Impact of emissions trading on pricing and profits in aviation: review of Vivid Economics reports

A REPORT PREPARED FOR THE EUROPEAN LOW FARES AIRLINE ASSOCIATION (ELFAA)

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Executive summary

The Department for Environment, Food and Rural Affairs (Defra) and the Department for Transport (DfT) have published two reports by Vivid Economics (Vivid) on the impact of the Emission Trading Scheme (ETS) on the aviation sector[1]. These reports have informed the debate on the appropriate mechanism to use to allocate aviation ETS permits. The European Low Fares Airline Association (ELFAA) has asked Frontier Economics to review these reports.

Our review has led us to conclude that it is impossible to base such a significant policy decision on the analysis and evidence presented in the Vivid reports. This paper highlights the limitations of the inappropriate and oversimplified theoretical model underpinning the conclusions of the two reports. We also find that the empirical evidence cited by Vivid is neither robust nor does it accurately reflect the contestable nature of the aviation market. These concerns are summarised here.

The Vivid reports fail to take account of the realities of the airline industry. This results in an overestimate of both the extent of pass-through and the expectation that airlines will earn windfall profits. The main characteristics that are not captured by the analysis are as follows.

- Airline passengers are price sensitive. This is the primary constraint on airlines' ability to pass increased costs onto customers. The Vivid model does not capture the extent of this sensitivity because it does not accurately capture the characteristics of passengers, the nature of pricing in the sector or the relationship between costs and fares.
- Airlines are not homogeneous. There is no sense in which an 'on average' conclusion can be reached for the sector that reflects the day-to-day reality of any one of the many business models observed in the sector. It is important to appreciate and understand the differentiation in the sector when evaluating models for allocating ETS permits. Vivid's model does not do this.
- Airlines operate in a dynamic market. Pressures from entry and exit influence pricing decisions, costs and operational strategies. Furthermore, dynamic competitive pressures ensure that above normal profits can not be earned over time. These dynamic considerations are not captured in Vivid's model.

The conclusions in the Vivid report can not be considered sufficiently robust for policy-making purposes.

VIVID'S THEORETICAL MODEL

Vivid's conclusions are based on an assumption that competition in the airline sector can be simulated by the "Cournot model". Vivid admits that this is an abstract theoretical model rather than a detailed accurate representation of inter-

1 'A study to Estimate Ticket Price Changes for Aviation in the EU ETS', November 2007 and 'A study to estimate the impacts of emissions trading on profits in aviation', January 2008.

airline competition. However, Vivid does not consider the implication of model limitations for policy predictions.

- There are significant differences between the assumptions of this model and the realities of competitive behaviour in the aviation sector. In particular Vivid's model fails to reflect the fact that airline markets are contestable and, hence, airlines are constrained by the behaviour of current and potential competitors in the market. Above normal profits can not be sustained in such a market.
- Airlines are significantly constrained by passenger behaviour. In particular, passengers are price sensitive and this has a significant impact on cost pass-through decisions. The elasticity of demand varies along a number of dimensions (for example, origin airport, destination type, customer type). The nature of demand reactions to price changes can not be understood with an assumption on a single elasticity number measured at a point in time.
- The model fails to address the reality of fare-setting by airlines. In Vivid's model prices are set on cost-plus basis with the assumption that there is a unique price in any given market. This could not be further from the reality of airline pricing. A number of different models are used to set fares in the airline sector, with varying levels of complexity. For example, some low cost airlines use complex algorithms that are designed to adjust real time to competitive conditions in an attempt to maximise revenues and load factors for each individual flight. Other airlines make fare decisions that reflect the profitability of the business across different markets (for example, intra-EU, transatlantic and long-haul). This may allow for profits in one market to be used to offset cost increases in another market and thereby limit required increases in fares in that market. There is no clear link between fares and costs in the sector.
- Furthermore, the complicated relationships between operational decisions, costs and fares can not be reflected in a simple economic equation. For example, when considering fuel costs, airlines consider a range of strategies in the round. These include options for reducing the amount of fuel used (for example, flying at lower speeds), reducing the fuel bill over time (for example, through hedging) and passing increased costs onto customers. The network of decisions involved is unlikely to be captured in any theoretical model but it is the combination of decisions that impacts on the way that costs (such as those arising from ETS) feed through indirectly into fares. A theoretical model that does not take into account the realities of supply, demand and competition in the airline sector cannot be relied upon to produce meaningful conclusions about the impact of ETS on prices and profits.
- The model also fails to capture the extent of differentiation in the airline market. Airlines are not homogenous. Cost shocks, and the ability of airlines to pass increases onto customers, will vary by airline because of differences in their business models. For example, an airline that only operates in the EU will have more limited options for financing the costs of ETS than one that has operations in markets outside the EU (including markets that are not liberalised). This variation is not captured in the Vivid model, and means that

conclusions about the sector 'on average' are difficult to interpret relative to the realities of the sector.

It is notable that Vivid does not attempt to justify the use of this model relative to other theoretical models that could be used to assess the impact of ETS on prices and profits. Nor does it consider the extent to which its results are an artefact of the assumed model rather than an accurate representation of the realities of airline competition. This suggests that the authors have not assessed real policy implications of their analysis.

VIVID'S USE OF EMPIRICAL EVIDENCE

Vivid also uses empirical evidence on the airline sector to support its analysis. But this evidence fails to reflect accurately the true nature of competition in the sector.

- In particular, Vivid characterises the intensity of competition according to the number of carriers operating on a given point-to-point route. But in practice, airlines compete for passengers from originating airports to a wide class of destinations (for example, City Breaks; Sun Breaks), which means that the intensity of inter-airline competition is significantly understated by Vivid's approach.
- Vivid's results are also dependent on assumptions regarding the shape of the demand curve (linear or constant elasticity) which are made without any supporting empirical evidence. This is despite the fact that the results are highly sensitive to this assumption. Neither is there any consideration of whether historical price elasticity figures are an appropriate assumption going forward, given the changing economic environment.
- Furthermore, Vivid's use of evidence from other sectors regarding the rate of cost pass through is of no relevance given the significant differences in the nature of competition in the sectors considered and competition in the airline market. No evidence is provided on cost pass-through experience in the airline sector (for example, pass-through rates for fuel costs)

The empirical evidence can therefore not be relied upon for policy-making purposes.

THE ASSUMPTION OF WINDFALL PROFITS

Pricing, and hence profits, in the aviation sector are determined by demand and the range of services offered by the market. Complex differentiated pricing arrangements are in place to reflect these combined factors. There is evidence of entry and exit, and hence an expectation of potential entry constraining current operators.

In this world it is inconsistent to assume that prices adjust to cost in the long run, but that supernormal profits can persist. In practice in a contestable market it is likely that any excess profits would be eroded away. Demand conditions will constrain the extent to which prices can respond to cost shocks, especially in the short to medium term.

We expect that if an assessment was undertaken that more accurately reflected these realities of the aviation sector, the conclusions reached would be very different to those in the Vivid reports.

POLICY RECOMMENDATIONS

We recommend that Defra and the DfT consider the realities of the airline sector in detail when determining the appropriate allocation mechanism for aviation ETS permits. This consideration needs to be wider than the predictions of a stylised and oversimplified model.

More generally, a decision on the allocation mechanism should be based on a transparent cost benefit analysis of a range of options. In this regard, the impact of the mechanism on airline profitability would be one of a number of environmental, economic and social factors to consider.

Executive summary

1 Introduction

Frontier Economics has been asked by the European Low Fares Airline Association (ELFAA) to review and comment on two reports published by Vivid Economics (Vivid)[2]. The reports, commissioned by the Department for Environment, Food and Rural Affairs (Defra) and the Department for Transport (DfT), consider the impact of the EU Emissions Trading Scheme (ETS) on airline ticket prices and on airline profitability. Vivid uses its analysis to deduce the proportion of ETS allowances that could be allocated for free to airlines, while keeping profitability in the aviation sector at its pre-ETS level.

We have reviewed the Vivid reports and conclude that it is impossible to base any ETS-related policy decision on the analysis and evidence presented. The results are derived from an oversimplified theoretical model that bears no resemblance to the realities of competition and demand in the aviation sector. We also consider that the empirical evidence used by Vivid is not robust and does not accurately reflect the contestable nature of the aviation market.

The reasons for our conclusions are presented in detail in this report. We also emphasise the areas where policy-makers need to focus their attention, when considering the best way forward for choosing a permit allocation mechanism.

Our consideration of the report has been undertaken at three levels.

- In Section 3 we review the theoretical model used by Vivid and consider whether it is 'fit for purpose'.
- In Section 4 we review the conclusions reached on cost pass-through, profitability and allowance allocation mechanisms and assess whether they are robust.
- In Section 5 we take a 'step back' to assess whether the information provided is sufficient to answer policy questions relating to the appropriate allocation mechanism for aviation permits in the ETS.

However, before entering into the detail of our findings, we present in Section 2 a high level description of the nature of demand, supply and hence competition in the aviation sector. Such a description is lacking in the Vivid reports and yet is essential to any understanding of the impact of a cost shock (for example, from ETS) on pricing and profitability.

2 'A study to Estimate Ticket Price Changes for Aviation in the EU ETS', November 2007 and 'A study to estimate the impacts of emissions trading on profits in aviation', January 2008.

2 The realities of the aviation sector

The analysis in Vivid's report is based on a rudimentary and simplistic economic model that appears in undergraduate economic textbooks. No attempt is made to discuss the applicability of this model to the realities of the aviation sector, or to assess alternative models and ask whether these produce similar or different conclusions.

In our view an assessment of the impact of a cost shock on prices and hence profitability in the aviation sector must start with a proper analysis of how demand and competition constrain prices. This requires an understanding of the specific characteristics of the sector. To help move the debate forward we therefore provide a high level description of demand and competition in the aviation sector. This description is based on observation of the sector rather than a simplified theoretical economic model. It is hoped that interested parties will consider these specific characteristics, when assessing the impact of different ETS options on the sector.

2.1 PRICING IS COMPLEX

As anyone who flies knows, there is no such thing as a single fare for an airline ticket on a given route or even on a given flight.

A number of different pricing models are used by airlines in the sector. The variety itself demonstrates the complexities involved and the fact that there is no clear link between price, cost, operational decisions and demand. For example, some airlines set fares, for any given flight, according to complex algorithms which cause the fare offered to any passenger to vary depending on when the ticket was bought and what proportion of the plane has already been filled. Other airlines offer a wide range of prices depending on the type and class of journey (for example, mid-week return) and these prices are adjusted to reflect the load factor on each flight.

Passengers will choose their flights, dependent on the fares offered at the time they choose to book and the fares offered on alternative competing services. The pricing algorithms adjust fares offered, in an attempt to maximise revenue and load factors, and hence are very dependent on the specific demand conditions affecting each individual flight.

This is, therefore, a market with significant price differentiation and variation in the pricing models used. There is no clearly identifiable link between cost and price, that can be said to apply across the sector. ETS would result in what is termed a 'common' cost shock (that is, a shock that affects all airlines at the same time), but the impact of that shock will vary by airline, depending on the specific characteristics of passengers and the pricing rules used. The impact will also vary for airlines that only operate within the EU and those that also operate in other markets (including markets that are not liberalised). A simple theoretical model can not capture this differentiation and complexity in the sector.

There are, as in all markets, two key constraints on the level of prices. The first is the nature of demand. Sensitivity of demand will constrain the extent to which a profit-maximising airline can increase fares in response to the common cost shock. For example, in a market with inelastic demand, customers would not change demand in response to a fare increase. In contrast, if demand is elastic, as it is for a large part of airline offering, firms will only adjust fares if the increase in revenue (from higher prices) is not offset by a reduction in revenue (from reduced demand). The second constraint on pricing is the extent of competition. Competitive pressure will constrain an airline's ability to earn above normal profits by pricing above cost. We consider each factor in turn below.

2.2 PASSENGERS ARE PRICE SENSITIVE

Passenger behaviour constrains fares because an increase in fares causes a proportion of passengers to not buy a ticket on a given flight, either because they choose to take an alternative service or not to fly at all. A trade-off therefore needs to be made between the revenue increase from a higher fare, and the revenue loss arising from a decline in sales. The more sensitive passengers are to price changes, the lower the probability of cost changes leading to price changes.

In general, airline passengers are considered to be price sensitive. This is the primary constraint on the ability of airlines' to pass cost increases onto customers.

The existence of price differentiation in a market indicates that there is variation in the extent to which passengers are sensitive to price changes. For intra-EU travel, more airlines are moving to business models, similar to those of the low-cost carriers. In this world it is harder to identify the variation in passenger characteristics and therefore identify the 'average' elasticity for an airline, let alone the sector. Historic evidence on price elasticity for particular passenger types (such as business/leisure) is no longer relevant for the sector. It is, therefore, extremely difficult to draw conclusions about demand elasticity 'on average' for the sector. This is primarily an empirical exercise, but one that needs to be based on an assessment of the exact proportion of passengers, that are considered to be price sensitive for any given level of demand or price level. Evidence of this type has not been presented in the Vivid reports.

2.3 COMPETITION IS DYNAMIC AND EFFECTIVE

The more competition there is, the more choices customers have and, hence, the more likely it is that they will choose to purchase a ticket from one airline if another one has higher prices. Furthermore, if it is easy for an airline to enter any given market, then prices of existing services will be constrained by the threat that new entrants could take their passengers. Other airlines (in the market or potential entrants) will prevent an airline from charging above cost (that is, making above normal returns) and will, combined with the extent of passenger price sensitivity, limit any price increases. It is therefore the extent of market contestability (that is, the extent of potential and actual competition) that is relevant for pricing.

The EU aviation market has seen a significant increase in the number of operating airlines in the last twenty years, with entry and exit observed on a regular basis. The growth of low cost airlines has played a significant role in this increase, alongside the expansion of established airlines into different markets. The evidence speaks for itself. There is scope to enter and exit the market and airline decisions are constrained by the choices made by existing airlines and by the threat of potential entry.

Furthermore, demand characteristics and customer awareness of travel options have changed. Increasingly, airlines observe that passengers look for a flight from a specific origin to either a destination type (for example, EU cities, "sun & sand" destination) or to a region (for example, airports near Barcelona) but are less constrained in their choice of destination airport. This partly reflects the price sensitivity of passengers, being willing to fly to different airports if 'the price is right', and the improved accessibility to different cities or holiday resorts from an increased number of airports.

Vivid's report assumes that the intensity of competition on a given point-to-point route is just a function of the number of carriers on that route. This is simply incorrect. Competition on point-to-point routes is not the relevant dimension to consider. There is competition from an origin airport to different 'clusters' of destination airports. Any given point-to-point route will be subject to competition on that route offered by the different carriers, competition from alternative routes and potential competition provided by the threat of entry.

If Vivid's model were correct, with competition characterised only by the number of operators on any given point-to-point route, then the aviation sector would be characterised by a low overall intensity of competition and the existence of persistent high levels of profit. This is not what we observe in practice,

The existence of effective competition means that above-normal profits are not sustainable over time. If an airline is making above-normal profits in liberalised markets such as intra-EU, other airlines will see that there is potential in the relevant markets and will enter to gain their share of the profits. In the medium term the increase in supply reduces prices and brings profits for the sector back to a normal level (that is, revenue covers their costs, including a reasonable return).

2.4 COST PASS-THROUGH IS AN "INDIRECT" COMMERCIAL DECISION

Across their business as a whole, airlines will continue to operate only if they can generate normal profits. In the short run an increase in costs will cut into existing profits and will need to be compensated for, either through a reduction in other costs or an increase in revenue.

As noted earlier, airline fares are not set on a cost plus basis. Fares are in fact determined "real time" in the market for each individual flight. The outcome will depend on demand conditions but also on the capacity decisions made by airlines. Hence there is likely to be a different short run and long run price response to a shock like the introduction of ETS.

In practice airlines review and fix their schedule of services on a six-monthly basis. Once that schedule is fixed, there is limited scope to alter these services in the meantime, especially at congested airports.

In the very short-run, therefore, a cost shock, such as an increase in fuel costs, will not affect the schedules offered by airlines. As supply is unchanged, prices paid by passengers will also be unchanged, unless the shock in question also impacts on consumers' willingness to pay. An upward oil price shock could therefore lead to a short run *fall* in fares, because supply capacity is unchanged in the short run, but passengers' willingness to pay is reduced because of the impact of rising oil prices on disposable incomes.

At the start of the subsequent scheduling period airlines will face a higher marginal cost per flight as a result of ETS, because each flight they choose to operate will lead to the requirement to surrender ETS permits at the end of the scheme.

As a result some airlines may reduce their number of services but this is not a straightforward matter. Short-haul point-to-point airlines need to maximise the utilisation of their aeroplanes, which means utilising them throughout the day. The contribution which each movement makes to the overheads of the airline will vary significantly by time of day (and by route). Only in the event that a complete return journey now fails to cover its avoidable costs will it be better for the airline to leave the plane parked on the apron than to operate the service. And even in that event, there are costs associated with leaving a plane parked for part of the day.

As a consequence only in very severe circumstances will an airline suspend part of the operation of a plane (say its middle of the day service). We are currently observing extreme decisions of this type amongst some airlines, in response to the significant increase in fuel costs. These are unusual circumstances, however, and extreme decisions of this type are not ordinarily observed in the sector. If services are not suspended then overall supply in the market is unaffected and so fares will not rise.

In the medium term if an increase in costs leads an airline to consider that the operation of an aircraft throughout the day no longer contributes sufficiently to overheads, then it can choose to ground that aircraft altogether. This also is not a simple matter. The costs of standing down an aircraft are significant, including releasing crew and either long term parking of the aircraft (which needs to be maintained during this period) or disposal of the aircraft. These costs are not borne lightly if there is a possibility that the aircraft will be required for the following scheduling period. Therefore the airline will try and maintain operation until such time as it is certain it cannot make profitable use of that aircraft in the future. Thus there will be significant resistance to standing down aircraft in the face of marginal increases in costs.

All of these observations suggest that the process, whereby an increase in perceived marginal costs would lead through into an increase in fares, is extremely indirect, with little likelihood of a one for one cost pass through of cost increases in the short to medium term. In the long-term, any increase in

price will only be sustainable if it is consistent with a competitive pricing regime. If prices result in airlines earning above normal returns, the profits will be competed away in the contestable market.

2.5 AIRLINES ARE NOT HOMOGENOUS

The Vivid model assumes that airlines are homogenous. This is not the case in reality. There is variation in the business models used and in the range of markets that airlines serve. This results in a wide range of pricing models and, hence different decisions on the extent of cost pass-through that is appropriate for each airline.

For example, some airlines only operate within the EU but others operate in other markets (some of which are not liberalised). The airlines that cover a wider range of markets will have different options for responding to the cost shock associated with ETS. They may be able to offset cost increases in the EU with financing from other markets instead of increasing prices. This option is not available to customers operating only within the EU. Similarly, airlines with a business-class model will have different options for increasing prices relative to airlines that primarily serve more price-sensitive customers.

In this world, it is difficult to reach conclusions about the sector 'on average'. Any decisions relating to ETS must taken account of this differentiation in the sector.

2.6 IMPLICATIONS FOR VIVID'S WORK

We have provided a summary of the main characteristics of the airline industry that are expected to affect cost pass-through and profitability. The main factors of interest are as follows.

- Passenger characteristics are the primary constraint on the ability to pass-through costs. On EU flights, passengers are price sensitive and this significantly limits pass-through opportunities.
- Competition is dynamic in nature. It is the threat of exit and entry that affects decision-making and profitability.
- Airlines operating in the EU are not homogeneous. It is therefore difficult, and unhelpful, to draw 'on average' conclusions. These conclusions mask a range of different business models. It is important that policy is based on an understanding of the impact on different types of airlines.

These factors, and others, are not captured in the Vivid analysis. The omission of these factors significantly limits the relevance of the analysis for policy-making.

3 Views on Vivid's theoretical model

Vivid has used a Cournot Model to assess the impact of a cost increase on prices, and hence profits, in the aviation sector. The costs in this case are the costs associated with the emissions allowances in the ETS. The marginal cost of permits is assumed to be the market price of the allowance in the trading scheme. This presumption is consistent with the economic definition of an opportunity cost (that is, if a permit is not used it can be sold, and the value of the alternative option is therefore the market price for the permit). It is also consistent with discussions in the Frontier Economics 2006 report for ELFAA[3].

It is currently proposed that airline permits can only be used by airlines, but that airlines can buy additional permits from other sectors in the ETS. The market price of airline permits, and hence the cost impact on airlines, will therefore be affected by the market price of all other permits in the ETS[4]. It is assumed that airlines perceive the marginal cost of permits to be the same whether allowances are originally auctioned or allocated for free. This assumption seems sensible at the point where an airline is planning its schedule for any forthcoming period, but does not imply that this "opportunity cost" will necessarily feed through into fares. Furthermore, as discussed in Section 2.4, an increase in perceived marginal cost will not result in an immediate or directional change in capacity. There are a number of factors affecting operational and pricing decisions, and the complexity involved can not be captured in a theoretical model.

In the Cournot model, a fixed number of firms compete with each other by choosing quantities they supply that maximise their objective (usually assumed to be profit maximisation) taking account of the choices that others firms are expected to make. The model can also represent situations where firms choose capacities initially and then compete on prices on the basis of known capacities. The model is static and does not take account of the potential impact of entry or exit.

The model can reflect a range of industry structures along a spectrum from duopoly (with two firms) to the 'perfectly competitive' ideal with a large number of firms[5]. However, this theoretical model abstracts from reality and has a number of limitations that have not been discussed in the Vivid reports.

We consider three questions to assess the appropriateness of the Cournot Model in this case:

1. Have the realities of competition in the aviation market been appropriately captured by the model?

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3 Frontier Economics, *Economic consideration of extending the EU ETS to include aviation: A Report Prepared for the European Low Fares Airline Association (ELFAA),* March 2006.

4 An analysis of what the level of the opportunity cost is for different sectors in the ETS, and for different players in a sector, may require further consideration.

5 A detailed, and theoretical, description of the Cournot model can be found in any number of economic textbooks. For example, O Shy (1995), *Industrial Organization: Theory and Application*, The MIT Press.

2. Are the data and assumptions used in the model robust?
3. Assuming a theoretical model of competition is required, is the Cournot Model the most appropriate one?

We consider each question in turn.

First, however, we would emphasise that a theoretical model of competitive behaviour, although it can be illuminating in some circumstances, is not essential to understand pricing and profitability in the aviation sector. Empirical evidence, and economic logic, will often get you to the required conclusions without reference to a theoretical model. Furthermore, as discussed in Section 5, we would not expect an assessment of the appropriate allocation mechanism for aviation ETS allowances to start from a review of the impact on fares and profitability. Other policy objectives (environmental and economic) need to be considered as well; and may indeed be given a higher weighting in terms of priorities.

3.1 DOES THE MODEL REFLECT THE REALITIES OF THE AVIATION SECTOR?

As a theoretical model, the Cournot Model abstracts from the realities of competition in most industries. The authors of the Vivid report recognise that this is the case, but make no attempt to discuss the implications of competition being more complex than the model suggests. Such a discussion is essential before policy-decisions are made on the back of a theoretical analysis.

We described, in Section 2, the nature of competition and demand in the EU airline sector. An airline's ability to pass-on increased costs fundamentally depends on the characteristics of demand. The ability to earn above normal profits (that is, price above costs) depends on the extent of competitive pressures in the market. To be an effective tool for policy-making, the Vivid model must adequately capture these characteristics to provide conclusions that reflect the realities of the sector. The Cournot Model fails to do this.

As a result the conclusions of the analysis are unlikely to bear much relationship with the way airline pricing and profitability changes in practice. For example, the sensitivity of demand to price changes may result in passengers choosing to fly less. The potential reduction in demand will constrain the extent to which costs will be passed through to prices.

3.1.1 Demand

Passenger behaviour is the primary constraint on airline cost pass-through decisions. This is particularly the case in the EU, where passengers are price sensitive and have a number of alternative options when making flight decisions.

The Cournot Model assumes that demand constraints can be reflected in a single price elasticity measure. It is difficult to judge what this elasticity measure reflects, given the mix of passenger types in the sector. Furthermore, the elasticities may change as the impact of environmental measures on different transport sectors evolve or as the overall price of the service increases.

For instance, it is often to be expected that price elasticities increase as the price of the service itself increases. If this is the case then it is likely that recent increases in fuel prices, which can be expected to lead to some degree of increase in fares in the long run, will also lead to an increase in demand elasticities. If this is the case then historic, backward looking price elasticities are likely to underestimate passengers' sensitivity to further price changes in the future.

A single elasticity number does not adequately capture the heterogeneity of demand and expected passenger behaviour in the sector. A more detailed review of potential passenger reactions to the cost increase is necessary. This is particularly important as the characteristics of demand are the primary determinants of the level of cost pass-through and profitability in a competitive sector.

3.1.2 Pricing

The Cournot Model assumes that there is a simple single price for a service. As noted earlier this is just not the case.

Importantly, fares are not 'set' by airlines, but are derived from the demand for any particular flight relative to the load factor for that flight. In this context there is no direct link, for a given flight, between marginal costs (however measured) and fares. A number of different pricing models can be observed in the sector, emphasising the point that the relationship between costs and fares is not clear cut. This is different to pricing in other sectors which may be affected by ETS (for example, power generation) and will affect the extent to which costs are passed through into fares, and the way in which this pass-through manifests itself.

The variation in pricing models, and the complex design of these models, also impacts on the relationship between prices and profits. In particular, unlike in the Cournot Model, an increase in price does not lead to a one-to-one increase in profits. This is because of the impact of load factors on both the pricing rule and costs. Any model that does not capture these realities of airline pricing and profitability will produce predictions that are not reflective of the industry in practice.

For example, if there is perfect price discrimination on a flight, such that each passenger is paying the maximum willingness to pay, there is no scope to charge them more following a cost shock. Similarly, if passengers flying to 'sun holidays' are very price sensitive, any increase in price will cause them to fly with another airline, use another mode of transport or not travel. When faced with a common cost shock (for example, increased fuel costs or ETS costs) each airline will adopt a different approach to balancing the revenue-increase from increased prices against the revenue-loss from reduced demand. This important feature of pricing in the airline sector is not reflected in the model.

3.1.3 Nature of competition

The Cournot Model assumes that the intensity of competition in the sector can be measured by the number of firms in the market. This is a very limiting

assumption, particularly for dynamic contestable markets where it is actual and potential competition that constrain behaviour. For example, if a market is served by two airlines today, there could have been five airlines operating in previous periods (that is, there was exit) and an expectation of three airlines operating in the future.

Airline behaviour will be affected by the threat of potential entry in such a fluid environment. These contestable aspects of the market are not captured in Vivid's static model. As discussed in Section 3.2.1, the definition of 'the market' is also important when reviewing empirical evidence.

3.1.4 Product differentiation

The Cournot Model assumes that the product or service being sold in the market is homogenous. In practice, there is a large degree of differentiation in the airline market. A trip on an airline can vary along a number of dimensions (for example, time of flight, level of service offered). The length of time before travelling that the passenger needs to book is also a relevant characteristic. The extent of pass-through and profitability of an airline would be different in this differentiated world to the predictions of a model based on the assumption of a standard homogeneous product being sold.

There is also significant differentiation in the business models that airlines operate. Some airlines only operate within the EU. Others also operate in international markets (some of which are not liberalised). These airlines have different options for internalising cost shocks and limiting the extent to which fares on EU flights increase. The Cournot Model does not capture decisions of this type. Vivid's conclusions therefore fail to reflect the important extent of differentiation in the airline sector.

3.1.5 Supply decisions

It is difficult to determine from the discussion in the Vivid reports what assumptions have been made about constraints on the supply of airline services and associated cost functions. In addition, the implications of supply-side assumptions on the pricing and profitability conclusions need to be clarified.

Elasticity of supply

The Cournot Model assumes that airlines can quickly change their production decisions (that is, can easily increase or decrease flights). As explained previously this is evidently not the case in the short-run (that is, within a scheduled season) and is unlikely to clearly be the case over a longer period at capacity constrained airports. The impact of inelastic supply (that is, the ease with which airlines can increase or decrease capacity in response to cost changes) on pricing and, hence, pass-through rates requires further analysis.

Basis of competition

The Cournot Model assumes that firms compete on the basis of outputs or capacity. Vivid has failed to justify this assumption for the aviation sector.

More generally, there is no discussion of supply-side constraints on airline behaviour and competition (for example, the need to maximise utilisation of aircraft; load factor objectives, slot or airport capacity constraints). The impact of these constraints on capacity and output choices would be expected to have a bearing on the appropriateness of conclusions reached in the Cournot Model.

Economies of scale

The Cournot Model assumes that there are no fixed costs of production, that is, no economies of scale. In the aviation sector, fixed costs arise at airline and base level, resulting in price needing to be above marginal cost to ensure a break-even position. The implication of these fixed costs for competition, pricing and profitability are not discussed in the report. Furthermore, there is no discussion of the fact that the ETS permits themselves may impact on the level of fixed costs because as explained above, for a given schedule, the cost of ETS becomes a fixed cost, not a variable cost per passenger. Pricing in the model therefore bears little or no relation to the reality of airline pricing.

Variation in cost levels

The Cournot Model allows for firms to have different cost levels and to vary in size (that is, market share). However, there is an assumption that smaller firms will also be higher-cost firms. In a sector that is evolving, with airlines at different points in their growth life-cycles, this is not necessarily the case. Moreover, in a sector with a set of incumbent airlines and illiquid markets for slots at congested airports, it is to be expected that it will take time for market share to be eroded even if the currently larger airlines are less efficient than smaller competitors.

The aviation sector therefore has industry-wide cost variations and smaller size does not necessarily mean higher cost. This situation is different to that assumed in the Cournot Model and implications for the conclusions on pricing and profitability require further analysis.

3.1.6 Conclusions on the Cournot Model

There is a wide difference between the underpinnings of the Cournot Model and the realities of competition and demand in the aviation sector. The results of the analysis cannot therefore be relied upon to provide a reasonable view of the impact of ETS on aviation prices and profits in practice. This is a case where over-simplification compromises the reliability of the model predictions.

While Vivid recognises this up to a point, it is suggested that using airline data to 'calibrate' the Cournot Model is sufficient to provide an indication of the magnitude of the impact of ETS on prices and profitability. We would argue that the use of airline data within the Cournot framework is not sufficient to capture the market complexities involved. It is not necessarily the case that the 'likely orders of magnitude' are consistent with actual competition in practice. An assessment of the implications of these complexities for the conclusions reached is needed.

3.2 ARE THE DATA AND ASSUMPTIONS ROBUST?

Vivid adds an empirical dimension to the economic model by using data from the UK aviation sector to 'measure' the important parameters in the Cournot Model. We consider here whether the data and assumptions used are robust. However, as noted above, the use of data within the Cournot Model is flawed because Vivid has assumed that the model holds whereas, as we have argued, the Cournot Model does not provide a reasonable approximation to competition and demand conditions in the aviation sector.

3.2.1 Intensity of competition

Vivid's empirical analysis assumes that competition is measured according to the number of airlines competing point-to-point (route-based) or the concentration of airlines. As we have explained airlines in fact compete over 'clusters' of routes or classes of destinations, from a given origin. The empirical analysis does not reflect the broader nature of competition.

Furthermore, as noted earlier, competition is dynamic. Vivid takes the number of operators on a particular route as a given. But the number of operators that may be sustained would itself be expected to depend on the level and structure of costs and the nature of the passengers choosing to use that route. A snap shot of the number of airlines operating on a route at any point in time does not reflect the contestable nature of the sector. In a contestable market, a single airline operating on a route is constrained by the threat of entry.

The data on number of airlines operating on specified routes appears to only be for UK origin airports, and even then the published sample is very limited. There is no discussion of how representative the sample is for the range of flights that would be covered by the ETS (into and out of the EU potentially). No information is provided on confidence intervals for the sample data. The impact of the restricted nature of the data requires further assessment.

The report suggests that 'the majority of the market will be mixed business and leisure and served by three or more airlines' (p. iii). It is not clear what the source of this conclusion is. Most notably, it is not clear whether the conclusion is reached on the basis of the sample of data produced in the report or whether a wider data set was used that is not presented. There is also no discussion of the extent to which there is variation in the market around this 'majority' position and any potential implications of the differentiation for the conclusions reached by Vivid. We would expect the differentiation to be quite significant and to have implications for the extent of cost pass-through and profitability across the sector.

3.2.2 Demand

We believe that Vivid have underestimated the extent of customer price sensitivity in the EU airline market. This is the primary constraint on airlines' ability to pass costs onto customers. Further analysis of expected passenger behaviour is required before realistic conclusions can be reached on the impact of ETS on fares.

Vivid estimate the impact of demand on prices by identifying a particular 'route' with a known number of airlines. They assume an elasticity for that route based on the assumed passenger type and then vary the assumption on the shape of the demand curve to get a range for the level of cost pass-through. The range is therefore sensitive to the assumed level of elasticity and the shape of the demand curve in addition to the assumption that Cournot competition applies. We consider both factors here.

Demand elasticity

The elasticity values used by Vivid range from 0.7 to 1.3 for leisure, 0.3 to 0.7 for business and 0.5 to 1.5 for freight. These appear to be a plausible set of "backward looking" estimates and are based on reputable available sources. The problem, as we have discussed, is identifying which elasticity value most appropriately reflects the expected demand reaction.

An 'average' demand is difficult to identify given the different types of passengers that travel and the different range of services that are offered. Airlines are changing the range of offerings made (for example moving away from a business class/leisure distinction) on EU travel. This makes it more difficult to clearly identify different passenger types and to therefore use historic elasticity estimates to predict behaviour in the future. Furthermore, passenger behaviour in response to a price change, that is driven by an underlying environmental objective, may not be adequately captured in historic estimates of the market elasticity. As we have also stated, it is possible that in the future elasticities will be higher as a result of other factors such as the general increase in fuel costs.

Care also needs to be taken to ensure that the evidence used on the number of airlines and the elasticity of demand is consistent. For example, if the number of airlines is based on data for the London-Paris flights, the elasticity estimate for that route should be based on data on the passenger mix on those flights. It is not clear that such a link was made. We expect that a more high level assumption was used (for example, City flights are primarily business) which may have distorted the predicted pricing decisions.

Shape of the demand curve

There is an additional assumption, in the analysis of profitability, about the shape of the demand curve. Two options are considered; constant elasticity or linear. The authors suggest that the constant elasticity demand curve may be more representative of business passengers and the linear demand curve representative of leisure passengers. There is no clear evidence on the proportion of the market which is one type or the other.

No supporting evidence is provided to support one shape of the demand curve over another. For example, no attempt is made to provide a bottom-up estimate of the demand curve (that is, to derive the shape from empirical estimation). This is concerning, given the sensitivity of the conclusions reached to the assumption on constant elasticity demand, especially if it is true that increased fuel prices may lead to generally higher fares in future. It would be helpful to test whether the assumption is reflective of demand for air travel into and out of the

EU. Vivid should also consider the impact of a wider range of demand curves on the cost pass-through conclusions.

3.2.3 Airline business strategies

Vivid considers three alternative business strategies in its empirical analysis. These options however still remain close to 'theoretical' optimisation strategies discussed in undergraduate economics textbooks. Vivid makes no effort at all to assess whether these assumptions are actually consistent with real strategies in the airline industry.

3.2.4 Cost pass-through in other sectors

Vivid presents its estimates of the rate of cost pass-through in the aviation sector based on its theoretical model. The range is compared to that observed in other sectors to provide comfort that it is reasonable. But given the sensitivity of the conclusions to the model assumed it would seem that these cross-industry comparisons may be of no value whatsoever. On the other hand, no evidence is provided on cost pass-through rates in the aviation sector itself. For example, no data has been provided on the pass-through rates for fuel costs in the sector. It seems that this information is the necessary benchmark to assess the likely impact of ETS costs on aviation pricing. This is particularly the case given the specific nature of pricing in the sector.

3.3 IS COURNOT THE APPROPRIATE MODEL?

The Cournot model is one of a number of theoretical models of competition that could be used to assess competitive behaviour (and hence pricing and profits) in the aviation sector. Vivid fails to review alternative theoretical models or to provide a detailed explanation as to why the Cournot Model is considered the most appropriate for the aviation sector.

3.3.1 A commonly used model

The authors note that they use the model because it is commonly used in economic analysis. We would suggest, however, that this is because of its relatively simple mathematical properties, rather than because it provides meaningful conclusions about real world markets. Common usage (especially in text book examples) does not make it applicable to the situation in question.

3.3.2 Limitations of the model

The model has recognised limitations (across all sectors). Most notably, the determination of price, and hence profits, is dependent only on the number of firms (which is assumed to be fixed) and the elasticity of demand in the sector at a point in time. In practice, as we have outlined, many other factors would be expected to affect the ability of a firm to change prices in response to a cost shock in the short run and in the longer term.

The assumptions about the elasticity of supply/capacity are also not explicit in this model, even though these facts can have a significant impact on pricing and profitability.

Vivid does not discuss the limitations of the model and the implications of these for the conclusions reached.

3.3.3 Alternative models

The reports make no reference to alternative models and do not consider whether the results would continue to hold.

For example, Vivid do not discuss the possibility of using a differentiated Bertrand model, which arguably has a number of characteristics that are similar to the realities of competition in the aviation sector. In this model it is possible that prices will increase by more than the change in marginal cost. However, profits can decrease as costs rise, depending on the demand reaction to the price increase.

3.3.4 Conclusion on model choice

Given the reliance of this paper on results of a theoretical simulation we would expect there to have been more sensitivity analysis around the results of the Cournot Model. This could be done by referring to results from other theoretical models and by comparing the theoretical results to evidence of behaviour in the aviation sector.

3.4 NEXT STEPS ON THE ECONOMIC MODEL

We have reviewed the Cournot Model and empirical analysis used by Vivid to determine the rates of cost pass-through and profitability in the aviation sector. Based on our assessment we consider that Vivid's results are not robust and are dependent on the choice of an inappropriate economic model. We would recommend that the results be subject to more detailed scrutiny and a number of cross-checks.

In particular, the predictions should be compared to known behaviour in the airline sector and the assumptions underlying the model scrutinised, relative to known characteristics of the sector (for example, price differentiation and the existence of fixed costs). Further work on price sensitivity of passengers is necessary, as this is the primary constraint on airlines' ability to pass-through costs.

Furthermore, any empirical analysis should be based on data that accurately captures the nature of competition in the market. For example, competition should be considered over time rather than at one point in time, and should not be focused on point-to-point routes. All data analysis should also be subject to standard robustness tests (for example, confidence intervals) and the results of these tests should be made available.

It is clear that there are key differences between the model assumptions and reality. Implications of these differences for the predictions of the reports could be significant and require careful analysis.

Views on Vivid's theoretical model

4 Review of Vivid's conclusions

Vivid reaches a series of (related) conclusions about the impact of ETS on the aviation sector. These conclusions are based on the economic model discussed in Section 3. Here we focus on the reasonableness of the conclusions themselves, rather than the methodology used to reach them.

In all stages of the analysis, Vivid reaches conclusions that relate to the aviation market 'on average'. The wide degree of variation in the industry is recognised but Vivid do not provide an explanation as to how the 'average' is determined for the sector or how this might impact on different categories of airline. For example, was there an assessment of a large dataset, that found that most of the market has a mix of business and leisure travel? How was the exact mix identified and assessed? The answers to these questions can not be found in the Vivid reports. It is therefore difficult to understand the basis for the 'on average' conclusions.

No attempt is made to consider the implications of the heterogeneity of airlines for policy making. It is important that policy makers review the impact of ETS on different types of airline. For example, it is important that the impact on different types of airlines is understood. Distinctions can be made between growing and declining airlines; "high emissions" and "low emissions" airlines; low fare and high fare airlines; long-haul and short-haul airlines and airlines operating in the EU only and those operating in a range of market (including non-liberalised markets).

These issues are not discussed in the Vivid reports but are highly significant for evaluating the impact of aviation on ETS and on the environment more widely.

4.1 COST PASS-THROUGH

Based on their analysis, Vivid claims that pass-through rates will:

- range from 80% to 150% in theory;
- range from 90% to 120% for most aviation services, when the mix of passengers is taken into account; and
- be 100% on average.

As noted earlier, the methodology used to calculate these rates is not robust. We review here whether the rates themselves might be considered reasonable.

4.1.1 100% pass-through

100% cost pass-through would, theoretically, be expected in the long run in an industry that is perfectly competitive. Each firm moves towards a position where price is equal to marginal cost and the marginal cost change symmetric across the industry. However, as we have demonstrated, the relationship between ETS costs and airline marginal costs is not straightforward. Furthermore, the relationship between costs, airline decisions on services, hence market prices, is indirect and very unlikely to lead to full cost pass through.

Price-sensitive passengers, with alternative options, also limit the extent to which airlines' can pass through costs. There is also such variation in the characteristics of demand across the airline sector that 'average' conclusions can mask significant differences in pass-through rates.

We would expect policy-makers to be as interested in the variation of impacts (that is, 'winners and losers') as in the impact on average; particularly when making trade-offs across allocation mechanisms, whose impact may be correlated with the identified winners and losers.

4.1.2 Pass-through above 100%

Vivid has not provided any explanation as to what factors drive these rates in the aviation sector. For example, is it the nature of demand or the intensity of competition that matters? A discussion of this kind is needed to ensure a better understanding of the extreme ranges, calculated from an empirical analysis that is not robust.

4.1.3 Pass-through of other costs

The airline industry has been subject to a number of cost shocks, most notably fuel costs. It is therefore feasible that evidence could be collected on the impact of these cost shocks on prices. Arguably, this would provide a reasonable comparison for estimating the impact of the ETS cost shock on pricing. It is not the nature of the cost that is most important, but the nature of demand and competition. Vivid has not attempted to provide comparison estimates of this type.

In our view, the comparisons of cost pass through with other sectors that Vivid has included are not relevant for an assessment of prices or profits, because of the differing nature of competition between these sectors.

4.2 PROFITABILITY

Vivid argues that airline profits are likely to fall as a result of ETS, even with cost pass-through. This is because the rise in prices will be more than off-set by the increase in cost and a reduction in flights sold. We consider here whether the conclusions on the profitability impact are reasonable. Our general concerns relating to the predictions of the Cournot Model and the empirical evidence used by Vivid are also relevant.

4.2.1 Implication of sector variation

The conclusions relate to the aviation sector 'on average'. As with cost pass-through, no explanation is provided as to how the 'average' industry position was identified.

Vivid considers the impact on profits of different types of airlines. The claim is that larger airlines will be more adversely affected than smaller airlines. This is based on the presumption that large airlines have lower costs (that is, are more efficient), which, as discussed earlier, is an unfounded assumption, that would

only apply in a steady state. It certainly need not apply in a dynamic environment, where smaller, newer airlines have more efficient fleets and are growing at the expense of larger legacy operators with older, less efficient fleets.

More generally, there is no discussion of the implication of sectoral variation for policy decisions on the allocation mechanism.

4.2.2 Windfall from free allocation

Vivid claims that the free allocation of permits will result in a windfall gain for airlines, relative to the case of an auction. These windfall gains will, according to Vivid, partly be offset by the fall in profits, resulting from the cost of ETS and any demand reaction to price increases. As we have already stated, we consider that Vivid's simplistic model is likely to overstate the extent to which costs can be passed through and, therefore, overstate the risk of a windfall.

There is no convincing case made for the risk of windfall profit. There is also no discussion in the Vivid report of the probability of abatement in the sector. Technological constraints mean that abatement costs are high and, hence, airlines are not in a position to earn profits by abating and selling permits.

Given that they have assumed that windfall profits are likely, we would expect Vivid to have factored the purported windfall profits into their profitability assessment. However, it is not clear whether alleged windfall profits were included as an additional factor in the calculated profit function for the industry, before the level of free allocation was determined.

There is insufficient evidence in the report to support a conclusion that windfall profits will arise in the aviation sector. Furthermore, it is not clear, how, if at all, the existence of purported profits has been factored into the technical analysis. Policy decisions can not be based on the resulting conclusions about windfall profits, given the absence of robust evidence.

Furthermore, even if there were windfall profits from ETS (which we strongly believe will not be the case), dynamic competition would ensure that they were not sustainable. Given the contestable nature of the sector, if Vivid's model were accurate, then the airline sector would generate persistently higher profits from one cycle of ETS to the next. The existence of any above- normal profits may attract entry, or dissuade less successful carriers from exiting the market, because the periodic allocation of permits would keep their business model viable, when otherwise it would not be

These factors could lead to a higher level of supply in the market, than would exist under an auctioning environment. This would lead to a countervailing reduction in overall prices and hence a re-establishment of overall profits to a normal level. Any profitability assessment that is focused on the long-term should take these dynamic considerations into account. Implications of supply changes for the environment should also be reviewed. .

It is unclear that, over the long run, the free allocation of permits could lead to persistently higher profits in the aviation sector. In this context the aviation industry differs significantly from other sectors affected by ETS, such as power

generation, due to the contestable nature of the aviation industry. This is a distinction that Vivid has failed to recognise.

4.3 ALLOWANCE ALLOCATION

Vivid considers what proportion of aviation ETS allowances could be allocated free of charge to ensure that there is a neutral impact on airline profits. The conclusion reached is that 20% to 40% of allowances could be allocated free. The range increases to 40% to 70% when Vivid assumes that there is limited competition (proxied by an assumption of no more than two airlines) and more price- sensitive passengers (classed by Vivid as 'leisure' passengers).

But these findings are a consequence of the assumptions that Vivid has made regarding the nature of competition and demand in the sector, including the Cournot model it has used. We emphasised earlier that neither the underlying theoretical model nor the empirical evidence are robust. They therefore do not provide a reasonable basis for the important policy question of choosing an allocation mechanism for aviation ETS permits.

We also have a number of other concerns relating to the reasonableness of these conclusions, discussed below.

4.3.1 Impact of the allocation mechanism on prices and profits

The choice of allocation mechanism is not explicitly incorporated in the economic model. The potential interaction between the allocation mechanism and the level of cost, pass- through rates and hence profits are not captured. While we accept that this may be difficult to do in a formal model framework; we would expect the analysis to be undertaken qualitatively, to ensure that all factors are taken into account.

4.3.2 Impact of free allocation with updating

The assumption is that the choice is between an auction and a one-off free allocation of emission permits. The authors recognise that, if the free allocation is updated periodically, so that the allocation reflects historic output levels, the decisions made by airlines will be different. This is because of the impact that choices have on the next round of allocation. A more detailed analysis of free allocation with updating on pricing and profitability would be warranted.

In our view, in a long run equilibrium, even if there were any chance of a "windfall", as a consequence of permit allocation, the conditions of entry and exit from the market would most likely adjust to cancel out any such effect.

4.3.3 Identifying a workable policy recommendation

There is a significant practical question as to what the policy recommendation is from the report. If the authors are suggesting, say, that 40% of permits be allocated free, and the remainder auctioned, a detailed discussion of how this could be implemented is needed. ~~At first sight, this would appear to be a difficult, potentially inefficient and costly way to allocate permits.~~

If the authors are suggesting that all permits should be auctioned, given that there is potential profit to be made from free allocation, the implication for industry profitability and other objectives needs to be presented and discussed.

4.4 NEXT STEPS ON VIVID'S CONCLUSIONS

It is not surprising, given our concerns about the Cournot Model and the empirical analysis, that we have a number of questions about the conclusions reached by Vivid Economics.

We recommend that, with any conclusions reached using an economic model, Vivid:

- sense-check the results against the realities of the airline sector;
- compare the results to other developments in the sector (for example, pass-through of fuel costs);
- consider the implications of the analysis over time;
- clearly define any policy recommendations; and
- explain how those recommendations could be applied in practice.

It is important that cross-checks of this type are undertaken before any conclusions are used as the basis for policy-making.

5 Policy decisions

We have reviewed the two Vivid Economics reports and conclude that neither the theoretical model nor the empirical analysis is sufficiently robust to provide a basis for policy-making. The impact of the cost-shock from ETS on prices and profits cannot be understood until the characteristics of the aviation sector, as briefly described in Section 2, are taken into account.

A number of ideas for taking the policy debate forward are presented here. We would advise that these points be taken into consideration, before a decision is reached on the appropriate allocation mechanism for airline ETS permits, especially the level of auctioning.

5.1 COST BENEFIT ANALYSIS

The reports refer to one potential policy objective: neutral impact on airline profitability. Vivid does not consider the range of other policy objectives (environmental, economic and social) that should be considered when deciding on the preferred allocation mechanism. The choice of allocation mechanism should be based on a detailed cost- benefit analysis that takes a broad range of factors into account and reflects the realities of the aviation sector.

5.2 FOCUS ON RELEVANT TIMESCALES

As noted earlier, Vivid is attempting to understand the impact of competition intensity on pricing and profits in the airline market after aviation joins the ETS. However, there is no discussion of the potential impact of ETS itself on the nature of airline competition or on demand (passenger behaviour)[6]. Indeed there is no distinction made in the Vivid reports between the short-term and the long-term. An analysis that identifies properly the short-term impacts on airlines and also separately takes into account the broader long-term interactions would provide a richer long-term assessment of the impact of ETS.

6 The potential impact of ETS on competition is discussed in Frontier Economics, *Economic consideration of extending the EU ETS to include aviation: A Report Prepared for the European Low Fares Airline Association (ELFAA),* March 2006.

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