{AB^*}(n+1)} \tag{1.2}$$

$$\pi^{1}_{AB}{*} = \pi^{i}_{AB}{*} = \frac{(a - c_D)^2}{b_{AB^*}(n+1)^2} \tag{1.3}$$

Having illustrated how the equilibrium solution is found in this case, and since all the markets are solved in the same manner, in future cases only the equilibrium solution is given.

<u>BA market:</u>

The solution is the same as in the AB market, except b_{BA^*} will replace b_{AB^*} in equation (1.1) to (1.3). The BA market includes all the interline passengers travelling from D to A and therefore is larger than the AB market ($b_{BA^*} < b_{AB^*}$). This in turn means that $Q_{BA}{*} > Q_{AB}{*}$.

$$q^{1}_{BA}{*} = q^{i}_{BA}{*} = \frac{a - c_D}{b_{BA^*}(n+1)} \tag{1.4}$$

$$Q_{BA}{*} = \frac{n(a - c_D)}{b_{BA^*}(n+1)} \tag{1.5}$$

$$\pi^{1}_{BA}{*} = \pi^{i}_{BA}{*} = \frac{(a - c_D)^2}{b_{BA^*}(n+1)^2} \tag{1.6}$$

<u>BC market:</u>

Airline 1 and 2 compete in this market, the equilibrium outcome is:

$$q_{BC}^1* = q_{BC}^2* = \frac{a - c_{SI}}{3b_{BC*}} \quad (1.7)$$

$$Q_{BC}* = \frac{2(a - c_{SI})}{3b_{BC*}} \quad (1.8)$$

<u>CA market:</u>

Airline 1 has a monopoly in this market, the equilibrium outcome is:

$$Q_{CA}* = \frac{a - c_{MI}}{2b_{CA*}} \quad (1.9)$$

<u>AC market</u>

Again airline 1 has a monopoly in this market and the solution will be the same as in the CA market, except b_{AC*} will replace b_{CA*} in equation (1.6). The AC market includes all the interline passengers travelling from A to C and therefore is larger than the CA market ($b_{AC*} < b_{CA*}$). This in turn means that $Q_{AC}* > Q_{CA}*$.

$$Q_{AC}* = \frac{a - c_{MI}}{2b_{AC*}} \quad (1.10)$$

<u>AD market</u>

Passengers who travel in this market must purchase two tickets, the first from airline 1 for travel AC and the second from one of the n airlines (including airline 2) operating in the CD spoke. The total fare is given by:

$$P_{AD}* = P_{AC}* + P_{CD}* = \frac{a + c_{MI}}{2} + \frac{a + nc_D}{(n+1)} \quad (1.11)$$

$$P_{AD}* = \frac{3a + an + (n+1)c_{MI} + 2nc_D}{2(n+1)} \quad (1.12)$$

Substituting this into the demand function:

$$Q_{AD}* = \frac{a(n-1) - (n+1)c_{MI} - 2nc_D}{2(n+1)b_{AD*}} \quad (1.13)$$

<u>Arbitrage constraints</u>

The following arbitrage constraint must be satisfied if airline 1 is able to charge the monopoly price in the AC market.

$$P_{AC} = \begin{cases} P_{AC}* & if \quad a \geq \dfrac{(3n+3)c_{MI} - (4n+4)c_{SI} - 6nc_D}{(5-n)} \\ P_{AB}* + P_{BC}* & if \quad not \end{cases} \qquad (1.14)$$

If this constraint is not satisfied then passengers will purchase two separate tickets for the journeys AB and BC. Given that airline 1 has the power to fully manipulate capacity in the AC market it is, however, unlikely that this constraint will not be satisfied. Airline 2 has no incentive to increase her capacity in the BC market - in order to violate this constraint, since this will adversely affect her arbitrage constraint in the BD market. Similarly airline 1 can adjust her capacity in the AB market, to hinder any attempts by the n-1 airlines to increase their capacity, in order to violate the constraint, and capture passengers in the AC market. Moreover, this arbitrage constraint should hold simply because using two carriers in this market would involve a horizontal double marginalisation, similar to that associated with the interline market.

3.2 Merger Equilibrium

Airline 1 and 2 merge, the merged airline (M) has a monopoly in all markets except for the spoke markets.

AB market

There is no change in this market - the same airlines compete, and the market size is unchanged ($b_{AB*} = b_{AB**}$).

$$Q_{AB}* = Q_{AB}** = \frac{n(a - c_D)}{b_{AB*}(n+1)} \qquad (1.15)$$

BA market

The same number of airlines compete in this market. However, following the merger the n-1 airlines that operate in this spoke market will no longer face any interline demand. The subsequent fall in the size of this market ($b_{BA*} < b_{BA**}$) will cause a fall in the equilibrium quantity, and in the profits of the n-1 carriers.

$$Q_{BA}** = \frac{n(a - c_D)}{b_{BA**}(n+1)} \qquad (1.16)$$

$$\pi^1_{BA}** = \pi^i_{BA}** = \frac{(a - c_D)^2}{b_{BA**}(n+1)^2} \qquad (1.17)$$

BC (CB) Market

Competition is eliminated in this market but the size is unchanged ($b_{BC*} = b_{BC**}$). Airline M has a monopoly:

$$Q_{BC}** = \frac{a - c_{SI}}{2b_{BC**}} \tag{1.18}$$

AC market

Again there is no change in the level of competition in this market. However, as in the BA market, this market no longer includes any interline demand and therefore the market size falls ($b_{AC*} < b_{AC**}$). This in turn causes a fall in the equilibrium quantity.

$$Q_{AC}** = \frac{a - c_{MI}}{2b_{AC**}} \tag{1.19}$$

CA market

There is no change in this market – the same number of airlines compete and the market size is unchanged ($b_{CA*} = b_{CA**}$).

$$Q_{CA}** = Q_{CA}* = \frac{a - c_{MI}}{2b_{CA*}} \tag{1.20}$$

AD Market

The merged airline has a monopoly over this route. Passengers no longer have to purchase two separate tickets for travel, instead they can purchase one ticket for the entire through journey. The size of this market is unchanged ($b_{AD*} = b_{AD**}$) and the equilibrium quantity is given by:

$$Q_{AD}** = \frac{a - c_{LI}}{2b_{AD**}} \tag{1.21}$$

Arbitrage Constraints

The following constraints must be satisfied if the merger airline (M) is able to charge the monopoly price in the AC and AD markets.

$$P_{AC} = \left\{ \begin{array}{lll} P_{AC}** & if & a \geq \dfrac{(n+1)c_{MI} - (n+1)c_{SI} - 2nc_D}{2} \\ P_{AB}** + P_{BC}** & if & not \end{array} \right\} \tag{1.22}$$

$$P_{AD} = \begin{cases} P_{AD}** & if \quad a \geq \dfrac{(n+1)c_{LI} - (n+1)c_{MI} - 2nc_D}{2} \\ P_{AC}** + P_{CD}** & if \quad not \end{cases} \qquad (1.23)$$

As in the non-merger case, if these constraints are not satisfied passengers will purchase separate tickets for each segment of their journey. It is however unlikely that they will not be satisfied simply because using two carriers would, as in the non-merger case, involve double marginalisation. At the same time the merged airline has a monopoly in all three international markets and can therefore fully manipulate capacity and ultimately fares, to ensure their satisfaction. She can also change her capacity in the AB market in response to any capacity increases by the n-1 carriers. The two constraints are very similar since they both compare a bundled monopoly fare with a combined, unbundled, monopoly and Cournot fare.

3.3 Competitive effects of the merger

This section compares the equilibrium quantities and the consumer surplus in each of the city pair markets, with and without the merger, and when all of the arbitrage constraints are satisfied. In addition to this assessment of consumer welfare, this section also examines the effect of the merger on the n-1 carriers operating in the spokes.

As illustrated above there are two common solutions, in the AB (DC) and CA (BD) markets, where the non-merger and merger equilibrium quantities are the same. In all of the other markets the merger affects the quantity and the profit of the airlines operating in it.

Lemma 1: *With the merger the equilibrium quantity and consumer surplus falls in all of the domestic and European spoke markets that also carry international passengers.*

$$Q_{BA}* > Q_{BA}** \qquad \Delta CS_{BA} = -\frac{(na - nc_D)^2 T_{AD}\beta}{2(n+1)^2}.$$

This fall in consumer surplus in the spoke market is increasing in n, therefore as the number of airlines operating in this spoke market increases, passengers suffer more.

Lemma 2: *With the merger the equilibrium quantity and consumer surplus falls in all of the medium international markets that also carry interline passengers.*

$$Q_{AC}* > Q_{AC}** \qquad \Delta CS_{AC} = -\frac{(a - c_{MI})^2 T_{AD}\beta}{8}.$$

In both of these markets the effect of the merger is to remove all interline traffic. The subsequent fall in market size results in a lower equilibrium quantity and a drop in consumer surplus. The extent of the fall in consumer surplus depends on the size of the interline market (T_{AD}).

Lemma 3: *With the merger the equilibrium quantity and consumer surplus falls in all of the interhub (short international) markets.*

$$Q_{BC}* > Q_{BC}** \qquad \Delta CS_{BC} = -\frac{7(a - c_{SI})^2 T_{BC}\beta}{72}$$

The fall in quantity and consumer surplus in this market is a direct result of the fall in competition and movement from a duopoly to a monopoly outcome.

Lemma 4: *The effect of the merger in the interline markets (AD and DA) depends on the number of airlines operating in the spoke markets and the cost structure.*

$$Q_{AD}** > Q_{AD}* \quad \text{iff} \quad a \succ \frac{(n+1)c_{IL} - (n+1)c_{MI} - 2nc_D}{2}$$

As the number of airlines operating in the spoke markets increases it is less likely that the equilibrium quantity increases with the merger. However if significant economies of scale can be realised with the merger, then an increase in the equilibrium quantity is more likely. Although marginal costs are constant for each flight, economies of scale can be realised when an airline flies over more that one section of the network[15]. Compare this condition with the arbitrage constraint (1.23) – they are exactly the same. If the arbitrage constraint (1.23) is satisfied then the double marginalisation problem exists. The attractiveness of the merger rests on it's removal, therefore, the condition for consumer surplus to increase in the interline market, and for the arbitrage constraint to be satisfied,

[15] For example by setting $c_{LI} < c_{MI} + c_D$, economies of scale can be realised by the merged airline in the interline market.

are synonymous. If this arbitrage constraint is not satisfied (and there is no double marginalisation) then consumers in the interline market do not benefit from the merger. If (1.23) is satisfied and the quantity of interline traffic increases with the merger:

$$\Delta CS_{AD} = \frac{[(a-c_{IL})^2(n+1)^2 - (a(n-1)-(n+1)c_{MI} - 2nc_D)^2]T_{AD}\beta}{8(n+1)^2}.$$

Lemma 5: W*ith a merger the profit of the n-1 airlines falls, with the possibility in the long run and with fixed costs, of this leading to market foreclosure (Proof see appendix 2).*

Following the merger it is possible that, given the fall in demand in the BA market faced by the n-1 airlines, profits would be pushed down and continued operation by some of the airlines could become unprofitable, forcing them to exit the market. Given that the price in this market depends inversely on n in the following manner; $p_{BA}^{**} = \frac{a+nc}{(n+1)}$, consumers would, in the long-term, suffer further from even higher prices in this market.

Proposition 1: *With competition in the spoke markets, the merger results in a fall in total consumer surplus (Proof see appendix 3).*

Previous research (Brueckner 2001a) shows that for the merger to increase consumer welfare, the horizontal double marginalisation problem must exist. Brueckner assumes this, therefore in his model interline passengers automatically benefit from the merger. The analysis above considers the effect of the merger both with, and without this problem. If there is no double marginalisation (arbitrage constraint (1.23) is not satisfied), then passengers in the interline market do not benefit from the merger. Total consumer surplus falls as competition in the interhub market is removed, and the merged airline is able to gain a larger share of the interline market. However, even if the double marginalisation problem does exist (arbitrage constraint (1.23) is satisfied), given proposition 1, total consumer surplus still falls. This contrasts with Brueckner's findings.

4. Symmetric case 2: competition in the interline market and in the spoke markets.

Relax the assumption that passengers travel as far as possible with their home carrier - this introduces competition into the interline market. Consumers originating at A wishing to travel to D now face the choice of changing airlines at either B or C. If the total fare is the same, irrespective of where they change, it is assumed that passengers are indifferent between either route (half of them fly via city B, and the other half fly via city C).

The introduction of competition in the interline market has no effect without simultaneous competition in the spoke markets. Crucially, without this competition, airline 1 and 2 have the power to fully manipulate fares in all of the markets they operate in. They can use this to hinder any attempts by their rival to increase their market share in the interline market. For example, if airline 1 increases her capacity in the AC market to gain a larger share of the AD market, airline 2 could respond to this by decreasing her capacity in the CD market, so that the total fare for travel AD remains the same. The airlines, therefore, have no incentive to deviate from the monopoly outcome in any of the medium international markets they operate in. Once competition in the spoke markets is introduced, this changes. Now if airline 1 increases her capacity in the AC market, to capture a larger share of the AD market, airline 2 cannot manipulate total capacity in the CD market. For example, if airline 2 reduces her capacity in the CD market, the n-1 carrier's optimal response is to increase their capacity, counteracting any attempt by airline 2 to raise fares in this market. The fare for the domestic segment of the interline passenger's journey is now fixed, and competition has made this route less profitable. Airline 1 and 2 therefore have an incentive to attract more interline passengers in their more profitable medium international markets.

4.1 Non-merger equilibrium

Given the symmetry of the network structure, pre-merger, there are 3 distinct types of market:

1. AB, BA, CD and DC, these markets include domestic passengers and interline passengers.

2. AC, CA, BD and DB, these markets include medium length international passengers and interline passengers.

3. BC and CB these markets include only those passengers making short international journeys.

Again, without a merger, passengers who wish to travel AD (DA) must purchase two separate tickets, their total fare is the sum of these two subfares. As in case 1, in light of the symmetry, the model needs only to be solved for airline 1 in the AB, AC and AD markets.

AB market

Airline 1 competes with n-1 airlines in this market and the solution is the same as case 1. The equilibrium quantity is therefore given by:

$$Q_{AB}{}^{*} = \frac{a - c_D}{(n+1)b_{AB*}} \tag{1.24}$$

AC market

Although airline 1 has a monopoly in this market, removing the assumption that all passengers travel as far as possible with their home carrier provides the airline with an incentive to increase capacity in medium international markets. In doing so airline 1 can depress the equilibrium fare in an attempt to attract a larger share of the interline market. Airline 1 and 2 therefore compete in the AD (DA) market using their capacity in their respective AC (CA) and BD (DB) markets. To find the equilibrium quantity in the AC market it must be combined with the BD market, and the reaction functions of the two airlines derived (for proof see appendix 4). The equilibrium quantity is then given by:

$$Q_{AC}{}^{*} = \frac{2(a - c_{MI})}{3b_{AC}} \tag{1.25}$$

BC market

The outcome in this market is the same as in the case 1, with airline 1 and 2 competing directly for passengers:

$$q^1_{BC}{}^{*} = q^2_{BC}{}^{*} = \frac{a - c_{SI}}{3b_{BC*}} \tag{1.7}$$

$$Q_{BC}* = \frac{2(a - c_{SI})}{3b_{BC*}} \tag{1.8}$$

AD market

Passengers must purchase two separate tickets for travel in this market, the total fare is:

$$P_{AD}* = P_{AC}* + P_{CD}*$$

$$P_{AD}* = \frac{a + 2c_{MI}}{3} + \frac{a + nc_D}{(n+1)} = \frac{a(4+n) + c_{MI}(2+3n) + 3nc_D}{3(n+1)} \tag{1.26}$$

Substituting this into the demand function, the equilibrium quantity is given by:

$$Q_{AD}* = \frac{a(2n-1) - c_{MI}(2+3n) - 3nc_D}{3(n+1)b_{AD*}}$$

Arbitrage Constraints

The following arbitrage constraint must be satisfied if airline 1 is able to charge the equilibrium price in the AC market.

$$P_{AC} = \begin{cases} P_{AC}* & if \quad a \geq \dfrac{(2n+2)c_{MI} - (2n+2)c_{SI} - 3nc_D}{3} \\ P_{AB}* + P_{BC}* & if \quad not \end{cases} \tag{1.27}$$

As in the previous case, using two carriers involves double marginalisation. Airline 1 also has the power to manipulate capacity in the AC market, and to hinder any attempts by the n-1 airlines operating in the AB spoke to change the equilibrium quantity. At the same time airline 2 has no incentive to alter her capacity in the BC market, therefore it is likely that this constraint will be satisfied.

4.2 Merger equilibrium

The merged airline (M) has a monopoly in all markets apart from the spokes. The airline no longer has any incentive to increase capacity in the medium international markets to capture a larger share of the interline market.

AB market

Although the same number of airlines compete in this market, as in the previous case, the size of this market has been reduced ($b_{AB*} < b_{AB**}$) as a result of the merged airline's ability to capture the entire interline market. The equilibrium quantity is still given by:

$$Q_{BA}** = \frac{n(a - c_D)}{b_{BA**}(n+1)} \qquad (1.16)$$

<u>AC Market</u>

The merged airline has a monopoly in this market and no incentive to deviate from the monopoly outcome, the equilibrium quantity is therefore the same as in case 1:

$$Q_{AC}** = \frac{a - c_{MI}}{2b_{AC**}} \qquad (1.19)$$

<u>AD market</u>

Again the solution is the same as in case 1:

$$Q_{AD}** = \frac{a - c_{LI}}{2b_{AD**}} \qquad (1.21)$$

<u>Arbitrage Constrains</u>

The post merger solutions are the same as those derived in case 1 and therefore the arbitrage constraints (1.22 and 1.23) must be satisfied. Again, given the double marginalisation, associated with using two carriers, and the ability of the merged airline to manipulate capacity over the entire network, it is likely that these constraints will be satisfied.

4.3 Competitive effects of the merger

The effect in the interhub market (BC) is exactly the same as in case 1 and therefore lemma 3 holds. Although the merger has similar effects in this case there are subtle differences in each of the markets.

Lemma 6: *With the merger the quantity of traffic and consumer surplus falls in all of the spoke markets.*

$$Q_{AB}* > Q_{AB}** \qquad \Delta CS_{BA} = -\frac{(na - nc_D)^2 T_{AD} \beta}{2(n+1)^2}.$$

This is similar to the result put forward in lemma 1, however, previously the merger resulted in a fall in the equilibrium quantity in only two of the spoke markets, whereas this proposition is translated into fall in all four spoke markets.

Lemma 7: *With the merger the equilibrium quantity and consumer surplus falls in all of the medium international markets.*

$$Q_{AC}* > Q_{AC}** \qquad \Delta CS_{AC} = -\frac{(a-c_{MI})^2 \beta(16T_{AD} - 9T_{AD})}{72}$$

In each market the fall in consumer surplus is likely to be larger than in case 1, since the merger not only cuts off all interline demand, but it also eliminates any competition in the interline market. With the merger there is therefore both a move to the monopoly outcome and a sharp reduction in the market size, as all interline demand is lost.

Lemma 8: *The effect of the merger in the interline markets (AD and DA) will depend on the cost structure and the number of airlines operating in the spoke markets.*

$$Q_{AD}** > Q_{AD}** \qquad \text{iff} \qquad a > \frac{3c_{LI}(n+1) - c_{MI}(2+3n) - 6nc_D}{5-n}$$

The number of airlines operating in the spoke markets and the cost structure has the same effect as in case 1. If the quantity of traffic in the interline market increases, then:

$$\Delta CS_{AD} = \frac{[9(a-c_{LI})^2(n+1) - 4(a(2n-1) - c_{MI}(2+3n) - 3nc_D)^2]T_{AD}\beta}{72(n+1)}.$$

As illustrated in the previous case, a necessary (but not sufficient) condition for the merger to increase consumer welfare is the existence of the horizontal double marginalisation problem (satisfaction of (1.23)). In this case the introduction of competition in the interline market, removes the double monopoly markup. This means that the possible gains in consumer surplus, post-merger, are smaller.

Finally lemma 5 holds for this case, in fact, the merger has an even stronger 'foreclosure effect'. The increased traffic in the interline market means that all spoke carriers are initially carrying more interline passengers. With the merger, the n-1 carriers loose all this traffic and therefore there is a dramatic reduction in their market size. Moreover, whereas in case 1 the merger only served to reduce traffic levels in two spoke markets, in this case the merger reduces the size of all four spoke markets.

Proposition 2: *With competition in the spoke and interline markets, the merger results in a fall in total consumer surplus (Proof see appendix 5).*

The introduction of competition in the interline market, without a merger, has three distinct effects. The first increases capacity in all medium international markets, the second increases the quantity of interline traffic, and the third results in all spoke and medium international markets carrying interline passengers. With the merger there is therefore a sharper fall in the equilibrium quantity in all medium international markets and an increase in the number of markets adversely affected. At the same time, given the higher level of interline traffic, without the merger, the possible gains in consumer surplus awarded to interline passengers are smaller. The total fall in consumer surplus in this case is therefore larger than in case 1.

Corollary 1: *The total fall in consumer surplus is greater when there is competition in the interline market, and in the spoke markets.*

5 Asymmetric case: one monopoly spoke (AB) and one competitive spoke (CD), competition in the interline market

The network structure for the asymmetric case is illustrated in figure 3 below.

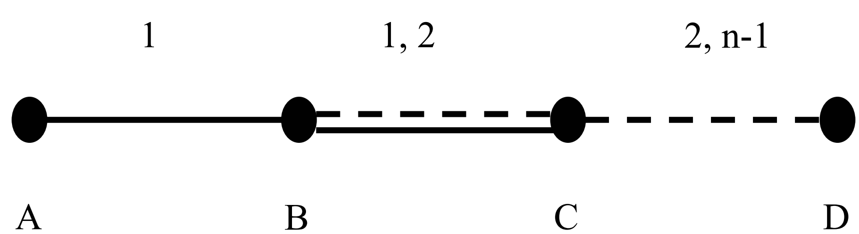


Figure 3: network structure for asymmetric cases.

At one end of the network there is a monopoly spoke, at the other end n airlines compete. The AB monopoly spoke represents the US domestic market, whilst the more competitive

CD spoke represents the inter-European market. The assumption that passengers travel as far as possible with their home carrier has been relaxed, therefore, the markets are the same as in case 2, except that the BD (BD) and AB (BA) markets face no interline demand – this is a result of airline 1's monopoly in the US spoke market. Subsequently fares are higher in these US markets when compared with those in the European spoke markets. In order to pay the lowest total interline fare, all passengers, in the AD and DA markets, make their medium international flight with airline 1 (AC, CA) and their short domestic flight with one of the n airlines operating in the CD (DC) spoke. Airline 2 therefore faces no interline demand in the profitable BD and DB markets[16]. Any attempts by airline 2 to increase her capacity, and reduce her fare in the BD market, in order to attract some of the interline passengers would be unsuccessful, since airline 1 has the power to fully manipulate fares in the AB (BA) market and can inflate the total interline fare. In effect, the varying competition in the spoke markets has eliminated any competition in the interline market - neither of the airlines will have an incentive to deviate from the monopoly outcome in the medium international markets. It has already be shown that airline 2 has no incentive to increase her capacity and since airline 1 can capture the entire interline market, whilst charging the monopoly price in the AC (CA) market, she too has no incentive to increase her capacity.

Rather than deriving all of the equilibrium outcomes for each of the markets, many of the results from case 1 and 2 can be used. The merger will have no effect in the AB (BA) and BD (DB) markets, but lemma 1 and 2 will hold for the respective CD (DC) and AC (CA) markets. The fall in consumer surplus, however, will be greater, as a result of the higher initial market size[17]. Lemma 3 will hold for the BC (CB) market and Lemma 5 will hold for all the n-1 airlines operating in the CD spoke. Finally the effect of the merger in the interline market will be the same as in case 1 and therefore lemma 4 holds.

---

[16] This would provide airline 2 with a very strong incentive to merge with airline 1.

[17] The initial market size of AC (CA) and CD (DC) is higher in case 4 since these routes carry all of the interline passengers in the AD and DA markets, whereas in previous cases the carried only half of them. The other half changed airlines at B and travelled the AB (BA) and BD (DB) sections.

Arbitrage Constraints

Due to the asymmetric nature of this case, there are different arbitrage constraints for the various medium and long international markets. In the medium markets the constraints depend on whether the route covers a European or an American spoke. In the long markets the constraints depend on whether the flight originates in the US or Europe. The first (1.28) assures that airline 1 is able to charge the monopoly price in the AC market. The second (1.29) assures that airline 2 is able to charge the monopoly price in the BD market.

$$P_{AC} = \begin{cases} P_{AC}* & \text{if} \quad a \geq \dfrac{3c_{MI} - 4c_{SI} - 3c_D}{2} \\ P_{AB}* + P_{BC}* & \text{if} \quad \text{not} \end{cases} \qquad (1.28)$$

$$P_{BD} = \begin{cases} P_{BD}* & \text{if} \quad a \geq \dfrac{(3n+3)c_{MI} - (4n+4)c_{SI} - 6nc_D}{(5-n)} \\ P_{BC}* + P_{CD}* & \text{if} \quad \text{not} \end{cases} \qquad (1.29)$$

With the merger there are four arbitrage constraints, these guarantee that the merged airline (M) is able to charge the monopoly price in each of the medium and long international markets. As in previous cases, given the double marginalisation problem, and the power of the airline M to manipulate capacity, it is likely that all these constraints will be satisfied.

$$P_{AC} = \begin{cases} P_{AC}** & \text{if} \quad a \geq c_{MI} - c_{SI} - c_D \\ P_{AB}** + P_{BC}** & \text{if} \quad \text{not} \end{cases} \qquad (1.30)$$

$$P_{BD} = \begin{cases} P_{BD}** & \text{if} \quad a \geq \dfrac{(n+1)c_{MI} - (n+1)c_{SI} - 2nc_D}{2} \\ P_{BC}** + P_{CD}** & \text{if} \quad \text{not} \end{cases} \qquad (1.31)$$

$$P_{AD} = \begin{cases} P_{AD}** & \text{if} \quad a \geq \dfrac{(n+1)c_{LI} - (n+1)c_{MI} - 2nc_D}{2} \\ P_{AC}** + P_{CD}** & \text{if} \quad \text{not} \end{cases} \qquad (1.32)$$

$$P_{DA} = \begin{cases} P_{DA}** & if \quad a \geq c_{LI} - c_{MI} - c_D \\ P_{DB}** + P_{BA}** & if \quad not \end{cases} \tag{1.33}$$

Proposition 3: *With asymmetric competition in the spoke markets and competition in the interline market, the merger results in a fall in total consumer surplus (Proof see appendix 6).*

Given the asymmetric nature of this case the merger has different welfare implications for US and European passengers. All interline and interhub passengers - irrespective of their nationality - are affected the same manner. However, the merger has different consumer welfare implications in the various spoke and medium international markets. The merger has no effect in the US spoke and EU medium international markets - since they include no interline passengers, but passengers suffer in the US medium international markets (AC and CA) and in the EU spoke markets (CD and DC).

Proposition 4: *The fall in consumer welfare is larger in the EU than in the US. (Proof see appendix 7).*

The fact that the European and American passengers are affected differently by the merger, may explain why the US and European competition authorities have voiced different responses to the proposed BA/AA alliance. When the BA/AA case was first referred for approval (1996), the European Competition Commission originally required the two carriers to give up 350 Heathrow slots - in order to facilitate the entry of new competitors, eventually this was reduced to 267. This is considerably higher than the release of 224 slots, required by the US Department of Justice the second time round in 2002[18]. Although it is hard to make direct comparisons between the views and conditions imposed by the two bodies, since only the European Competition Commission's remedies are publicly available for BA/AA's first attempt, and similarly only the US Department

[18] However, the matter is complicated by political concerns such as the removal of Bermuda II, and the opening up of Heathrow to more US carriers. In 2001 BA and AA where both keen for the British Government to continue 'open skies' negotiations with the US - such a deal to bring in more competition would make the competition authorities more likely to approve their alliance.

of Justices remedial action is available for the second. Irrespective of the exact differences, this asymmetric case illustrates that there may theoretical reasons for them. According to proposition 4, the alliance would have a different effect on American and European consumers and one should expect this to be reflected in the competition authorities' conclusions.

So far only one asymmetric case has been considered in detail, a similar case, without competition in the interline market has not been looked at. This is partly due to the problems associated with using Cournot competition in the interline market, and because many of the results from case 3 carry over. As explained in section 2, a quantity based approach cannot be used when complementary products must be purchased in fixed proportions, from two separate firms. In the above analysis it has been assumed that interline passengers pay the same fare as local passengers. As a result fares for travel in the interline market, without the merger, have been very high, but crucially they have not been high enough to remove all interline passengers from the market. In an asymmetric case without competition in the interline market, where airline 2 has a monopoly in the medium international market, DB, and airline 1 has a monopoly in the domestic market, BA, the combined interline fare for travel DA is high enough to eliminate any interline demand. In previous models (Brueckner 2001a) this problem has been resolved by a move to price competition[19]. This approach is, however, not entirely satisfactory. In Brueckner's analysis, the airlines set subfares in their respective medium international and spoke markets, which make up the total interline fare, and the resulting subfares are less than the local fares. There is, however, no explanation of how the airlines are able to distinguish between interline and local passengers. For example, how do the airlines stop local passengers mimicking interline passengers and purchasing tickets at lower, interline fares. Interline passengers must purchase two separate tickets, one from each airline, and therefore the airlines cannot easily distinguish between interline and local passengers. If the airlines cannot tell which type of passenger they are serving (and all passengers pay the same fare), the equilibrium fare cannot be precisely determined, since it will depend

[19] As stressed this is only legitimate when there is no competition in the medium international and spoke markets, and price and quantity are equivalent decision variables.

on the varying profitability of the local and interline market and therefore requires assumptions with regard to the relative size of the two markets. A feature that ultimately inhibits any detailed investigation of an asymmetric case, without competition in the interline market.

Without any detailed analysis, it is evident that number of results from case 3 carry over to a similar asymmetric case, without competition in the interline market. For example, it is known that the merger has no effect in the markets that carry only domestic (AB, DC) and medium international passengers (CA, BD), that it eliminates competition in the interhub market (BC) and that it reduces the size of all of the markets that initially carry interline passengers (AC, DB, BA, CD). Given that the loss in consumer surplus in the spokes increases with n, it is also evident that passengers in the EU spoke markets will suffer more than those in the US spoke markets. At the same time, the varying degree of competition in the spoke markets means that US interline passengers pay a lower total interline fare, without the merger. EU interline passengers therefore benefit more from the merger. As in previous cases total consumer surplus falls with the merger (see appendix 8 for sketch proof). However, unlike the previous asymmetric case, a proposition with regard to whether the fall in total consumer surplus is larger in the EU, or in the US, cannot be made. It will depend on the quantity of European interline traffic, which is not well defined. Not only does this quantity obviously affect the increase in consumer surplus in the European interline market, but it also affects the fall in consumer surplus in the American BA spoke market, and the European medium international DB market. Without knowing these values a clear comparison with the changes in consumer surplus in the American interline, and the relevant American medium international and European spoke markets cannot be made. However, as with the previous asymmetric case, this case illustrates why one should expect different responses from the European and American antitrust authorities with regard the BA/AA case.

7. Conclusion

This paper examines the effect of mergers across hub-and-spoke networks on traffic levels, consumer surplus and the profit of competing airlines. Three specific cases are analysed in detail, each with a different level or nature of competition in the spoke and interline markets. In all cases the merger leads to a fall in total consumer surplus and to a fall in traffic for competing carriers in the spoke markets, which could eventually facilitate market foreclosure. Consumers suffer most when competition in the spoke markets is coupled with competition in the interline market, since the merger leads to a sharp reduction in traffic levels in all medium and short international, and spoke markets. The smallest reduction in total consumer surplus arises when there is one monopoly spoke, and no competition in the interline market. Before drawing to the final policy conclusions, this section briefly discusses a few of the assumptions invoked, and some possible generalisations.

7.1 Generalisations

So far, it has been assumed that operations over each route of the network are subject to constant marginal costs or constant returns to scale. The cost structure imposed allows for the realisation of economies of scale when an airline flies over more than one section of the network, but it does not allow for economies of traffic density, insofar as it has not taken into account the effect that changes in the level of traffic density could have on costs. If economies of traffic density are present, then as the number of passengers travelling a route increases, the cost per passenger falls. If density (quantity) falls, this could intensify the fall in total consumer surplus. Given propositions 1 to 4, the fall in traffic, in the short and medium international, and spoke markets, is greater than the increase in the interline market. Therefore the conclusions of these propositions are strengthened by the presence of economies of traffic density. Moreover, the presence of such economies will enhance the negative impact of the merger on the n-1 airlines operating in the spokes. Given that the number of passengers travelling with these airlines falls with the merger, lower traffic levels will cause their costs per passenger to increase. As a result, these airlines may find continued operation unprofitable even sooner. Introducing economies of traffic density into the model therefore reinforces the results.

The simple network structure only includes two endpoints and as suggested in section 2, a more realistic network structure may well have more. In Brueckner's model (2001a), with an increase in the number of endpoints the unfavourable outcomes of the merger virtually disappear, since the number of interline markets (where consumer surplus rises) increases. In this model, the effect of an increase in the number of endpoints, and interline passengers, is not restricted to the interline markets – it also felt in the spoke and medium international markets which carry interline passengers. Apart from in the interhub market, in all other markets the magnitude of the change in consumer surplus depends on the size of the interline market. Therefore whilst adding another endpoint and including more interline passengers results in a larger gain in consumer surplus in the interline markets, it also results in a steeper fall in consumer surplus in the medium international and spokes markets which carry interline passengers. The proofs for proposition 1 and 2 show that the gains in the interline market are smaller than the losses in the other markets. Moreover, a closer examination of the comparative statics of the changes in consumer surplus illustrate that the gains arising from an increase in the number of interline passengers will always be smaller than the losses, since $c_{MI} < c_{LI}$. Therefore increasing the number of endpoints does not change the overall consumer welfare implications of the model.

It has also been assumed that the demand for non-merger, interline trips, and single-airline trips is the same, despite the changes in convenience. This is because the model solely focuses on the supply-side effects of the merger, and has not taken into consideration the possibility of demand-side efficiency gains. Potential efficiency gains would include an increase in the number of city pairs where intra-line connection is available, increases in flight frequency and shorter connection times and an increase in the number of routes served by a non-stop service. Each of these efficiency gains would increase the quality of the products available to consumers, post merger. Incorporating these efficiency gains into a model is very hard since it involves the comparison of differentiated products. It is, however, very unlikely that all passengers would benefit from quality improvements, for while interline passengers would benefit from connectivity improvements, according to the results above it is likely that the total number of flights (quantity) in other markets will fall, and here passengers will suffer from less frequent flights.

7.2 Policy Conclusions

The initial motivation for this paper stemmed from the proposed BA/AA alliance, therefore the network structure, and nature of competition are well suited to this particular case. It differs from previous airline mergers and alliances in two distinct respects. First, unlike previous alliances, such as the Lufthansa/SAS/British Midland formation of the Star Alliance, the markets in which BA and AA directly compete are significantly larger and more concentrated than the routes that could benefit from improvements in connectivity. Secondly, given the route structure of BA and AA, there was a real fear that the airlines would, post-merger, have incentives to reduce the capacity available for local traffic and may therefore reduce the benefits that may otherwise accord to interline passengers from connecting the two networks (DOJ 2001, p46). According to propositions 1 to 4, if this alliance where allowed (without any remedial action) then consumers would suffer, which is in accordance with the findings of the US Department of Justice. Such a conclusion contrasts with those stemming from previous research (Brueckner 2001a).

Whilst this paper appreciates that the model developed best fits this case, and that the nature of competition and network structure may differ for others, the main results should hold. As illustrated, the competitive effects of mergers across hub-and-spoke networks depend on the initial degree of competitive overlap, the number of airlines operating in each market and the merged airline's ability to capture interline traffic. Interhub passengers suffer if there is considerable competitive overlap, and competition cannot be constrained by a third party. Spoke and medium international passengers suffer when the merged airline is able to differentiate between interline and local demand, they suffer more as the initial level of competition increases. Interline passengers benefit if the networks are complementary and result in connectivity improvements, but they also suffer if initial interline competition is removed. Finally the foreclosure effect of the merger depends on the merged airline's ability to capture most the interline market.

8. Bibliography

Brueckner J K, 2001a, 'The Economics of International Codesharing: an Analysis of Airline Alliances', *International Journal of Industrial Organisation,* 19 pp1475-98.

Brueckner J K, 2001b, 'The Benefits of Antitrust Immunity and Codesharing for Interline Passengers: The Case of American Airlines and British Airways', study prepared for American Airlines and British Airways.

Brueckner J K & Spiller P T, 1990, 'Competition and Mergers in Airline Networks', *International Journal of Industrial Organisation,* 9 pp323-42.

Brueckner J K & Whalen W T, 2000, 'The Price Effects of International Airline Alliances', *Journal of Law and Economics,* 43 pp503-45.

Brueckner J K, 2002, 'International Airfares in the Age of Alliances: The Effects of Codesharing and Antitrust Immunity', forthcoming *Review of Economics and Statistics.*

Clougherty J, 2002, 'US Domestic Airline Mergers: the Neglected International Determinants', *International Journal of Industrial Organisation,* 20 (4) pp557-76.

Economides N, 1996, 'The Economics of Networks', *The International Journal of Industrial Organisation,* 14 (2) pp673-699.

Encaoua D, Moreaux M & Perrot A, 1993, 'Demand-side Network Effects in Airline Markets', Working Paper Cahier EcoMath 92.28, Universite de Paris I, Pantheon-Sorbonne.

Farrell J & Shapiro C, 1990, 'Horizontal Mergers: An Equilibrium Analysis', *American Economic Review,* 80 pp107-126.

Kreps D & Scheinkman J, 1983, 'Quantity Pre-commitment and Bertrand Competition yield Cournot Outcomes', *Bell Journal of Economics,* 14 pp326-37.

Organisation for Economic Co-operation and Development (OECD), Committee on Competition Law and Policy, 2000, '*Airline Mergers and Alliances'.*

Organisation for Economic Co-operation and Development (OECD), Committee on Competition Law and Policy, 2002, *'Portfolio Effects in Conglomerate Mergers'.*

Park J H & Zhang A, 2000, ‘An Empirical Analysis of Global Airline Alliances: Cases in North Atlantic Markets’, *Review of Industrial Organisation,* 16 pp367-84.

Park J H, 1997. ‘The Effects on Airline Alliances on Markets and Economic Welfare’, *Transportation Research – Part E,* 33 (3) pp181-95.

Park J H, Zhang Y & Zhang A, 2001, ‘Analytical Models of International Alliances in the Airline Industry’, *Transportation Research – Part B,* pp865-886.

Straiger J, 2001, ‘Airline Alliances and Mergers – the Emerging Commission Policy’, paper presented at the 13th Annual Conference of European Air Law Association, Zurich, November 2001.

US Department Of Justice (DOJ), 2001, ‘The US-UK Alliance Case’, Comments of the DOJ.

US Department of Transport, 1999, ‘International Aviation Developments: Global Deregulation Takes Off’, first report.

US Department of Transport, 2000, ‘International Aviation Developments: Transatlantic Deregulation, the Alliance Network Effect’, second report.

Youssef W & Hansen M, 1994, ‘Consequences of Strategic Alliances between International Airlines: The Case of Swissair and SAS’, *Transportation Research Part A,* 28 pp414-31.

Appendix 1: derivation of b_{ij}

Let $Q_{ij} = T_{ij} q_{ij}$

Q_{ij} represents the total demand for roundtrip travel between city i and j, where T_{ij} consumers each demand quantity q_{ij} .

The quantity demanded by each individual depends inversely on the price:

$$q_{ij} = \alpha - \beta P_{ij}$$

Summing over the T_{ij} consumers in the market, the total demand for roundtrip travel in one market is given by:

$$Q_{ij} = T_{ij}\alpha - T_{ij}\beta P_{ij}$$

This can be rearranged to give the inverse demand function:

$$P_{ij} = \frac{T_{ij}\alpha}{T_{ij}\beta} - \frac{Q_{ij}}{T_{ij}\beta}$$

Which can be simplified to:

$$P_{ij} = a - b_{ij} Q_{ij}$$

Where $a = \frac{\alpha}{\beta}$, and $b_{ij} = \frac{1}{T_{ij}\beta}$. The parameter b_{ij} includes a measure of the market size (T_{ij}), they are inversely related - as the market size (number of consumers) increases b_{ij} falls.

Appendix 2: derivation of lemma 5

Without the merger, if it is assumed that airline i's profit must cover fixed costs (F), the maximum number of airlines that can profitably operate in the spoke market BA can be expressed as:

$$n^* = \frac{(a - c_D)}{\sqrt{b_{BA^*} F}}$$

In the same manner, with the merger, the maximum number of airlines that can profitably operate in the spoke market BA can be expressed as:

$$n^{**} = \frac{(a - c_D)}{\sqrt{b_{BA^{**}} F}}$$

With the merger the size of the BA market falls, since all of the interline passengers are removed. This is translated into an increase in the parameter b_{BA} ($b_{BA^{**}} > b_{BA^{*}}$). Given that the maximum number of airlines that can profitably operate in the BA spoke (n^{*}, n^{**}) depends inversely on b_{BA}, as the market size falls with the merger, the maximum number of airlines that can profitably operate in the BA spoke also falls ($n^{**} < n^{*}$).

Appendix 3: Proof of proposition 1

Proof: This can be proved by comparing the largest possible gain in consumer surplus in the interline market with the loss in consumer surplus is the AC market alone. The possible gain in the AD market $= \dfrac{((a - c_{IL})^2 (n+1)^2 - [a(n-1) - (n+1)c_{MI} - 2nc_D]^2) T_{AD} \beta}{8(n+1)^2}$,

by setting the term in the squared bracket to zero, the largest possible value that this can take is $\dfrac{(a - c_{IL})^2 (n+1)^2 T_{AD} \beta}{8(n+1)^2}$. The loss in the AC market is $\dfrac{(a - c_{MI})^2 T_{AD} \beta}{8}$. Comparing these, the loss in consumer surplus in the AC market is larger than the gain in the AD market since $c_{MI} < c_{LI}$. With the merger consumer surplus also falls in all the spoke markets that carry interline passengers and in the interhub market. □

Appendix 4: derivation of equilibrium in AC market in case 2

As a result of the competition in the spoke markets the medium international markets are more profitable, and the airlines therefore want to attract more interline passengers into these markets. If the assumption that passengers travel as far as possible with their home carrier is relaxed, passengers located at A wishing to fly to D can change airlines at either B or C, and therefore have the choice of flying either the medium international route AC or BD. If interline passengers are indifferent between either route, the two markets can be combined, since the airline 1 and 2 are competing directly for interline passengers in these markets. They can change their capacity in these markets to attract more interline traffic, and in effect steel passengers from their rival's medium international market.

Given the inverse demand functions:

$$P_{AC} = a - b_{AC*}Q_{AC}$$
$$P_{BD} = a - b_{BD*}Q_{BD}$$

If these two markets are combined the total quantity is:

$$Q_{AC} + Q_{BD} = \frac{a}{b_{AC*}} + \frac{a}{b_{BD*}} - \frac{P_{AC}}{b_{AC*}} - \frac{P_{BD}}{b_{BD*}}$$

Given the symmetry of the network structure and nature of competition, $b_{AC*} = b_{BD*}$ and $P_{AC} = P_{BD}$. This enables to total quantity to be expressed as:

$$Q_{AC} + Q_{BD} = 2(\frac{a}{b_{AC*}} - \frac{P_{AC}}{b_{AC*}})$$

This can be rearranged to give the inverse demand function:

$$P_{AC} = a - \frac{b_{AC*}}{2}(Q_{AC} + Q_{BD})$$

The profit of each of the two airlines can then be expressed as:

$$\pi^1_{AC} = Q_{AC}(a - \frac{b_{AC*}}{2}(Q_{AC} + Q_{BD}) - c_{MI})$$

$$\pi^2_{BD} = Q_{BD}(a - \frac{b_{BD*}}{2}(Q_{AC} + Q_{BD}) - c_{MI})$$

Finding the best responses and solving for the equilibrium quantity:

$$Q_{AC}* = \frac{2(a - c_{MI})}{3b_{AC*}}$$

$$Q_{BD}* = \frac{2(a - c_{MI})}{3b_{BD*}}$$

Appendix 5: Proof of proposition 2

Proof: The proof for proposition 1 shows that the fall in consumer surplus in the AC market is greater than the gain in the AD market. The fall in the AC market is larger in this case than in the previous one:

$$\frac{(a-c_{MI})^2\beta(16T_{AD}-9T_{AD})}{72} > \frac{(a-c_{MI})^2 T_{AD}}{8},$$

At the same time the gain in the AD market, in this second case, is smaller

$$\frac{9(a-c_{LI})^2(n+1)-4(a(2n-1)-c_{MI}(2+3n)-3nc_D)^2}{72(n+1)} < \frac{(a-c_{IL})^2(n+1)^2-(a(n-1)-(n+1)c_{MI}-2nc_D)^2}{8(n+1)^2}$$

It follows that the costs to passengers in the AC market must therefore outweigh the possible benefits to passengers in the AD market. With the merger consumer surplus also falls in the interhub and spoke markets. □

Appendix 6: Proof of proposition 3

Proof: Lemma 2 holds for the AC and CA market and 4 holds for the AD and DA market, in the proof for proposition 1 it has already been proved that the resulting gains in consumer surplus are smaller than the losses. With the merger consumer surplus also falls in the European spoke and interhub markets. □

Appendix 7: Proof of proposition 4

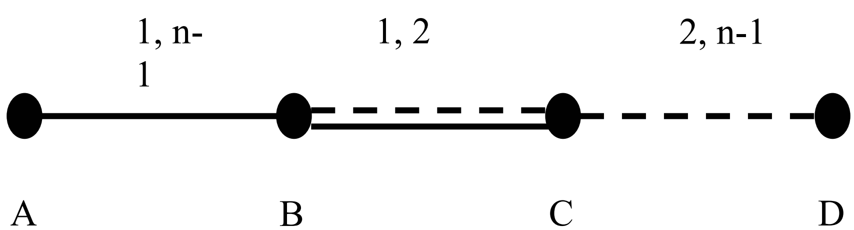
Proof: The total fall in consumer surplus in the US medium international markets = $\frac{(a-c_{MI})^2 T_{AD}\beta}{4}$. The total fall in consumer surplus in the EU spoke markets = $\frac{(na-nc_D)^2 T_{AD}\beta}{(n+1)^2}$. Therefore the total fall in consumer surplus is larger in the EU than in the US if $a > \frac{2nc_D-(n+1)c_{MI}}{n-1}$. This inequality is likely to hold since $c_{MI} > c_D$. The loss in consumer surplus in the spoke markets is increasing in n, therefore as the number of airlines operating in the EU spoke increases so too does the loss in total EU consumer surplus relative to the total loss in the US. □

Appendix 8: Sketch of Proof that with asymmetric competition in the spoke markets and no competition in the interline market, the merger results in a fall in total consumer surplus.

Proof: To be consistent with the analysis of the majority of the paper, assume that the airlines care more about local passengers. With this assumption, irrespective of the nature of competition in the interline market, in both asymmetric cases, the airlines strategies are exactly the same in all medium and short international and spoke markets. The only difference is in the interline markets. In both cases interline passengers benefit from the merger, but to varying degrees. Lemma 2 holds for the American AC market and lemma 4 holds for the American AD market, in the proof for proposition 1 it has been shown that the loss in consumer surplus in the AC market is larger than the gain in the AD market. Assuming that the airlines only care about local passengers, allows for the largest possible gain in consumer surplus in the European DA market = $\frac{(a-c_{LI})^2 T_{AD}\beta}{8}$. The loss in consumer surplus in the European DB market = $\frac{(a-c_{MI})^2 T_{AD}\beta}{8}$. Comparing these, the loss in the DB market is greater, since $c_{MI} < c_{LI}$. The loss in consumer surplus in the medium international markets therefore wipes out the gains in the interline markets, whilst consumer surplus is still falling in the interhub and spoke markets. □.

Appendix 9: network structure

Network structure for the symmetric cases:



Network structure for the asymmetric cases: