State-of-the-art: A review of empirical airport performance studies

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Introduction

- **Research on airport efficiency assessment**
  - Primary methods: DEA, SFA, PIN
  - 1997: Gillen and Lall; Hooper and Hensher
  - More than 50 articles published

- **Distribution of Studies (1997-2009)**

Methods	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
DEA	1		3	2	4	3	3	4	1	3	1	6	4	35
SFA					1		1				1	6	4	13
TFP	1			2			1	3		2				9
other				1		1	2	1			1			7
	2	0	3	5	5	4	7	8	1	5	3	12	8	

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Introduction

- **Research Focus:**
  - What methods have been used and how did these change over time?
  - The efficiency of airports might not only depend on managerial abilities but also on factors that are beyond their managerial control. What are the findings on the effects of privatization?

Outline

- Overview of Methods
- Exogenous Effects on Efficiency- The Case of Privatization
- Summary
- Open Questions

Overview of Methods
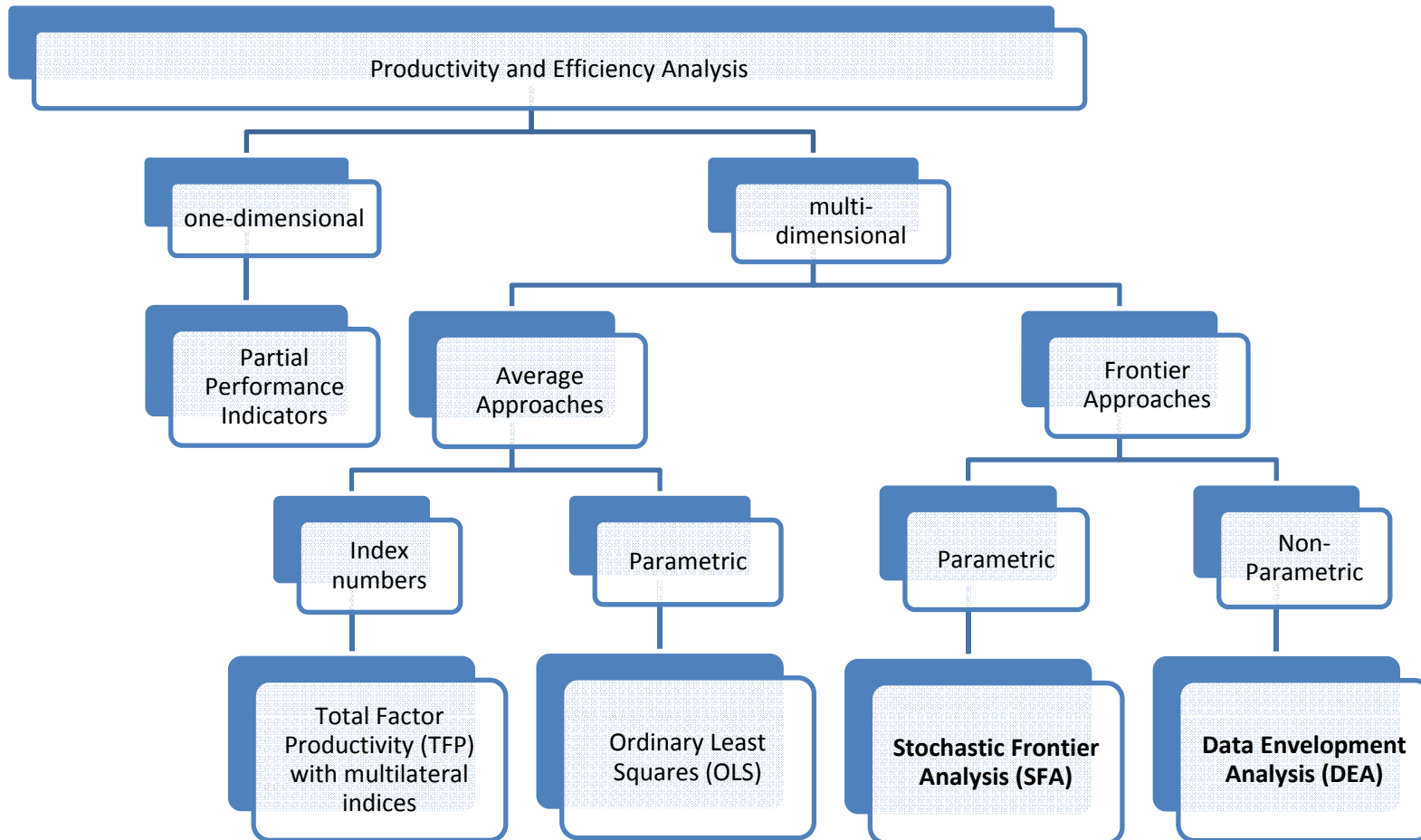
Source: adapted from Hirschhausen et al. (2006)

Overview of Methods-
DEA vs. SFA

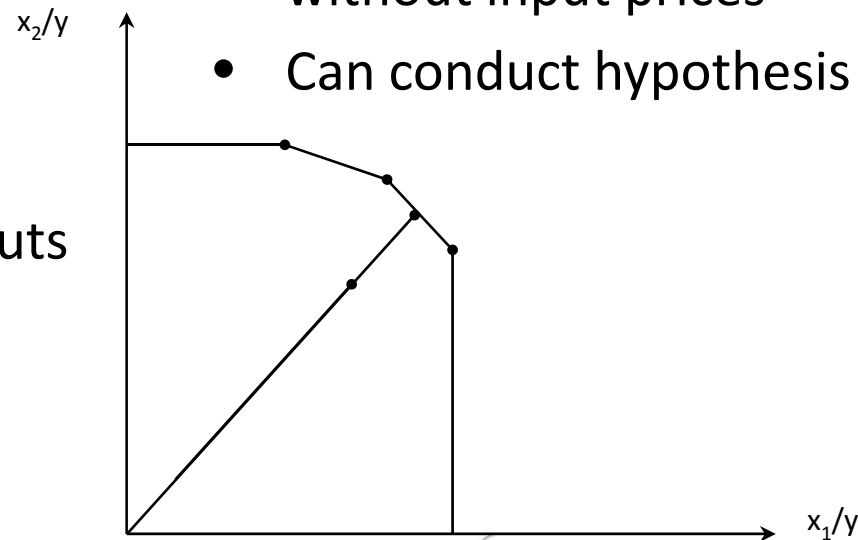- Non-parametric approach that constructs efficient frontier with linear programming

$$\max_{\theta,\lambda} \theta$$
$$s.t.\ Y\lambda \geq \theta y_i,$$
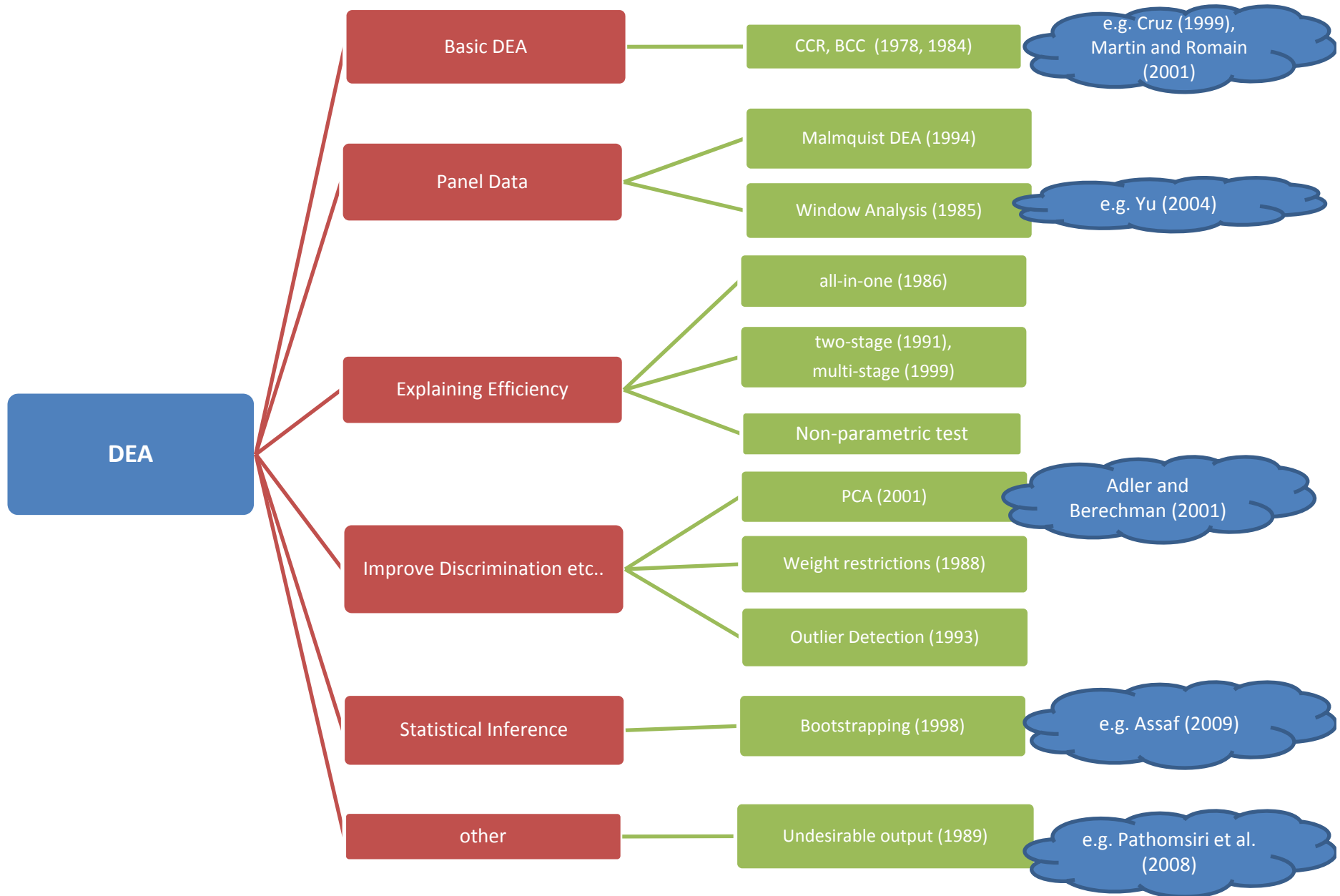$$x_i \geq X\lambda,$$
$$\lambda \geq 0,$$

- Multiple inputs and outputs without input prices

- Parametric methods that also accounts for noise

$$\ln(y_i) = x_i'\beta + v_i - u_i$$

- Multiple inputs and outputs without input prices

- Can conduct hypothesis tests

Liebert & Niemeier
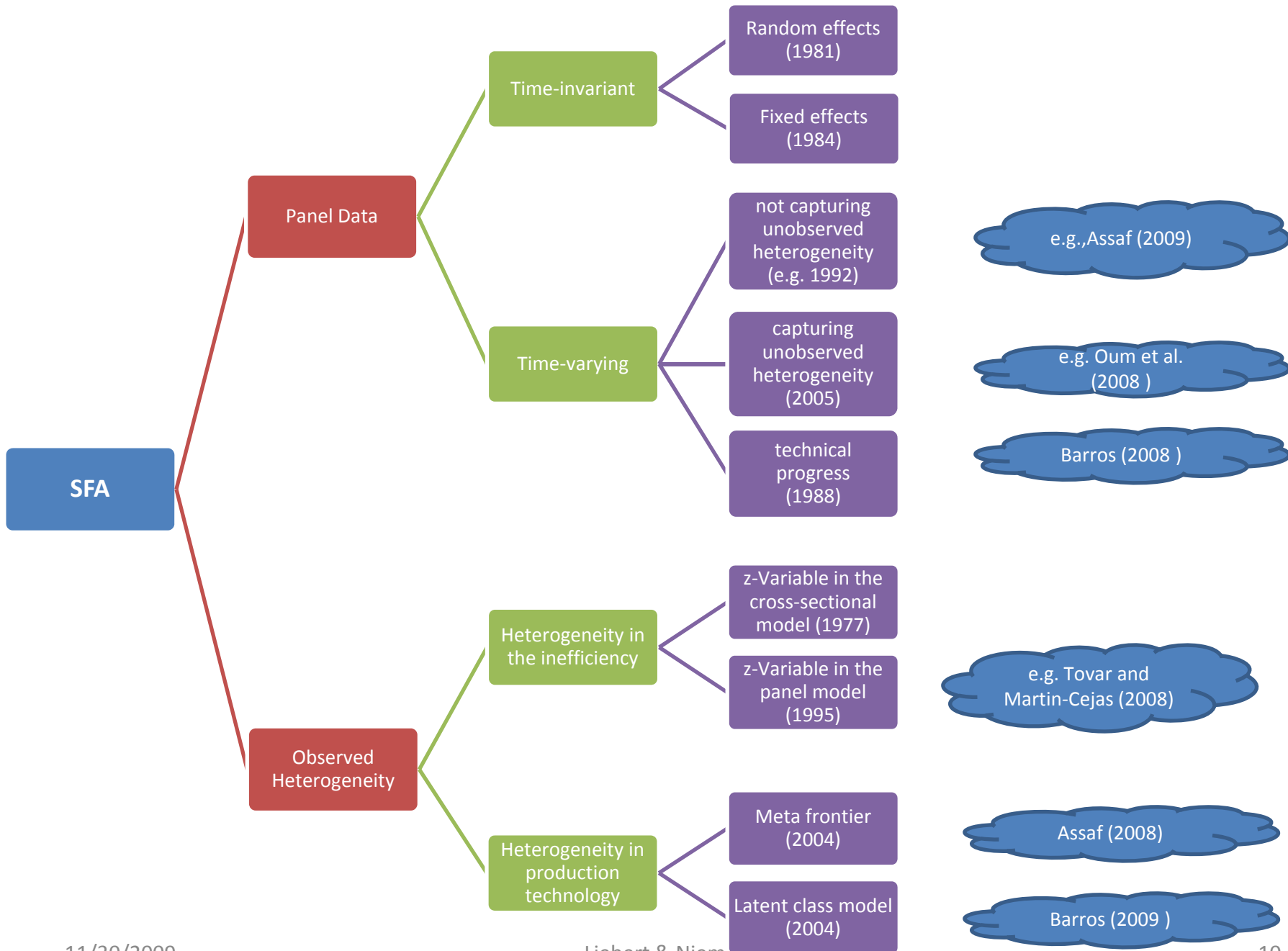
Malmquist-DEA

Authors	Sample	Time Period	Method		Inputs	Outputs
Murillo-Melchor, C. (1999)	33 Spanish civil airports run by AENA	1992 - 1994	Malmquist-**DEA**		=> no of workers => amortisation => intermediate expenses	=> no of passenger
Gillen, D. and Lall, A. (2001)	22 major US airports	1989 - 1993	Malmquist-**DEA**		Terminal Services => physical capital => no of employees Movement Model => physical capital => no of employees	Terminal Services => no of passenger => pounds of cargo Movement Model => air carrier mvts => commuter mvts
Abbott, M. and Wu, S. (2002)	12 main airports (all private except SYD)	1990 - 2000	Malmquist-**DEA**	Tobit regression	=> no. of employees => capital stock (PIM) => runway length	=> no. of passengers => cargo (in tons)
Fung, M.; Hui, Y., Law, J., Wan, K. and Ng, L. (2008)	25 Chinese regional airports	1995-2004	**DEA** (CCR) and Malmquist-DEA (dynamic)	simple regression	=> total length of runways => terminal size	=> passenger => cargo => ATM
Barros, C.P. and Assaf, A. (2009)	35 major US airports	2002-2007	Malmquist-**DEA** and Bootstrapping		Terminal Services => physical capital => no of employees Movement Model => physical capital => no of employees	Terminal Services => no of passenger => pounds of cargo Movement Model => air carrier mvts => commuter mvts
Barros, C.P. and Weber, W.L. (2009)	27 UK airports	2000-2004	Malmquist-**DEA**		=> staff numbers => capital value (fixed assets) => other costs prices deflated to 2002	=> no of pax => tons of cargo => no of ATM

technical change

Explaining Efficiency

Authors	Sample	Time Period	Method		Inputs	Outputs	Non-discretionary and environmental variables
Gillen, D. and Lall, A. (1997)	21 major US airports	1989 - 1993	**DEA** (CCR and BBC)	Tobit regression	Terminal Services => physical capital => no of employees Movement Model => physical capital => no of employees	Terminal Services => no of passenger => pounds of cargo Movement Model => air carrier movements => commuter movements	Different sets of variables clustered according to => Year dummies => Hub Dummy => Noise strategy variables => management operational and investment variables
Bazargan, M. and Vasigh, B. (2003)	45 US airports (15 small, medium, and large hub airports)	1996 - 2000	**DEA** (CCR)	Kruskal-Wallis-Test and Mann-Whitney-Test among the three hub sizes	=> operating expenses => non-operating expenses => no. of runways => no. of gates	=> no. of passengers => no. of air carrier operations => no. of other operations => aeronautical revenue => non-aeronautical revenue => % of on-time operations	
Barros, C.P. (2008)	33 Argentine airports that are operated by Aeropuertos Argentina 2000	2003-2007	**DEA** (BCC) with Bootstrapping	Truncated bootstrap regression (Simar and Wilson 2007)	=> no of staff => runway area => apron area => pax terminal area	=> ATM => Pax => Tons of cargo	=> year dummy (due to financial crises) => hub dummy => WLU
Chi-Lok, A. and Zhang, A. (2008)	25 Chinese (major) airports	1995-2006	**DEA** and Malmquist-DEA	OLS and Tobit regression	=> runway length => terminal size	=> passengers => ATM => Cargo	=> airport localization program => regional competition intensity => public listing

SFA

- **Panel Data**
  - **Time-invariant**
    - Random effects (1981)
    - Fixed effects (1984)
  - **Time-varying**
    - not capturing unobserved heterogeneity (e.g. 1992) — e.g.,Assaf (2009)
    - capturing unobserved heterogeneity (2005) — e.g. Oum et al. (2008)
    - technical progress (1988) — Barros (2008)
- **Observed Heterogeneity**
  - **Heterogeneity in the inefficiency**
    - z-Variable in the cross-sectional model (1977)
    - z-Variable in the panel model (1995) — e.g. Tovar and Martin-Cejas (2008)
  - **Heterogeneity in production technology**
    - Meta frontier (2004) — Assaf (2008)
    - Latent class model (2004) — Barros (2009)

| Authors	Sample	Time Period	Methodology	Inputs	Outputs	Non-discretionary Variables
Assaf, A. (2008)	27 UK airports (16 large and 11 small)	2002-2006	**SFA** (heterogenous Cobb-Douglas production-Metafrontier by O'Donnell 2007 and Battese et al. 2004)	=> no of staff => fixed assets => operational costs => other costs	=> operational income	
Oum, T.H., Yan, J. and Yu, Ch. (2008)	109 airports worldwide	2001-2004	**SFA** (heterogenous translog cost function based on true random effects)	=> FTE and wage rate => non-labour variable costs and non-labour variable input price => no of runways (fixed) => terminal size (fixed) all PPP deflated	=> no of passengers => volume of aircraft movement => non-aeronautical revenues (PPP deflated)	=> % international traffic => % cargo => regional dummy variables => ownership form (see paper)
Barros, C.P. (2009)	27 UK airports	2000-2006	**SFA** (heterogenous Translog costfunction latent class model)	=> op. costs (2002=100) => price of workers (wages/employee) => price of capital (amortization/ total assets) price of capital investment (long-term investment/ long-term debt)	=> pax => ATM	

Overview of Methods

	PIN	DEA	SFA
Parametric methods	-	-	•
Frontier Method	-	•	•
Accounts for Noise	-	-	•
Hypothesis testing	-	-	•
Decomposes TFP into technical and efficiency changes	-	•	•
Requires input prices	•	-*	-*
Requires large sample sizes	-	•	•

* assuming the basic model

Empirical studies on comparison of DEA and SFA result → ☹

Exogenous Effects on Efficiency-
The Case of Privatization Effects
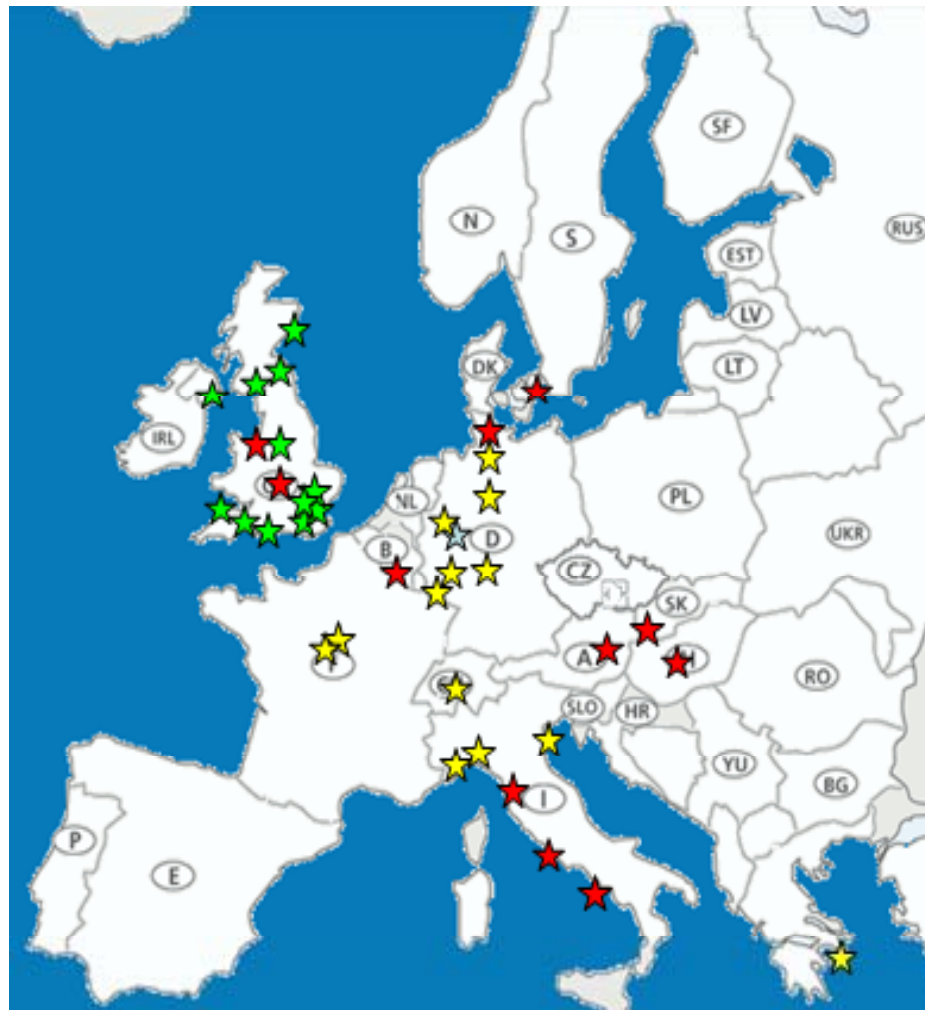
★ Fully privatized airports

★ Partially privatized airports with a majority share

☆ Partially privatized airports with a minority share

☆ Partially privatized airport with equal private and public shares

* Malta International Airport has been partially privatized as well (minority share privatization)

Source: Gillen and Niemeier (2006)

Exogenous Effects on Efficiency-
The Case of Privatization Effects

- **General theory on privatization inconclusive:**
  - Vickers and Yarrow (1988): no separation from regulation and competition
  - Laffont and Tirole (1991): for natural monopolies effective regulation and competition
  - Shirley and Walsh (2001): support for privatization stronger from empirical work than theoretical literature

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Exogenous Effects on Efficiency-
The Case of Privatization Effects

Authors	Sample	Time Period	Method	Inputs	Outputs	Effect?
Parker, D. (1999)	(1) BAA as a whole and (2) 22 UK airports	1) 1979 - 1995 (2) 1988- 1996	DEA	=> no of employees => capital input => non-labour and capital costs	=> no of passengers => cargo and mail business	no
Vasigh, B. and Gorjidooz, J. (2006)	22 major airports in the US and Europe (8 US, 7 BAA, 7 EU private and public)	2000-2004	TFP (multilateral)	=> operation cost => net total assets => runway area	=> operational rev. => non-operational rev. => terminal pax => movements => landing fees	no
Oum, T.H., Yu, Ch. and Fu, X. (2003)	50 airports worldwide	1999	gross EW-TFP	=> FTE => number of runways => number of gates => total terminal area => soft cost input	=> no of passengers => cargo => commercial rev.	no
Yokomi, M. (2005)	6 BAA airports	1975-2001	Malmquist-DEA	For Both Sides => staff numbers => deflated operating costs	Aeronautical: => ATM Non-Aeronautical: => commercial rev.	yes
Barros, C.P. and Marques, R.C. (2008)	117 airports	2003-2004	SFA	=> operating costs => price of worker => terminal size	=> no of ATM => no of pax	yes
Barros, C.P. and Dieke, P.U.C. (2007)	31 Italian airports	2001-2003	DEA (and Mann-Whitney)	=> Labour costs => Capital invested => Operational costs	=> no. of planes => no. of passengers => general cargo => handling receipts => aeronautical rev => commercial sales	yes
Oum, T.H., Yan, J. and Yu, Ch. (2008)	109 airports worldwide	2001-2004	SFA	=> FTE and wage rate => non-labour variable costs and non-labour variable input price => no of runways => terminal size	=> no of passengers => volume of aircraft movement => commercial rev.	yes
Oum, T.H., Adler, N. and Yu, Ch. (2006)	116 airports worldwide	2001 - 2003	VFP (multi-lateral)	=> FTE => soft costs	=> no of passengers => volume of aircraft movement => commercial rev.	yes

Exogenous Effects on Efficiency-
The Case of Privatization Effects

- **Airport studies on privatization are inconclusive**

  – Differences in methodology and data?

  – Studies too early?

  – More categorization?

  – Combine privatization with regulation and competition?

Summary

- Increasing interest in airport efficiency analysis

- Recent developments in DEA and SFA applied

- Much attention on
  - TFP-changes
  - explaining efficiency
  - methodological perspective

Open Questions from us

1) How to improve the assessment of dynamic efficiency → considering time-lags

2) How to measure capital?

3) Is collection of airport data a nightmare everywhere?

Thank You!