DESIGNING A MARKET MODEL TO ANALYSE TRADABLE NOISE PERMIT SCHEMES FOR AIRPORTS

Astrid Gühnemann, John Nellthorp, Richard Connors
Institute for Transport Studies, University of Leeds, UK

ABSTRACT

Despite considerable improvements in the development of quieter aircraft, noise is still a major environmental concern around airports and a limiting factor for their extension. Innovation and adoption for noise abetment technologies are long-term solutions, and current practice shows that administrative measures are costly for both operators and institutional stakeholders. Furthermore, they have negative impacts on airline operations, limiting growth. In order to find an optimal solution for this problem it is necessary to analyse other instruments available from the economic theory. This paper presents ongoing work from the European Commission co-funded MIME project which has the aim to assess the efficiency of market based solutions to tackle noise problems at airports. These instruments should on the one hand be effective in reducing noise and on the other hand allow airlines and airports to choose the least costly noise mitigating solutions. The focus of the MIME project is on studying whether tradable noise permits could be introduced effectively to fulfil these expectations. A central part of this analysis is a market model which will be used to simulate the impacts of different permit scheme designs on noise levels, abatement costs for airlines and finally on airline operations and their business models.

In the first part of our paper we identify those attributes of permit schemes that are crucial for the functioning of the market and their effectiveness. Different permit schemes are discussed based on an overview of existing applications of permit trading systems in order to identify the main elements that need to be incorporated in the market model. The definition of a noise permit is crucial for the scheme design and its efficiency, as it implicitly circumscribes degrees of freedom that operators have to adopt noise reduction measures/behaviour. In the second part of our paper we outline the market model used for the assessment of the schemes. It consists of three main parts: a simple air transport demand model, an airline operation model, and a permit trading model. The outputs of the market model are determined by the requirements of a cost-benefit-analysis for different stakeholders. For each part of the market model we present the main operational elements and outline how feedback mechanisms are formalised.

Keywords: tradable permits, airport noise, market model

1 INTRODUCTION

Despite considerable technical improvements towards quieter aircrafts, air traffic noise is still a major source of annoyance to many residents in Europe and a restricting factor for airport expansion and growth in the aviation sector. According to information provided by Member States of the European Union, up to 11% of the population in some of the countries is exposed to noise above 55 L_{den} from major airports (ETC-LUSI, 2010). More than 600 airports worldwide and 200 in the European Union today operate some form of noise regulation (Boeing, 2010), often in response to local concerns about airport capacity extension (see Figure 1). Hence, against the background of expected further growth in the aviation sector, there is a need for developing cost-effective instruments for regulating noise annoyance at airports while maximising airport capacity.

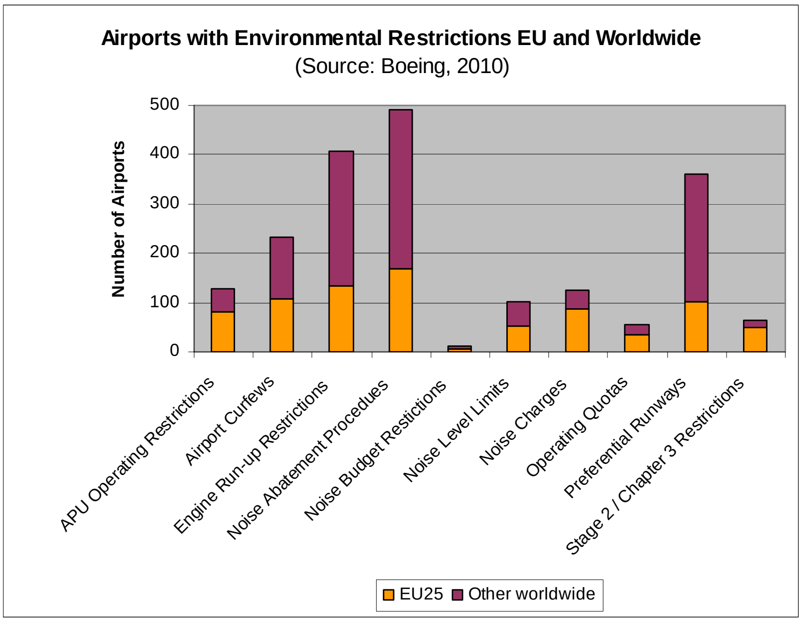

Figure 1 – Airports with environmental restrictions in the EU and Worldwide

Against this background, the European Commission co-funded project MIME[1] has the aim to analyse market based instruments for noise control at airports. These complement the four types of instruments endorsed by ICAO in its balanced approach (ICAO, 2007): reduction of noise at source, land-use planning and management, noise abatement operational procedures and, as a last resort, operational restrictions. As has been shown in other industries (see e.g. Tietenberg, 2006), there are conditions under which a market-based mechanism using transferable permits can be used to provide improved control over environmental impacts, and at the same time, allow efficient business operations. MIME is aimed at discovering whether, and how, such mechanisms can be used to improve environmental noise control in air transport, especially at airports that have limited capacity due to noise constraints. A central part of the analysis is a market model which will be used to simulate the impacts of a potential trading scheme design on abatement costs for airlines and finally on airline operations and their business models.

[1] http://www.mimeproject.com

In the first part of the paper, we describe potential attributes of a tradable permit scheme for noise at airports. The design of the potential trading scheme is based on economic theory as well as a review of lessons learnt from a state-of-the art-review of permit trading applications (Hullah et al., 2008). In the second part of our paper we will outline the market model used for the assessment of the schemes. It consists of three main parts: a simple air transport demand model, an airline operation model, and a permit trading model. The outputs of the market model are determined by the requirements of a cost-benefit-analysis for different stakeholders.

2 OUTLINE OF THE POTENTIAL PERMIT TRADING SCHEME

Noise from aircraft operations is a typical example of a negative environmental externality where negative impacts (costs) from economic activities are not borne by those who benefit from the activities. They constitute a form of market failure, where the market mechanisms fail to achieve an outcome that maximises overall social welfare and it is possible to increase welfare through government intervention. Tradable permits[2] are one of several options to control environmental externalities and have existed for several decades as a means of reducing environmental impact (Tietenberg, 2006). They are placed in between command and control instruments (e.g. emission standards) and fiscal instruments (taxes/subsidies) in that they set a limit to overall pollution but at the same time use market based incentives (permits) to efficiently allocate the contribution of individual firms (or market actors) to the pollution reduction. Unlike standards the regulator does not prescribe a set level of output (here: noise) for each source (e.g. aircraft or airline) but an overall level and any increase in (noise) pollution must be offset by an equivalent decrease elsewhere (Perman et al., 2003). The system of transferable permits allows each actor to decide whether it is cheaper to reduce pollution or to acquire permits from the market. Market actors with high abatement costs will abate pollution (i.e. reduce noise) rather than purchase permits, while polluters with high abatement costs will purchase permits. Since polluters have different abatement costs a market will arise and trade will minimise total abatement costs. Compared to taxation, permit schemes do not require the regulator to adjust charges to inflation or economic growth, and provide a stronger incentive for innovation than standards (Baumol & Oates, 1988, Milliman & Prince, 1989).

Tradable permit schemes have so far been mostly applied for the control of air pollutant emissions, water quality or for fishing quotas and lessons learnt from their application need to be taken into account in the design of our system. Notable examples of practice in permit trading include (for a wider overview see Hullah et al., 2008) the sulphur dioxide (SO_2) trading in US under the Clean Air Act 1990 – which used a free grandfathering system and severe penalties – fear of high permit costs led to massive investment in clean technology; and the European Emissions Trading Scheme (EU ETS), in which aviation will be included from 2012, with permit allocation at EU level, 15% by auction; emissions are initially capped at 97% of 2005.

[2] Alternative names are marketable permits, emission certificates

Compared to emissions trading, there are peculiar qualities of noise at airports that need to be taken into account: Impacts are local, strongly non-linear and mostly short term and non-cumulative; and there is a certain degree of market power at many airports due to the presence of a strong home carrier. A permit system for noise permits in which residents are owners of the permits for specific zones has been described by Bréchet & Picard (2007). In this system, airlines are assumed to have a choice between several route possibilities and use these as part of the optimisation. Our consultation with stakeholders has, however, revealed that airlines are very restricted in their route choices due to safety and capacity constraints set by air traffic control and thus, a different system design was chosen. In the following we concentrate on those attributes for a trading scheme that are crucial for the functioning of a market and the further specification of a market model.

2.1 Type of System

There are different options how to design a transferable permit system. Two broad types can be distinguished: the 'cap-and-trade' system involves the definition of an overall quantity of emissions (the 'cap') and tradable property rights on the emissions while the 'baseline-and-credit' (or 'emission-reduction-credit') system sets minimum performance (a baseline profile) for sources and credits can be purchased to exceed the baseline emissions without penalty. For noise trading at airports, a *'cap-and-trade' system* is deemed more suitable as it guarantees to limit the overall annoyance around an airport to the chosen level, whilst allowing polluters to trade the fixed volume of permits. A primary allocation is performed by a regulatory authority while the price of permits is later determined by market demand through trading. Permits are tradable at any moment.

Further distinctions between scheme types can be made in whether they are mandatory or voluntary for actors in a given sector, and upstream (sourced at production) or downstream (sourced at consumption), open or closed. The system is defined as an *upstream* system as it has the advantage that fewer entities (air operators) need to be involved in the trading scheme than in a downstream system (passengers). The system will be *compulsory* for all air operators wanting to carry out flights at the airport where the system is in place. Although voluntary schemes are usually effective when offered as an alternative to paying a fixed tax, mandatory schemes are more common. A possible variant would be to analyse a hybrid system in co-existence with noise charges for small air operators in order to keep the arrangements simple for those without substantial planning capabilities.

The scheme is a *closed* scheme, i.e. non-air operators will not be allowed to exchange permits unlike Bréchet & Pircard [8] in order to make it acceptable to air operators. It is also restricted to the noise produced by air operations at the airport as it is assumed that the annoyance caused by flight noise cannot be offset by reduction from other noise sources. This means that unlike in the trading of greenhouse gas emissions as in the European ETS, the cap set for the airport is an absolute cap on the overall annoyance produced.

2.2 Commodity

The definition of a noise permit is crucial for the scheme design and its efficiency, as it implicitly circumscribes degrees of freedom that operators have to adopt noise reduction measures/behaviour. Permits must be measurable, unique and clear, their compliance must be enforceable and the granularity related to the lowest measurable and reducible unit possible. Figlar et al. (2009) show that noise annoyance around airports can be connected in a linear way to single flight events and then related to tradable units. Based on this, they describe different options for defining such a *noise metric*. In the simplest case, the quantity of annoyance that defines the number of permits is linked to the aircraft's noise certification similar as in quota systems used e.g. at London Heathrow airport. In more complex cases, time of day, operational procedures, routes flown and land use are taken into account. The outcome are in any case tradable unit(s) for each single flight which we label "*Mime's*".

2.3 Geographical scope & actors

The trading scheme should be limited to *individual airports* as offsetting noise annoyance between airports is not regarded as a valid option given the political tensions likely to be generated. In a real world application, an airport could choose to apply the noise trading as one noise mitigation option depending on the severity of its noise problem, the number of air operators and other local circumstances. For the simulation exercise, we apply the scheme to a single airport and assume that other airports with a noise problem have noise mitigating measures in place in order to avoid relocating the annoyance.

At the airport, *all air operators* will be included in the scheme. For our model, however, only passenger airlines will be included to keep it simple. These cover a range of flights and aircraft typical for a one runway airport that has been chosen as a representative fictitious airport for our model. More information on the airport layout is available in Figlar et al. (2009). At this fictitious airport, different types of airlines are operating which have different characteristics as listed in Table 1. A total of 19 airlines are included in our model. For each airline a storyboard is developed based on its type describing e.g. their business strategies, types of operation fleet composition and renewal plans. Airlines in the model will thus react differently to the introduction of a noise permit scheme which will enable trading and also provide the means for a more detailed analysis of impacts on different airline types.

Similar to the EU ETS, a *minimum threshold* for aircraft (e.g. maximum take-off weight less than 5700 kg) could be defined. For these aircraft, a noise charge that is derived from the market price of permits could then be applied.

For the model we assume that *new entrants* will only be an issue at the start and not during a season. In reality, small air operators might want operate unscheduled flights, thus a reserve for new entrants would have to be foreseen. If an airline stops operating at the airport, unused permits would have to be given back. Permits for unused flights can be kept till the end of the season.

Table 1 – Airline categorisation used for MIME (Figlar et al. (2009), p. 68-69)

Airline Type	**Characteristics**
Home Carrier	- national flag carrier of the country where the analysed airport is situated - large market share - national and international routes, intercontinental traffic - large variety in fleet composition
Flag Carrier	- flag carrier or carrier with a structure and operational characteristics similar to those of a flag carrier, based in a country other than the country of the airport, but on the same continent - several flights per day to major airports in home country - international routes - short and midrange fleet, several different aircraft types
Intercontinental Carrier	- flag carrier or carrier with a structure and operational characteristics similar to those of a flag carrier, based in a country on another continent with respect to the airport served. - a few flights per day to major hubs in home country - intercontinental routes - few types of large aircraft
Charter Carrier	- short, medium and long range flights offered depending on airline - only a few different types of aircraft in use (e.g. one for short range and one for long range) - flights often use off-peak times at airports
Low Cost Carrier	- mainly European traffic - usually only one type of aircraft – uniform fleet - flights usually at less popular off-peak times at airports - LCCs often chose small secondary airports with less fees
Regional Carrier	- only short range traffic - small jet aircraft and Turboprops in use - scheduled feeder traffic (scheduled wrt. connecting flights at hub airports) and regional point-to-point flights

2.4 Budget Size

The total allowed annoyance at an airport over a season determines the overall size of annoyance budget and thus the cap on permits. This cap can be kept *constant* over time or, if the regulatory authority sees a need, be *decreasing*. We treat these as two alternative cases in a sensitivity analysis. Even in the constant case we assume that the growth in demand for air traffic movements will lead to increasing demand and thus force trading.

2.5 Allocation

In principle, a '*grandfathering*' to the previous year's operators (which allocates permits for free to airlines based on operations over a time period prior to introduction of the scheme), or by *auction* (which makes the scheme as 'open' as possible, but introduces uncertainty for current operators) are possible. Consultations with stakeholder from the aviation industry confirm that the grandfathering model is most acceptable to the existing operators and will be tested in the basic version of our model. Initial allocations under a grandfathering scheme can be based on their *historical annoyance* caused, i.e. the number of permits they would have required during the reference period, or on a *benchmark* in comparison to all other airlines in order to not penalize early technology adapters. Both alternatives will be tested in our simulation. A more advanced version of our model will be tested in which a minor share of the permits are allocated by auction, which makes the scheme as 'open' as possible, but introduces uncertainty for current operators. A combination of grandfathering and auctioning reduces market distortions caused by barriers to entry, whilst retaining the majority of the free allocation for incumbents.

One option under a grandfathering scheme is to *update* the baseline annoyance after a certain number of periods. The reason for introducing such an updating rule is usually to take into account actors leaving and entering the system over time. Without an updating rule, the unused permits of closures would decrease the freely allocated proportion and new entrants would have to compete for the permits left after allocation to the existing actors. Although such an updating rule gives the market participants, i.e. the airlines, less incentives to reduce annoyance, in a closed system all participants face the same rules and thus the expected benefits from future allocations would be represented in the price of permits (Rosendahl, 2008, Böhringer & Lange, 2005). Åhman et al. (2006) suggest updating on a ten year rule basis for the ETS. A similar rule could be applied to a noise permit trading at airports as well. In our model, we keep the number of airlines constant over the modelling period and an updating rule will not be applied.

2.6 Trading mechanism and timing

The system should be linked to the timeline of airlines planning their schedules as shown in Figure 2. Each year's flying programme is represented by one season. Banking and borrowing permits over several seasons should not be allowed as the overall seasonal cap on annoyance should not be exceeded in accordance with European legislation. Within the season, from the start to the end, trading is allowed at any time. We will model this using three intra-season trading rounds.

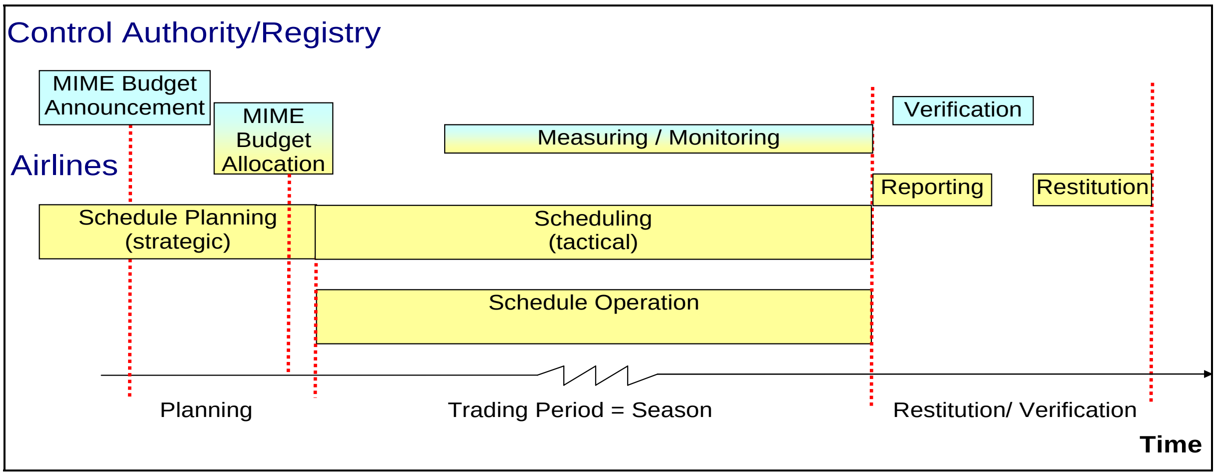

Figure 2: Timeline of noise trading scheme

2.7 Regulation & monitoring

Unlike the EU ETS, we can assume that the regulatory authority (e.g. the airport) has full knowledge over the amount of annoyance produced and thus, measuring and monitoring will be less of an issue. A major issue of concern for airlines is the ability to still be able to operate flights towards the end of the trading period. Hence, rather than stopping flights a penalty will be applied in addition to the requirement to purchase and surrender missing allowances in case on non-compliance. This avoids that the penalty determines the maximum price of permits. The amount of the penalty will be subject to sensitivity testing. It needs to be high enough to be a deterrent rather than a possibility to 'buy your way out'.

3. DESCRIPTION OF THE MARKET MODEL

The aims of the market model in MIME are:

- to provide a market modelling framework, based on
  i) a review of the functioning of tradable permits markets in other sectors and
  ii) a scoping of future market players (airlines, airports,…) and of the geographical limits of a future noise market; and
- to identify and analyse the market functioning possibilities at all levels, including initial allocation methods, transferability issues, risk assessment, etc.

Options for the tradable permit scheme itself were discussed in the previous section. We now focus on:

- the industry context in which the scheme will need to be analysed, including the demand for airline services and the economics of airline operation;
- trading behaviour, captured in a permit trading model; and
- cost-benefit analysis using the outcomes predicted by the modelling work.

The modelling framework is shown in Figure 3. The market model consists of 3 main parts: a Demand Model (MDM); an Airline Operation Model (MAM); and a Permit Trading Model (MTM). A schedule builder tool is used to map changes in demand or operations onto the flight schedule of the simulated airport. The modelling of noise emissions from aircraft operations in a flight model (FM + NM) and of the annoyance produced (AM) as well as the calculation of permits required are performed outside the market model and carried out by partners in the project. Table 2 shows the main links and parameters for the market model.

Table 2: Inputs and Outputs to/from the Market Model

	Input	**Output**	**Parameters**	**Links**
MDM	Initial Schedules and Load Factors	Annual passenger demand	Price + Frequency elasticities	Schedule Builder Tool
MAM	Passenger Demand, Price and availability of MIMEs	Schedules Fares	Cost per ASK Fuel cost per ASK Revenue per ASK Pre-tax profit margin target	Schedule Builder Tool
MTM	Demand for MIMEs Supply of MIMEs	Market Price of a MIME permit	Abatement cost database	Schedule Builder Tool

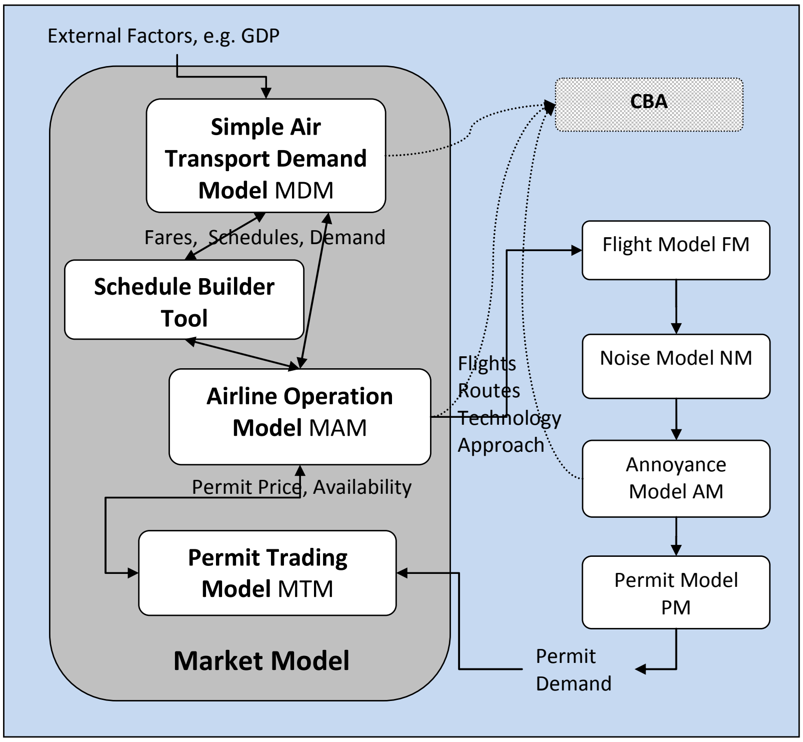

Figure 3: Market Model Framework

It is intended that the market modelling framework currently in development will provide:

- air transport demand over 20 years;
- airline costs;
- airlines' response to the changing market conditions:
  - two scenarios: with/without noise permits.
- model of permit trading.

3.1 Demand model

Air transport demand is assumed to be driven by a set of factors:

- global economic outlook
- GDP elasticity of air transport demand
- price elasticity of demand
- other influences including service frequency.

In the wake of the global financial crisis, the emerging and developing economies are recovering fastest. World GDP growth is currently at around 4% per annum. European airports link the faster growing emerging/developing economies with established advanced economies, so are influenced by both sets of growth trends.

The GDP elasticity of air travel demand is believed to be in the range +1.0 to +2.0 and is already included in aviation demand forecasts. Historically, the relationship between GDP and air travel demand has been positive and pro-cyclical: air travel tends to grow faster than GDP in growth periods but is highly sensitive to downturns. Looking forward, the long-term trend growth rate in air travel is addressed by several forecasts, in particular: (i) the Airbus Global Market Forecast (Airbus, 2009) which predicts 4.7% per annum growth in Revenue Passenger Km (RPKs) 2009-2028; and (ii) the Boeing Current Market Outlook (Boeing, 2009) which predicts 4.1% passenger growth and 4.9% RPK growth over the same period. Boeing's forecast for RPK growth in Europe is 4.1%, which is consistent with the lower GDP forecast for this region. EUROCONTROL (2008) has a forecast of 3.0% per annum growth in Air Transport Movements in Europe, which can be reconciled with the 4.1% growth in RPKs, since aircraft size is increasing at a trend rate of 1.1% per annum. Overall, based on a poll of forecasts, for a representative western European airport we assume:

- passenger growth, short-haul = 3.0% per annum
- passenger growth, long-haul = 5.0% per annum.

For the response of demand to changing prices, we adopt price elasticities shown in Table 3. Thus a 1% increase in ticket price leads to a 0.5% reduction in short haul business demand. For comparison, Airbus' elasticity estimate for Western Europe Domestic and Transatlatic is -0.8 across business and leisure.

Table 3: Price elasticities of demand for air travel

	Business	Leisure
Short haul	-0.6	-1.1
Long haul	-0.5	-1.0

Finally, it is recognised that air travel demand responds to the frequency of service offered. In this case, a useful source is Jorge-Calderon (1997). Based on his range of estimates from +0.79 to +1.26, we adopt +1.0 as a central estimate.

These features of the demand model allow it to represent not only the expected growth of the market over the next 20 years, but also: the demand response to any part of the price of noise permits which the airline considers passing on in airfares; and the demand response to any changes in the number and timing of flights – for example, if an airline considers consolidating flights to reduce its noise footprint, the extent to which the frequency reduction will impact on demand.

3.2 Airline operations model

In this part of the modelling framework, key aspects of the airline's operational economics and decision-making are represented, in particular its cost base, scheduling, pricing, and revenue growth. The model is again fairly simple, and the focus is on representing those aspects that are needed in order to analyse the response to noise permit trading.

The cost base is represented by a cost per available seat km (CASK) for each airline type, and within that a fuel cost per available seat km (Fuel CASK). For example, for a major European low-cost carrier in 2009, the costs were (easyjet, 2009):

- 5.41 €cents per ASK
- of which, 1.67 €cents per ASK fuel.

Costs are further differentiated by aircraft type and take-off weight (TOW). When an airline considers its abatement options under noise permit trading, any expected changes in aircraft types, load factors or in operational procedures can be taken into account through the cost function.

Scheduling changes are modelled using a Schedule Builder Tool which starts with a 2009 schedule for the representative airport, and then makes annual adjustments based on inputs of demand, frequency and aircraft type. Revenue is determined jointly by price and demand. Purchases of noise permits are negotiated in the Permit Trading Model (MTM).

The airline is assumed to pursue a long-run profit target of 10% pre-tax profit margin (=profit/revenue), setting fares and frequencies accordingly. As is often observed, the airline industry as a whole has exhibited very low profitability over several decades (Doganis, 2002). In recent years, even a commercially successful airline such as British Airways has only achieved 10% once in the period 1995-2009, and its mean pre-tax profit margin has been 4.2% over that period. Nevertheless, there are signs of a renewed moves towards profitability, in particular the success of low-cost carriers such as Ryanair, whose most recent financial data shows a 5-year average pre-tax profit margin of 12.4%, and the consolidation of the network carriers taking place through mergers and acquisitions, joint ventures, and the growth of airline alliances – Oneworld, Skyteam and Star Alliance.

3.3 Permit trading model

The principle underlying the permit trading model is that at any given price, *P*, each airline can decide to buy or sell permits. An airline whose current schedule requires more permits than they hold can:

A. Abate noise by adjusting the schedule
B. Buy permits (if it is cheaper – in terms of impact on profitability – than abating noise).

The reverse is also true, so an airline that can abate noise cheaply can choose to do so in order to sell permits onto the market.

In general, there is a trade-off between the noise impact of the schedule and the cost of operation, shown in Figure 4. Using the noise metric labelled the ‘Mime’, there is therefore a marginal cost to the airline of abating noise by one unit. In practice, most of the abatement options open to an airline (e.g. switch aircraft type) lead to noise savings in discrete blocks not equal to 1 ‘Mime’, so marginal cost is not the only issue.

Permits are traded at two time intervals: a pre-season trading period and an intra-season trading period. The main difference is that pre-season, the airline has a full set of abatement options open to it.

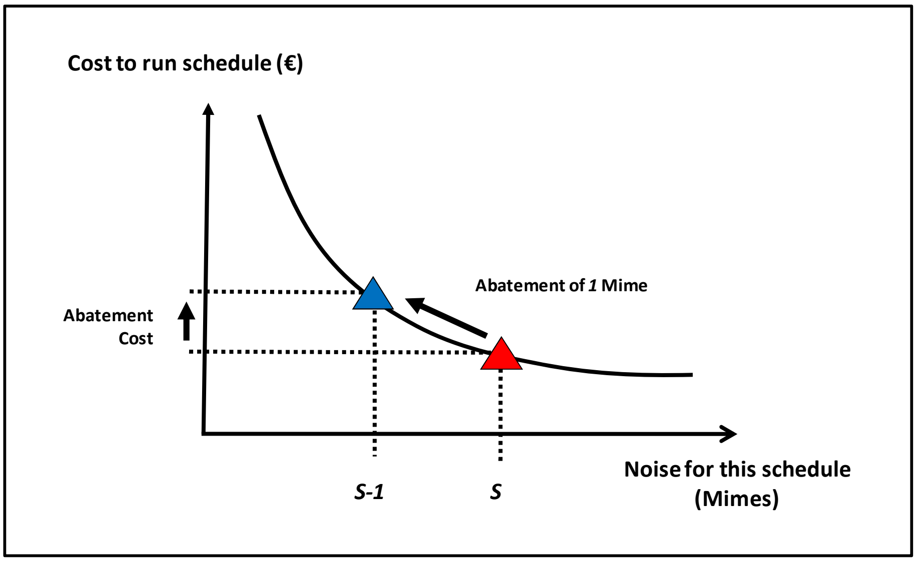

Figure 4: Abatement cost trade-off

The trading process is shown in Figure 5. There is a fixed total number of permits available, in order to control noise to the target amount. If permit price is very low (e.g. *P* = €0.01 per Mime), it will almost certainly be cheaper to buy permits than to abate noise. Hence demand for permits will be higher than total number of permits available. Conversely, if permit price is very high (e.g. *P* = €10^8 per Mime), there will be an excess supply of permits onto the market, and the market price will fall. Ultimately, at some price (the *market price*), demand = supply

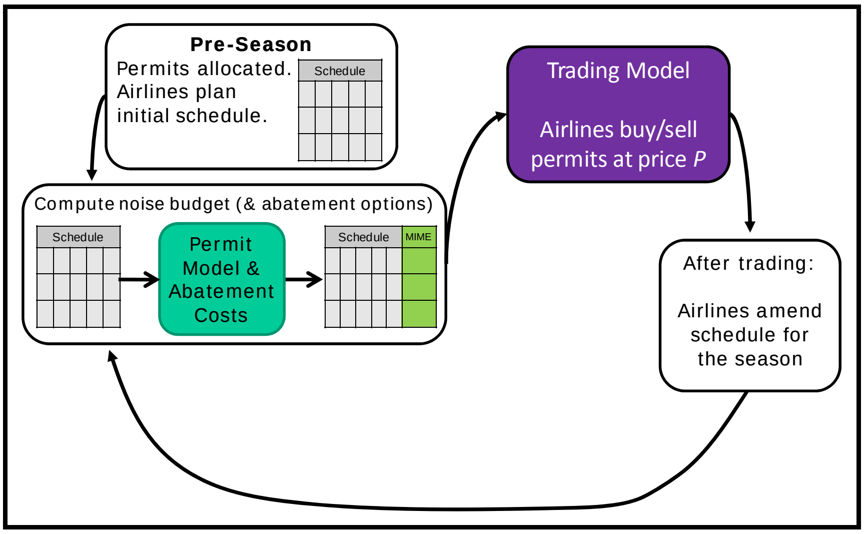

Figure 5: Pre-season trading

Intra-season trading is much more limited, as airlines are closely tied to their schedules. Nevertheless, there may be 'perturbations' – e.g. late/early arrivals, flight cancellations due to equipment or weather, and so – which cause a deviation from the planned schedule, and therefore a deficit or surplus of Mimes going into the next trading period. Figure 6 shows the n^{th} round of trading.

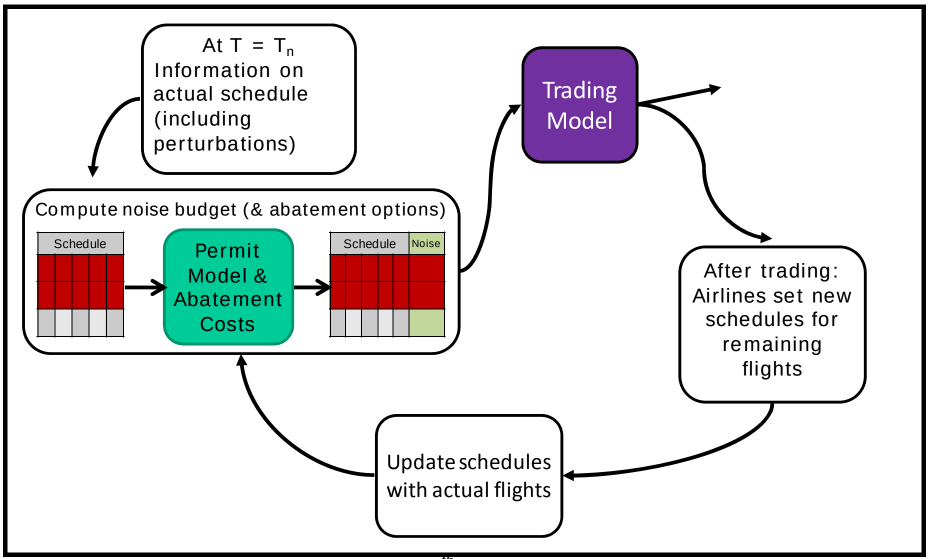

Figure 6: n^{th} trading round

The main model outputs are therefore:

- the price of Mimes
- the total quantity traded on the market each period
- allocations per airline, based on market incentives and behaviour.

These provide inputs for the Airline Operation Model above, and for the Cost Benefit Analysis which we describe briefly in the next section.

3.3 Cost Benefit Analysis

Cost Benefit Analysis (CBA) is a widely used and objective evaluation instrument. A CBA compares the potential economic benefits across a set of impacts with all the relevant potential costs deriving from the implementation of the scheme. As a result of this assessment a quantitative relationship between the benefits and costs can be calculated and a Value for Money (VfM) assessment conducted. CBA is a commonly used framework within the field of transport (for examples see HEATCO (2006)) although there are limited examples in the area of aviation (e.g. EUROCONTROL, 2009) and more specifically in the area of aviation and permit schemes (Ernst &Young and York Aviation, 2007).

The aim of the CBA within the MIME work is to provide evidence for the major stakeholders on the effect in financial and welfare terms of the selected noise trading options selected for analysis. The key stakeholders that have been identified are:

- Government
- Airlines
- Airports
- Air Navigation Service Providers (ANSP)
- Customers (passengers)
- Society (residents, wider impacts)

Table 4 shows the potential costs and benefits elements to be included in the CBA for the different stakeholders. The cost values used in the CBA will be in line with EUROCONTROL (2009) and HEATCO (2006) European guidelines.

Table 4: CBA potential costs and benefit elements for stakeholders

Stakeholder	**Potential Costs & Benefits**
Government	Tax Revenue
Airport	Cost of monitoring Revenue
Airline	Revenue Transaction costs (e.g. cost of participating in the Permit market) Operating costs due to changes in aircraft type used Operating Costs (permits specific) Investment costs (e.g. new technology)
ANSP	Revenue
Consumers	User costs and benefits (freight and passenger)
Society	Noise annoyance CO_2 emissions Accidents

4. OUTLOOK

This paper describes different options for a tradable permit scheme for noise at airports and a modelling framework that has been developed for simulating and assessing the impacts that such as scheme could have on different stakeholders in the aviation sector. This framework is currently operationalised and implemented in computational tools for the simulation of the different scheme options. A crucial input to the models is the construction of marginal abatement cost curves for the different types of airlines covered in the model. These determine the most cost effective measures that can be taken to reduce noise and the market price of permits. Abatement options for which costs are currently been determined are changes in flight operational procedures, rescheduling of flights, swapping aircraft within the fleet, replacing aircraft, and cancellation of operations.

In addition to the assessment of the model results through the CBA, a wider assessment of the permit trading system proposals will be made which includes various forms of engagement with stakeholders to assess the system's acceptability and wider economic impacts. A validation strategy has been developed that sets out the procedures and tools applied in the project for ensuring the fitness-for-purpose of the developed concepts (van Engelen et al., 2009). The MIME project is expected to complete in late 2010.

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