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Single-till Versus Dual-till Regulation of Airports

Where Do Academics and Regulators (Dis)agree?

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Abstract

Most airports operate under public ownership, while the number of private and economically regulated airports is increasing. Furthermore, airports nowadays earn as much revenue from non-aeronautical business activities as from aeronautical activities. These observations lead to a natural question: whether and how to optimally integrate profits derived from commercial activities into the regulation of aeronautical charges? This paper's approach to this question is to compare literature results on the benefits of regulatory regimes with actual regulatory practice in Ireland and the UK, and to identify avenues for future research that could be useful to support and improve future regulatory decisions.

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1.0 Introduction

The air transport industry is of growing importance as a transportation mode. A crucial element in the value chain is airports, and airport charges are usually regulated. The strongest form of government intervention is public ownership, with many airports currently operating under public ownership including airports in the USA.[1] Yet, starting with the privatisation of major United Kingdom (UK) airports in 1987, a growing number of airports around the world have been privatised, or partially privatised, especially in Europe, Australia, and New Zealand. As the ownership changes from public to private hands, this change is often associated with some form of economic regulation.[2] In this paper we discuss how airport price-cap regulation can be used to improve the performance of the air transport industry, and, especially, how airport commercial businesses (so-called 'concessions') such as the supply of car parking, car rental services, food and beverages, duty-free shopping, and so on, can contribute to this objective. The main contribution is to compare literature results on the efficient use of profits derived from commercial businesses with regulatory practices in Ireland and the UK, and to identify directions for future research that could potentially support and improve future regulatory frameworks.

We first introduce, in Section 2, a simple airport model with a single aeronautical good to discuss basic issues in airport regulation that are relevant for the design of the regulatory system. These include the role of airport market power, the vertical airport–airline relationship, airport cost recovery, airport congestion, distributional issues between airports and airlines, infrastructure investments, and the growing importance of airport concession revenues. This discussion reveals the insight that welfare-optimal pricing will often lead to airport financial deficits in the area of infrastructure businesses. Accordingly, it is useful to examine how the supply of airport concession services can be used to optimise the pricing and thus the use of airport infrastructure.

Then, in Section 3, we discuss the differences and relative benefits of single-till regulation and dual-till regulation, which are two common regimes used in airport regulation, based on the literature results described in Section 2. Roughly speaking, 'single till' means that profits derived from concession businesses are used to cover the cost of the airport's transport-related infrastructure like runways and terminals (so-called 'aeronautical services'), whereas the basic idea behind the dual-till approach is to separate the aeronautical activities from concession activities by ensuring that infrastructure (aeronautical) charges are sufficient to fully cover airport infrastructure costs and operating expenditures. This discussion relies partly on a recent survey paper by Zhang and Czerny (2012).

Section 4 compares academic theory to regulatory practice, identifying many similarities but also some differences. The UK and Ireland (the only two EU countries with dedicated airport regulatory agencies) are used as illustrations. The UK's is one of the world's leading airport regulatory offices, with experience of intense regulatory debates extending over three decades. When it last debated the definition of the regulatory till, in

[1] However, airports in the USA or their airline customers outsource many of their activities to private companies. By contrast, European airports produce many services in-house (for example, ground handling).

[2] Adler *et al.* (2015) provide a recent overview over the changes in airport governance structures as a result of privatisation.

the early 2000s, the regulator and the competition authority took different sides of the single-/dual-till choice. Ireland, where low-cost carriers account for much more of the airport traffic, has considered the till definition more recently, and also illustrated the policy positions of airports and airlines. These examples of airport regulatory discussions also provide insights into the determinants of regulatory regimes, not all of which are yet addressed by the literature. Avenues for future research are then identified and discussed in Section 5, while Section 6 provides concluding remarks.

2.0 Basic Issues in Airport Regulation

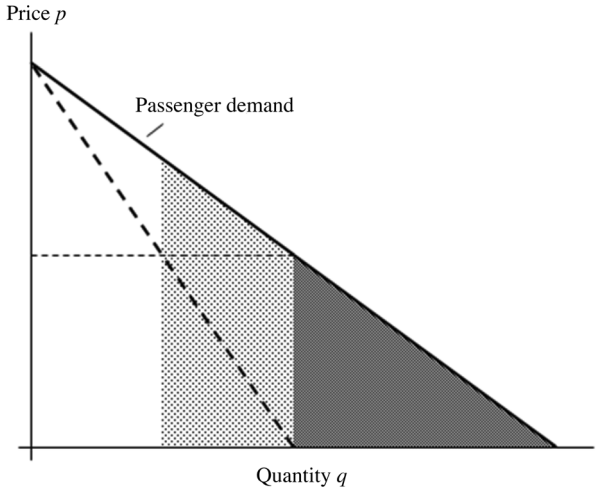
Airports often possess local monopoly market power to some extent. This gives rise to the concern that airport charges for the use of aeronautical infrastructure such as runways and terminals may be excessive. This does not have to be the case. Think of the London area in the UK or the San Francisco Bay area in the USA, where citizens can choose from several competing airports.[3] In Asia and Europe, intermodal competition between air and rail transport can also limit the pricing power of airports, because some travellers may decide to travel by rail if airport infrastructure charges are excessive.[4] Passengers who change flights also limit airport pricing power when they can choose among several hub airports (for example, from Europe to the USA via hub airports in Paris, London, or Frankfurt). Yet there remain numerous airports with significant market power. Existing studies show that the demand for aircraft movements at an airport is very inelastic with respect to airport charges; for example, Gillen *et al.* (1989) calculated the elasticity to be in the range of -0.07 to -0.15 in the context of a major North American airport. One reason is that airports in a geographic area may actually serve different routes and so not compete very much.[5] Moreover, Bel and Fageda (2010) found higher aeronautical charges at private unregulated airports in their cross-sectional study of major European airports. Accordingly, as the ownership of airports changes from public to private hands, economic regulation may become increasingly important due to the local monopoly nature of airports.

2.1 Airline market power

For the economic regulation of airports, it is useful to recognise the 'vertical structure' of air transport markets. Figure 1 illustrates this relationship for the case of a monopoly airport. It shows that the passenger demand depends on airfare p. As a starting point, we employ the extreme assumption that the number of airlines in competition is so large that p is determined by the airlines' operating costs per passenger — 'perfect competition' among airlines — and that these operating costs in turn are solely determined by the airport infrastructure charge. This is a convenient set of assumptions because the ticket price and the airport infrastructure charge are then the same, and given by p. Airport operating costs are typically relatively low (especially compared to airport infrastructure costs, to be discussed below), and for simplicity we assume that they are equal to zero.

[3]For recent studies on multi-airport competition and its various implications, see, among others, Odoni (2009), Mun and Teraji (2012), and Noruzoliaee *et al.* (2015).
[4]See Givoni and Dobruszkes (2013), and Jiang and Zhang (2014), and the references cited therein.
[5]See Bilotkach and Polk (2013) for an interesting recent examination of the issue.

Figure 1
Monopoly Airport Charges With and Without Airline Market Power



In this situation, the airport profit-maximising passenger quantity is determined by the intersection between the horizontal axis and the thick dashed line, where the latter displays the gain in airport revenue associated with an increase of the passenger quantity by exactly one. If the revenue gain of an additional passenger is zero, the airport's profit is maximised. The airport's profit-maximising price is depicted by the thin dashed horizontal line. This price is higher than the airport cost of zero, which leads to a welfare loss equal to the dark-grey area.

Turning now to those routes served by only a few or even only one airline (for example, Levine, 1987; Borenstein, 1992; Lazarev, 2013), the presence of airline market power can cause a substantially larger welfare loss. To illustrate this, consider a monopoly airport with the extreme case of a monopoly airline. Assume that the airport charge is still given by the thin dashed horizontal line. Airline market power means the airport charge and the ticket price are no longer the same because, like the airport, the airline also charges a markup over its marginal cost. Since the airline's marginal cost is determined by the airport charge (in our simplified scenario), the airline chooses the passenger quantity such that the airline revenue gain of an additional passenger is just equal to its marginal cost. This situation thus leads to two markups on marginal cost — one by the airport and the other by the airline — or so-called *double marginalisation*. The welfare loss when there is double marginalisation is given by the sum of the dark-grey and the light-grey areas in Figure 1. As can be seen from the figure, the loss is substantially higher than the welfare loss without double marginalisation.

2.2 Airport cost recovery

Airfares are typically determined by market forces; regulators do not directly control them. The only way to 'convince' the monopoly airline to charge the welfare-maximising price of zero (recall that for simplicity, airline operating costs are assumed to be zero) is to introduce a negative airport infrastructure charge; that is, a per-passenger airline subsidy. The society

as a whole can benefit from such a charge when airline market power exists. Such a system requires subsidy payments to airports because both fixed airport costs and airline subsidies need to be financed. However, airport subsidy payments have been typically unavailable for the last two decades when airports are under growing pressures to become financially self-sufficient.[6] Given that airport revenues are supposed to ensure airport cost recovery, the issue here is to find a way to maximise welfare subject to airport cost recovery ('second best'). Ramsey (1927) has shown that the second-best prices are inversely related to the price elasticities of demands, which means that markups should be higher in the markets where customers are less price-sensitive.

2.3 Congestion

In the presence of congestion, welfare maximisation requires that airfares be positive, even in our simple model. For much of the last decade, air travel delays have been a problem in many countries, with the traffic volume relative to airport capacity being a cause. Airport capacity can often only be expanded in the long term, due to the political pressure and environment concerns from residents in the airports' neighbourhoods, as well as the length of infrastructure financing and construction. An effective way of matching demand to supply with congestion in the short run is to increase airport charges (thus, airfares), which reduces the demand for airport infrastructure, and thus congestion and delays caused by scarce airport capacity. Another way to deal with shortages in airport capacity, which is widespread in Europe, is the use of airport 'slots'. With airport slots, airlines need 'permission' (that is, slots) to incorporate slot-constrained airports into their flight schedules, which effectively reduces the demand for airport infrastructure if the number of airport slots is sufficiently small.

2.4 Distributional considerations in a vertically related aviation industry

The discussion about congestion shows that rationing — either by higher charges or slot constraints — can reduce congestion. However, there is an important distributional difference between the two methods. Specifically, an increase in the airport infrastructure charge increases airline costs and thus reduces airline profits, while slots can increase airline profits if the slot allocation is based on 'grandfather rights'. The latter essentially ensures that airlines can use the infrastructure in the future as often as they have in the past, and hence constitutes a valuable access to airport capacity. Since the grandfather rights are usually provided to airlines free of charge (for example, in Europe), slots can indeed increase airline profits. These could increase for two reasons: reduction in delays; and reduction in competition, as rival airlines may be squeezed out from operating at the airport. Thus the distributional implications of regulatory regimes is an important issue (see Section 4). Regulators may prefer slots over airport pricing as internalisation measures if they attach a higher weight to airline profits than to airport profits.

[6] Airports are sometimes considered to subsidise low-cost carriers in terms of aeronautical charges (for example, Barbot, 2006). However, since low-cost carriers typically boost passenger demand for aeronautical capacity *and* airport concession services (which will be discussed in detail at the end of this section), such as food and beverages, clothing, car parking, and so on, these 'subsidies' can actually increase overall airport profit, which complicates the evaluation of airport charges structures.

2.5 Investment

Investment is a further motive for a social planner to want to see a positive infrastructure charge. Spence (1975) and Sheshinski (1976) showed that minimum quality standards may be necessary to ensure that price regulated monopolies will not reduce service quality too much. Generally, private airports will invest in service quality if the associated revenue gains exceed investment costs. However, these gains will largely depend on the level of the infrastructure charge. Figure 2 illustrates this case — it shows two demand functions and two prices. One is the old demand function, already analysed in Figure 1. The second is a new passenger demand. This new passenger demand is higher than the old passenger demand because it shows the demand after the airport invested in some new infrastructure (for example, a modern terminal building) that increases service quality. For simplicity, the new function represents the demand for higher quality, and is chosen so that passengers with a high willingness to pay for travelling benefit more from the investment than passengers with a low willingness to pay. This ensures that the monopoly passenger quantity remains unchanged. The prices are represented by the two horizontal dashed lines. Inspection of the diagram shows that, at unchanged prices, the revenue gains from investments are greater at the higher price than at the lower price because the light-grey area is larger than the dark-grey area. This means that airport investments may be discouraged by low infrastructure charges and the associated low returns. Czerny and Forsyth (2008) consider a congested airport that can invest in a new runway in order to reduce congestion. Their analysis reveals that exogenous price reductions will inevitably reduce the incentives in new runway capacity of a private airport operator. Yang and Fu (2015) show this result for the case of continuous airport investments in service quality that can easily be adjusted according to uncertain market conditions.

Figure 3 elaborates on the example introduced by Figure 2 and illustrates how passengers might be better off with the investment in improved airport services, even at a higher

Figure 2
Revenue Gains from Investments

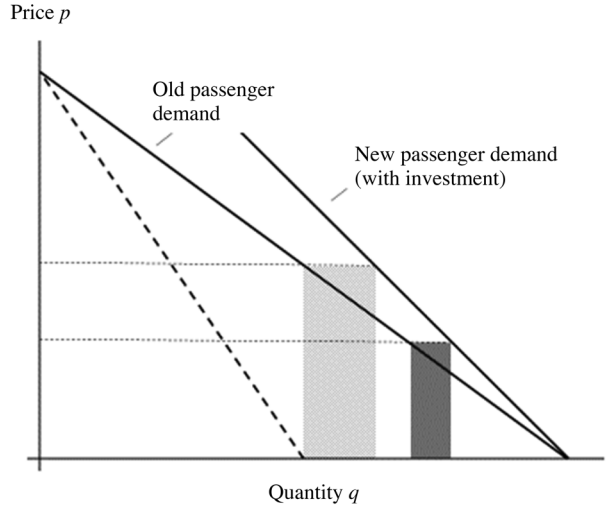
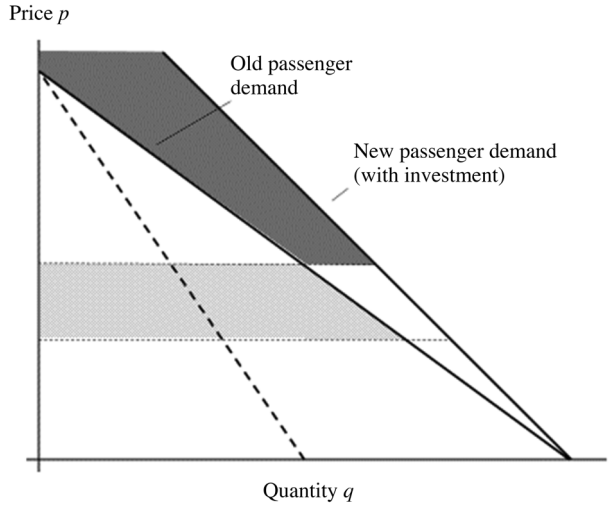


Figure 3
Consumer Surplus Changes from Investment



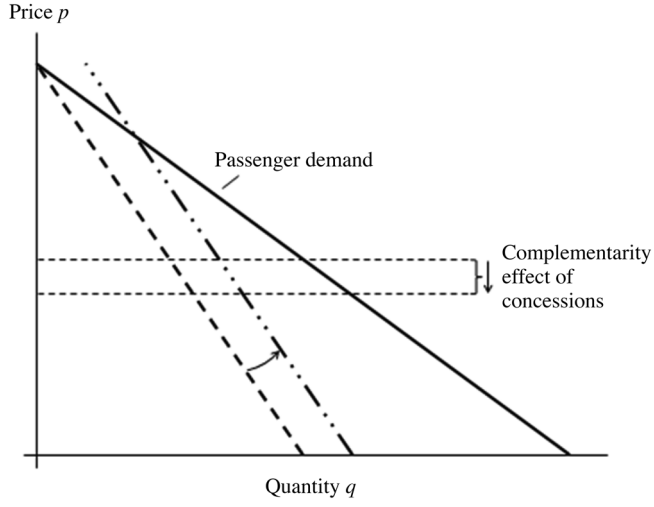
airport charge. The light-grey area represents the loss of consumer surplus due to higher charges, whereas the dark-grey area shows the gain in consumer surplus due to improved service quality. To the extent that the dark-grey area is larger than the light-grey area, consumers are better off with the higher price and investments relative to a situation with a lower price and without investments.

2.6 Concessions

There are two main facets of an airport's business: the traditional aeronautical operation and the commercial operation ('concessions'). The former refers to the aviation activities associated with runways, aircraft parking, and terminals, whereas the latter includes retailing, advertising, car rentals, car parking, and land rentals. Airports worldwide currently derive as much revenue, on average, from concession services as from aeronautical ones (for example, Zhang and Zhang, 1997; Van Dender, 2007; ACI, 2008; ATRS, 2013).

Starkie (2001) was the first author to suggest that airport monopoly power might be dampened because airport concessions provide an incentive for airports to keep aeronautical charges low. This downward impact of concessions on aeronautical charges is formalised in the models analysed by Zhang and Zhang (2003, 2010), and Oum *et al.* (2004). Figure 4 illustrates this effect of concession services on the airport charge for aeronautical services (aeronautical charge). This figure is almost identical to Figure 1 — it shows the monopoly price in the absence of concession services (the upper horizontal dashed line), which is determined by the intersection of the downward-sloping dashed line (increase in revenue per extra passenger) and the horizontal line (zero operating cost). However, the presence of concessions changes the monopoly airport's choice of aeronautical charge. To demonstrate this, suppose that there is a fixed extra profit from concession businesses per passenger. This is similar to an increase in revenue per extra passenger, meaning that with concession services, the dot-dashed line (not the dashed line any more) is relevant for the monopoly airport's charge decision, which leads to a

Figure 4
The Complementarity Effect of Concessions on Aeronautical Charges



reduction in the monopoly aeronautical charge. This is the so-called 'complementarity effect' of airport concession services.

The above analysis assumes that there is a unidirectional relationship between aeronautical services and concession services. This means that the aeronautical charge can affect both the passenger demand and the concessions demand, while prices for concession services have no effect on the passenger quantity. This may be true if the ticket demand and the demand for concession services are separated in time, and, therefore, passengers are not aware of the surplus from concession services when they book a flight (Zhang and Zhang, 2003). On the other hand, the time-separation issue has been somewhat moderated over the last several years, with the e-commerce advancement and airports increasingly advertising their concession services online (Bracaglia *et al*., 2014). Furthermore, many passengers, in particular business passengers, are frequent travellers. The assumption that individuals are totally unaware of the surplus associated with concession services can, therefore, be critical for at least this passenger group. For example, business passengers may plan their trip based on the total travel costs, including airport car rental charges, and some leisure passengers may well be aware of airport car parking charges when they plan their holiday trip (Czerny, 2013). In fact, empirical studies have found that shopping can depend on travelling activities to some extent.[7] For instance, recent empirical studies by Ivaldi *et al*. (2015) and Czerny *et al*. (2016) indicate that an increase in the prices for airport car parking or airport car rentals, respectively, can reduce travel demand.

To see how the effect of concession services on passenger demand can change the monopoly aeronautical charge, note that the supply of concession services can increase the benefits of travelling and shift passenger demand — this is the so-called 'demand effect' of airport concession services. As a result, the private aeronautical charge can *increase* with the existence of concession services. Czerny (2006) uses a linear model to

[7]For useful literature reviews, see D'Alfonso *et al*. (2013), and D'Alfonso and Bracaglia (2016).

show numerically that concession services lift the passenger demand, and that the private and profit-maximising aeronautical charge can be increased with the existence of concession revenues relative to the situation without concessions.

3.0 Single-till Versus Dual-till Regulation

The analysis of single-till and dual-till airport regulation centres around the question of whether profits from the supply of airport concession services, denoted as S, should be used to cover the airport infrastructure cost, denoted as F. The most direct way of regulating airport aeronautical charges (as opposed to the regulation of revenues, profits, or the rate of return on assets), on which this paper concentrates, is to choose an upper limit for the airport aeronautical charge (the 'price cap'). We denote this upper limit by τ.[8]

With single-till regulation (indicated by superscript ST), an airport can freely choose prices for concessions and concession services, but the profits derived from airport concession services are used to cover the airport infrastructure cost. If the airport is supposed to cover infrastructure cost fully through its own revenues (that is, there are no subsidy payments from the government to the airport), the price cap is derived from the formula:

$$\tau^{ST} = \min\left\{\tau : \tau = \frac{F - S}{q(\tau)}\right\}. \qquad \text{(single-till)}$$

The right-hand side involves the difference between infrastructure costs and commercial profits divided by the passenger quantity. A price cap equal to this average value ensures airport cost recovery. This shows that a positive aeronautical charge is required to cover infrastructure cost if concession profits are less than infrastructure cost, while the aeronautical charge may become negative if concession revenues are sufficiently high. Note that the single-till formula recognises that the passenger quantity is a function of the aeronautical charge; that is, $q = q(\tau)$. The 'min' operator is used because the same revenue can typically be achieved with either a high aeronautical charge or a low aeronautical charge when the demand is strictly downward-sloping, and because welfare is higher when the lower aeronautical charge is chosen.

With dual-till regulation (indicated by superscript DT), the airport can still freely choose prices for concessions and concession services, while aeronautical charges cover the entire infrastructure costs (that is, profits from concession services are not used to cover infrastructure cost at all). In this case, the price-cap formula can be written as:

$$\tau^{DT} = \min\left\{\tau : \tau = \frac{F}{q(\tau)}\right\}. \qquad \text{(dual-till)}$$

This shows that the price cap is chosen to ensure infrastructure cost recovery from aeronautical charges; if concessions are profitable, airport charges are higher under a dual-till than a single-till approach.[9]

[8] Yang and Zhang (2012) discuss single-till and dual-till policies in the context of price-cap regulation and rate-of-return regulation.

[9] Empirical work by Bilotkach *et al.* (2012) supports this analytical prediction.

One difficulty with the implementation of dual-till regulation, which has already been pointed out by Beesley (1999), is that the fixed airport costs must be allocated between the infrastructure and the concession businesses. While this adds some arbitrary element to the comparison of single-till regulation and dual-till regulation, for our analysis it is sufficient that the regulator imposes one specific division of the fixed infrastructure costs that leads to a positive value of F.

Recall that welfare-optimal (that is, 'first best') airport charges may imply subsidy payments from the airport to the airlines, while Ramsey optimal (that is, 'second best') airport charges require that markups be higher in the markets where customers are less price sensitive. For airports, Czerny (2006) shows that the single-till approach may better approximate the welfare-optimal airport charges, thereby limiting the welfare cost of airport market power and of double marginalisation when airports are uncongested.

What if the airport is congested? In this case, as the discussion in the previous section showed, the welfare-optimal airfares may be positive. Consequently, one objection to the single-till approach at congested airports is that aeronautical charges would be set too low. More specifically, when the single-till approach is applied to a capacity-constrained airport, aeronautical charges fall — as more profits are made from commercial activities — with higher congestion *ceteris paribus*. The charge under single-till regulation may, therefore, be too low as compared to the efficient charge, while the dual-till charge is higher than the single-till charge and may be closer to the efficient charge (for example, Beesley, 1999; Starkie, 2001).

This intuition is formalised by Yang and Zhang (2011), in their analysis of single-till and dual-till price-cap regulations for a congested airport (where airlines may or may not have market power). They show that when the efficient aeronautical charge covers the airport cost associated with aeronautical services and airport congestion is significant, then dual-till regulation performs better than single-till regulation from a social viewpoint.

To focus on the comparison between the single-till and dual-till schemes, Yang and Zhang (2011) do not consider the role of slots. The problem of inefficiently low airport charges at congested airports can be alleviated, at least partly, by a regime of airport slots, including slot auctions and slot trading. In Europe, in particular, the single-till price-cap regulation normally operates alongside slot controls. Airport slots are highly valuable assets for many airlines under these conditions.[10] This is because a single till reduces the airline payments to the airport (thus, airline operating costs), while imposing restrictions on flight frequencies and thus on competition, which together tend to increase market prices and airline profits.

Table 1 summarises this discussion and shows that the evaluation of single-till vs. dual-till regimes depends heavily on the underlying set of regulatory goals.

4.0 Regulatory Practice

This section of the paper briefly reviews airport regulatory practice to see how fully academics and regulators take account of each other's work.[11]

[10] Brueckner (2009) shows that slot auctions or slot trading can lead to an efficient outcome.

[11] A large body of regulatory materials may be found on the websites of these two offices: www.aviationreg.ie for Ireland; and the CAA archive at www.nationalarchives.gov.uk/webarchive.

Table 1
Evaluation of Single-till and Dual-till Policies Based on Available Studies

Goals	*Single-till*	*Dual-till*
Market power	(+)	(−)
Ramsey/cost recovery	(+)	(−)
Congestion	(−)	(+)
Distribution	Airlines can benefit	Airports can benefit
Investments	(−)	(+)

Note: '(+)' ('(−)') means that one regulatory regime is better (not as good) relative to the other regime.

4.1 Ireland

The case of Irish airport regulation is of interest as one of only two examples of specialist airport price regulators in the EU, with a large low-cost airline base (unlike at regulated UK airports) and a recent review during which interested parties made arguments for each approach to the till.

At its inception (2001), the Irish Commission for Aviation Regulation (CAR) suggested a single till might be advantageous for an airport with surplus capacity, since it would tend to lower aeronautical charges and encourage efficient airport use. On the other hand, an airport that faced capacity constraints might be better served by a dual-till regime because higher aeronautical charges would help to ensure that higher-value passengers use the airport, as well as encouraging investment to alleviate congestion (CAR, 2001). In their responses, airlines argued for a single till and the airport for a dual till.

Aer Lingus, then the largest airline at Dublin airport, argued that commercial activities located at airports earned locational rents which should be shared with airport users. Aer Lingus also argued that a single-till policy would maximise industry joint profits by reducing aeronautical charges in order to capture increased concession profits (Aer Lingus, 2001).

In contrast, the airport identified several problems with a single-till policy (Aer Rianta, 2001). First, such a till absorbs revenues that should be used to finance capital investment, reducing airline costs in the short run only at the expense of raising them in the longer run. Second, it absorbs revenues that would be better spent improving commercial facilities, worsening the commercial offering available to passengers and possibly undermining the future commercial basis of the single till. Third, as airports become congested, lower airport charges encourage overuse of the airport instead of permitting capacity to be expanded to meet growing demand. Dublin airport further argued that a single till increases uncertainty, by linking overall (not just commercial) returns to uncertain future concession revenues. Finally, the airport was concerned that a single till widens the scope of regulation beyond services subject to market power, when such oversight ought to be left to competition authorities; a position that was later also supported by the Airport Council International in Europe.

The CAR opted for a single-till regime, which it retained at later price reviews.

4.2 The UK

The 2003 review of London airport charges featured an extended debate over the merits of single- vs. dual-till regulation, which included both sides of industry, but also, unexpectedly,

quite intense disagreement between the UK airport regulator (the Civil Aviation Authority or CAA) and the UK competition authority (the Competition Commission or CC) on this issue. The UK example therefore demonstrates that conflicting till definitions may be supported not only from commercial perspectives, but also from public interest arguments. Although UK airport regulatory debates are somewhat different today (more commercial and negotiation-focused), the arguments rehearsed in 2003 remain relevant to the many jurisdictions where the traditional approach still applies.

The CAA firmly supported a change to a dual-till policy (CAA, 2000). Given its statutory objective of minimising regulatory intervention, the CAA considered the basic argument against the single-till approach to be that it extended economic regulation beyond those areas in which the airport had substantial market power (that is, aeronautical services). It pointed out that locational rents are not, in general, regulated in a market economy (other than by competition law); that the single till would not in any way reduce such rents, but would merely use such profits to lower airport charges; and that at congested airports, lower airport charges would be unlikely to lower passenger fares, leaving allocative efficiency unchanged but increasing airline profits. The idea that airlines should share some of the profits created by the superior airport retail location available at airports was considered to be an argument over an equitable distribution of rents, and not a compelling reason for a single till. While recognising that the exact boundary of the till is arbitrary, the CAA argued that a dual till would deliver more focused regulation, raise charges closer to incremental capacity cost,[12] and increase incentives to invest in new capacity, especially at Heathrow and Gatwick.

In contrast, the CC was sceptical about a move to a dual till (Competition Commission, 2002). It asserted that as investment rates at Heathrow airport were already close to their feasible maximum, a dual-till approach would not make much difference to airport investment. It considered that there were ways (without raising airport charges) for airlines to use the runway more efficiently (such as use of 'internal markets' by airline alliances, or slot trading), while international air service agreements would limit efficiency even with a dual-till approach. It did not rule out efficiency improvements from a dual till, but considered them to be speculative and not sufficient to justify a changed approach to the till. It pointed out that as 'there was no effective constraint on passenger numbers' (for a given frequency, airlines could still increase passenger quantities by an increase in aircraft sizes and load factors), it was not possible for airline ticket prices to be constrained by capacity, and hence a rise in airport charges would actually lead to a significant rise in ticket prices.

The CC further felt that if the dual-till approach were adopted, compensating regulation to control the 'excess' profits from commercial services at airports would likely be required, increasing the regulatory burden. The CC rejected the distinction between monopoly rents and locational rents. It considered rents earned at airports to derive from the monopoly over aeronautical services, and thus to be different to rents earned from retail locations; for example, on the principal shopping streets in a large city. The CC also considered a dual-till approach to be harmful to regulatory stability because the separation of aeronautical and concession businesses would prove arbitrary, and lead to disputes at each

[12]In proportional terms, the estimated increase in airport charges (under a dual till) ranged from 30 per cent for Heathrow to 70 per cent for Gatwick, although in absolute terms this corresponded to only about £2 per passenger at Heathrow.

subsequent quinquennial review of airport charges. Given the public and strong resistance to the dual-till approach expressed by the CC, the CAA's final price-cap decision retained the single-till policy.

Today, only the airport charges of Heathrow airport remain price-capped (based on the single-till approach). Other airports, such as Gatwick and Stansted, have been freed from such (ex-ante) regulations because regulators concluded that long-term contracts between airports and airlines, together with a lack of 'substantial market power', justified abandoning them (CAA, 2014).[13]

5.0 Avenues for Future Research

There is wide, though not unanimous, acceptance (by regulators, airlines, and airports) that a single till is an effective tool to control airport market power. This is consistent with the literature cited above (Section 3). The UK CAA goes so far as to consider the single till to be 'too effective' in the sense that it extends economic regulation to areas that should be overseen by competition authorities, and in so doing have non-trivial distortionary indirect effects. However, the optimal boundaries of regulation have not been formally analysed by academics, to our knowledge; rather, an assumption of *ceteris paribus* is applied. The literature on airport single-till and dual-till regulation typically assumes that regulators are perfectly informed about market conditions and will consider the airport as a whole, then compare the welfare results that can be achieved by single-till and dual-till regulations. However, future market conditions are difficult to predict in reality, and the information available to regulators may be different from the information available to firms.[14] In such a framework, it may be possible that the attempt to separate aeronautical and concession businesses provides some additional benefits from the social perspective, because it may reduce regulatory 'distortions' on airport concession businesses.

The recent regulatory practice in the UK, where the aeronautical charges of only two airports are regulated, indicates that regulators seem to believe that long-term arrangements between airports and airlines may be a substitute for the economic regulation of airport aeronautical charges (for example, Bush and Starkie, 2014). However, there is mixed evidence for the potential success or failure of such self-regulatory approaches. Xiao *et al.* (2016) investigate the effects of airport–airline arrangements on airport capacity investments. They find that such arrangements can indeed be beneficial from the viewpoint of airports, airlines, and society as a whole. Czerny and Zhang (2015) show that airport–airline agreements on the mix of per-passenger based and aircraft-weight related charges may be of no concern for regulators as long as airlines show a strong preference for per-passenger based charges. Their analysis, however, assumes monopoly airline markets. While a significant share of airline markets can indeed be characterised as a monopoly, the majority of the airline markets are clearly more competitive than a monopoly in the

[13]We thank one anonymous referee for pointing out this to us.

[14]Crew and Kleindorfer (2012) provide a 30-year retrospective on the development of regulatory economics, and seem surprised that economic models on regulation still work with the assumption of perfect information. Laffont and Tirole (1993), in their book on economic regulation, discuss at length the issue of asymmetric information between regulators and firms.

sense that passengers can choose between the services of multiple airlines. Czerny *et al.* (2016) show that an increase of per-passenger based airport charges can soften competition and lead to undesired welfare effects when airports are slot-constrained, as is the case for many European and Asian airports.

The benefits of airline subsidy payments play an important role in the literature, while such a discussion seems to play no major role in regulatory practice. This is understandable because practitioners are likely to consider airport subsidies as infeasible. Yet, although airline subsidy payments may be impossible under current political conditions, they still affect the (second-best or Ramsey) optimal pricing schemes; they are, in fact, one important reason why airport cost recovery is a major policy issue. A relevant implication is that the applied benchmark scenarios, such as the outcomes of a virtually competitive market and the orientation on the long-run incremental costs, might not be appropriate because the optimal airport markups on marginal costs should be inversely related to the price elasticities of demand for the different airport services. And this may indeed require that, for example, the markups on marginal infrastructure costs be low relative to the markups on the marginal costs of concession services, given that the demand for infrastructure is elastic relative to that for airport concession services.

The CC pointed out that the welfare effects of single-/dual-till regulatory regimes at congested and slot-constrained airports depend on the aircraft sizes in operation and load factors. On the other hand, theoretical models of airport–airline markets usually assume that either aircraft load factors or aircraft sizes (or both) are fixed. Only recently did researchers start to develop and use airline models where both load factors and aircraft sizes are endogenous (for example, Brueckner and Zhang, 2010; Czerny, 2015; Czerny *et al.*, 2015; Czerny *et al.*, 2016). These studies concentrate on the effects of emission charges, airline alliances, or uncertainty structures on aircraft sizes and load factors. They abstract from congestion and passenger delays. To derive a more complete understanding of the effect of regulatory regimes at slot-constrained airports, it would indeed be useful to apply such models with endogenous load factors and aircraft sizes. As has been pointed out by the CC, airfares and, thus, passenger quantities are not fully determined by slot constraints under these conditions. Thus, the effect of regulatory regimes on fleet structures may change the relative benefits of regulatory regimes at congested and slot constraint airports.

In line with the theoretical considerations in Section 3, regulatory practice shows that airports in general are strongly in favour of dual-till regulation, while airlines are strongly in favour of single-till regulation. The consumers' position is ambiguous, and depends largely on investments and how they affect passengers (that is, whether passengers with high or low willingness-to-pay for flights benefit most from investments).[15] However, the fact that the CC preferred single-till over dual-till regulation may indicate that it did not expect that potential new investments would bring passengers sufficiently high benefits to justify higher infrastructure charges under dual-till regulation. In any case, the disagreement between the CAA and the CC in the UK shows a strong divergence between the weights that different regulators attach to the surpluses achieved by different groups

[15]Recent changes in the ownership of the main London airports will, over time, help researchers to understand better the impact of increased airport competition (Heathrow, Gatwick, and Stansted are all now separately owned) on the topics discussed in the present paper.

(airports, airlines, passengers). In contrast, much of the literature concentrates on the effect of regulatory regimes on total surplus, implicitly assuming that regulators attach the same weight to these surpluses. This seems a (too) strong assumption.

Another insight is that both airlines and regulators seem to believe that concession services are an incentive for lower airport infrastructure charges. However, this ignores the possibility that airports may reduce concession prices to boost the aeronautical business. Abstracting away from the effect of concession service supply on infrastructure can lead to some serious misjudgement of regulation regimes. A simple numerical example can be used to illustrate this. Consider passengers with a willingness-to-pay for travel of \$100. The airfare is \$50. Furthermore, these passengers want to rent a car at the destination airport, but only if the rental price does not exceed \$30 (they will use public transport otherwise). Without regulation, a profit-maximising airport would charge these passengers a total of \$50 for airport use and car rental, while making sure that the car rental charge will not exceed \$30. Suppose average fixed airport costs are \$20, while variable costs (for airport operations and car hire services) are normalised to zero. In this situation, the airport realises a profit of \$30 per traveller. With dual-till regulation, average fixed airport costs are covered by an aeronautical charge of \$20. The profit-maximising car rental charge under dual-till regulation is \$30, leading to an airport profit of \$30 per traveller. Thus, dual-till regulation does not improve the position of travellers. This is because aeronautical and concession services are complementary, and regulation of only one price can be compensated by an increase in prices of the complementary services. Here, a single till can be more effective in that it may be used to increase the travellers' surplus. In fact, a zero price-cap on aeronautical charges can increase the travellers' surplus from zero to \$20 relative to dual-till regulation, and still ensure an airport profit of \$10 per passenger. This highly stylised example shows that the effect of concession services on travel demand (that is, the demand effect of concession services) can be crucial for the evaluation of regulatory regimes. The fact that airlines and regulators abstract away from this demand effect *may* indicate that it is not empirically important for airport pricing.[16]

A major issue pointed out by regulators and stakeholders is the incentive to invest in airport infrastructure, but also in concession businesses. The literature mentioned above, however, does not distinguish between different types of investment. However, it seems reasonable to assume that under certain conditions, dual-till regulation may provide better incentives to invest in concession businesses. However, considering both the complementarity and demand effects of concession businesses substantially complicates the analysis, and makes it difficult to derive a clear intuition without further analysis.

Our discussion shows that regulators act consistently with previous academic studies in their effort to regulate airports efficiently. However, it has also become clear that some insights derived by the literature have not found their way into regulatory practice, and that more input from researchers is required to facilitate and, perhaps, improve regulatory practice. The opportunities for future research may be summarised as follows:

- To derive a better understanding of the optimal boundaries for economic regulation, researchers could incorporate information deficits and asymmetries into their analyses.

[16]For more general recent work on the interactions between aeronautical and concession businesses, and their implications for airport pricing, see Flores-Fillol *et al.* (2014) and D'Alfonso *et al.* (2015).

This may allow us to show which approach (single till or dual till) is less likely to distort airport behaviour relative to the socially optimal behaviour.

- Regulators seem to trust that long-term arrangements between airports and airlines can be an (imperfect) substitute for the economic regulation of airport aeronautical charges. A few recent studies explicitly analyse such arrangements, and they show that they can imply positive as well as negative welfare effects. For a better understanding of the different forms of airport–airline arrangements and their welfare effects, more theoretical and empirical evidence would need to be produced.
- While regulators often use the outcome of a perfectly competitive market as a benchmark for regulatory behaviour, this approach abstracts away from the vertical structure of airport and airline markets, and the need to subsidise airlines to control airline market power. A comprehensive analysis of Ramsey-optimal airport charges structures would be useful to provide guidance for the (second-best) optimal pricing of airport infrastructure and concession services.
- Airline models usually consider either load factors or aircraft sizes as fixed. In the case of congested and slot constrained airports, this may downplay the welfare effects of single-till regulation. More flexible models with endogenous load factors and aircraft sizes may be helpful in deriving a better understanding of the relative benefits of single-till and dual-till regulations.
- The UK example clearly shows that distributional effects can be a strong driver for the choice of regulatory regimes; particularly when changes in the distribution of rents (arising from a re-defined till) are seen as 'windfall' gains and losses vis-à-vis the initial position. Comparison of single-till and dual-till regimes should involve an analysis of how changes in the weights attached to airline profit, airport profit, and consumer surplus changes the relative benefits of regulatory regimes.
- Regulators seem to abstract away from the possibility that the pricing of airport concession services can affect passenger demand. Empirical analyses that go beyond Ivaldi *et al.* (2015) and Czerny *et al.* (2016) (on the effects of airport car parking and car rental prices, respectively, on passenger demand) would be required to challenge this approach.
- The literature covers the analysis of airport infrastructure investments, but it abstracts away from the airports' needs to invest also in concession businesses. It seems natural to assume that single-till and dual-till regimes provide different incentives to invest in these airport businesses. A rigorous theoretical and empirical analysis is required to derive a better understanding of the incentive structures.[17]

6.0 Concluding Remarks

The main objectives of the present paper are to survey the literature on the relative benefits of single-till and dual-till regulatory regimes, and to compare these with the regulatory

[17] A recent study along this line is Kidokoro *et al.* (2016), in which an airport decides on both its aeronautical capacity and the size of its non-aeronautical service. In particular, the size of the airport's non-aeronautical service is determined endogenously, taking into account both the substitutability between goods sold at the airport and those sold elsewhere, and the locational rent by airport shops.

practices in Ireland and the UK, to identify avenues for future research that would be of potential use for regulatory decisions concerning the optimal regulatory regime. Our discussion produces two general results for researchers and practitioners. First, to a large extent, the literature results can be used to explain the regulators' decisions. This is encouraging for researchers because it clearly shows that there has been a fruitful exchange of ideas between practitioners and academics in the past. Second, regulators need to form an opinion about many things that have yet been well researched. This is also encouraging because it indicates that there is plenty of room for future research in the field of single-till and dual-till regulation, which can have a substantial impact on the regulatory practice and ultimately consumer welfare.

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