The Value of Additional Airport Slots

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האוניברסיטה
העברית
בירושלים
THE HEBREW
UNIVERSITY
OF JERUSALEM

Outline

- Regulated vs. Unregulated capacity
    - Europe versus United States
    - Consequences: costs and delays

- Measuring the effect of capacity constraints
    - Marginal productivity estimation
    - Structural equation modeling

- Case study: EU & US
    - Value of additional slot at peak in Europe
    - Value of reduction in slot at peak in US
    - Overall social welfare comparison considering airports, airlines & passengers

Consequences of Unregulated Capacity

- 1986: 1,144 flights per day experienced delays ≥ than 15 min
- 2007: nearly ¼ US airline flights ≥ 15 min late
  - 1/3 result of inability of aviation system to handle growth in demand

Table 2-4: Overall cost of US air transportation delays for 2007 ($ billions)

Cost Component	Cost
Cost to Airlines	8.3
Costs to Passengers	16.7
Cost from Lost Demand	3.9
Total Direct Cost	28.9
Impact on GDP	4.0

Regulated capacity: Europe

| Airport	Feasible Capacity
Amsterdam Schiphol	Movement capacity: 510,000 movements/year Technical capacity: 615,000 movements/year
Dusseldorf	Movement capacity: 45 movements/hour Technical capacity: 56 movements/hour
London Heathrow	Current capacity: 41 arrivals/hour, 43 departures/hour Annual capacity: 480,000 movements/year
Madrid Barajas	Current capacity: 98 movements/hour Technical capacity: 120 movements/hour
Milan Linate	Current capacity: 18 movements/hour far below technical capacity of airport
Paris Orly	Legal limit: 250,000 slots/year far below technical capacity of airport
Source: European Commission, Impact assessment of revisions to Regulation 95/93, Final report (sections 1-12), March 2011	

Regulated capacity: Europe (European Commission, Impact assessment of revisions to Regulation 95/93, Final report (sections 1-12), March 2011)

FIGURE 3.8   LONDON HEATHROW SLOT REQUESTS AND ALLOCATION
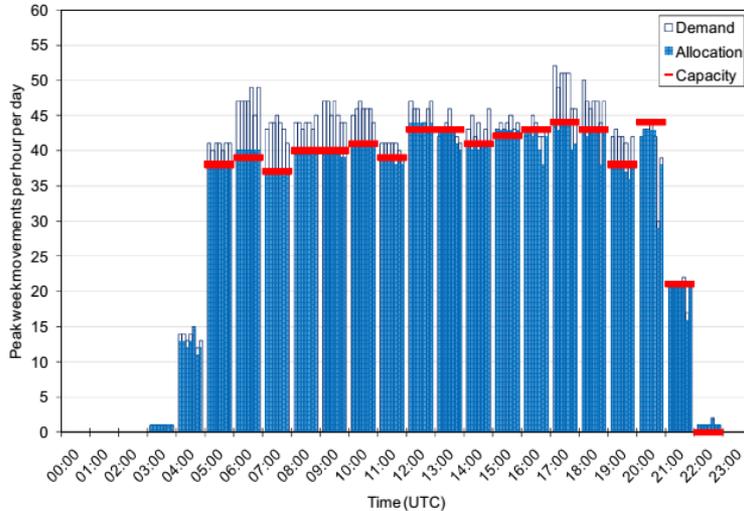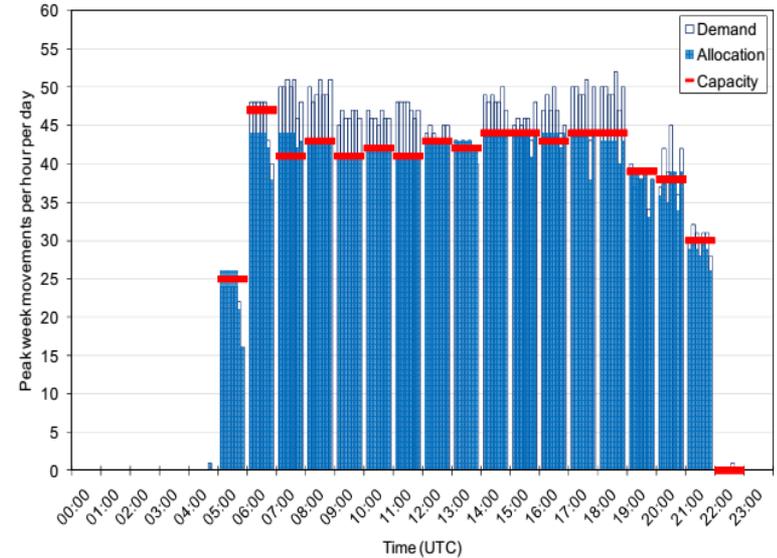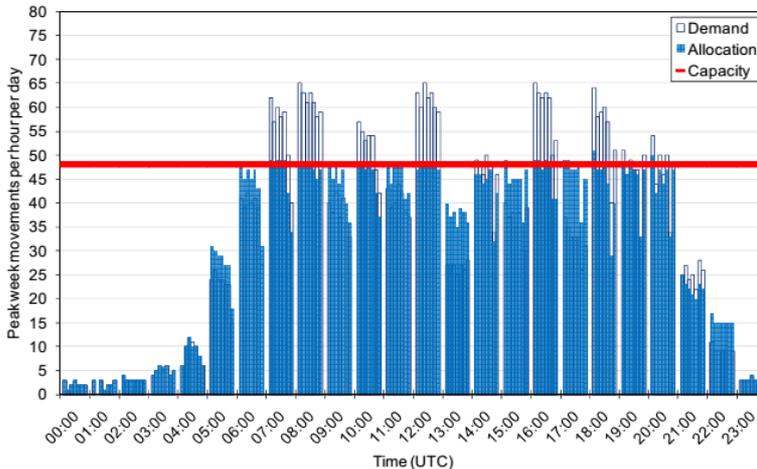
S10 Arrivals:

S10 Departures:

FIGURE 3.9   MADRID SLOT REQUESTS AND ALLOCATION
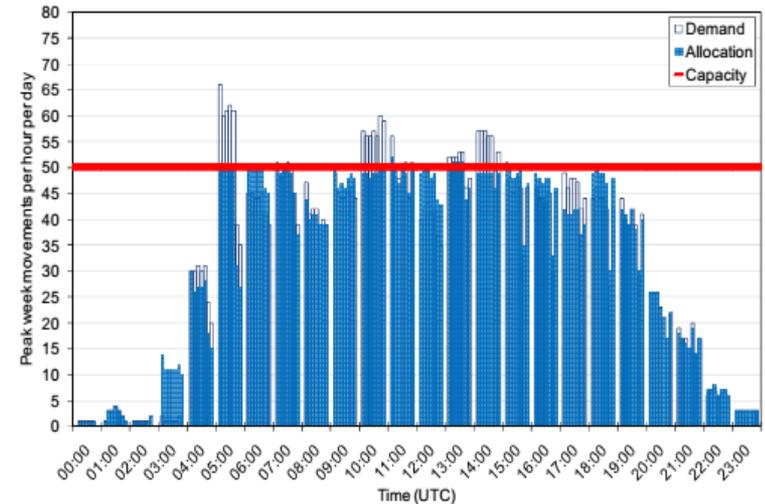
S10 Arrivals:

S10 Departures:

Comparing the US versus European Approach

Source: Odoni & Morisset (2011)

TABLE I. COMPARATIVE OVERVIEW OF THE TWO AIRPORTS IN 2007

	FRA	EWR
No. of passengers[a]	54.2 million	36.4 million
No. of movements	479,874	443,952
Passengers per movement	113	82
No. of runways	3	3
Cargo volume (tons)	2.2 million	0.9 million
International passengers	85%	29%
Dominant carrier	Lufthansa	Continental

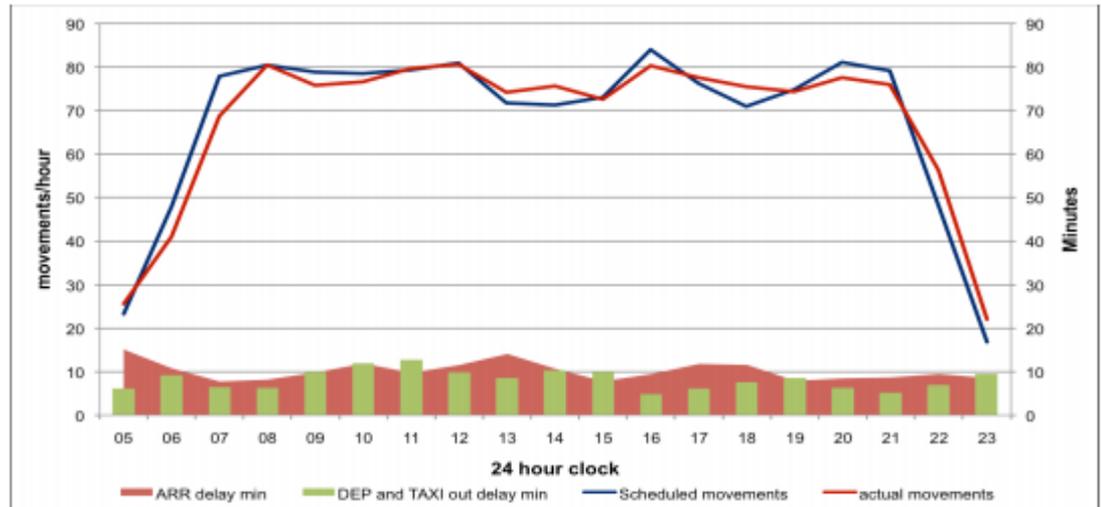

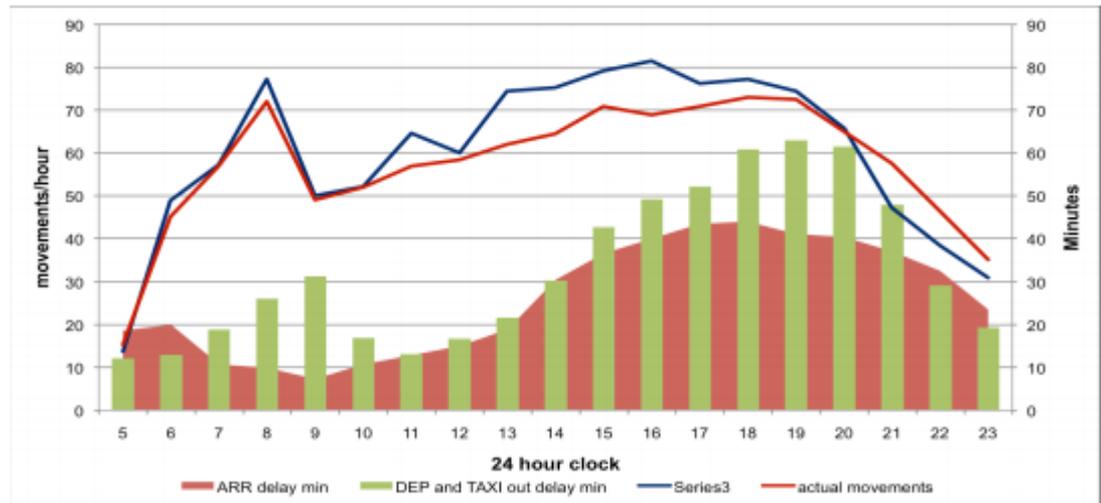Figure 6. FRA: schedule (left scale) and delays (right scale)

Figure 7. EWR: schedule (left scale) and delays (right scale)

Intermediate Conclusions

- Inferences
  - Need to balance capacity utilization (highest in US) with delays (lowest in Europe)
  - Slot allocation system needs to be rebalanced at peak
    - In Europe, slots could potentially be increased
    - In US, slots could be introduced or decreased
- Aim
  - Evaluate marginal benefit of additional slot
- How?
  - Structural equation modeling
 - Second stage welfare comparison

Structural Equation Modeling (SEM)

- SEM allows simultaneous modeling of relationships between multiple independent and dependent variables
- SEM distinguishes between
  - exogenous (independent) and endogenous (dependent) *latent* variables
  - highly-correlated indicators (causal measures)
- Using PLS:
  - assuming linear relationships
  - non-parametric analysis
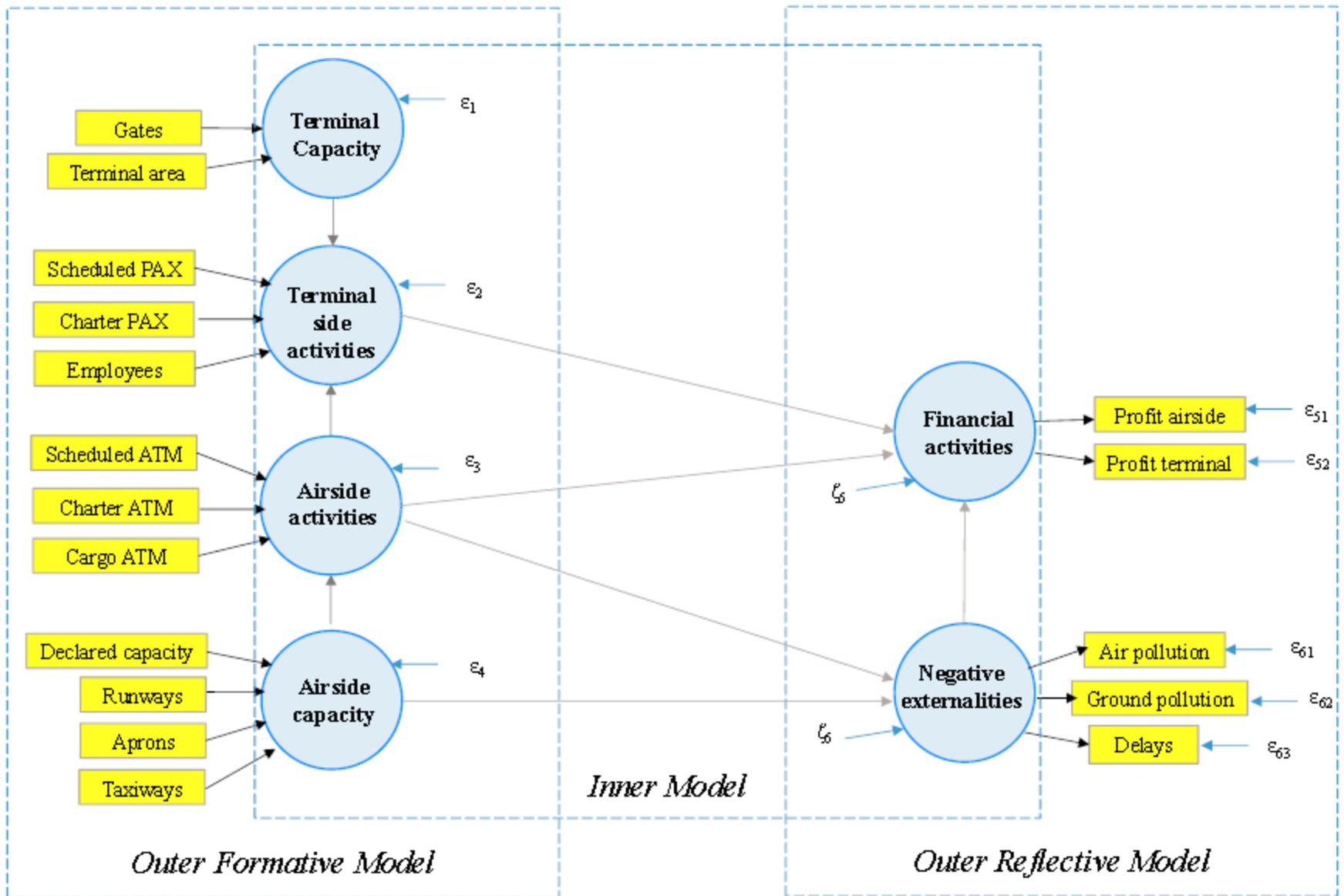
Marginal impact on consumer surplus from increasing slots
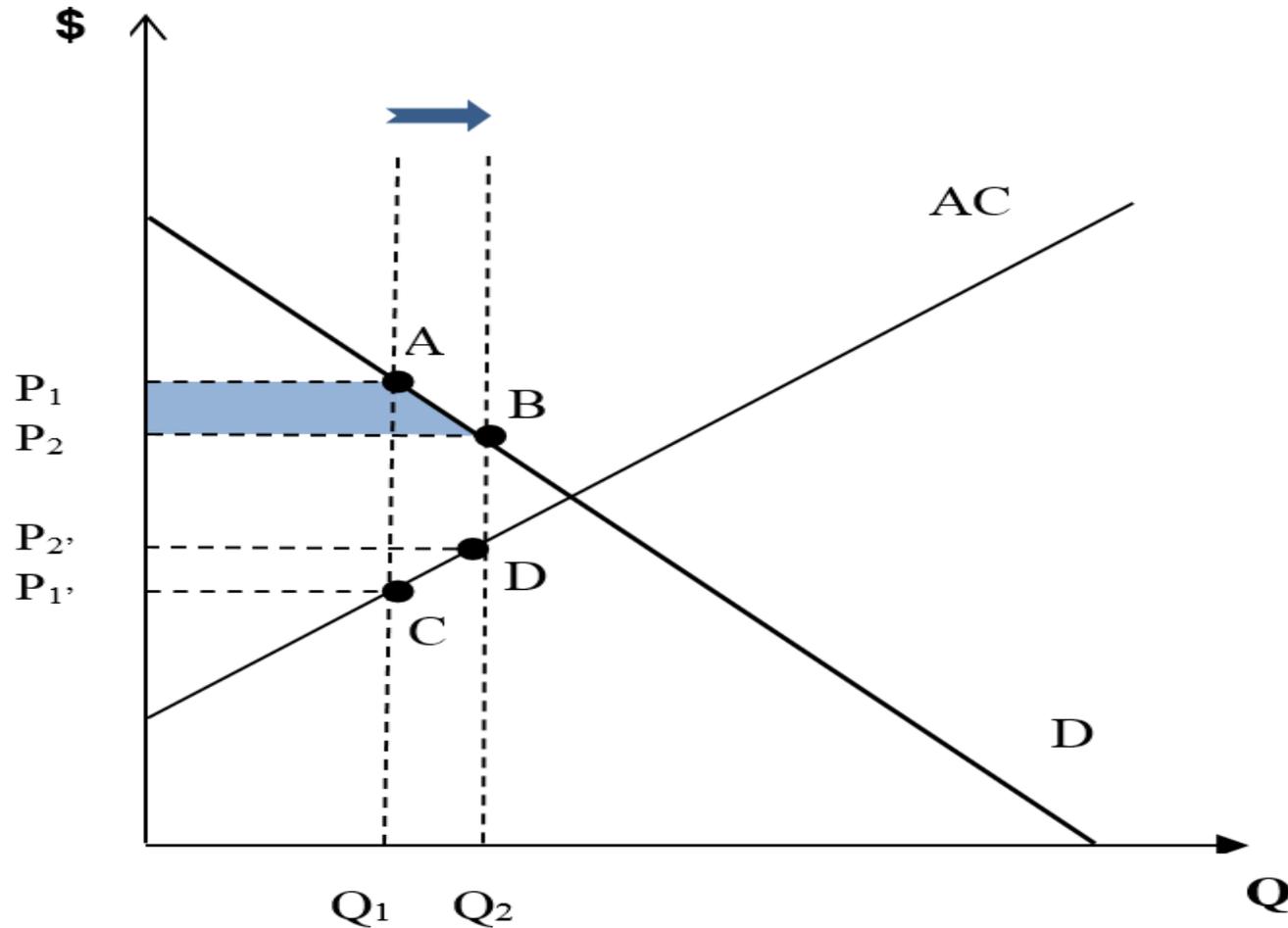
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Airports: 30 busiest in US and Europe

Europe	North America
Amsterdam (AMS)	Atlanta (ATL)
Barcelona (BCN)	Charlotte (CLT)
Copenhagen (CPH)	Chicago O'Hare (ORD)
Dusseldorf (DUS)	Denver (DEN)
Frankfurt (FRA)	Houston (IAH)
London Gatwick (LGW)	LaGuardia (LGA)
London Heathrow (LHR)	Las Vegas (LAS)
Madrid Barajas (MAD)	Los Angeles (LAX)
Milan Linate (LIN)	New York (JFK)
Munich (MUC)	Newark (EWR)
Palma de-Mallorca (PMI)	Philadelphia (PHL)
Paris (CDG)	Phoenix (PHX)
Rome Fiumicino (FCO)	Washington (DCA)
Vienna (VIE)	
Zurich (ZRH)	
Brussels (BRU)	
Tel-Aviv (TLV)	

Variables: 2002-2013

- **Operational:-**
  - Runway Capacity: VFR / IFR
  - Terminal Capacity
  - Air traffic movements: February & August
  - Passengers: February & August
- **Delay:-**
  - Average delay per movement: arrival /departure/total in February & August
- **Economic:-**
  - Revenues: commercial and aeronautical
  - Passenger facility charges (US)
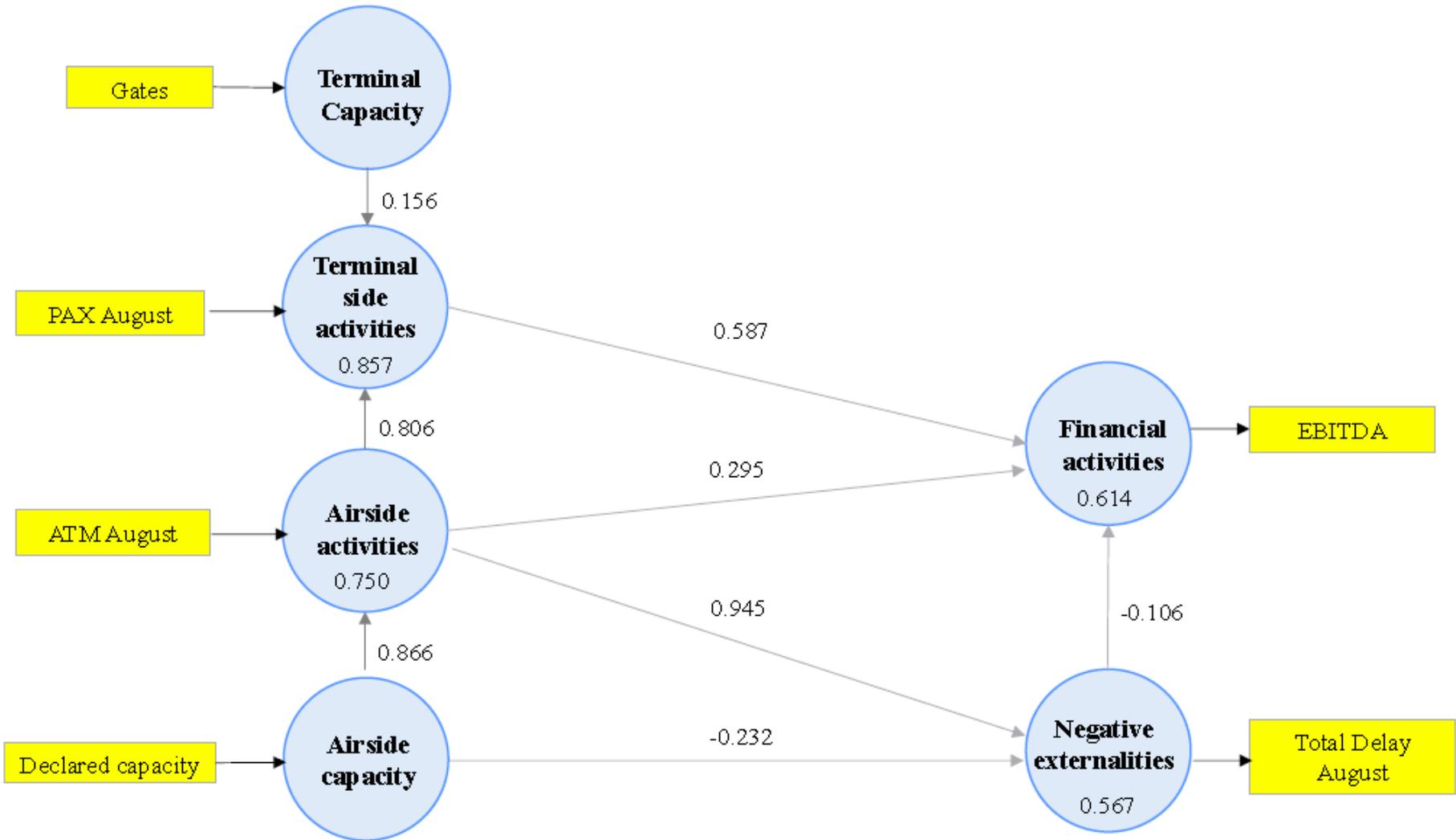 - Costs: staff, other operating, fixed
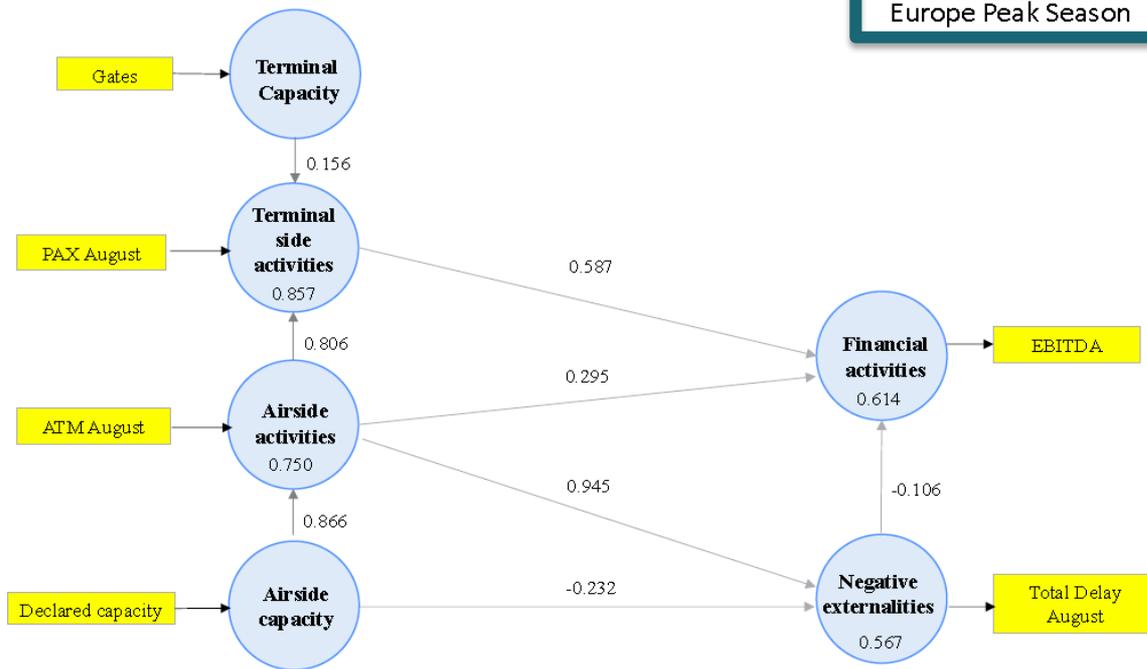
US vs Europe: averaged 2002-13

	Airside Capacity		Gates	Air Traffic Movements		Passengers		Average Delays (minutes)		EBITDA (PFC)
	VFR	IFR		Feb	Aug	Feb	Aug	Feb	Aug	
US	141	110	117	41,725	48,890	3,168,868	4,126,340	27	27	1,345,429
Europe		75	112	22,765	28,146	2,146,103	3,314,899	24	22	261,628,487

Results: Europe in Peak
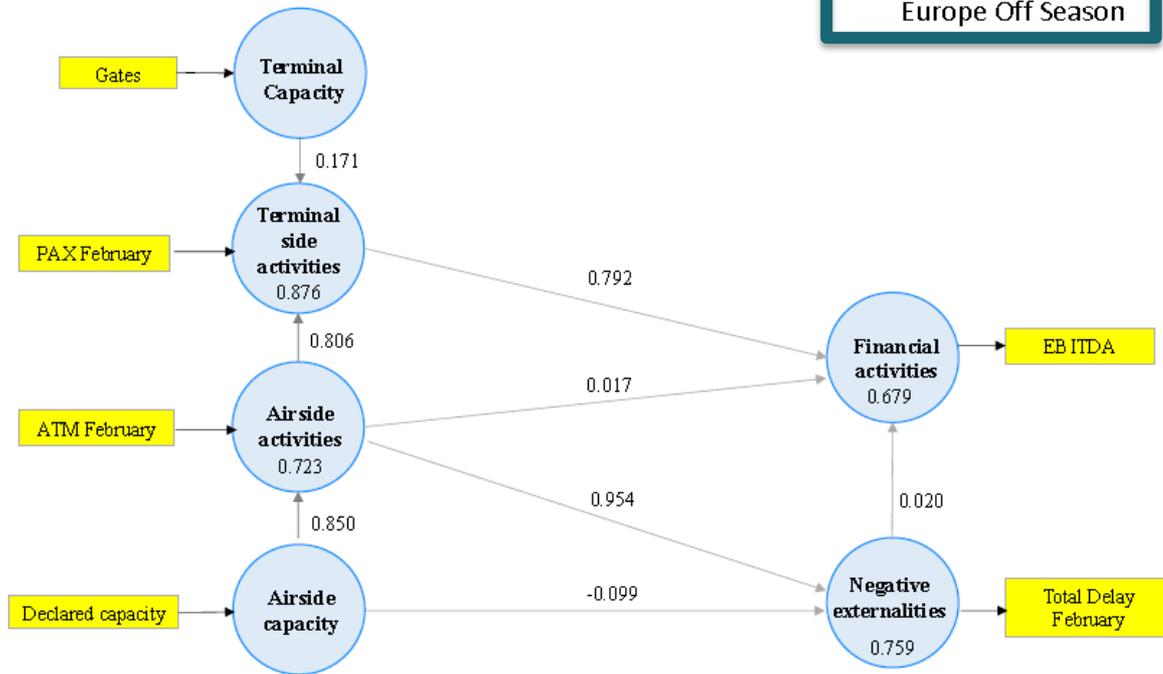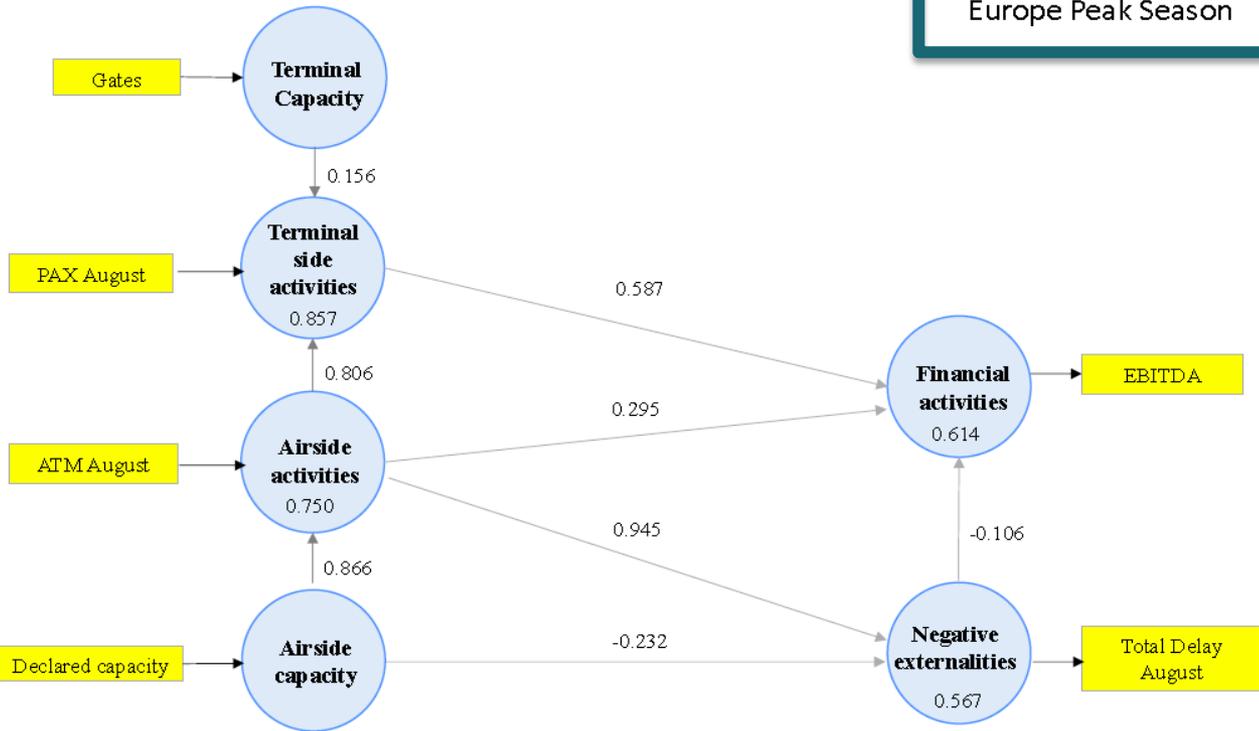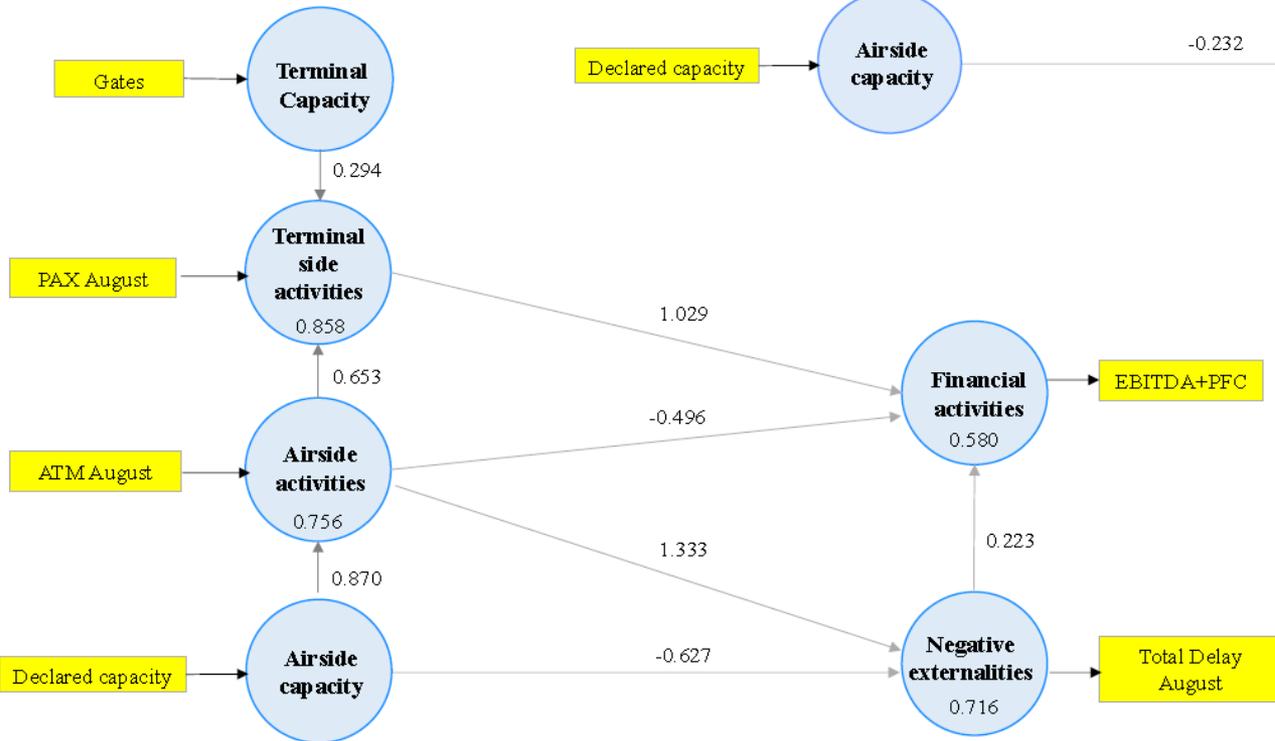
Path Total Effects

	Europe			United States		
	Std. coefficient	t- statistic	Nominal coefficient	Std. coefficient	t- statistic	Nominal coefficient
August						
Airside capacity -> Delays	0.59	10.11	8,109	0.53	8.14	7,445
Airside capacity -> PAX	0.70	20.44	47,300	0.57	9.31	22,011
ATM -> Profitability	0.67	11.71	13,296	0.47	3.75	2,114
Airside capacity -> Profitability	0.60	14.14	4,731,791	0.27	2.42	450,785
Terminal capacity -> Profitability	0.09	2.67	328,922	0.30	3.19	615,980

Social Welfare Analysis Annually (2013 $)
from addition/reduction of 10 peak flights/day

	Europe (additional 10 flights/day)			US (reduction 10 flights/day)		
	Expected	Lower (Narrow-body)	Upper (Wide-body)	Expected	Lower (Regional)	Upper (Wide-body)
Airports:						
Profit/Loss	54,367,012			-10,371,621		
Airlines:						
Profit/Loss	929,714	312,110	4,705,253	-854,361	-279,550	-8,620,700
Delay	-14,807,451			21,903,873		
Passengers:						
Willingness to Pay	38,233,307			-38,806,079		
Delay	-11,124,931			10,089,832		
	67,597,651			**-18,038,356**		

Conclusions

- Airside greater impact on throughput than landside
- Slot allocations limit throughput hence reduce delays
  - In Europe **worthwhile** increasing slots because:
    - value of marginal slot exceeds additional cost of delay
    - worthwhile for airports & passengers, *not for airlines*
  - In US: savings in delays from reduction of flight in peak hour **insufficient** to justify slot limitations
    - worthwhile for airlines *not for airports or passengers*
- Results dependent on value of time for passengers
  - If tripled, US marginal slot reduction worthwhile