

The other side of an airport's two-sided market: issues in planning and pricing airport surface access

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The first part of the paper considers the two-sided nature of airport platforms, and argues that on the land-side, analysis and policy has generally over-stated the items that should be included. In this context, the paper's focus is on airport access and how it should be embraced, along with airside considerations, in a two-sided framework when establishing prices and investment. In the second part, the more theoretical argument is juxta positioned with prior empirical analysis of landside access which has largely been treated in a rather *ad hoc* way, usually implicitly assuming it involves a one-sided market. The subsequent arguments of what needs to be done, are suggestive rather than specific given the diverse institutional and physical nature of airports and their surroundings.

Keywords: Airport accessibility, airport topography, transportation networks, two-sided platforms, airport pricing.

1 Introduction

Pricing by airports for the airline services they provide is usually examined in terms of its importance for income growth, aviation technology, and the local economic/geographical features of the airport's hinterland. Airlines services are treated as an independent market. Generally, decisions regarding landside access are then treated as reactive to trends in the aviation market; in terms of Evan's and Schmalensee's (1999) chicken and egg problem, air traffic is the fowl that initially lays the surface access egg.²

Airports are thus seen in physical terms as being part of a recursive logistic supply chain or in Porter's (1985) more financially driven approach, of a recursive value chain. In either case, each stage in the chain is independently optimized with the outcome of the previous action being a constraint. Taking Porter's approach, the process generally requires marginal cost pricing, the Lange-Lerner condition in the jargon of welfare economics, at each stage in the chain, with the costs from the optimization of the prior stage providing some of the input costs for the next. Each stage has its own, largely independent demand function. This is seldom realistic.

The challenge comes, when at any point in the chain, the demands from two or more elements are highly interdependent. Thelle *et al* (2012, p. 4) put it thus, "Airports are indeed two-sided businesses, engaging in a commercial relationship with both airlines and passengers. The profitability of an airport is therefore crucially dependent on traffic volume as revenues increase in proportion to passenger numbers while costs increase more slowly because of the high fixed cost element. Airports therefore have to respond to increased passenger and airline choice by competing to both retain and attract traffic."

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²An exception to this may be when airports are directly linked with high-speed rail services. In this case, the airport may on occasions provide access to the rail network (Givoni and Rietveld, 2008).

Airport landside access is examined here treating airport markets in this two- or multi-sided way. This situation exists when an economic platform has multiple distinct user-groups that provide each other with external network benefits because their demands mutually interact. To formalize, if an airport has passengers (i) and airlines (a) as customers, a single-sided platform's traffic is realized if it depends only on the aggregate price, $P = P^i + P^a$. The traffic is insensitive to the allocation of the total price between passengers and airlines. If the traffic, however, varies with P^i while P^a is kept constant, the platform is two-sided.

It is assumed that airports are unregulated, private entities that aim to maximize their profits, and can price discriminate, hence also offering socially optimal levels of service for their users.³ Given trends in privatization and regulation this is not unrealistic, and in doing this, the debates regarding issue such as price capping, unless they are of direct relevance, are avoided. The paper neither complicates matters by bringing in environmental or social distribution factors, important as they can be in airport policy-making (Budd *et al*, 2014), nor dwells on the complexities of platform competition; Bracaglia *et al* (2014) offer theoretical insights into airport access in this latter context.⁴

But first, as an *aide memoire*, a brief account of what two-sided platforms entail, highlighting the key elements of the theory relevant to airports and airport access.⁵

2 Airports as two-sided platforms

2.1 A two-sided platform

The clearest definition of a two-sided platform is in Tirole's (2015, p. 1674) Nobel Lecture. He argues two sided-platforms, "...bring together multiple user-communities that want to interact with each other: gamers and game developers for video games; users of operating systems and app developers for operating systems; 'eyeballs' and advertisers for search and media platforms; cardholders and merchants for payment card transactions." More precisely, and quoting Rochet and Tirole (2006, pp. 664-5), "...a market is two-sided if the platform can affect the volume of transactions by charging more to one side of the market and reducing the price paid by the other side by an equal amount; in other words; the price structure matters, and platforms must design it so as to bring both sides on board."

In the context of airport access, Figure 1(A) takes the airport as a platform that receives income from both airline fees and food concessions. This, however, is unlikely to meet the Rochet and Tirole criteria for a two-sided market; a point also made by Czerny (2013). While food concessionaires will probably enjoy positive external gains from having more flights at the airports, additional or better eating facilities are unlikely to provide external benefits to the airlines by stimulating many more passengers with local origins or destinations to use the airport. They may, however, influence choices of transit hubs to move through. Major hubs often provide an array of on-site facilities for passengers on-lining, but this is not of relevance here because surface access is not involved.

³This is the type of situation found in the UK where airports operate as commercial entities. But even with the non-profit models found in the US and in parts of Europe, where Ramsey-Boiteux style pricing may be adopted – or even Lange-Lerner on one side and Ramsey on the other (Ivaldi *et al*, 2015) – there is seldom any allowances for the interface between land- and air-side pricing. Ramsey-Boiteux pricing ignores usage externalities just as Lange-Lerner pricing does.

⁴This latter treatment, while often somewhat unrealistic, is in line with major airport studies such as that of the 2005 Davies Commission on London's Airports.

⁵For more detailed discussions of the general economics of two-sided markets, provided at various degrees of analytical detail, see, Evans (2003a; b); Roson (2005); Rysman (2009); Eisenmann *et al* (2006); Tirole (1988, 2015); Rochet and Tirole (2003, 2006); Glen (2010); Evans and Schmalensee (2014).

Judgment is involved in deciding this because of a lack of empirical analysis, but, surface access, origins and destinations serviced, airline fares, and flight schedules are found to dominate passengers' decisions (Forsyth, 2007; Blackstone *et al*, 2006; Harvey 1987; Pels *et al*, 2000; Leon, 2011; Takase and Morikawa, 2005).⁶ Hence, in Figure 1(A) the single direction of the dashed-line indicates an airport would, in terms of efficiency, consider the impacts of its airline pricing on revenue from food concessions, but not the consequences of food concession pricing on airline traffic. This is not two-sidedness.

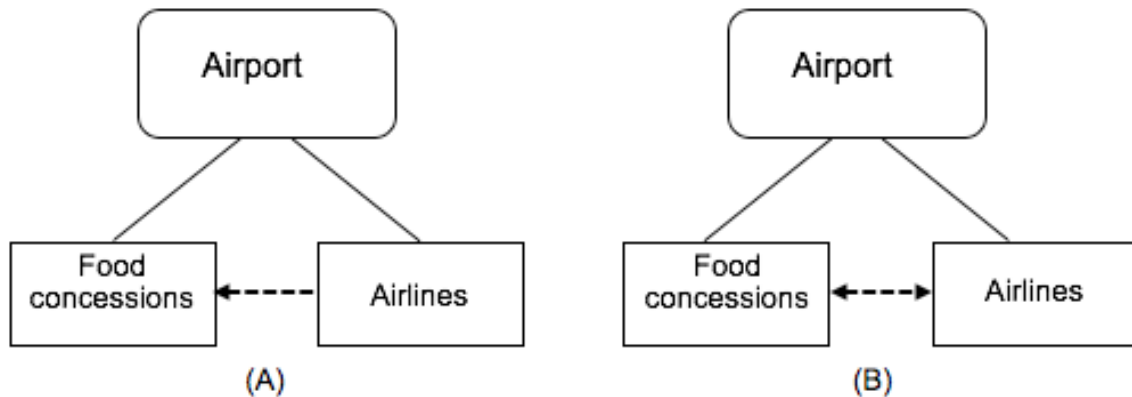


Figure 1. Network externalities in one- and two-sided airport markets.

Surface access to an airport, essentially the ease of reaching or leaving it, has a two-sided effect represented by the double arrowed dashed-line in Figure 1(B). Cheaper generalized access to an airport will both lower the overall cost of flying from and to it, and will improve the competitive advantage of the airport *vis-à-vis* other airports to the advantage of resident airlines. Equally, lower costs of flying will have a positive effect on the demand for surface transportation to and from the airport. The airport can extract through discriminate pricing, some, if not all, of the additional usage externalities enjoyed by both parties, but in doing this needs to incorporate the interacting impacts.

2.2 Optimal pricing

Pricing of the two sides of a platform can appear to run counter to the Lange-Lerner principle of microeconomics, namely that all prices should equal marginal cost, because it is demand driven (Wright, 2004). But this is incorrect. The optimal strategy of an airport selling to both airlines and passengers may be to price below direct marginal costs on one side of the market (a static lost-leader strategy) to attract customers on the other; essentially skewed pricing.⁷ To say this violates the Lange-Lerner principle, however, maybe to misunderstand the relevant marginal cost or, putting it differently, the way one is approaching the problem of double marginalization.⁸

⁶Van Dender (2007) finds that per passenger concessions revenue does fall with passenger numbers suggesting to Czerny that it possibly shows some link between concession prices and passenger numbers. Inferring causality from this is, however, another matter.

⁷This problem was encountered in assessing the price-capping regime at London's airports, and is germane to the pricing of surface access when roads to airports are generally accessed for zero cost at the time of the journey, and transit is heavily subsidized (Evan, 2003b; Gillen, 2011). This is not to say that in some cases the optimal pricing for passengers to access an airport is not zero, say free car parking or shuttle bus services to gain maximum benefits from the airline fees, but rather that the estimation is seldom, if ever, made.

⁸Double marginalization occurs when different firms in the same industry with their respective market powers at different vertical levels in the supply chain apply their own markups in pricing. Due to these individual markups, a deadweight loss is induced and, because the markups are at different points in the supply chains, the losses can be additive. The traditional way of reducing these losses is through mergers and vertical integration of firms in the supply chain. A two-sided platform approach serves a similar function through pricing.

To illustrate we use Rochet and Tirole (2003) approach involving a two-sided monopoly airport platform with no membership externalities, only usage externalities, that levies no membership fees, only per-transaction usage charges.⁹ The demand for transactions from group i is given by $D^i(P^i)$, for $i = 1, 2$, where P is the per-transaction charge to members of group i . The two groups, can again be taken as airlines (a) and passengers (i). The number of transactions is proportional to the product of the groups' demands, so that there is a value to balanced participation. With a cost per transaction C^i of serving a member of i , the platform's profit is,

$$\Pi = [(P^i - C^i) + (P^a - C^a)] [D^i(P^i)^a D(P^a)] \quad (1)$$

Profit maximizing prices when the price elasticity of demand with respect to P is E^i , are;

$$[(P^i + P^a) - (C^i + C^a)] / (C^i + C^a) = 1 / (E^i + E^a) \quad \text{and} \quad P^i / E^i = P^a / E^a \quad (2)$$

The left equality resembles the standard Lerner condition for monopoly equilibrium when the markup over cost is lower the higher is either demand elasticity. The second condition makes it clear, however, that this is not an ordinary multi-product firm that would generally maximize profit by charging prices that are inversely related to demand elasticities. Optimal prices are directly proportional to demand elasticities. In other words, the platform, an airport, cares about balanced participation of the two groups, while balance has no value to an ordinary multi-product firm.

But there may also membership externalities e.g. more airlines attract more passengers to the airport that in turn attract more passenger. An airport will place a lower revenue-over-cost burden on that side of the market that benefits the other the most (Armstrong, 2006). Assuming this is the passenger side (i), and that v^a is the benefit enjoyed by airlines from an extra-passenger using the airport, the airlines will be willing to pay up to this amount to increase passenger throughput. The airport can extract rent from the airlines up to v^a above their allocated costs (c) for providing the platform service of increasing their customer base.¹⁰ This involves transferring the external benefits derived by airlines from additional passengers using the airport to the airport. Akin to Ramsey pricing, but allowing for cross-effects, the airport will place the lower burden on the side of the market where demand is relatively elastic, i.e.

$$\{p^i - (c - v^a)\} / p^i = 1 / \eta_a. \quad (3)$$

Whether this type of skewed pricing violates Lange-Lerner skewed pricing is a matter of definition (Armstrong, 2006; Rochet and Tirole, 2003). Pricing surface access should not just consider the immediate physical costs involved, but also the costs of the revenues lost from airside activities if, say, the prices are set high. Skewed pricing, correctly applied, thus reflects the true marginal opportunity costs of the pricing decision (Parker and van Alstyne, 2005). As Tirole argues (2015, p. 1675), "A regulator failing to understand the nature of two-sided markets might misleadingly complain about predation on the low-price side or even excessive pricing on the high-price side, despite that such price structures are also selected by small, entering platforms."

2.3 Two-side markets and dual-tills

An added practical problem in recent policy debates arose regarding price-cap regulation of the London airports. This centers on whether regulation should treat an airport as a single-till, and cover both airside and landside incomes, or as a dual-till separating airside activities for regulation and leaving land-side concessions, including parking and other surface transportation fees, to the market (Starkie, 2001, 2008; Czerny, 2006). One challenge is that not all landside

⁹User externalities occur when the value received by agents on one side of the market increase with the number participating on the other side. The number of those involved is fixed. Membership externalities occur when two agents act together to create value and there is expansion in the market.

¹⁰It can also run the other way as implicit in Levine's (1987) notion of economies of market presence. The ability a hub to service more destinations than a small airport, allows it to charge hub premiums to travelers from the hub's hinterland without any consideration of its monopoly situation.

airport concessions, as seen earlier, involve genuine reciprocal network externalities with airside activities; some are just complimentary ways of gleaning additional revenues from spatial monopoly power.¹¹

This blurring between two-sidedness and dual-till extends, in varying degrees, to academic studies. Gillen (2011), for example, looked at airports more generally as two-sided markets, arguing essentially that an airport is a platform linking airlines and passengers in the way Tirole describes, but does not specifically focus on access. He therefore includes within concession some single-sided markets such as restaurants, souvenir stands, and bookstores, thus making his analysis more akin to examining the dual-till issue than to strict analysis of two-sided markets. The more theoretical studies by Czerny (2006), Fu and Zhang (2010), Czerny and Zhang (2015) are in a similar vein.

The argument that airport markets are two-side, in the Rochet and Tirole strict sense, is not without critics. Froehlich (2010) argues that airports, while having many features of two-sided platforms, are better treated within a conventional vertical relationships framework, basically as a Porter value chain. While accepting that airports do have features amenable to other forms of analysis, Appold and Kasarda (2011), however, argue airports are close enough to being two-sided markets to make the model a reasonable approximation, especially in that it helps clarify thinking about airport economics and planning.

3 Neglect of the second-side of the market

Setting practice against theory, the idea of treating airports as two-sided platforms has tended to be neglected or downplayed in economic discussion of their operations. While the airline-airport interface has received considerable attention, this is usually within a one-sided market framework. The literature on airport slot congestion, and its alleviation, reflects this (Brueckner, 2002; 2005; Daniel and Pahwa, 2000; Daniel and Harback, 2008; Button, 2008). There has certainly been, albeit largely separately, a growing interest in the non-aeronautical revenues that can represent 75 percent or more of the total incomes at large airports in the US and Europe (Air Transport Research Society, 2012; Graham, 2009; Fasone, *et al*, 2016). The analysis, however, has been mainly driven by dual-till regulatory debates over monopoly rents rather than two-side price setting.

The issue of individuals' access to and egress from airports that are part of the two-sided airport market is, though, one of increasing importance not only because of growth in air transportation, but also because of encroachments on many airports as suburban sprawl has grown, and as airports themselves have become magnets for commercial development (Button, 2002a). From a two-sided perspective, locating or expanding an airport near a city center can reduce, or at least contain, passenger access costs but, because land is likely to be more expensive, the airside costs to airlines are inevitably higher. And if the various other external costs of aviation are included, the latter would be even greater. In practical terms, while seldom quantified, this lies at the heart of many of the debates in cities like New York (with La Guardia), Washington (Reagan National), and Chicago (Midway) that have airports close to their centers.

One reason for the neglect of landside access seems to lie in how the positive user externalities enjoyed by airlines and passengers are viewed. Commercial concerns in a two-sided context

¹¹Malavolti (2016) argues for a single-till approach to airport regulation on the basis that concessionary revenues from airport shop sales vary according to the time people spend at an airport and thus, in many cases, to the transfer time between flights. This effectively takes retailers and airlines as the two-sides of an airport's market, with the interacting user externalities being that rapid transfers reduce airline costs but also reduce shops' revenues (and thus airport concession incomes). There is some truth in this, but the revenues of the shops also depend, and probably more so, on the volume of passengers that are linked to overall activity at the airport. More importantly, the argument only seems to apply to transfer passengers when local access is not a concern.

means the platform provider will seek to attract users thought to be providing the greatest external benefits. Regarding airports, airline, not surface access, facilities have traditionally been seen to generate most scope and density economies, and to drag along demand for parking, taxi services, etc. after them.¹² Airports also find it relatively easy to identify and aggressively targeted airlines.¹³ The external benefits to passengers of good landside access are less easy for an airport to identify, and to extract rent from. This is especially so when access involves infrastructure over which airports have little control or few fiscal ties.

Given the dearth of two-sided market analysis, one question is “Just how does the extant literature on surface access juxtaposition with the idea of airports being two-sided platforms?”

3.1 Airport topologies and access

The importance of surface access revenues to airports under existing charging varies widely. This is true of individual airports within countries but also between large aviation markets; e.g. in 2015 it was less than 10 percent of non-aeronautical revenues in the Middle East where most airports act as transit points, and only slightly higher in the Asia-Pacific and Latin America-Caribbean regions where much of the traffic is international. In North America, however, parking revenues account for 39.3 percent of non-aeronautical revenues, and rental concessions for another 20.3 percent - retail concessions and food and beverage amount to just over 15 percent (Airport Council International - North America, 2016). These access revenues amount to about 25 percent of overall airport revenues. Given the degree of hubbing in North America - Southwest generally considered a point-to-point carrier still had 28 percent of its traffic on-lining through its hubs in 2013 - the importance of landside access revenue for origin and terminating airports is even less than these figures imply.

Even regarding those with smaller hubbing functions, and where surface access is relatively more important, topologies are difficult and categorizations of airports are inevitably transient, changing with wider air transportation network trends.¹⁴ One approach is to focus on the immediately quantifiable, such as airport size (Adikariwattage *et al*, 2012). For example, the US Federal Aviation Administration groups airports by passenger boarding numbers. But this poses the problem of “How much value do passengers put on landside access side, and how can airports translate this into producer surplus?”

To deal with this, land-use planners focuses on individuals' abilities to reach regularly used facilities, often in or adjacent to urban areas (Bhat *et al*, 2002). But airports for many people, however, do not fall into classification. Trips for them are often infrequent, and in the case of tourism involve families or groups going together.¹⁵ Some individuals do fly frequently on business, and there are those that work at airports, and crew or aircraft maintenance staff, that regularly use surface access; these are returned to later. Added to this, the derived-derived demand for airport facilities (passengers demand airline services and the airlines then demand airport services) means that if the air services offered change frequently, as either the final demand changes or the services of the airlines change, this affects the broader view of accessibility by travelers.

At the extreme, a fast, free, frequent, and reliable access system ceases to be relevant for travelers if final destinations can no longer be reached from the airport, say when airline services have

¹²These are the network equivalent of Marshallian scale-based external benefits (Button, 2002b).

¹³ Whether this targeting succeeds is another matter as seen in the bilateral bargaining involved and as some European airports have highlighted (Barbot, 2006; Button, 2008).

¹⁴ For examples, Burghouwt and Hakfoort (2001); Redondi, *et al* (2012); Malighetti *et al* (2009); Guida and Maria (2007).

¹⁵The US National Household Travel survey shows that about 40 percent of air travel is for business, but provides limited information about how many of the associated trips are by frequent travelers, or indeed how often those traveling for leisure or personal business are regular fliers. The general pattern is that business travelers yields far more revenue than other passengers.

been withdrawn. Marcucci and Gatta (2011) found this when looking at a set of Italian airports where paramount importance was given by users to the availability of low cost services rather than any consideration, within reasonable boundaries, of the quality of airport land access. The broader work of Pels *et al* (2009) came up with similar conclusions. More generally, the de-hubbing of an airport by an airline has serious consequences for the demand from surface access that can be enduring (Redondi, 2012).

It is partly for these reasons that there are differences in the ways large hub airports may be viewed. The large international hubs in the Gulf, for example, have very little local traffic, most of their activities involve airline transfers between Asia and Europe. The focus of airports with large amounts of on-line air movements is thus air access, although in the case of Dubai there are also good, fixed land links. Other major international airports, such as Heathrow, Paris, Frankfurt and Schiphol, while fulfilling major hubbing roles, also cater for those living or having business in their hinterlands resulting in large numbers of people accessing and egressing them by surface modes (Budd *et al*, 2014) This latter traffic, however, also shares large parts of the surface infrastructure with others in the vicinities of the airports making it difficult for the airport authorities to isolate specific rents associated with the landside of its market.

Smaller airports at the end of spokes generally have very few interlining or on-line airline services. Their volumes of traffic can also fluctuate considerable, and especially so if they are heavily dependent on single carriers or a certain type of passenger, such as tourists. This can place less pressure on the links to these airports, which are primarily served by local roads, and thus the need for dedicated surface access infrastructure, although there is often the demand for significant amounts of parking and for taxi services for which airports can extract economic rents. The exceptions are those that have been enveloped by urban spread, and local congestion has grown, giving multiple justifications for mass transit services or dedicated road capacity; the former of which reduces demands for parking, and with this potential airport revenue (Gosling, 2008).

3.2 Direct demand analysis for surface access

The direct price sensitivity of air- and land-side access markets depends very much on the levels of competition in each. The degree of competition between airports for airlines' business varies considerably between them because, as discussed above, of the various networks and markets they serve and the degree to which they have good surface access.¹⁶ Competition in terms of air services in all its dimensions has been extensively researched but the space devoted to surface access competition is considerably less.

While economically efficient pricing and investment by airports involve internalizing the user externalities associated with both sides of their markets, there are problems in doing this on the surface side. As Gould (1969, p. 64) says, "accessibility...is a slippery notion...one of those common terms that everyone uses until faced with the problems of defining and measuring it." Here the definition of Bhat *et al* (2002, p.1) is favored, "...accessibility is a measure of the ease of an individual to pursue an activity of a desired type, at a desired location, by a desired mode, and at a desired time", nuanced to the features of surface access to airports. But measuring and gaining property rights over this is difficult and, whereas airport surface accessibility defined in this way was the subject of some of the earliest studies of airport accessibility (Armstrong, 1972), and has been deployed in discrete choice models (Leake and Underwood, 1974; Hess and Polak, 2005; Tam *et al*, 2008), such work has not been within a two-sided platform context.¹⁷

¹⁶There are also possibilities of market imperfections in terms of how airlines and airports interface; e.g. Fu and Zhang (2010) examine the possibility that airports may favor dominant carriers when deciding which airlines to share revenue with.

¹⁷He used network analysis data that included distance and population weights and found Eastleigh to be the most accessible airport in the Southern England followed by, Lee, Portsmouth and Hurn.

The problem of ground access analysis has been made harder with time, and changed with technical and economic developments. There are, for example, now purpose-built, dedicated highways and rapid transit systems serving airports (Wong and Baker, 2013; Humphreys *et al*, 2005). On the softer-side, many countries are beginning to integrate their inter-city rail networks with air services allowing common ticketing that offers longer distance surface, interlined accessibility to the air transportation network but at the same time blurring the sides of the market (Albalade *et al*, 2015). Changes in access to one airport may also have implications for others, invoking notions of airport network competition that affect elasticities of demand. This can be seen in Monterio and Hansen's (1996) study of the implications for regional airports of a major rapid transit extension to San Francisco International Airport.

Although airports generally have only limited control over surface access other than at the terminal itself, changes are taking place (Wei and Gosling, 2013). Some airports, for example, are becoming more involved in the financing of local public transit links. This is partly seen in the construction of the Silver Line metro linking Dulles International Airport to downtown Washington DC. It has been designed by the Metropolitan Washington Airports Authority, the airport operator. But, the method of financing, and the regulated prices that will be charged, provide little scope for the airport to extract revenues from those who will enjoy better access to airline services. The Port Authority of New York and New Jersey has an even wider asset base including overseeing the Authority's Bus Terminal and the PATH rail system, as well as LaGuardia, John F. Kennedy, Newark Liberty International, Teterboro, Stewart International, and Atlantic City Airports. But there is little scope for the airports operating as two-sided markets given the high levels of cross-subsidization, partly established by statute, between the Authority's activities, and the diversity of local agencies involved.

In addition to parking, airports license taxi (Croix *et al*, 1986; Wong and Baker, 2014) and mini-bus (Graham, 2009) access, and facilitate car rental availability to serve residents and visitors to the region. In addition to the ACI-NA macro results cited earlier, looking at 55 large US airports from 1998 through 2002, van Dender (2007) found that landing fees and terminal rents generated 84 percent of revenues, and of the concession revenue, 20 percent came from rental car services, and 40 percent for parking revenues. More generally, Jacobs Consultancy (2010) found that up to 26 percent of US airport revenues are generated from parking. But each case is specific in terms of the ways airports operate and concessions are awarded, and in terms of local market conditions. In Coasian terms there is little consistency in the ways property rights are allocated. But it is clear that the idea of two-sided platforms is seldom reflected in the way things are done.

Furthermore, revenue figures seldom reflect airports' access pricing strategies. While airport users enjoy options over purchasing food and, with many international flights, duty-free items, they have less choice regarding access. This generally means that surface access charges for such things as parking and taxi operating rights can relate to relatively inelastic demand curves making their concessions potentially costly to acquire. Bracaglia *et al* (2014), for example, cite annual reports highlighting the success that several airports have enjoyed in attracting travelers to their parking facilities by offering on-line pre-booking. This, however, may simply be a trade-diversion effect from other surface modes they have no control over rather than generating new traffic for airlines.

While empirically, the way data is currently collected makes it difficult to study airports as two-sided platforms, quantitative work can give insight into the relative importance of control variables acting directly on access.¹⁸

Automobiles, for example, because of their convenience, flexibility, and provision of door-to-door service with a low marginal cost, generally account for over 65 percent of journeys accessing

¹⁸The methodologies used in this work are mainly revealed- or stated-preference based, although some involve straightforward questionnaires, Tam *et al* (2005; 2011) and Akar, (2013).

airports, with the share increasing for smaller airports where public transportation is less readily available (Mandle *et al.*, 2000). There may, however be economies of scale in providing public transportation, especially if an airport has non-aeronautical destinations adjacent to it as Orth *et al* (2015) found regarding Zurich International Airport.

3.3 *The role of journey purpose*

We know that frequency of use of any airport is generally correlated with journey purpose, with more frequent, business travelers viewing access differently to leisure travelers (Hess and Polak, 2005). This is primarily due to the principal-agent situation whereby employers pay for business trips, and the self-employed can claim tax rebates, neither of which apply to leisure travel. In this context, Panou (2014) found modal access bias at Athens International Airport where business travelers do not pay for their parking. Added to this, business travel-time savings are in general more valuable than those of leisure travelers; see Morrison (1987) and Pels *et al* (2003). The situation is reinforced because leisure travelers book flights earlier than their business counterparts and thus seek less flexibility in access and favor cheaper modes when family groups are involved. Also as Jou *et al* (2011) highlight, business trips are often of short duration involving a carry-on, whereas the number of bags carried by a family generally requires checking-in. Added to this is the physical nature of travelers with unaccompanied minors and those with physical disabilities are more limited in their choice of access mode; e.g. Chang (2013) finds this so in the case of the elderly.

Access reliability is important. The frequent business traveler tends to allow shorter buffer times for unforeseen events, putting a premium on access modes that are more reliable. Yamasati and Kuroda's (1997), for example, find that for Japanese travelers to Osaka International Airport, a 50-minute buffer time was likely for 80 percent of first time, 55 percent for monthly, and 33 percent of weekly users. Similarly, general patterns emerge, albeit using different matrices, in Tam *et al* (2008; 2011) for passenger's departing Hong Kong Airport and in Koster *et al* (2011) regarding Schiphol Airport, Amsterdam.

In terms of price sensitivity, Panou (2014) find regarding the use of long-term parking at Athens airport, that because users of these facilities are mostly business travelers not paying for parking themselves, they exhibit low price elasticity of demand, placing more value in their time and the flexibility that automobile travel offers. At the same airport, Psaraki and Abacoumkin (2002) find that after more parking is provided, the use of taxis by business travelers would not change, more people would drive and park, but drive-and-drop would decrease. All factors relevant to the revenues an airport can expect to gain from the land access side of its market.

3.4 *Land-use and airport access*

While airports can directly extract revenue by providing parking, taxi, bus and car rental concessions, and, in some case rapid transit, they can also influence land-use in such a way that passengers may live or work closer to an airport. Basically, better access afforded by generates income for the airport through land rents rather than fees. The passengers or their employers buy proximity to the airport and the high level of surface access accompanying this. At the extreme is the concept of Aerotropolis outlined in Kasarda and Lindsay (2011), and discussed in terms of two-sided markets by Appold and Kasarda (2011).

This approach has been operationalized in the Netherlands in the Randstad's notion of a Mainport with, not only good quality rail and road transportation providing access to Schiphol Airport, but also business activities, often with strong international links, developed around the airport that employ over 60,000 people. There are other, smaller examples, including Alliance Texas and Panama City-Bay Country Airports, and the Northern Carolina Global Transpark and Detroit Region Aerotropolis.

The ability of an airport to extract revenue from the enhanced access that goes with proximity depends whether it has the rights to develop land around it. There are also questions about the

way that land-use development is implemented, and indeed the speed at which an airport develops more generally. In other two-sided markets, there is evidence that rapid expansion of one side of the market may lead to high costs and slow revenue growth, and that an iterative approach may be desirable (Evans, 2003a). How this dynamic process could be implemented regarding airports is still unexplored.

4 Where do airport and airline employees fit in?

Not only has the work on airport surface access tended to be one-sided in its orientation, it has largely ignored airport related workers that on average constitute one-third of airport traffic. The interacting travel costs of employees with passengers are important, with employee trips often concentrated around a few daily peaks leading to congestion and parking issues that intersect with passenger movements (Ison *et al*, 2007; Humphreys and Ison, 2005; Humphreys *et al*, 2005).¹⁹

Access for these workers thus has implications for both sides of an airport's market. Low employee access costs, irrespective if these are airline workers, have external benefits for the airlines using the airport, but may have either negative or positive external effects for airport passengers. The latter is theoretically indeterminate because the combination of employees and passengers may, even if they pay for their own access, produce positive Marshallian effects in terms of economies of scale in access provision (Orth *et al*, 2015), but negative Pigouvian congestion effects if the employees' travel impedes that of passengers. We know little about these conflicting possibilities.

We do know is that peaking, combined with the diffuse origins of those associated with those workings at airports, the timing of many of their trips and their relatively small numbers, can pose serious challenges in the provisions of mass public transportation (Ricard, 1995; Boyle and Gawkowski, 1992; Spear, 1984). Specific modeling of such traffic at airports is, however, limited, Tsamboulas *et al* (2012) being an exception. This may be unimportant if those making the trips are influenced by the same factors as the public when traveling to and from work; one can just use value transfers. But the empirical basis for such an assumption has been little researched. Studies do find that airport employees are particularly sensitive to travel time and money costs relative to their income when making modal choices, but do not distinguish between the time costs of the various elements in their journeys.

5 Conclusions

Virtually all network platforms are two-sided to some extent, but while this may have trivial implications, in many cases it can be of greater significance. We initially set out how surface passenger access to airport platforms can be viewed as part of a two-sided market because its demand is entwined with pricing in the related markets of airline slots and gates. This was then set against the actuality of the empirical work conducted on surface access, finding the latter largely treats such access as being supplied in a unitary market assuming minimal external effects on airline networks. Thus, we have some idea of the relevant control variables that need to be considered in looking at surface access markets, but generally little idea of the scale of the interaction between it and airline markets. At the very least, the latter requires knowledge of the reciprocal cross-price elasticities of demand between land-side and air-side which currently is largely missing.

¹⁹Airports often seek to influence employees' travel, for example by subsidizing transit passes and promoting cycling and car-pooling. Parking restrictions on employees is, however, often a contentious issue especially when few workers are direct employees of the airport, about 7 percent, in the UK, rather than of airlines or concessionaires (Budd *et al*, 2011).

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