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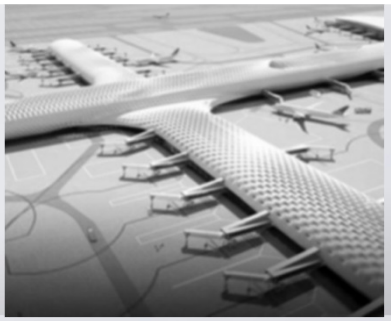

Exploratory analysis on LCC potential to influence airport efficiency

Sérgio Domingues

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INSTITUTO SUPERIOR TÉCNICO

Universidade do Porto
Faculdade de Engenharia
FEUP

Universidade da Beira Interior
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Contents

- Introduction
- Drivers of airport efficiency
- Data Collection
- Discussion of results
- Conclusions

Deregulation of the air transport market: USA

- US-Netherlands bilateral (1978):
  - Carriers determine their own capacity, frequency and tariffs with reduced government intervention
- Air Transportation Competition Act (1979):
  - Main purpose was to allow designation of multiple carriers, liberal access to charter carriers, the elimination of capacity and fare restrictions, and common treatment of domestic and foreign carriers for airport facilities. (H. Good, Röller, & Sickles, 1995)
- European Civil Aviation Conference for North Atlantic routes (1982) :
  - Governments would automatically approve any fare that was in a “zone of reasonableness” that was as low as 50% of current fares. (H. Good, Röller, & Sickles, 1995)

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Deregulation of the air transport market: Europe

- Treaty of Rome (1957)
  - Article 84 exempted European air and sea transport of rules regarding competition policy.
- "French Seamen" case (1974) and "Nouvelles Frontiéres" case (1986)
  - European Member-States strongly opposed EU's interference in the air and maritime sectors. This case was crucial for the long-term application of competition rules to transportation sectors.
  - European Court of Justice definitively confirmed that the competition rules of the EU Treaty applied to the air transport sector.
- European Air transport Liberalization (1988-2004)
  - Three liberalization packages between 1988 and 1993 enforced legislation on air fares and rates, capacity sharing, market access, licensing of air carriers.
  - Single European Sky (2004): EU's reregulation of aviation policy aims to rationalise the costs and emissions along with the improvement of air safety and it involves currently 38 countries

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LCC's Background

- Southwest Airlines (US) first introduced the low-cost, non-frills business model in 1967:
  - Operated a single aircraft type with high-density seating and aim at high daily utilisation by reducing turnaround times to thirty minutes or less.
  - Use of less congested and secondary airports, reducing airport related costs were possible to achieve, and facilitated short turnarounds and higher punctuality.
  - All traditional scheduled frills such as free in-flight meals, pre-assigned seats and connecting flights were cut back. Some airlines went even further by completely cutting out travel agents' commissions and only selling directly to their customers. Furthermore, Southwest betted on an intensive marketing strategy where "flying is fun", and to do so, the key factor was flexible and highly motivated staff. (Doganis R. , 2001).
- European Low-Cost seat capacity has moved from 3 million passengers in 1994 to more than 178 million passengers in 2006. (RDC, 2007)

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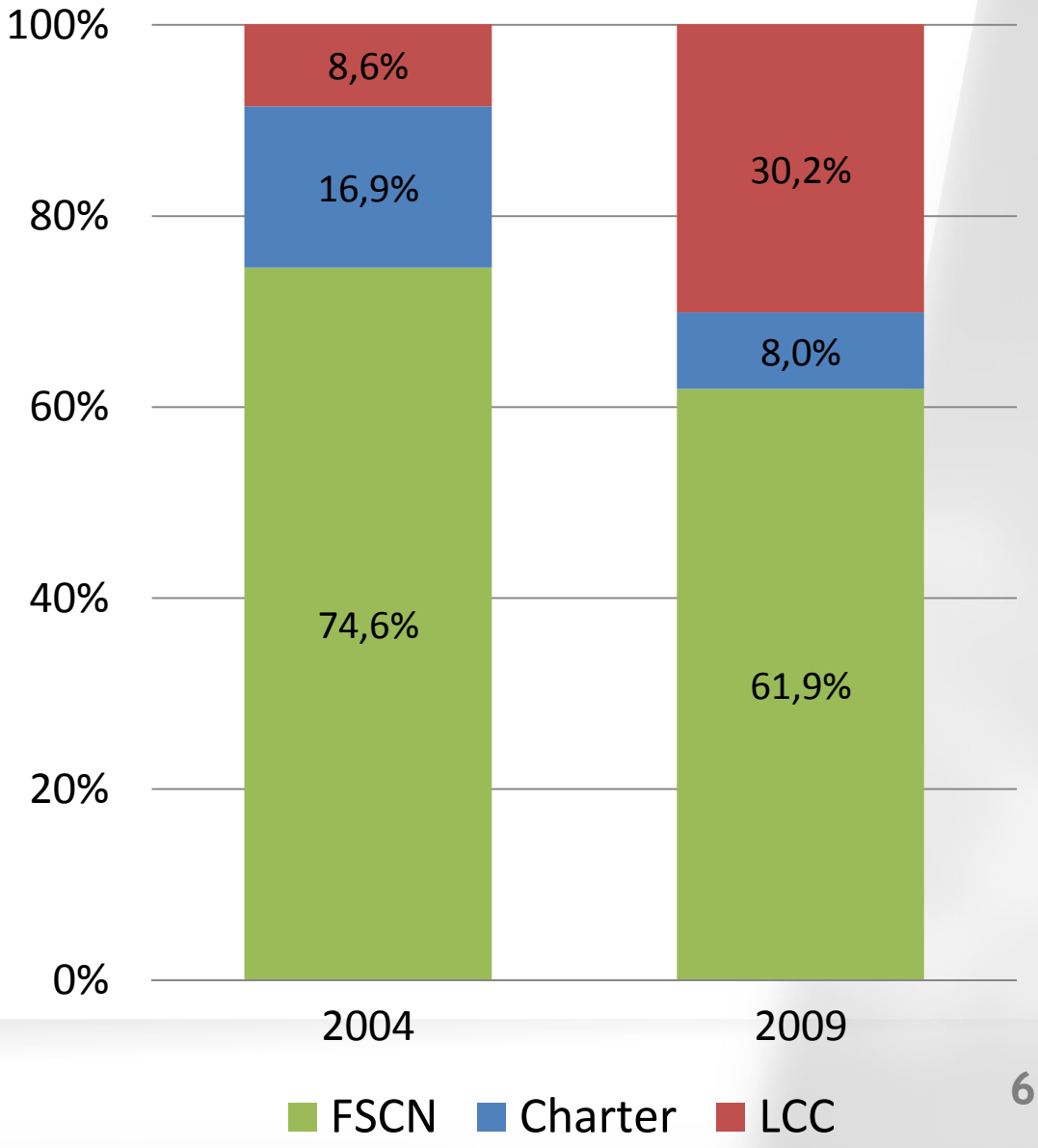
LCC's in Portugal

Source: ANA



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Methodologies on efficiency measurement

- Partial Measurement
  - Partial ratio data compares of target sample in single dimension (financial and cost performance).
  - Lacks to provide a more comprehensive evaluation of an airport's performance.
- Index Number: Total Factor Productivity (TFP)
  - Measures cost efficiency and effectiveness and distinguishes productivity differences. Three approaches exist: parametric, non-parametric and the endogenous-weight.
  - Requires an aggregation of all outputs into a weighted output index and all inputs into a weighted input index using pre-defined weights, which can be biased.
- Frontier Analysis - Parametric approach: Stochastic Frontier Analysis (SFA)
  - SFA is one of the main parametric approaches used by researchers to evaluate efficiency.
  - Parametric methods still faces challenges on separating random error from efficiency.
- Frontier Analysis - Non-Parametric approach: Data Envelopment Analysis (DEA)
  - DEA requires no assumptions about the functional form and calculates a maximal performance measure for each firm relative to all other firms.
  - Does not allow for random error in the data, assuming away measurement error and luck as factors affecting outcome, which implies that the measured inefficiency is likely to be overstated.

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Literature on airport efficiency

- Operational Efficiency
  - Gillen and Lall (1997, 2001) (DEA)
    - Boarding and common use gates are important for operational efficiency. Increasing size of the terminal or number of baggage belts doesn't have positive impact.
  - Pels et al. (2001, 2003) (DEA)
    - Importance of Parking stands and insignificant 2nd order effects on number of runways
  - Barros, C. P. (2008) (SFA)
    - Institutional framework of Portuguese airports
- Ownership Efficiency
  - (Parker D. , 1999)
    - BAA's privatization had no noticeable impact on efficiency.
  - (Vogel, 2006)
    - Economically meaningful differences between 35 European publicly owned and privatized airports.
  - (Oum, Adler, & Yu, 2006) and (Oum, Yan, & Yu, 2008)
    - Majority of shares should be transferred to private sector
    - Mixed ownership with governmental majority should be avoided in favor of 100% public firm.
    - Privatization of one or more airports in cities would improve efficiency of all airports.
  - (Vasigh, Erfani, & Miner, 2009)
    - Privatized airports outperform government owned airports

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DEA methodology

- What is it?
  - Non-parametric frontier methodology that uses the panel data to establish best-practice frontiers.
- How does it work?
  - Based on (Farrell, 1957), DEA uses linear programming to construct a piecewise linear efficient frontier that envelops the data based on information of inputs and outputs only. DEA measures relative efficiency by comparing the efficiency of a decision-making unit (DMU) with the efficiency of other DMUs that have a similar mix of inputs.
  - The most efficient DMUs will be located on the efficiency frontier with relative index of 1,0.
- Pros?
  - Does not involve the estimation of underlying production or cost functions. Also the weights for inputs and outputs are not predetermined, but instead the result of the programming procedure.
- Cons?
  - Does not allow for random error in the data, assuming away measurement error and luck as factors affecting outcome, which implies that the measured inefficiency is likely to be overstated.

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Drivers on airport efficiency

- Airside
  - Airfield design
  - Capacity and delays of airfields
  - Demand management
- Landside
  - Passenger buildings
  - Security and check-in processes
  - Low-Cost Airports
- Airport-Airline Relationship
  - Airport privatization and management
  - LCC's implication on airports' revenues
  - Regulatory environment

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Airside

- Airfield design
  - Airfields typically account for 80 to 95% of the total land area occupied by an airport. Land unavailability due to urban expansion is an important factor that constrains airports to add new runways.
  - Traditional approach of airport design based on masterplans (FAA's Advisory Circular 150/5070 , ICAO's Airport Planning Manual-Part 1) should move forward to provide flexibility to the infrastructure.
- Capacity and delays of airfields affected by several factors:
  - Number and geometric layout of the runway system; Separation requirements between aircrafts; Visibility and overall weather conditions (wind, precipitation, snow, etc); Mix of aircrafts; Mix and sequencing of movements on runways (departures only, arrivals only or mixed); Type and location of taxiway exits from runways; Performance of the air traffic management system; Environmental constraints (noise, land availability, etc)
  - Importance of taxiways, high-speed exits and aprons on airfield capacity
- Demand management: purely administrative, purely economic and hybrids
  - Schedule coordination: lack of economic penalties or incentives may lead to market distortions
  - SMC Pricing: congestion pricing relates with users' *willingness to pay* for the infrastructure access. However, it is difficult to estimate accurately marginal external costs and conflict of interests among different stakeholders is prone to slow down implementation of such pricing policies.
  - Hybrid approaches, in addition to slot coordination, will include economic measures such as congestion pricing, slot market or slot auctions to achieve the final allocation among users.

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Airport-Airline Relationship

- Airport privatization and management
  - Airport privatization does not actually involve the sale of property but the transfer of ownership rights such as profits and management control on short and long-term development issues.
  - ELEPHANT IN THE ROOM: NLA+TAP?
- LCC's implication on airports' revenues
  - Airport costs represent on average 4% of traditional airlines' operating costs, but it accounts up to 17% for LCCs, being the third most important cost for LCCs right after fuel and aircraft leasing cost. (Graham A. , 2008)
  - Increasing market share counterbalances their intrinsic volatility
- Regulatory environment
  - Operational, safety and security, environmental and **economic**.
  - Economic legislation encourages principles of non-discrimination, user's consultation and transparency… but adds nothing new to the discussion on how to improve airport's economic efficiency!

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Data Collection

- Commercial traffic.
  - Represents in average 92,3% of total ATM and 99,9% of PAX.
- LCC's traffic considered on a monthly basis
  - Monthly data unavailable for Porto between 2005 and 2008, and for Lisbon between 2005 and 2006. It was assumed to follow the same distribution as of total traffic.
- Lack of information regarding infrastructure availability
  - Renewal and expansion works in Porto (until 2007) and Lisbon (always!)
- Operational characteristics and accounting practices
  - Faro accounts LCC traffic according to ELFAA's members, whereas ANA airports consider typical charter companies as LCC, resulting in diminished LCC traffic
  - In 2011, for instance, airberlin and Brussels airlines have requested ANA to be classified as a full-service carrier. Moreover, in 2009, Porto considered Tuifly as an LCC whilst Faro did not.
  - easyJet operates most of their flights in Lisbon's more expensive T1.
  - Bogus transit traffic in Funchal airport, when flights are diverted to Porto Santo instead of to Canarias Islands.

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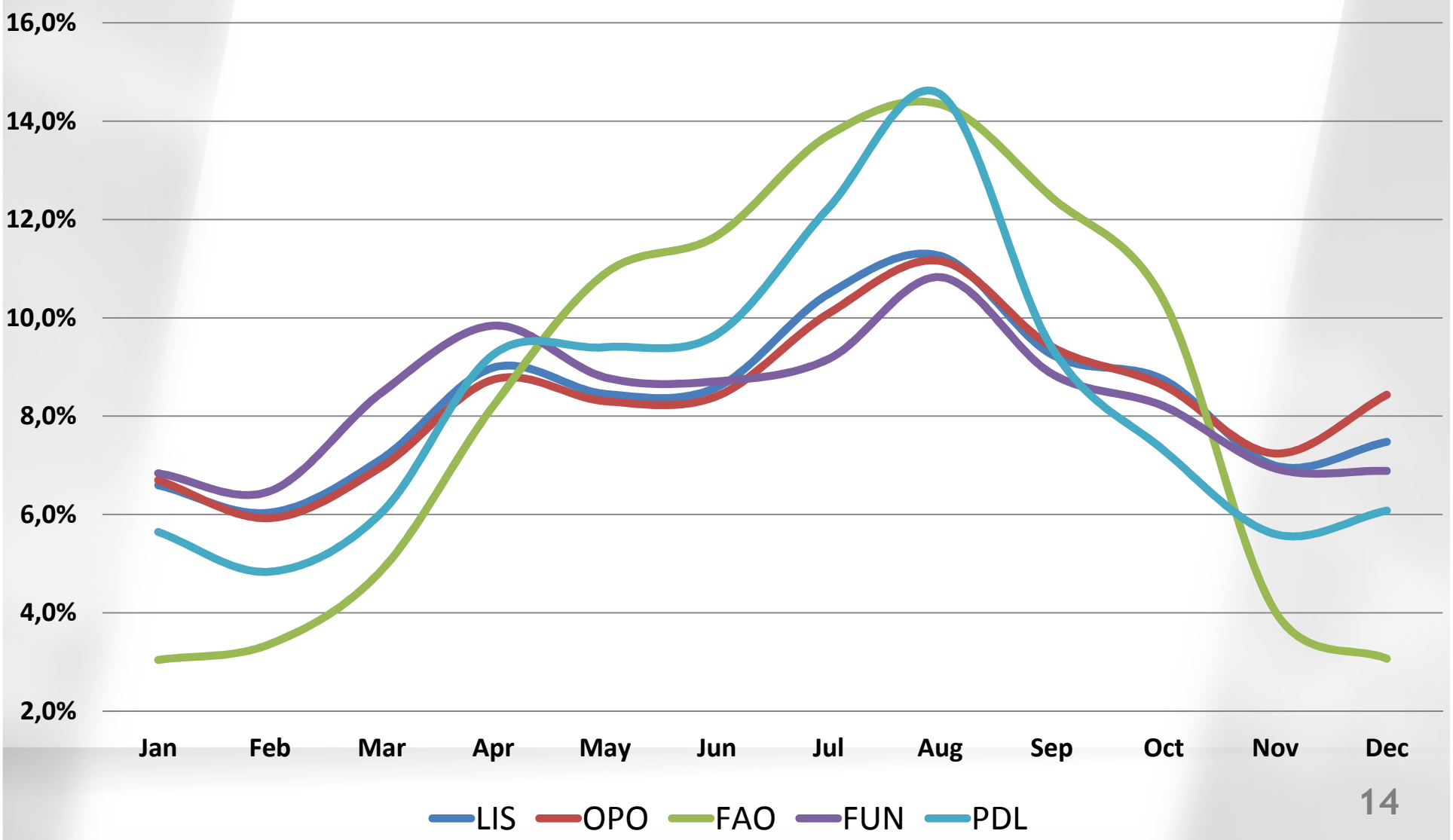
Data Collection

2009'S MONTHLY PAX DISTRIBUTION ON THE TOP5 BUSIEST PORTUGUESE AIRPORTS



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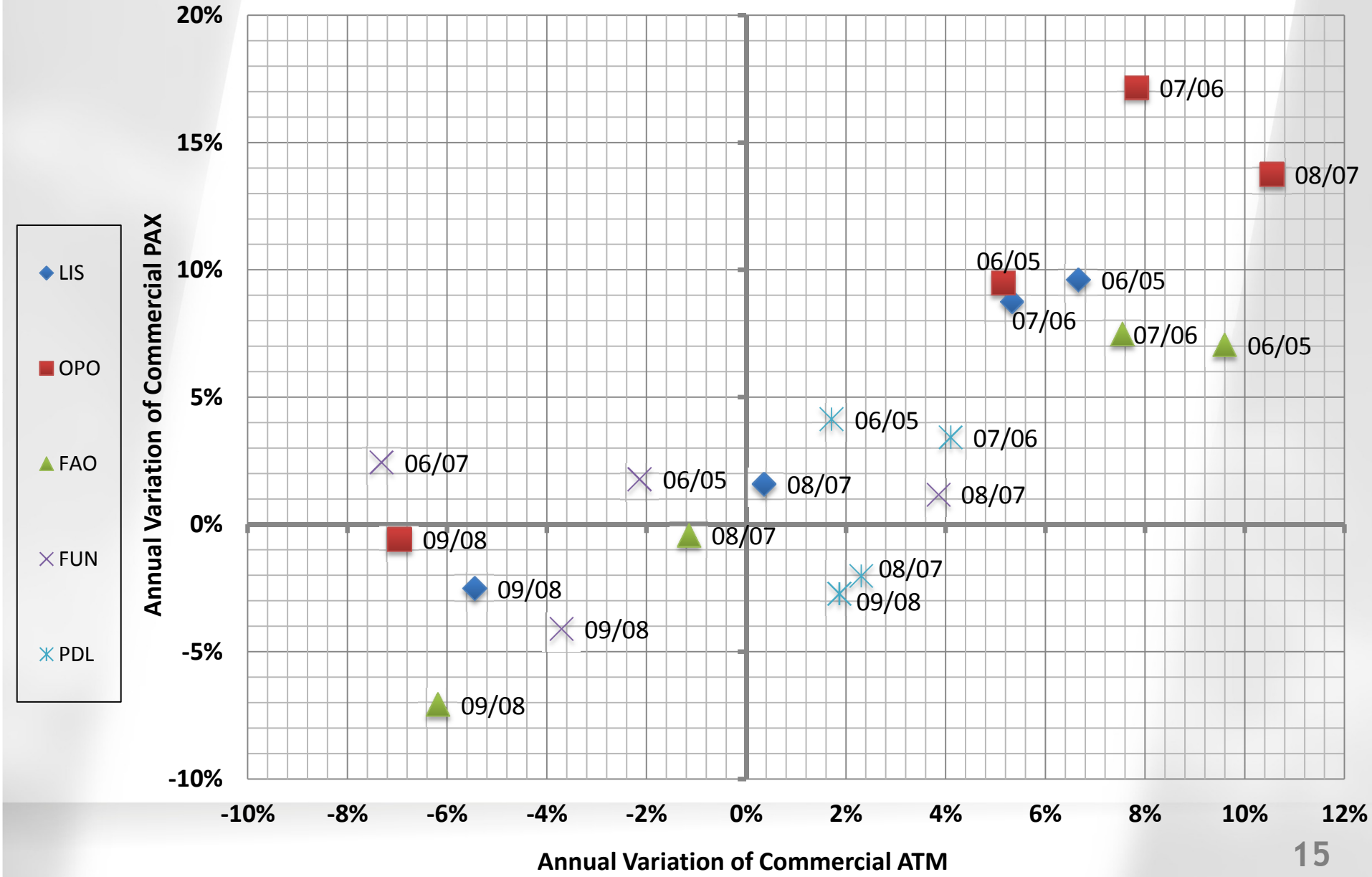
Data Collection



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Data Collection

Total Parking Stands

Runway Declared Capacity

Total Boarding Gates

Total Terminal Area

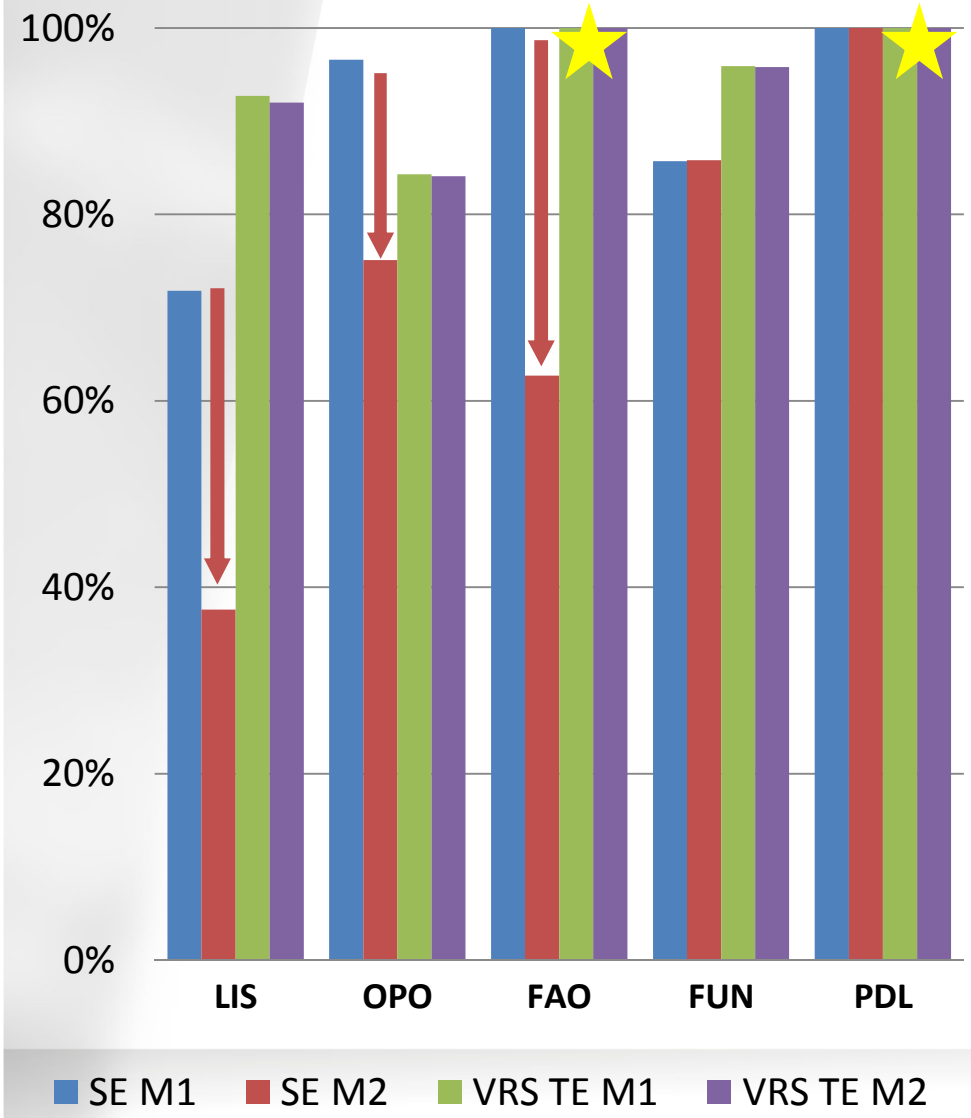
DMU #	DMU NAME	OUTPUTS				INPUTS					
		ATM		PAX		TPS	RDC	BSC	CID	TBG	TTA
		NON-LCC	LCC	NON-LCC	LCC	#	ATM/h	bag/h	#	#	m^2
1	LIS_05	122.829	1.296	10.936.809	297.842	51	33	2.800	106	28	65.943
2	LIS_06	123.929	8.529	11.197.402	1.116.912	51	35	2.800	106	28	66.646
3	LIS_07	122.865	16.651	11.321.465	2.070.594	51	36	2.800	115	34	69.266
4	LIS_08	121.781	18.235	11.386.875	2.216.745	57					72.231
5	LIS_09	116.968	15.413	11.273.466	1.987.512	65					76.676

Baggage System Capacity

Check In Desks

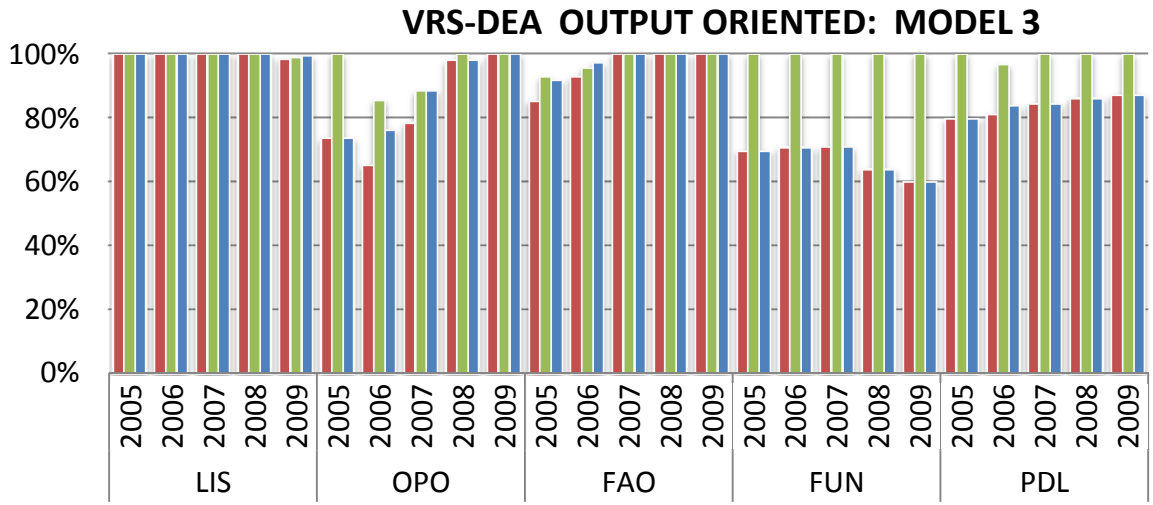
Approach description	Output Data	
	Disaggregated (LCC + Non-LCC)	Aggregated (Total)
1. Analysis on seasonality influence (5 DMUs in 60 months)	Model 1	Model 2
2. Each airport in each year as an individual firm (25 DMUs)	Model 3	Model 4
3. Panel data (5 DMUs in 5 years)	Model 5	Model 6

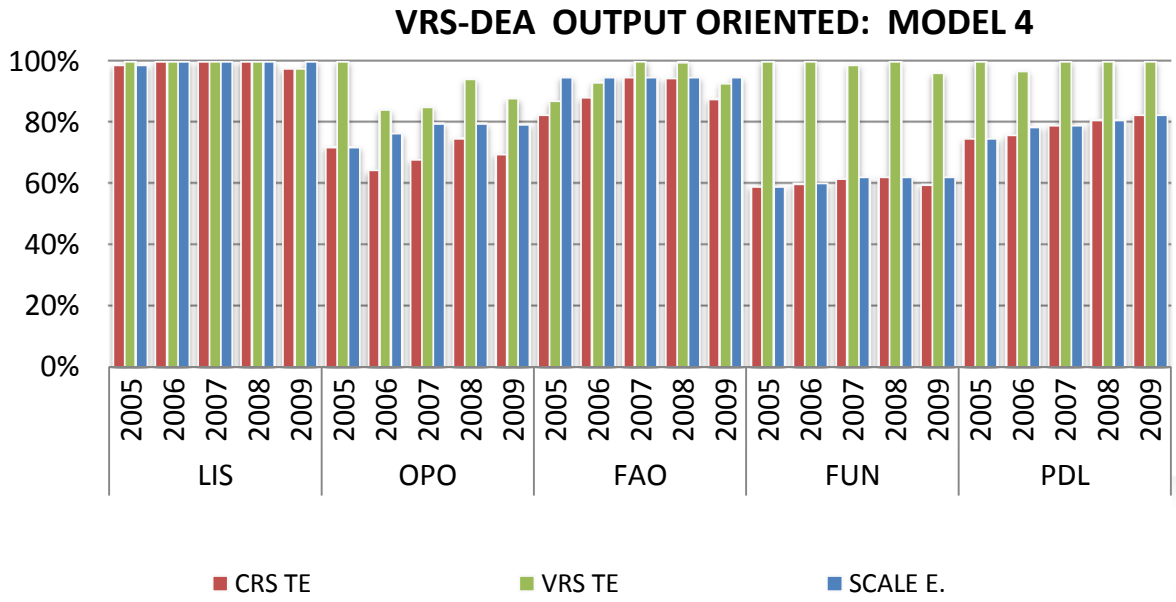
Discussion of Results: Models 1 and 2



- 5 DMUs; 60 periods; 6 inputs
- Disaggregation of output data on M1
- LIS, OPO, FUN and FAO operating under DRS, in model 2;
- Maximum TE in touristic airports:
  - FAO and PDL's high seasonality (5x more pax traffic in summer time)
  - Use of shared facilities would promote efficiency gains
- Reduction of SE in M2 for busiest airports:
  - LIS by 34,2%; OPO by 21,5%, FAO by 37,3%
  - Average SE of 90,8% and 72,2%.
  - St.Dev SE of 12,1% and 23,7%.

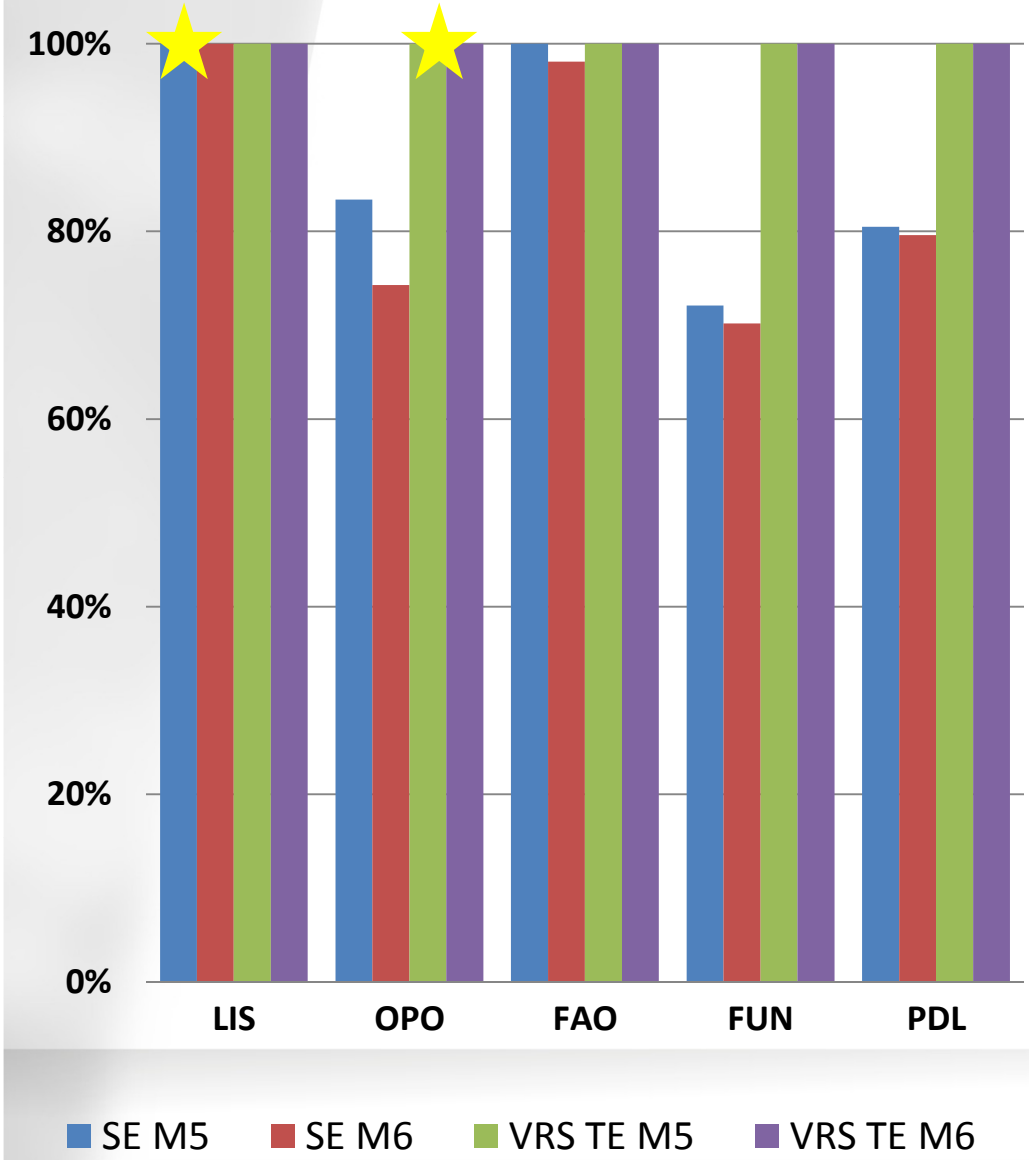
Discussion of Results: Models 3 and 4





- 25 DMUs (each year and each airport); 6 inputs
- Disaggregation of output data on M3
- OPO, FUN, PDL and FAO operate under IRS in M4 and M3;
- LIS more efficient. :
  - DRS in LIS'09 on M3
  - OPO maintains worst VRS TE scores
  - Consistent efficiency growth at FAO and OPO.
- Other aspects:
  - FAO's SE rises in M4 and drops in M3:
  - Similar SE and TE scores in both models (less variance)
  - As in M1 and M2, output disaggregation appears to influence airports' efficiency

Discussion of Results: Models 5 and 6



- 25 DMUs panel data; 6 inputs
- Disaggregation of output data on M 5 (LCC + non-LCC)
- OPO, FUN, PDL and FAO operating under IRS in M6;
- All airports achieve 100% VRS TE
  - LIS and FAO outperform all other airports in M6, but only LIS in M5.
- Small reduction of SE in M6 in OPO, FUN and PDL:
  - FUN has the worst score
  - Similar results to M3 and M4
  - Average SE of 87,2% and 84,4%.
  - St.Dev SE of 12,4% and 13,8%.

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Discussion of Results: Overall

- All three approaches show that Portuguese airports operate efficiently.
  - Average TE scores of 97,3% and s.d. of 3,7%. SE scores drops to 84,1% on average whilst s.d. gets near to 15%.
- Different approaches = different best-practitioners
  - On Approach 1, touristic airports of Faro and Ponta Delgada register higher efficiency scores which are most likely related to great increase of passenger and aircraft increase in summer time.
  - Approaches 2 and 3 both reveal Faro and Lisbon airports as best practitioners. Such was expected, since panel data in approach 3 should result in average efficiency scores of each airport in the considered study period
- Data disaggregation
  - Consistent in all three approaches the influence of LCC traffic in scale efficiency scores
  - On the other hand, share of LCC traffic in each does not appear to have strong influence on airports' technical efficiency
- Data limitations
  - Small panel data is a strong limitation to the DEA methodology.
  - desirable a more detailed characterization of which infrastructures are devoted to each type of airline carrier.

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Conclusions

- Data Envelopment Analysis
  - While it is considered the best methodology to deal with multiple input/output firms and with the issue of biased weighs, a relative large number of inputs and outputs in comparison to the number of DMUs are likely to conduct to performance overstatement.
  - While most literature assessing airports' efficiency suggests the output-oriented approach, passengers and aircraft movements are not airports only source of revenue. Airports' commercialization has lead to increasing non-aeronautical revenues, not considered in our model.
- Data limitations
  - Different accounting practices and data availability.
  - Impossible to make omelettes without eggs, hence demystification of DEA as powerful benchmarking tool.
- LCC potential on influencing airports' efficiency
  - Appears to be sustained in our efficiency models that considered disaggregation of commercial traffic into low-cost and non-low-cost segments.
  - Importance of LCCs on touristic destinations, should drive managers to consider use of shared facilities. In Porto airport, traffic's sustained growth fails to cope with the underused available infrastructures for planning reasons. In Lisbon, LCC traffic helps flattening the airport's daily demand curve.

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sergio.az.domingues@gmail.com

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