How scale and institutional setting explain the costs of small airports

An application of spatial regression analysis to French and Norwegian airports

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Preface: PhD Thesis with 3 Articles

i. Data Envelopment Analysis		ii. Spatial Regression
Article 1: Small regional airport sustainability: Lessons from benchmarking	***Article 2:*** An Empirical Analysis of Group Airports: AENA (Spain) and DHMI (Turkey)	***Article 3:*** How scale and institutional setting explain the costs of small airports: An application of spatial regression analysis
85 airports across Europe	*Spain* *Turkey*	*Norway* *France*
-Relative efficiency • *Airport groups* • *Remoteness* *-Break-even point*	*-Relative efficiency* • *Privatization* • *Scale*	

Article 1: Lessons from Benchmarking

85 airports from 6 countries:

- Austria, France, Germany, Italy, Norway and UK
- Below 1.6 million passengers annually
- Time Period: 2002-2009

1st Main Result:

Second stage regression results explaining efficiency estimates.

Ln(efficiency estimate)	Explanatory variables	OLS		Truncated	
		Coef.	*t*-stat.	Coef.	*z*-stat
Managerial Variables	Commercial rev >50%	0.03	3.38	0.04	3.67
	Ground handling or fuel sales in-house	−0.03	−5.96	−0.03	−6.16
Non-Discretionary Variables	Belongs to airport system	−0.05	−5.41	−0.05	−5.50
	PSO served	0.03	4.53	0.04	4.46
	Military involvement	0.02	1.76	0.02	1.74
	Remote area	−0.03	−3.07	−0.03	−3.03
	STOL	0.00	−0.21	0.00	−0.18
	Public	0.01	1.19	0.01	1.13
Partially discretionary	Log EBIT	0.02	4.86	0.02	4.67
Time dummies	d2003	−0.04	−3.30	−0.05	−3.71
	d2004	−0.07	−5.52	−0.08	−5.74
	d2005	−0.08	−6.63	−0.10	−6.79
	d2006	−0.08	−6.93	−0.10	−7.08
	d2007	−0.08	−7.07	−0.10	−7.34
	d2008	−0.09	−7.66	−0.11	−7.92
	d2009	−0.10	−8.29	−0.12	−8.34
	Constant	−0.45	−5.68	−0.42	−5.14

2nd Main Result:

Year	Break-even Point	
2002	200,832	101,015
2009	463,549	166,233
	Status quo	Hypothetical

Article 2: Comparison of AENA and DHMI airports

- 73 airports from Spain and Turkey
- Time Period: 2002-2009

Estimates from OLS Regression		
explanatory variables	***coefficient***	***t-statistic***
weekly opening hours	-0.132	-2.66
bot (ppp) partnership (dummy)	0.166	2.69
share of commercial revenues	0.047	1.18
percentage of international traffic	-0.023	-1.62
work load unit (airport size)	0.034	2.70
population density	0.018	1.13
seasonality measured by gini	0.026	1.06
joint military-civil airport (dummy)	0.098	3.38
spain (dummy)	0.178	4.79
2010 (dummy)	0.019	0.63
2011 (dummy)	0.006	0.21

Longer opening hours → Less efficient

PPPs in Turkey increase the efficiency!

Larger airports are relatively more efficient

Seasonal strategy successful

Spanish airports are more efficient than Turkish ones!

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Research Questions:

- What is the level of spatial interdependence between airports regarding airport unit costs?
- What is the effect of subsidies on airport costs?
- What is the effect of scale on airport costs?

Outline

1. Introduction
2. Literature Review
3. Methodology
4. Data
5. Results
6. Conclusions and Further Research

1. Introduction

Introduction and Motivation

- In Norway: Avinor → Cross-subzidization increased since 2003
  - 39 of 46 airports serve under 1 million pax/year
  - 7 airports break even. (Only 2 airports under 1 million)

- In France: Mostly individual management → direct subsidies via local or federal governments
  - 64 of 80 airports serve under 1 million pax/year

2. Literature Review

Literature Review: Airport Costs

- Estimation of cost functions (selection):
  - Carlin&Park (1970)
  - Carlsson (2002)
  - Martin-Cejas (2002)
  - Oum et al. (2008)
  - Voltes-Dorta&Pagliari (2012)

- Various external factors influence costs
  - traffic structure, airport size
  - competition and ownership etc.
  - delays

- various research questions & different answers

Literature Review: Subsidies vs. Costs

- Extensive literature on urban public transport (mainly US)
  - Bly et al. (1980)
  - Anderson (1983)
  - Pucher et al. (1983)
  - Bly & Oldfield (1986)
  - Nolan et al. (2001)

  → Higher subsidies
  - higher unit costs
  - higher # of employees
  - lower productivity

- Railway sector
  - Oum & Yu (1994)
  - Cowie (2009)

  → Higher subsidies
  - lower efficiency

- Air
  - Baker & Donnet (2012) : joint strategic decision by all stakeholders

→ But; no empirical analysis of airport subsidies vs. costs to date

Literature Review: Spatial Interdependence

- Similar geographical, climatic and natural characteristics
- Cultural similarities: Behaviour of economic agents
- Unique or close economic conditions (such as GDP)
- Unbiased estimates from econometric point of view

(Pavyluk, 2012)

- Various applications of spatial econometrics to airports by Pavyluk (2009, 2010, 2012, 2013)

3. Methodology

Methodology: Spatial regression

„The collection of techniques that deal with the peculiarities caused by space in the statistical analysis of regional science models"

- Anselin, 1988

<u>On the spatial depence;</u>

"Everything is related to everything else, but near things are more related than distant things."

- Tobler, 1970

Methodology: Spatial regression

Following Anselin (1988) and LeSage and Page (2009)

$$y = \rho \cdot W \cdot y + X \cdot \beta + \Upsilon \cdot W \cdot X + u$$
$$u = \lambda \cdot W \cdot u + \varepsilon$$
$$with\ \varepsilon \sim N(0, \sigma_\varepsilon^2 I_n)$$

$\rho = \Upsilon = \lambda = 0$ → Standard regression model

$\rho \neq 0$ and $\Upsilon = \lambda = 0$ → Spatial lag model

$\rho = 0, \Upsilon = 0$ and $\lambda \neq 0$ → Spatial error model

$\rho = 0, \Upsilon \neq 0$ and $\lambda = 0$ → Cross regressive model

W is an n x n spatial weights matrix, with a distance decay function

$$W_{ij} = 1 - \frac{1}{1 + a * exp(-b * distance_{ij})}$$

Methodology: Final Specification and Variables

Spatial lag model:

$$y_{it} = \rho W y_{it} + \beta X_{kit} + \alpha_i + \varepsilon_{it}$$

Zero values on the diagonal of *W* matrix assures that the interaction of the same observation in the regression equation is excluded.

dependent variable (*y*):	
costppax	operating costs per passenger
independent variables (*x*):	
year	time trend dummy variable
wlu	work load unit (airport size)
subspcost	subsidies per costs
aerrevppax	aeronautical revenues per passenger
noncommatm	share of non-commercial ATM
pso	public service obligation dummy variable
deprppax	depreciation per passenger
α	fixed effect parameter
ε	independent error terms

All monetary variables are in inflation and PPP adjusted Euros.

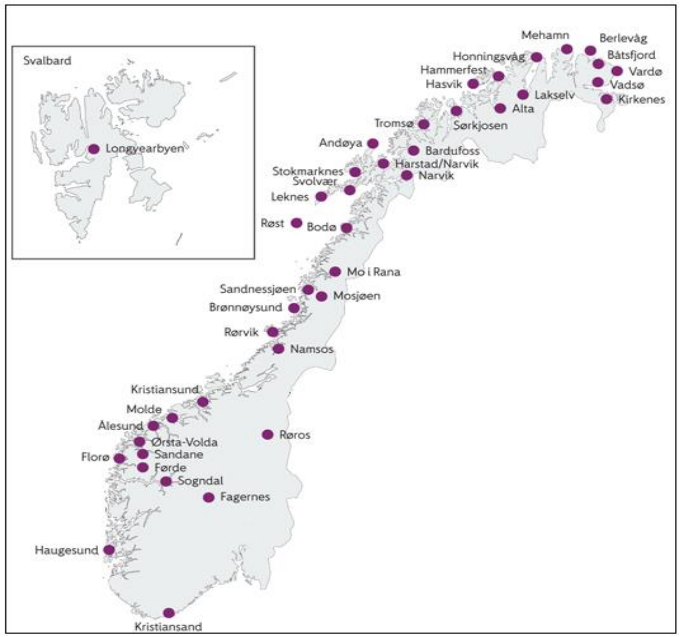
4. Data

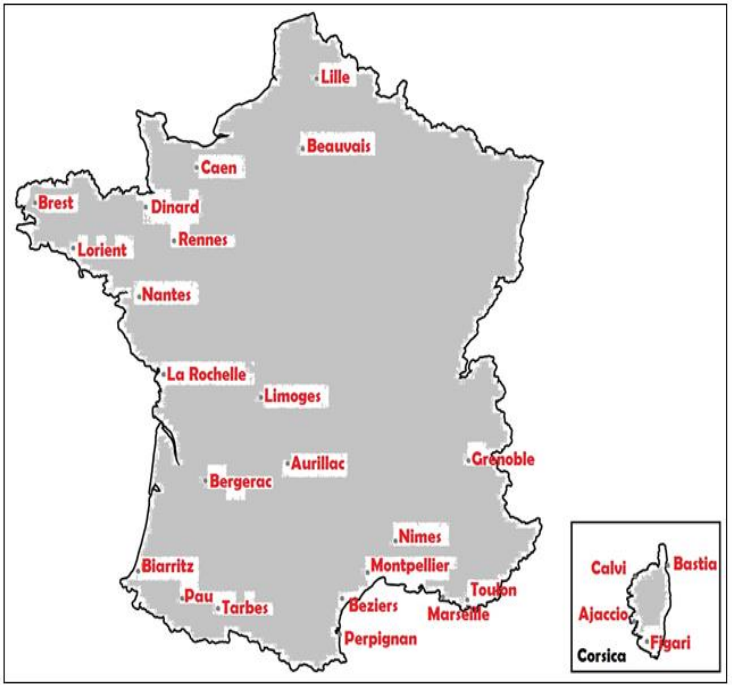
Data: Descriptive statistics (two separate datasets)

Descriptive Statistics for Norwegian Airports, 2002-2010

Variable	costppax	wlu	subs	aerrev	noncommatm	pso	depr
Minimum	3.42	5850	0	2.80	0.02	0	0.79
Maximum	247.00	1,649,847	1.50	25.98	0.83	1	142.26
Average	38.62	206,035	0.52	7.91	0.23	0.74	10.50
Standard Deviation	35.45	342,347	0.31	2.69	0.16	0.44	15.01

$n_{Norway} = 41$





Descriptive Statistics for French Airports, 2002-2009

$n_{France} = 26$

Variable	costppax	wlu	subs	aerrev	noncommatm	pso	depr
Minimum	8.25	14,441	0	4.50	0	0	0
Maximum	66.46	7,295,964	0.70	22.15	0.96	1	18.66
Average	16.67	826,325	0.15	8.45	0.66	0.53	3.21
Standard Deviation	8.89	1,274,584	0.16	1.90	0.26	0.50	2.70

5. Results

Estimation results

Variable	Norway	France
year	0.050*	0.026*
	(9.23)	(6.46)
wlu	-0.816*	-0.443*
	(-18.81)	(-10.46)
subspcost	0.203*	0.219*
	(3.87)	(2.76)
aerrevppax	0.113*	0.223*
	(3.25)	(4.39)
noncommatm	0.229***	-0.266*
	(1.65)	(-2.85)
pso	-0.018	-0.046***
	(-0.67)	(-1.75)
deprppax	0.032**	0.014***
	(2.20)	(1.71)
ρ	0.685*	0.365*
	(12.36)	(3.55)
R^2	0.98	0.94
Adjusted R^2	0.84	0.56
Log-Likelihood	307.00	185.14

- "wlu", aerrevppax" and "deprppax" in natural logarithms.
- t-values are in parentheses

* 1% significance; ** 5% significance;
*** 10% significance

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- spatial autoregressive parameter
- significant spatial dependence
- costs of one airport are positively influenced by the weighted average of costs of neighboring airports
- positive correlation between costs of nearby airports in Norway is stronger than in France

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- unit operating costs have increased since 2002
- 5 percent annual increase in Norway
- 2.6 percent annual increase in France

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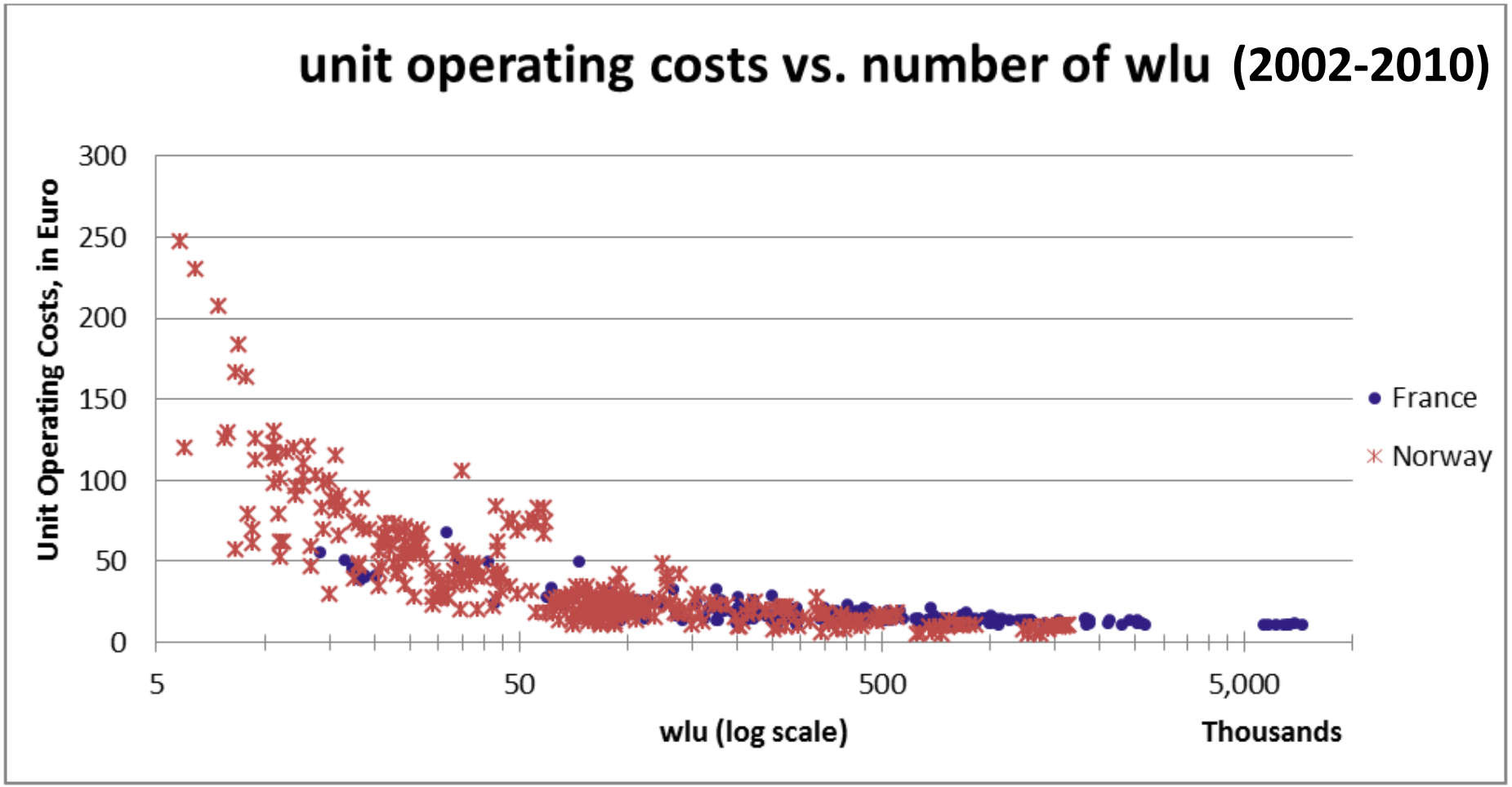
- economies of scale
- A 1% increase in wlu decreases unit costs by 0.82% in Norway & by 0.44% in France

Economies of Scale



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- higher cost coverage by subsidies

→ higher unit costs

- subsidies relative to costs increase by one percent

→ unit costs increase by 0.2 percent

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- an airport serving a PSO route in France has 4.6 percent less average costs
- in Norway, insignificant

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- positive relationship
- lagged effect of investments
- low capacity utilization
- distortion due to data

→ Lifetime of investment
→ Avinor‘s infrastructure investment*

*2002-2003: growth of average depreciation → 53 percent

6. Conclusions and Further Research

Conclusions:

- significant level of spatial relatedness
  - ✓ airports in a group present higher similarities

- subsidies lead to higher unit costs
  - ✓ fiscal decentralization,
  - ✓ ex-ante subsidies

- inadequate demand → economies of scale
  - ✓ increase traffic (see Bel, 2009)

Further Research:

- indirect effects
  - ✓ secondary relationships, where spatial dependence of unit costs is transited via an airport located between those two airports

- Granger-causality test
  - ✓ Causal effects of subsidies and unit costs

- effects of direct vs. cross subsidies

- improve data on French airports

- A more elaborated cost function approach

Thank you for your attention!

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