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An incentive pricing mechanism for efficient airport slot allocation in Europe

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ABSTRACT

We define a supervised market mechanism to deal with the airport slot allocation problem. This mechanism is based on the principles underlying the AIP model for regulation of radio spectrum. Incentive prices for airport slots should reflect an estimate of the marginal value of each slot to end users. We compute this value by assessing the downgrade in the provision of the air transport service, both in terms of quantity (i.e. number of transported passengers) and quality (i.e. passenger travel times), should access to any given slot be denied. Incentive prices consider interdependencies among slots at different airports. We argue that, in principle, incentive prices may better align private and social decisions over the use of slots compared with the outcomes of pure market interactions (such as auctions and trading).
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1. Introduction

In the last decades, airlines and passengers have been suffering from growing congestion at busy airports. Evidence shows that several large airports in the European Union (EU) are currently operating at full capacity. According to Eurocontrol (2013), as much as 12% of the demand for air transport will not be accommodated by 2035 because of a shortage of airport capacity. Due to severe constraints to capacity expansion, airport slots are a scarce resource. Thus, the European Commission (EC) is pursuing the optimal allocation and use of slots to foster competition and improve quality of air transport services (EC, 2011a). In this paper, we focus on airport slot allocation and provide an incentive pricing mechanism to effectively manage scarce capacity.

Currently, in the EU, the Slot Allocation Regulation (EC Regulation 95/93, as amended by Regulation 793/2004) defines the mandatory rules for coordinated airports, namely, airports where slots are essential for using infrastructures (EC, 1993, 2004).[1] Although there are no property rights, there are *grandfather rights* in using slots. If an air carrier has used some slots for at least 80% of the time during a season, then it is entitled to use the same slots in the next corresponding season, otherwise slots become free and may be allocated to new entrants (see also IATA, 2013).

Unfortunately, the outcome of this slot allocation mechanism can be far from economic efficiency. Even the *use-it-or-lose-it* rule may induce airlines to use slots inefficiently, since airlines are reluctant to cede slots for fear of rivals' entry (Dempsey, 2001; Starkie, 1998).[2] Thus, the EC has planned to amend the current regulation to enforce market mechanisms for slot allocation and use (EC, 2011b).

At one extreme, market mechanisms would imply withdrawing and auctioning historical slots. Auctions may ensure that slots are assigned to carriers with the highest willingness to pay, which are prospectively the ones that will be able to generate the highest value from managing the assets. Despite the idea of auctioning off airport slots has been widely discussed (Brueckner, 2009; Button, 2008; Verhoef, 2010), it seems far

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[1] In order to land or take off in a coordinated airport, an air carrier or any other aircraft operator should have been allocated a slot by a coordinator (except for State flights, emergency landings and humanitarian flights). The granting of a slot at a coordinated airport means the airline may use the full range of elementary infrastructure services (both airside and groundside) that are necessary for operating a flight at a given time. In the European Economic Area plus Switzerland, where the Slot Allocation Regulation applies, there are currently 89 fully coordinated airports.

[2] Incumbents may have incentives to opt for inefficient schedules and aircraft sizes to dampen competition. In practice, a few carriers hold a large amount of available slots and operate several flights merely to comply with the use-it-or-lose-it rule (Madas and Zografos, 2008). Sieg (2010) stresses that, since air carriers may have better information than airports on passenger demand, the use-it-or-lose-it rule may increase slot use. However, social welfare decreases under that rule.

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from being actually implemented, either inside or outside the EU.[3]

On the other hand, following the UK practice,[4] the EC promotes secondary trading of slots between airlines at EU airports. Trading introduces flexibility in the management of slots, since slots may serve different end users from those for which they have been originally employed. This in turn may mean that slots remain assigned to inefficient uses.[5]

Despite their benefits, market mechanisms have some important drawbacks.[6] Indeed, high private carriers' valuations of slots may not reflect their social value. Moreover, there is the risk that dominant carriers collect the majority of prominent slots and thereby foreclose entrants. Finally, assigning slots locally (i.e. at any given airport) fails to internalize interdependencies among slots at different airports (e.g. at the origin and at the destination of a flight).[7] Thus, there is the need for mitigating the issue of lack of coordination over using scarce resources such as airport slots.[8]

In this paper, we define a supervised market mechanism that aims at overcoming market failures by introducing incentive prices for airport slots. Incentive prices consider the interdependence among slots, and thereby may induce carriers to take efficient decisions concerning the use of slots. Since any slot reserved for a route is subtracted from other possible routes, and thus to other possible end users, then we derive an incentive price for each slot that reflects an estimate of the marginal value of the slot to end users, while preserving recovery of total costs of supplying all slots in the network.

We compute the marginal value of any slot by assessing the downgrade in the provision of the air transport service, both in terms of quantity (i.e. number of transported passengers) and quality (i.e. passenger travel times), should access to that slot be denied. This reflects the loss of utility for end users in the case where the slot becomes unavailable (total costs of providing all other slots being unaffected). Incentive prices should be periodically updated to consider changes in slot use. The mechanism relies on the principles of Administered Incentive Pricing (AIP) for spectrum use in electronic communications markets (Ofcom, 2010). The AIP model leads to regulated charges that reflect the social opportunity cost of the spectrum, thereby inducing an efficient use of that resource.

This paper is organized as follows. Section 2 applies the principles of the AIP model to airport slot allocation. Sections 3–5 explain the procedure to derive incentive prices for slots. Section 6 discusses the main drawbacks of pure market mechanisms. Finally, Section 7 concludes.

2. Incentive pricing for airport slots

In the last two decades, a number of regulatory authorities in electronic communications markets have introduced radio spectrum fees, based on the AIP model, which reflect the underlying marginal value of the spectrum. The AIP model was first introduced in the UK with the Wireless Telegraphy Act in 1998. Current estimates from applying AIP generates yearly revenues to the UK government are equal to 185 million euro (see e.g. Cambini and Garelli, 2011).

The AIP model considers all alternative uses of congested spectrum. If spectrum is used to provide a given network service to end users, then it must be suitably priced to account for the alternative uses of spectrum that have been prevented. Thus, incentive prices reflect the social opportunity cost for spectrum use.[9] If the incentive price is excessive, then the rights holder may release the allocated spectrum and give it back to the government for reallocation. Hence, the AIP model rationalizes the resource use.[10] Incentive prices are then periodically updated to consider changes due to a technology that uses scarce resources more efficiently, or to a shift in demand towards less congested resources.

Ofcom, the industry regulatory authority in the UK, has clarified that the AIP model can be suitably employed both as a substitute for and as a complement to market mechanisms (e.g., incentive prices could be set as reservation prices for spectrum auctions). According to Ofcom (2009), AIP contributes well to pursuing the optimal spectrum use, and is especially effective in the following cases:

- where potential excess demand for alternative uses of the spectrum is significant, but secondary market trading mechanisms are not yet sufficiently mature to secure efficient reallocation;
- where spectrum use requires the coordination of multiple users sharing frequencies, and the costs that would arise if multiple parties attempted to trade with each other directly would be prohibitive;

[3] In 2008, the US Federal Aviation Administration (FAA) initiated a proposal to auction off 10% of the slots at New York City's three major airports, but it was met with criticism from airlines and IATA. In 2009, the Obama Administration rescinded the plans for slot auctions after the US Court of Appeals challenged the proposal in December 2008 (IATA, 2010).

[4] In 1999, slot exchanges with monetary side payments were judged lawful by the English High Court. In March 2008, Continental Airlines paid $ 209 million (about € 143 million) for four pairs of slots at London Heathrow (EC, 2011b).

[5] Madas and Zografos (2006) discuss a number of mixed strategies for slot allocation that embody various forms of decentralized auctions, centralized trading and secondary trading.

[6] In Section 6, we discuss in detail the main drawbacks of pure market mechanisms for allocating scarce resources and provide some relevant examples of radio spectrum auctions.

[7] Castelli et al. (2012) propose a mechanism that simultaneously allocates slots at several airports considering the structure of the network. They also allow for fairly redistributing the system disutility (i.e. the sum of the costs of individual airlines due to the imbalance between demand and capacity at airports) among airlines through monetary compensations.

[8] In principle, specific auction formats may consider the interdependence among slots, thereby allowing airlines to bid for packages of slots (see e.g. Rassenti et al., 1982). However, these formats suffer from severe implementation problems. Indeed, the problem of determining the winning bids is NP-hard, so that solving it to optimality is very difficult. Moreover, the high level of complexity of these auction formats may even prevent bidders from formulating optimal strategies (see e.g. Pekeč and Rothkopf, 2003)

[9] The AIP model departs from the principle of private cost-orientation that is often applied to set network access charges in many regulated industries. Avenali et al. (2010, 2014) show that deviating from private cost-oriented access charges may foster competition and improve dynamic efficiency in telecommunications.

[10] Incidentally, the AIP model shares the idea of assessing the marginal contribution of an element in a given setting with the well-known Vickrey–-Clarke–Groves (VCG) mechanism. In fact, the VCG mechanism aims at evaluating the externalities caused by the participation of an element (e.g. an agent) on the other elements in a setting (e.g. an auction), namely, revenues and costs imposed on the other elements, given that there is not a market where the element participation can be negotiated and priced (Ausubel and Milgrom, 2002). For this purpose, the VCG rule removes the element from the setting and measures the change in some metric of the outcome (e.g. the optimal allocation in an auction). On the other hand, the AIP model has been implemented in the UK on the basis of two different assessments of the marginal value of radio spectrum. Indeed, incentive prices have been set by measuring the additional network costs due to subtracting a portion of radio spectrum from a given service (e.g. for moving to a higher uncongested frequency band). Alternatively, incentive prices have been set by measuring the decrease in network costs due to adding a portion of spectrum to a given service (e.g. when technology innovation yields some digital dividend). Future work may investigate whether these alternative assessments could be considered equivalent. More generally, it may study the relationship between AIP and the VCG rule. In particular, since the VCG rule is affected by some drawbacks (Ausubel and Milgrom, 2002; Avenali, 2009), it is worth verifying whether AIP suffers from similar drawbacks.

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