Optimal Airport Charges Considering Delays and Environmental Externalities

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Existing Airport Charges (AEA)

Aeronautical Charges:

- Runway
- Passenger
- Transfer pass.
- Security fee
- Aircraft parking
- Airbridge
- Terminal navigation
- Noise

Ground-Handling Charges:

- Ramp handling package
- Passenger handling
- CIP lounge
- Bus
- Cleaning
- Ground power
- Pushback

Future airport charges

- The European Commission is planning to introduce the following charges within the next 5 years at all EU based airports:
  - Congestion charges
  - Scarcity charges
  - Noise charges
  - Engine emission charges
- How will the addition of all these charges affect airport use and social welfare?

Outline

- Introduction
- Literature search
- The theoretical pricing model
- Schiphol Airport Case Study
- Conclusions

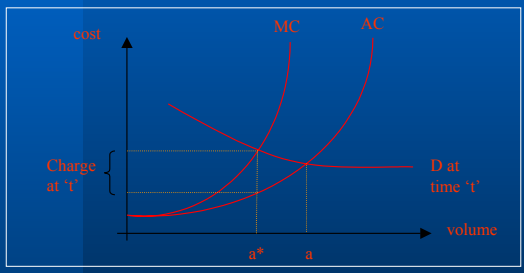
Literature Search

- Carlin and Park (1970)
- Borins (1978)
  - None of their ideas were implemented, as administrative allocation techniques were introduced instead
- Oum and Zhang (1970)
- Oum et al. (1996)
- Daniel (1995, 2001)
- Brueckner (2002)
  - Greater interest on the part of the EC over past five years (the EC White Papers (1998, 2001)) also fuelled research in the area, both on the pricing issues and externality charge

Literature Search on environmental externalities

- Nero and Black (1998)
  - environmental externalities associated with extensive hubbing and examined 2 scenarios: a passenger and an aircraft related tax.
  - concluded that a sufficiently high environmental tax would induce airlines to move from the economically efficient hub-spoke network design to a fully connected network.
- Lu and Morrell (2001)
  - analyzed aircraft noise and engine emissions and applied it to a case study of Schiphol Amsterdam airport.
  - The average noise social cost per landing, according to the model, ought to be €623, which is higher than the current charge of €157, whilst the engine emissions charge (currently not in existence) ranges from €244 to €4,967 depending on the scenario.

Maximum Social Welfare Model



Assumptions of marginal social cost pricing model

1. **Airline demand is linear in price and there are no cross-elasticities between the two periods**
2. **Airport operating costs per landing are fixed, therefore marginal costs are fixed too**
3. **No scale economies in capacity investment i.e. the average cost of capacity is constant**

Computation of Marginal Social Cost Pricing

Social welfare = **producer surplus**
+ consumer surplus
– airport fixed costs
– congestion charges
– noise charges
– engine emission charges

$$\max_{P_1,P_2} SW = \alpha_1\left\{\int_{P_1}^{\frac{a_1}{b_1}}(a_1+b_1x)dx+(P_1-c_1)D_1(P_1)\right\}+\alpha_2\left\{\int_{P_2}^{\frac{a_2}{b_2}}(a_2+b_2x)dx+(P_2-c_2)D_2(P_2)\right\}$$
$$-FC-C\alpha_1D_1(P_1)-(N+EE)(\alpha_1D_1(P_1)+\alpha_2D_2(P_2))$$

Constraints

1. **Airport budget constraint:**

$$\alpha_1[D_1(P_1)(P_1-c_1)]+\alpha_2[D_2(P_2)(P_2-c_2)]-FC(K)\geq\mu$$

2. **Airport capacity constraint:**

$$D_1(P_1)-K\leq\delta$$

Analytical solution

For $\lambda_1,\lambda_2\geq 0$

$$P_1=\frac{c_1+N+EE+C+\lambda_1(c_1-\frac{a_1}{b_1})+\frac{\lambda_2}{\alpha_1}}{1+2\lambda_1}$$

$$P_2=\frac{c_2+N+EE+\lambda_1(c_2-\frac{a_2}{b_2})}{1+2\lambda_1}$$

Schiphol airport case study: 1999 Data

- **c_i = €2,380, for t={1,2}.**
- **$\alpha_1=0.3,\alpha_2=0.7$, share of peak (off peak) hours at Schiphol, given airport is closed for 4 hours at night.**
- **N= €157, where *N* is the cost of noise per ACM.**
- ***FC* = €4,300, based on capital cost estimation of 4.0% for Schiphol and CAA method of calculation.**

Schiphol airport case study: 1999 Data

- EE= €0.
- C= €450.

Congestion Costs	Computation	Total per flight
Fuel cost of delay	240*(17.5/60)	70
Crew cost of delay	1300*(17.5/60)	380
Total		450

Social Welfare Analysis for Schiphol Airport

€ per average hour			peak			off-peak	
Budget constraint	Social welfare	Airport Profit	P1 (€)	Landings per hour	# of Delayed landings	P2 (€)	Landings per hour
0	43,226	8,614	3,056	45	9.99	2,537	34
10,000	43,206	10,000	3,056	45	9.99	2,600	34
20,000	41,632	20,000	3,399	39	3.82	3,021	28
25,000	38,102	25,000	3,723	33	0	3,403	22

Congestion fee options

€ per average hour			peak			off-peak	
congestion charge	Social welfare	Airport Profit	P1 (€)	Landings per hour	# of Delayed landings	P2 (€)	Landings per hour
1	49,287	8,614	3,056	45	9.99	2,537	34
225	46,263	8,614	3,056	45	9.99	2,537	34
450	43,226	8,614	3,056	45	9.99	2,537	34
675	40,254	10,019	3,212	42	7.18	2,537	34
900	37,544	11,582	3,437	38	3.13	2,537	34
1,125	35,106	12,598	3,662	34	0	2,537	34

Increasing Marginal Congestion Cost Options

€ per average hour			peak				
congestion charge	Social welfare	Airport Profit	P1	Landings	# of Delayed landings	congestion charge collected	% increase in P1 over base case (table 3)
1	49,284	8,614	3,056	45	9.99	55	0
225	45,588	8,614	3,056	45	9.99	12,371	0
450	42,269	11,582	3,437	38	3.13	18,571	12.47
675	40,030	13,068	3,887	30	0	16,921	21.01
900	38,884	12,367	4,337	22	0	7,981	26.19

Noise and Engine Emission charge options

		€ per average hour		peak			off-peak	
Noise charge	Engine emission charge	Social welfare	Airport Profit	P1 (€)	Landings per hour	# of Delayed landings	P2 (€)	Landings per hour
157	0	43,226	8,614	3,056	45	9.99	2,537	34.5
624	0	27,146	20,094	3,454	37.8	2.83	3,004	27.9
624	244	20,057	23,824	3,698	33.4	0	3,248	24.5
624	696	9,315	25,951	4,150	25.3	0	3,700	18.2
624	4967	-8,737	0	5,312	4.4	0	4,983	0
2875	244	-5,052	0	5,355	3.6	0	4,957	0
2875	696	-5,729	0	5,341	3.9	0	4,966	0
2875	4967	-1,208	0	5,300	4.6	0	4,989	0

Policy analysis of the effects of all parameters

				€ per average hour		peak			off-peak	
Budget constraint	Congestion charge	Noise charge	Engine emission charge	Social welfare	Airport Profit	P1 (€)	Landings / hour	# of Delayed landings	P2 (€)	Landings / hour
0	450	157	0	43,226	8,614	3,056	44.992	9.992	2,537	34.482
0	675	624	244	17,937	24,206	3,923	29.386	0	3,248	24.528
0	900	624	244	16,090	24,041	4,148	25.336	0	3,248	24.528
10000	450	157	0	43,206	10000	3,056	44.992	9.992	2,600	33.6
10000	675	624	244	17,800	23,824	3,698	33.436	0	3,248	24.528
10000	900	624	244	16,090	24,041	4,148	25.336	0	3,248	24.528
20000	450	157	0	41,632	20000	3,399	38.818	3.818	3,021	27.706
20000	675	624	244	17,937	24,206	3,923	29.386	0	3,248	24.528
20000	900	624	244	16,090	24,041	4,148	25.336	0	3,248	24.528

Summary

- Externalization of certain costs, that are currently ignored, may encourage more efficient use of existing capacity
- Case study of Schiphol airport suggests that current tariffs (1999) are higher than optimal when considering social welfare maximization
- If marginal social costs are introduced, peak tariffs should increase by upwards of 25% and off-peak by a mere 2%
- It is unlikely that demand could be sustained if marginal noise and engine emission charges are introduced, though an average externality cost would only dampen demand slightly