Comparative study (benchmarking) on the efficiency of Avinor´s airport operations

Revised report submitted to the Norwegian Ministry of Transport and Communication

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List of abbreviations

ACI – Airoport Council International

AFIS – Aerodrome Flight Information Service

AIP – Aeronautical Information Publication

ATC – Air Traffic Control

ATM – Air Transport Movements

BAM – Bounded Adjusted Measure

CAA – Civil Aviation Authority

CEO – Chief executive officier

DEA – Data Envelopment Analysis

DMU – Decision Making Units

EBIT – Earnings Before Interest and Taxes

EBITDA – Earnings Before Interest, Taxes, Depreciation and Amortization

FTE – Full Time Equivalent Employees

GAP – German Airport Performance

HIAL – Highlands and Islands Airports Limited

NMTC – The Norwegian Ministry of Transport and Communications

NOK – Norwegian Krone

OLS – Ordinary Least Squares

p.a. – per annum (yearly)

PAX – Passengers

PPM – partial productivity measures

PSO – public service obligation

ROE – Return on Equity

STOL – short take-off and landing

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Executive Summary

The Norwegian airport system is a *centralized system*, in which the Avinor Group acts as a public firm delivering airport services to the central and rural regions. The Avinor Group (which includes OSL as a separate company) is responsible for the operation of 46 airports. This report was initiated in a report to the Parliment (St. Meld. nr 48 (2008-2009)) following concerns that Avinor was not operating in a cost efficient manner. Concurrently, similar concerns were stated by The Office of the Auditor General of Norway.

E.1. Airport Costs and Revenues

1. Based on an analysis of 154 European airports serving up to 10 million passengers per annum, it is clear that airport operations have become more costly over the last decade. An econometric break-even analysis shows that on average, about 400,000 passengers annually were sufficient to cover operational costs in terms of *earnings before interest and tax* (EBIT) in 2002, but by 2009, about 800,000 passengers per year were required for this. Our analysis of Avinor airports showed, that while some smaller sized Avinor airports broke even serving approximately 200,000 passengers annually in 2002, by 2010, their most profitable airports break-even only when serving about 800,000 passengers per year.

2. Total operating costs at Avinor have increased in real terms by over 100% from 2002 to 2010. In 2002 Avinor airports had a cost advantage in comparison to the airport operators in the dataset used in the study, but this advantage dissipated by 2009. Taking the institutional and financial aspects of the Norwegian airport system into account, the regional and local airports will continue to need subsidies. *Cross-subsidies* have grown about twofold in real terms and threefold in nominal terms, i.e. faster than the profits in terms of EBIT.

3. The cross-subsidies that are financing the local and regional airports are drawn mainly from profits earned at the large airports. Oslo is the main financial contributor, since its duty free revenues per passenger are two to three times larger than at the other major Avinor airports, and on average 10 times higher than at Avinor regional airports. The growing importance of commercial revenues was mainly driven by a rising number of international passengers which has doubled from 2002 to 2010, as well as from more flexible regulations introduced in 2006, such as duty-free shopping at arrival. In real terms duty free revenues tripled over the period from 2002 to 2010.

4. While *security charges* for the Avinor airports have increased significantly since their introduction in 2004, landing and passenger charges have almost remained constant.

Furthermore, the aviation charges at Oslo's airport are lower in comparison to those at other Scandinavian hubs and the majority of high-traffic European airports. *Landing and passenger* charges are also lower at smaller Norwegian airports than at similar sized UK airports that are also facing potential competition from neighboring airports and serving low cost carriers. Avinor airport charges are set by the Department of Transport and are constant across airports. Regulating airport charges by setting the same level and structure of charges across all Avinor airports is most likely inefficient because the marginal costs differ across airports.

E.2. Airport Productivity

1. The dataset used for benchmarking *small airports (i.e. below 2 million passengers)* consists (in 2009) of 102 airports from nine countries, of which 41 belong to Avinor. Small Norwegian airports suffer from low runway utilization linked to the large number of airports compared to the population of the country. For example, 24 airports serve fewer than 100,000 passengers annually.
2. The Norwegian airport system was relatively cost efficient in 2002 despite the size drawback but this advantage had been lost by 2007, particularly with respect to the local and regional airports, while the large airports remain efficient. In comparison, Avinor airports enjoy low staff and other costs, but also suffer from relatively low infrastructure utilization and non-aeronautical revenues.
3. Bodø, Hammerfest, Mo i Rana and Tromsø have been consistently efficient as well as Røst and Vadsø which are also important benchmarks among the Avinor airports. The remaining 35 local and regional Avinor airports have not been efficient and the level of productivity has decreased over the last decade. The non-Avinor benchmark airports include the Icelandic airports of Gjogur, Grimsey, Thorshofn, Vestmannaeyjar and Vopnafjordur. These airports achieve higher runway utilization and lower costs than their Avinor counterparts although it must be noted that the Icelandic airports have lower security costs on domestic flights.
4. From the small airport analysis, it appears that the dual use, military-civilian airports are 8% more efficient despite the removal of all military movements from the analysis. This would suggest that these airports enjoy lower staff and other costs as a result of military staff availability.
5. The *large Norwegian airports (above 2 million passengers)* were benchmarked in a separate sample. They enjoy a relative competitive advantage over their European counterparts with respect to commercial revenue opportunities. This advantage is three-fold:

Norway is not within the European Union which permits duty free sales to all international passengers; Norwegian tax rates on alcohol and tobacco are substantial, which increases the value of duty-free products relative to the Norwegian high street; and a change in the duty-free laws in 2006 permits the airports to sell larger quantities of duty free products per passenger than other airports in Europe on both outbound and inbound flights. The change in the law resulted in additional revenues of 350-500 million NOK annually.

6. The four large Avinor airports, Oslo, Bergen, Stavanger and Trondheim, are relatively efficient, but their productivity trend is negative because their costs have surpassed those of comparable airports. We note that most airports in the dataset have suffered from a frontier retraction over time, due in part to the increased security costs imposed on the airports as a result of the European Union Security Directives. Norway's performance is in line with that of Austria, Switzerland and Belgium, however Copenhagen airport has better managed the cost increases and is a good benchmark for similar sized counterparts in this respect.

7. From the large airport analysis, we find that European airports undertaking ground handling or fuel sales in-house are approximately 17% to 19% less efficient than those which outsource these activities, as is done by most Avinor airports. It would be reasonable to conclude that outsourcing is preferable from a managerial perspective. The small airport dataset show similar patterns. Airports undertaking ground handling or fuel sales in-house are 10% less efficient than those which outsource these activities, but multitasking options for the smaller airports must be kept in mind.

8. Belonging to a national airport system such as AENA or Avinor reduces average efficiency by a statistically significant 8% to 11%. Airports managed locally have a higher probability of achieving a more "relatively efficient" outcome. Finally, the short take-off and landing (STOL) Avinor airports are 15% to 20% more efficient, suggesting that the shorter runways help to maintain lower costs.

9. When benchmarking the local and regional civilian Avinor airports, one can compute the efficiency differences in terms of potential savings with respect to staff and other operating costs, as well as the potential increases in non-aeronautical revenues. We find significant efficiency savings compared to airports on the efficiency frontier: At least 280 million NOK could have been saved on average annually through a reduction in costs of at least 20%. The analysis also suggests that the STOL airports could have increased commercial revenues by 22 million NOK annually on average.

10. The efficiency analysis could be further improved by incorporating natural comparators such as Finland and Sweden, for which we were not able to obtain the relevant

data in the required level of detail. We cannot therefore rule out the possibility that Avinor airports may be more inefficient than they appear in the current analysis, if airports in the neighboring countries perform above average.

E.3. Potential Measures to Improve Efficiency

As inefficiency is caused by a variety of factors, there is no single instrument which could improve the performance of Norwegian airports. All instruments implemented should aim at increasing the efficiency of regional and local airports as well as preventing the large airports from becoming inefficient. It should, however, be stressed that these instruments need to be evaluated regarding their impact by further research and that they have to be combined in a systematic, comprehensive and well-designed reform program.

The key point of such a program would be to set incentives without distorting the motivation to work effectively for the public airport system. We argue that the current public airport system with a growing level of cross-subsidies and a soft budget constraint does not encourage cost efficiency at the airport level and ought to be changed through the use of management or franchise contracts, whereby a share of the efficiency improvements could be passed on as *boni* to the local airport management. Furthermore, a more precise operating budget constraint ought to be set as an incentive for the airport management in order to lower the required subsidies.

Acknowledgements

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Chapter 1 was prepared by Prof. Jürgen Müller and Prof. Hans-Martin Niemeier, with the later concentrating on benchmarking airport charges and the role of PSO routes. Chapter 2 was prepared by Prof. Jürgen Müller. For both chapters, we were assisted by (in alphabetical order) Branko Bubalo, Savia Hasanova, Nikola Ivanov, Roman Pashkin and Mikhail Zolotko. Chapter 3 was prepared by Prof. Nicole Adler with the assistance of Tolga Ülkü, Dr. Vanessa Liebert and Dr. Ekaterina Yazhemsky. Chapter 4 was a joint effort.

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Prof. Jürgen Müller and Prof. Hans-Martin Niemeier

Project Coordinators.

Chapter 1: Bechmarking Avinor: Institutional settings and international comparisons

1.1. Introduction

1.1.1. Study objectives

In the beginning of 2011 the Norwegian Ministry of Transport and Communications (hereafter referred to as Ministry or NMTC) requested a benchmarking study of Avinor AS (hereafter referred to as Avinor), the Norwegian national Airport system. It was initiated as a response to a report to the Parliment (St. Meld. nr 48 (2008-2009). Concurrently, similar proposals were stated by The Office of the Auditor General of Norway (Riksrevisjonen, 2009).

This report is the result of a follow-up tender by the Ministry, in which the German Airport Performance (GAP) research project was asked to conduct a cost efficiency benchmarking of the airports owned by Avinor. The aim was to produce a report that can support the Ministry of Transport and Communications in its dialogue with Avinor, both as owner of the company and as an economic regulator.

1.1.2. Object description

The state-owned limited company Avinor was established on the 1st of January 2003 as the successor of the former Norwegian Civil Aviation Administration Luftfartsverket. It is currently responsible for the operation of 46 of the 52 civil airports located in Norway, of which 12 airports are managed in cooperation with the Ministry of Defence with an agreement outlining the shared use of airport infrastructure and operations.

Avinor operates small local, medium regional and large hub airports, as well as the air traffic control (ATC) towers and regional control centers in Norway[1]. Three airports, namely the airports of Bergen, Stavanger and Trondheim, are categorized by Avinor within the large airport group, serving international traffic and functioning as hubs for domestic traffic. The largest airport, *Oslo Gardermoen*, is operated separately by Oslo Lufthavn AS (OSL), a wholly-owned subsidiary of Avinor[2]. 13 airports are categorized by Avinor as regional airports and the remaining 29 airports are grouped into the local airport category[3], which are then divided into four subgroups according to their geographical location (Table 1.1.1).

[1] There are six airports in Norway outside the Avinor system. These external airports include two located in the Oslo region (Sandefjord/Torp (TRF) and Moss/Rygge (RYG)) which has led to a more competitive market in this catchment area (Denstadli and Rideng, 2010). There are four other small airports located in the Southern part of Norway with a relatively low share of commercial flights.

[2] Oslo Gardermoen airport was established as Oslo Lufthavn AS in 1997 when it still was under construction.

[3] In 1997-1998 the predecessor Luftfartsverket had taken over the local and regional airports from local communitues.

Avinor Division	Airport Name	Region	IATA Code	ICAO Code
1-Oslo Lufthavn AS	Oslo Gardemoen	Akershus	OSL	ENGM
2-Large Airports	Bergen	Hordaland	BGO	ENBR
	Trondheim	Nord-Trøndelag	TRD	ENVA
	Stavanger	Rogaland	SVG	ENZV
3-Regional Airports	Ålesund	Møre og Romsdal	AES	ENAL
	Alta	Finnmark	ALF	ENAT
	Bodø	Nordland	BOO	ENBO
	Kristiansand	Vest-Agder	KRS	ENCN
	Bardufoss	Troms	BDU	ENDU
	Evenes (Harstad-Narvik)	Nordland	EVE	ENEV
	Haugesund	Rogaland	HAU	ENHD
	Kristiansund	Møre og Romsdal	KSU	ENKB
	Kirkenes	Finnmark	KKN	ENKR
	Molde	Møre og Romsdal	MOL	ENML
	Banak (Lakselv)	Finnmark	LKL	ENNA
	Svalbard	Svalbard	LYR	ENSB
	Tromsø	Troms	TOS	ENTC
4-Local airports southern Norway	Førde	Sogn og Fjordane	FDE	ENBL
	Fagernes	Oppland	VDB	ENFG
	Florø	Sogn og Fjordane	FRO	ENFL
	Ørsta-Volda	Møre og Romsdal	HOV	ENOV
	Røros	Sør-Trøndelag	RRS	ENRO
	Sandane	Sogn og Fjordane	SDN	ENSD
	Sogndal	Sogn og Fjordane	SOG	ENSG
5-Local airports Helgeland and Namdal	Brønnøysund	Nordland	BNN	ENBN
	Mosjøen	Nordland	MJF	ENMS
	Namsos	Nord-Trøndelag	OSY	ENNM
	Mo i Rana	Nordland	MQN	ENRA
	Rørvik	Nord-Trøndelag	RVK	ENRM
	Sandnessjøen	Nordland	SSJ	ENST
6-Local airports Ofoten, Lofoten and Vesterålen	Andøya	Nordland	ANX	ENAN
	Leknes	Nordland	LKN	ENLK
	Narvik	Nordland	NVK	ENNK
	Røst	Nordland	RET	ENRS
	Svolvær	Nordland	SVJ	ENSH
	Stokmarknes	Nordland	SKN	ENSK
	Værøy	Nordland	VRY	ENVR
7-Local airports Finnmark and Troms	Båtsfjord	Finnmark	BJF	ENBS
	Berlevåg	Finnmark	BVG	ENBV
	Hammerfest	Finnmark	HFT	ENHF
	Hasvik	Finnmark	HAA	ENHK
	Honningsvåg	Finnmark	HVG	ENHV
	Mehamn	Finnmark	MEH	ENMH
	Sørkjosen	Troms	SOJ	ENSR
	Vardø	Finnmark	VAW	ENSS
	Vadsø	Finnmark	VDS	ENVD

Table 1.1.1. Divisions and Location of Avinor Airports.

The vast majority of local airports serve public service obligation (PSO) routes, which the NMTC has designated through a tender process. These tenders have been organized on an ongoing basis since 1996 (Lian and Ronnevik, 2011)[4]. Furthermore, all local airports with the

[4] For details on PSO routes, see section 1.2.3 below.

exception of Andøya, Fagernes and Røros airport operate with short take-off and landing (STOL) runways, which restricts them to serving only small turboprops (Lian, 2010)[5].

Such different types of airports are not easily comparable within one group. Therefore, we adjusted the airport sample and the variables used, also taking the specific requirements of the different approaches to benchmark charges and efficiency in general, such as the Partial Performance Measures (hereafter referred to as PPM) and Data Envelopment Analysis (hereafter referred to as DEA) into account. We decided in our DEA benchmarking to compare the four largest Avinor airports with larger European airports from the GAP project internal database[6]. The other 42 airports in Avinor (below two million passengers per year) were benchmarked in a second group against other smaller European airports, again from the GAP project database and our own surveys conducted within this project[7].

1.1.3. The Avinor airport system: institutional background

In Europe, there are only a few examples of nationally integrated airport systems that also operate a fully integrated air traffic control (ATC) system comparable to Avinor. The Spanish AENA, the Portuguese ANA and the Turkish DHMI could be viewed as being the closest counterparts[8]. Such integrated systems may be able to reap the benefits of economies of scale and scope for each activity and to coordinate airport investment on a system-wide base. They may be able to cross-subsidize small loss-making airports from large hubs. On the other hand, integrated systems may suffer from higher costs, which might be due to incentives to gain cross-subsidies from other parts of the system and poor cost control.

One of the major challenges in this study is the evaluation of such single national entities within organizational structures spanning over a whole network of intertwined entities of airports and ATC units. In this report our main focus is on the airport side only and

[5] These local airports are the 26 airports from Avinor's predecessor, Luftfartsverket, which were taken over from the local communities in 1997-1998, Båtsfjord Airport that was constructed by Luftfartsverket at that time and the heliport at Værøy. Avinor also considers Andøya as a local airport, though this is an "old" Luftfartsverket-airport from the time before 1997-1998.

[6] In this study, we employ a unique panel dataset covering over 100 European airports: data that were collected within the German Airport Performance (GAP) project (see www.gap-projekt.de).

[7] See chapter 3 for details. The dynamic DEA together with Malmquist index conducted for large airports required a balanced dataset in order to be able to measure the efficiency changes over time, which restricted the data used to 8 years (2002 to 2009). On the other hand, for the DEA of small airports and the PPM analysis we were able to use also other airports, variables and years. The heterogeneous samples include mainly airports from France, Germany, Greenland, Italy, Iceland and the United Kingdom under different organizational regimes. We included public, private and partially privatized airports, operated in a group or stand-alone. Our choice of airports was mainly limited by the availability of comprehensive financial data, fulfilling our main variables requirements.

[8] Isavia in Iceland and Finavia in Finland are similar organizations, but on a smaller scale, which also do ATC. Globally the Federal Aviation Administration (FAA) in the United States of America is a similar institution integrating nationwide civil and military ATC and airport operations.

specifically on *the single airport*, defined as "decision making unit" (DMU) in chapter 3. With this aim we highlight the main interdependencies between the organizational parts inside Avinor, such as airport operation, airport infrastructure and management, air navigation, regional centers and the Avinor headquarters. Furthermore, we highlight other important institutional relations of Avinor, such as its association with the Ministry of Defence with regard to the share of infrastructure and labor they control together with military areas of an airport, or with the NMTC concerning PSO subsidies.

1.1.4. The motivation for establishing Avinor

Luftfartsverket was established as a departmental public enterprise in 1993. In 2000 the tasks which Luftfartsverket was responsible for as an authority were separated into the Norwegian CAA. In 2003 Luftfartsverket was established as a limited company fully owned by the state with the responsibility for an airport network and ATC. The intention behind this reform was greater independence from the state and more professionally run operations. It is against this background, that the former CEO Randi Flesland had a mandate from the coalition government of the day to rationalize the airport and ATC system. Randi Flesland´s program called Take-Off 05 involved significant rationalization with the aim to deliver more with available human resources in a growing market. However, the coalition government lost power in October 2005, and the CEO, who ran into strong union opposition, was replaced in April 2006 by Sverre Quale, who canceled the program (Lofquist, 2008).

1.2.Financial Analysis

In this section we analyze the financial performance of Avinor. First, we identify the level of activity at which Avinor airports become profitable. As many of the Avinor airports are below this threshold, we analyze in section 1.2.2 how subsidies have evolved over time. The next two sections outline the main drivers on the cost and revenue side. Thereafter the results of our financial analysis are summarized. To achieve comparability over years, all financial figures were adjusted for inflation taking 2010 as base year.

1.2.1. Profit and breakeven analysis

The obligation to manage a nationwide network of 46 airports, including several very small ones, would normally require a certain amount of external subsidies to cover the costs of loss-making airports. In the case of Avinor, this is mainly done through the "internal" cross-subsidization from the large profitable airports to the loss-making local and regional airports[9]. To analyze where such subsidies are needed, we first show the profitability for each airport as measured by EBIT (earnings before interest and taxes)[10] and its dynamics over time.

Figure 1.2.1 provides a first overview of the financial situation of Avinor airports by representing EBIT per passenger figures for each airport for the selected years from 2002 to 2010 related to airport size (measured in number of passengers per year). Each point on the graph represents an airport. Different colours are used for each year. We can then identify the enveloping frontier that indicates the most profitable airports for each year[11]. The analysis indicates that the majority of the smallest airports have significant losses per passenger, due to high fixed costs of airport operations. The break-even point (minimal passenger volume, at which zero EBIT is achieved) in Figure 1.2.1, has moved to the right over time for both most profitable Avinor airports and all Avinor airports on average. In 2002, the most profitable airportswere able to break even with a size of 200,000 passengers p.a., but in 2010 none of them were profitable at that level of operation. In 2010 an airport seemed to become profitable only when the passenger volume exceeded approximately 800,000 passengers p.a., thereby requiring more subsidies than in earlier years to keep the airports system operating.

We shall return to the question regarding the size at which an airport can break even later on in chapter 2, where we present a similar benchmarking analysis for the whole sample of airports including other European regional airports.

Figure 1.2.2 shows how the EBIT of Avinor was distributed to retained earnings, interests, dividends and taxes between 2004 and 2010. As indicated by the length of the bars, inflation adjusted total EBIT figures (in 2010 prices) for all airports have not changed significantly. There was a substantial drop in 2004, when Avinor had to invest in upgrading regional and local airports to a consistent, nationwide level of quality. The financial situation improved in 2006 and the operating results stayed stable with slight fluctuations at the level of slightly over 1,200 million NOK.

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[9] However, in the past external funding from the Ministry of Finance was received for that purpose by the small and regional airports,

[10] Earnings before interest and taxes (EBIT) is a profit measure which is calculated by subtracting operating expenses (including assets' depreciation and amortization expenses) from total revenue without subtracting interest expenses and taxes.

[11] Here we focus on boundary results only and do not estimate the "average" breakeven volume since a reliable estimation is unlikely given the small sample size..

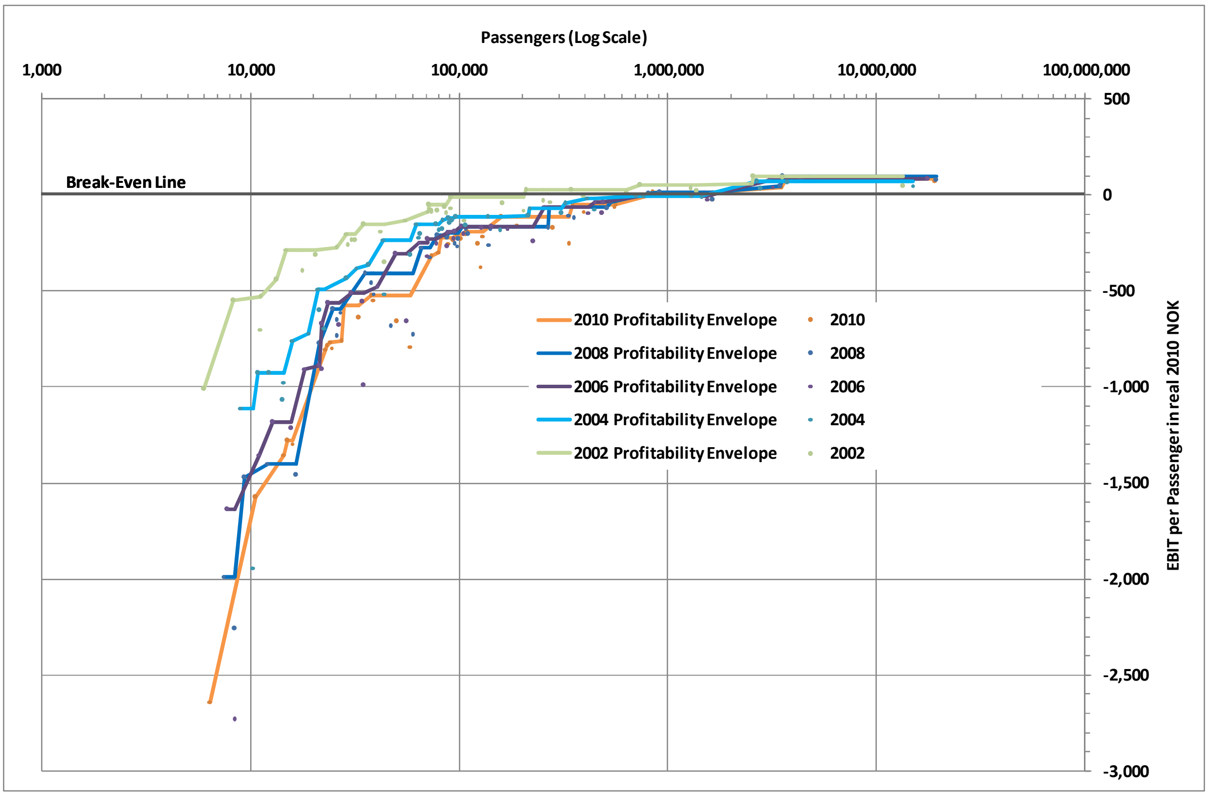


Figure 1.2.1. Operating results (EBIT) per passenger for Avinor Airports for selected years, in NOK, 2010 prices.

How EBIT is decomposed depends on the dividend policy. Note that for instance no dividends were paid in 2008 and 2009. Due to this, with regard to retained earnings, the highest result was reached in 2008 with 869 million NOK or 56% of EBIT respectively remaining after net finance cost and taxes were covered. However, that level was significantly reduced in 2010 to approximately 29%, when Avinor was again paying dividends.

1.2.2. Growing subsidies

After Avinor was established in 2003, the NMTC continued to help improving the financial situation of Avinor through a number of measures. These included government purchases of airport services between 2003 and 2005 and grants to airports in 2009 and 2010. Furthermore, the Ministry did not take out any dividends in 2003, 2008 and 2009. Table 1.2.1 shows the amounts of the above mentioned sources of support. In addition, in light of the international financial crisis in 2009 and 2010 Avinor received an exemption from repayment of the government loan that financed the development of Oslo Gardermoen[12].

[12] Source: http://www.avinor.no/en/avinor/press/_newsarchive?_2011&id=181-121666, St.meld. nr. 48 (2008–2009). Om verksemda i Avinor AS.

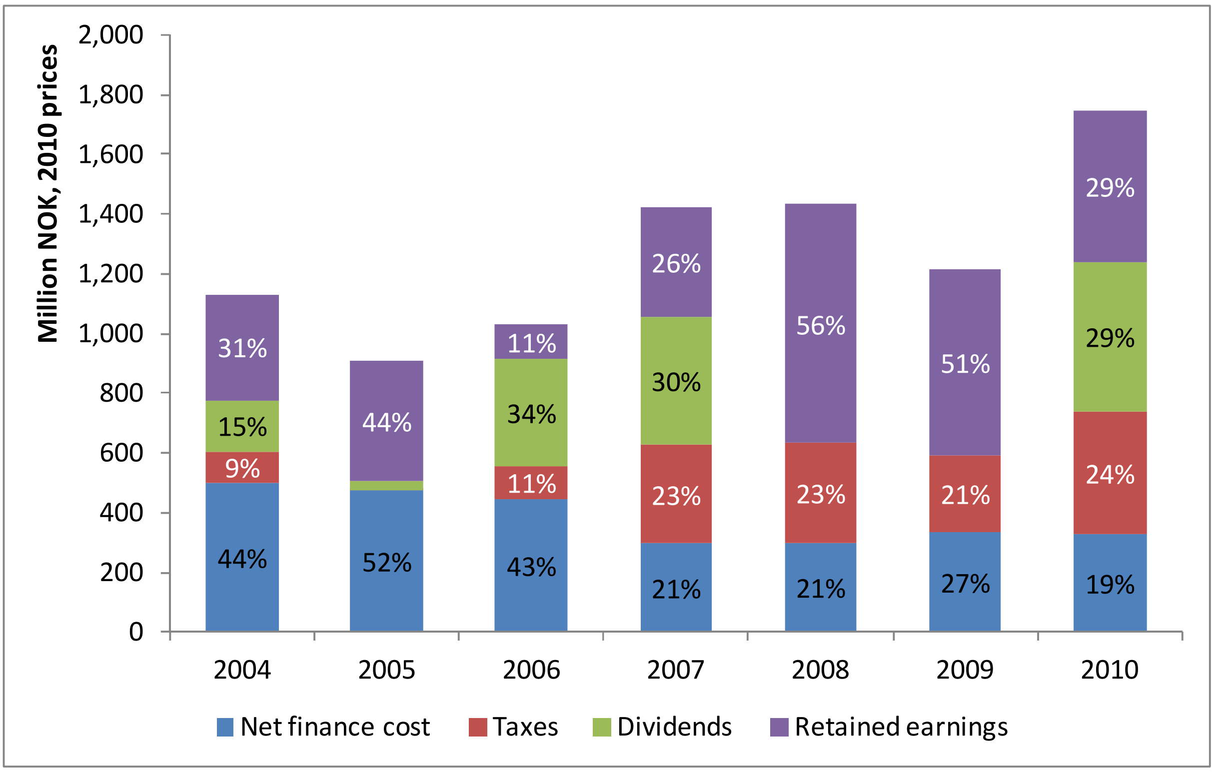


Figure 1.2.2. Avinor Group EBIT distribution during 2004-2010 in NOK, 2010 prices (values inside bars represent proportion of EBIT).

In addition, extra measures in the form of greater freedom for duty-free sales were undertaken in 2006 to increase non-aviation revenues for Avinor and to make them the main funding source. Duty-free sales at arrival were instituted and the permitted alcohol purchase volumes were increased. We estimated the financial effect of this change to be around 350-500 million NOK[13] per annum.

Starting from 2005 Avinor AS became subject to Value Added Tax (VAT) scheme of low rate (7%), which benefited Avinor through the deduction of VAT on its inputs (included in prices) paid to suppliers from its own VAT obligation in the amount of about 250-300 million NOK in total during 2004 and 2005[14]. After 2005 the estimation of input VAT (proportionate to operating costs less labor costs) has been rising and reached over 207.5 million NOK in 2008[15] .

[13] Own calculation based on St.meld. nr. 48 (2008–2009). Om verksemda i Avinor AS.
[14] Lian et al, 2005; St.meld. nr. 48 (2008–2009). Om verksemda i Avinor AS.
[15] Riksrevisjonens kontroll med forvaltningen av statlige selskaper for 2008. p. 102

	2003	2004	2005	2006	2007	2008	2009	2010
Government purchase of the regional airport services	250	264	35	0	0	0	0	0
Government grants to regional airports	0	0	0	0	0	0	150	50
Dividends to Government[16]	0	0	151.5	26.4	324.5	396.9	0	0
PSO subsidies[17]					474	509.8	589.6	656.5

Table 1.2.1. Overview of government subsidies for Avinor (2003-10), in million NOK, nominal values. Source: St.meld. nr. 48 (2008–2009). Om verksemda Avinor AS, 2009.

Apart from these subsidies, the responsibility to maintain the Airport system financially rests with Avinor. Fig. 1.2.3 and 1.2.4 give a snapshot of the cumulative distribution for income and expenses across the airports in 2010. The discrepancy between total costs and generated revenues of the vast majority of airports is clearly depicted. Airports are shown in ascending order by share of total revenues and expenses respectively, thus showing the disparity of cost and revenue distribution. For local and regional airports to generate 17% of total revenue, they have to incur 39% of total costs, meaning the financial return from these airports is negative and has to be compensated by the large group airports and Oslo airport.

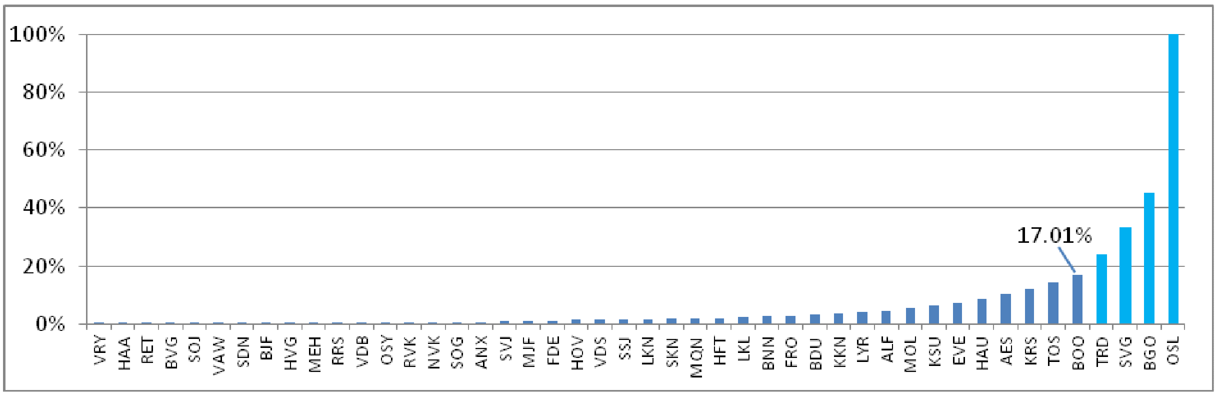


Figure 1.2.3. Cumulative distribution of revenues' shares in total revenue for Avinor in 2010.

[16] Dividends payments relate to years when they were actually paid.
[17] Source NMTC, per operating year (March-April), only part of these subsidies go to the Avinor airports, see section 1.2.4.

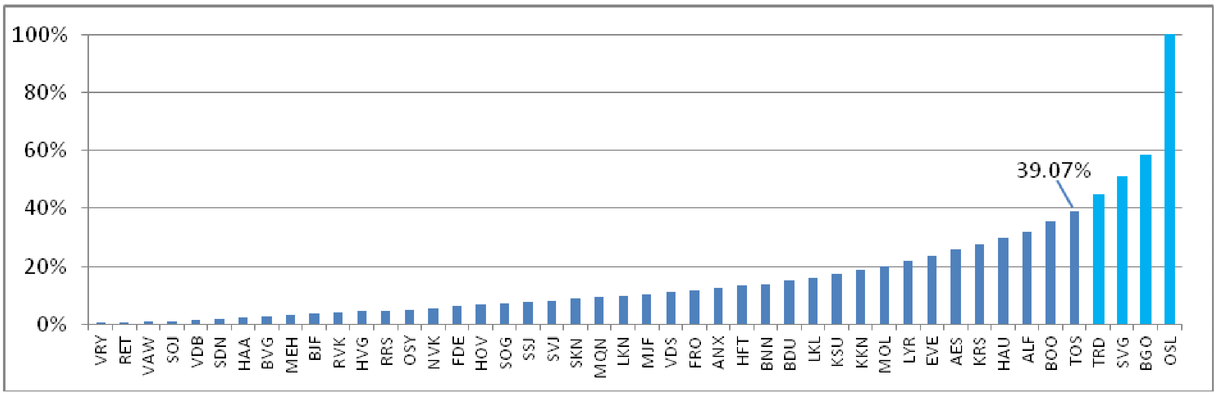


Figure 1.2.4. Cumulative distribution of cost shares in total cost for Avinor in 2010.

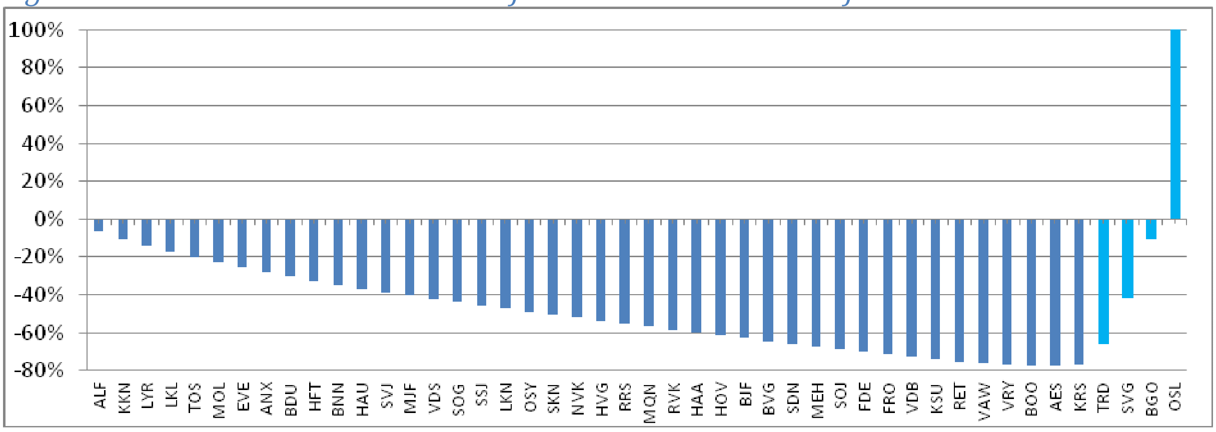
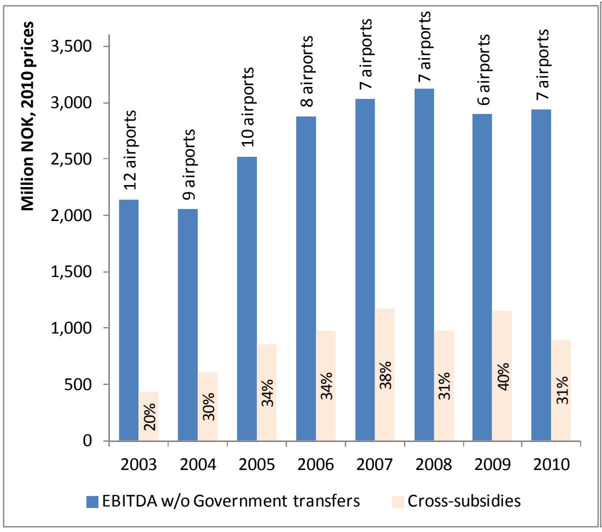


Figure 1.2.5. Cumulative distribution of EBIT shares in total EBIT for Avinor in 2010.

The sum of losses as shown in Fig. 1.2.5 (in terms of EBIT) by local and regional airports in absolute values reaches almost 80% of total operating profit (EBIT). These losses are then almost covered by profits from the three large airports TRD, SVG and BGO alone, while OSL makes the whole system profitable.



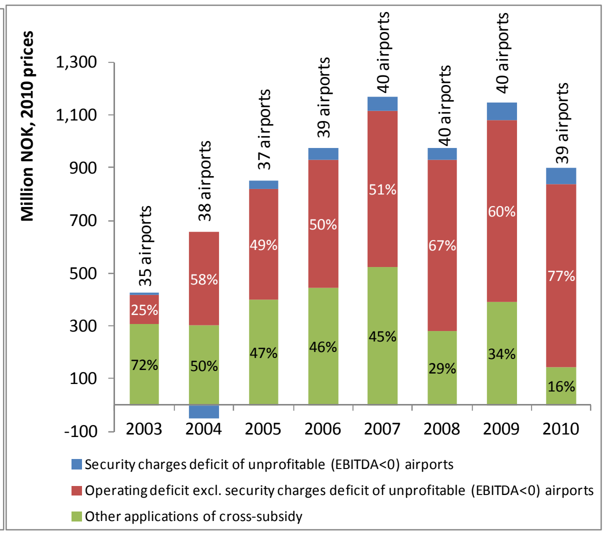


Figure 1.2.6a (left): Source of cross-subsidy – group of profitable (EBITDA > 0) airports of Avinor: EBITDA (excluding government transfers) and Cross-subsidies (values inside bars represent percentages in EBITDA) in 2003-2010 in NOK, 2010 prices.
Figure 1.2.6b (right): Distribution of Cross-subsidy in 2003-2010 in NOK, 2010 prices (values inside bars represent share in total cross-subsidy amount).

The system of cross-subsidization reflects cash transfers from cash generating airports (best available proxy for cash result is EBITDA) to cash-losing airports. Figure 1.2.6a shows the total EBITDA (excluding government transfers occurred in 2003) of profitable Avinor airports that represents the source of cross-subsidy. In spite of the fact that the total inflation adjusted profit has grown by one third, the number of profitable airports has fallen from 12 in 2003 to 6-7 in the last years.[18] In the meantime the amount of cross-subsidy has grown faster than the profits - about twofold in real terms and threefold in nominal terms. That is reflected in the development of the significance of cross-subsidies represented by their share to total EBITDA which rose from 20% in 2003 to 30-40% during the last years.

Fig. 1.2.6b shows the growing share of cross-subsidies inside the Avinor system, applied to covering the operating deficits (operating costs excl. depreciation minus operating revenues). That share of total cross-subsidy has grown from 25% in 2003 to to 77% in 2010. The major items covered by cross-subsidy (such as capital expenditures, cash expenditures not reflected in accounting operating deficits, etc.) have been growing until 2007 inclusively. Security charges deficits (security costs minus security revenues), while growing, constitute only 4-7% of the total cross-subsidy. However, the application of cross-subsidy for such purposes has sharply decreased after 2007, thanks to the extra government initiatives (i.e. government grants for investment, zero dividends for some years, loan repayment exemption). Besides the growing operating deficits of unprofitable airports, the number of unprofitable airports has grown from 35 to 39 from 2003 to 2010.

In summary, since the viability of the Avinor system is currently only based on cross-subsidization from 4 large airports, its financial long-term viablility depends on the future development of revenues and costs.

We therefore look next at the role of government subsidies for PSO routes, which positively influence the performance of regional and local airports by increasing output and revenues and then study in more detail the cost and revenue drivers, in order to understand how they have changed over time and how they differ from those drivers at airports abroad.

1.2.3. PSO routes

We now explore the role of subsidies on the demand side and more specifically the revenues which are generated by subsidized traffic through Public Service Obligation (PSO)

[18] Government transfers included in the EBIT of several airports in 2002 and 2003 were not taken into account in Figures 1.2.6a and 1.2.6b. Without these transfers taken into consideration, the number of profitable airports is relatively stable from year to year. We also have to note that due to a change in the Avinor accounting system, the figures for 2002 and 2003 may not be as reliable as the later ones. Still we can use them to identify the number of profitable airports.

routes. Such PSO subsidies aim to guarantee air service to populations residing in peripheral regions, which under a liberalized market would most likely experience a reduction in flight frequency and level of service.[19] Most PSO routes in Norway are served by the regional network carriers Wideroe, and few by Danish Air Transport and DOT LT (EU Commission 2010b). The total PSO subsidies are quite large, as was seen in Table 1.2.1 above, with 474, 509.8, 589.6 and 656.5 million NOK annually for the period from 2007 to 2010. About 75% of these subsidies flow to the airline operating the PSO routes in order to cover its costs, the remaining 25%, or about 167.2 million of the 656.5 million NOK in 2010 flow indirectly to the airports in form of aeronautical charges paid by the subsidized airlines (see the sum of Column IV in Table 1.2.2). As a consequence, flights on PSO routes influence the performance of airports by creating revenues and demand, which otherwise would not be available at all or only to a lesser degree, through fixing frequencies, capacities and maximum ticket fares in most cases well above the number of economically viable airline operations. Furthermore they create costs to the airports as these flights have to be served under various difficult regional conditions such as weather or topography. In addition, the efficiency of PSO subsidy allocation (i.e. that regional access will be reached with minimal costs) also influences capacity utilization at these airports.[20] Although their capacity may be limited by the number of parking positions and short take-off and landing (STOL) runways, at most airports on PSO routes there is enough capacity available to serve this additional demand.

The individual Norwegian airports rely to different degrees on PSO routes.[21] At 19 out of 36 airports (~53%) more than 90% of the traffic is generated from these routes. In some cases, such as at Florø, Sognal or Røros airport (and Værøy heliport), their traffic comes only from flights on PSO routes (Table 1.2.2)

The subsidies as a percentage of total aeronautical revenue are on average about 39% and vary from about 1% at Oslo up to around 81% at Florø and 82% at Værøy.[22]

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[19] According to EU-Regulation 1008/2008 on PSO routes, these can be tendered out to one carrier, restricting market access by competitors.

[20] Airport mangers cannot influence the efficiency of PSO routes because they cannot influence the type of aircraft, load factors and passenger demand. They can only influence the costs of the airport to serve these PSO flights.

[21] For calculating the percentage of PSO-passengers on some of the airports we calculate the fractions of the annual departing PSO Passenger numbers as stated in the annual PSO tender documents (averaged over 4 years, but depending on availability of data) and the annual departing pax as reported in the traffic statistics (total pax divided by 2). Due to different reporting periods (April to March for the PSO figures and January to December for the traffic figures), the averages from 2006 to 2008 and 2009 to 2011 were used for smoothing).

[22] Subsidies for airports received through PSO are calculated as the aeronautical charges of an airport multiplied by the share of PSO routes in terms of movements. Please note that this approximation represents an upper limit as aeronautical revenues also include the revenues from general aviation and other activities.

Our aim in Table 1.2.2 was to measure the *degree of dependency* of Avinor airports from PSO traffic, i.e originating passengers or aeronautical revenues. Table 1.2.2 can only give an indication of this degree of traffic dependency (Column II) by stating the four year average percentage of *originating passengers* from airports on PSO routes (Column I; derived from the call for tender documents) over total 'domestic scheduled originating passengers' (i.e. total passengers minus transit and transfer passengers from Avinor traffic statistics). The degree of dependency from revenues generated through PSO traffic (Column V) is calculated by multiplying 'average aeronautical revenues per passenger' at each airport by the number of originating passengers on PSO routes (Column IV) divided by the total revenues. At some airports we observe a large discrepancy between the degree of dependency from PSO traffic and PSO revenues, thus it seems that those airports receive large amounts of non-aeronautical revenues and fees from non-scheduled traffic (e.g. airports Fagernes, Roros, Banak, Berlevåg, Båtsfjord, Andoya etc.). In total about 1 million passengers or 10% of domestic air passengers travel on PSO-routes in Norway (sum of Column I in Table 1.2.2).

The efficiency of PSO subsidy allocation (i.e. that regional access will be reached with minimal costs) also influences capacity utilization at these airports.[23] Of interest in this connection is a study by the Institute of Transport Economics (2010) – commissioned by the NMTC – which evaluated the tendering of PSO routes in Norway. The study recommended among other things:

a) To increase competition for the tender by loosening the size specification for aircraft (allowing smaller aircraft with less than 30 seats and non-pressurized cabins) and to increase the runway length at some airports to allow for more types of aircrafts and airlines to compete in that market.
b) To set only a maximum *average* price so that airlines can offer discount fares and prices according to the willingness of passengers to pay.

The recommendations are also highly relevant for the performance of airports. Less restrictive service quality standards, which would lead to the use of smaller aircraft with higher seat load factors, would not only give the government a better value for its PSO subsidies, but would also increase the performance of airports through more aviation output and revenues[24].

[23] Airport mangers cannot influence the efficiency of PSO routes because they cannot influence the type of aircraft, load factors and passenger demand. They can only influence the costs of the airport to serve these PSO flights.
[24] However, some revenues from weight-based landing charges are going to decrease due to lower aircraft weights. A practical problem remains the lack of competition in serving such low demand and STOL runway locations.

Airport Name	IATA	Average departing Passengers flying on PSO routes in 2006 to 2008 and 2009 to 2011 in thousands (I)	Passengers on PSO routes/Passengers flying on scheduled domestic flights (Average 2006 to 2008 and 2009 to 2011) (II)	Percentage of all Passengers flying on PSO routes in Norway (III)	Aeronautical Charges from flights on PSO routes in thousand NOK (2010)[25] (IV)	Aeronautical Revenues from flights on PSO routes per Total revenues (2010)[26] (V)
Alta	ALF	13.2	8%	1.3%	1,896	5%
Andøya	ANX	16.4	91%	1.6%	2,558	36%
Bergen	BGO	45.3	3%	4.5%	9,100	1%
Båtsfjord	BJF	5.00	95%	0.5%	750	30%
Brønnøysund	BNN	32.0	87%	3.2%	8,889	50%
Bodø	BOO	147.5	30%	14.7%	22,748	13%
Berlevåg	BVG	2.4	88%	0.2%	395	22%
Førde	FDE	35.8	95%	3.6%	5,497	69%
Florø	FRO	56.0	99%	5.6%	14,583	81%
Hasvik	HAA	2.9	88%	0.3%	470	36%
Hammerfest	HFT	18.9	38%	1.9%	2,677	23%
Ørsta-Volda	HOV	33.1	93%	3.3%	4,982	60%
Honningsvåg	HVG	5.3	79%	0.5%	828	31%
Kirkenes	KKN	19.3	19%	1.9%	2,708	10%
Banak (Lakselv)	LKL	20.8	89%	2.1%	3,282	23%
Leknes	LKN	42.7	98%	4.2%	6,345	69%
Mehamn	MEH	5.6	81%	0.6%	969	33%
Mosjøen	MJF	26.0	92%	2.6%	4,066	52%
Mo i Rana	MQN	39.2	93%	3.9%	5,854	55%
Narvik	NVK	13.3	96%	1.3%	2,165	60%
Oslo Gardemoen	OSL	112.2	3%	11.2%	19,445	1%
Namsos	OSY	10.4	95%	1.0%	1,529	44%
Røst	RET	4.6	96%	0.5%	1,043	71%
Røros	RRS	5.3	100%	0.5%	1,032	33%
Rørvik	RVK	10.7	95%	1.1%	1,567	44%
Sandane	SDN	14.2	94%	1.4%	1,023	42%
Sogndal	SOG	32.9	100%	3.3%	3,837	58%
Sørkjosen	SOJ	5.3	85%	0.5%	762	36%
Sandnessjøen	SSJ	27.0	94%	2.7%	4,141	49%
Svolvær	SVJ	33.7	98%	3.4%	5,435	77%
Tromsø	TOS	30.9	5%	3.1%	4,290	3%
Trondheim	TRD	101.4	8%	10.1%	16,626	4%
Vardø	VAW	4.3	70%	0.4%	643	28%
Fagernes	VDB	2.0	98%	0.2%	735	22%
Vadsø	VDS	24.3	75%	2.4%	3,428	41%
Værøy	VRY	4.8	100%	0.5%	906	82%
Sum		1,004.7		100%	167,204	
Average		27.9	74%		4,645	39%

Table 1.2.2. Subsidies from Public Service Obligation (PSO) routes (2010).
Source: Own Calculations based on Data from NMTC 2011 and Avinor 2011.

[25] Aeronautical Charges per PAX x (Column I)
[26] (Column IV) / Total Revenues (incl. 'Other Revenues' from non-operational sources)

Similar effects would occur from the use of additional discount air fares on PSO routes, depending on the catchment areas. Both recommendations would lead to higher seat load factors which would increase capacity utilization at airports and have a particular strong effect at those airports with a large share of PSO routes.

1.2.4. Estimating Subsidies per Airport

As we saw, the Avinor system has to finance (internally) the growing deficits of the local and regional airports. In addition, the government finances (externally) the PSO routes which positively influences the performance of regional and local airports. To get an understanding of the influence of these financial flows, we now summarize the two effects (see Table 1.2.3):

- Concerning cross-subsidies we lack detailed figures on the basis of each airport. Therefore we were forced to perform a rough calculation for each individual airport by taking operating deficits (costs minus revenues) per airport as a proxy for internal cross-subsidy per airport. This proxy underestimated the real flows as subsidies are also used to finance investment: indeed, our proxy covers only about half of the total reported subsidies[27].
- Concerning the subsidies from PSO flights, we have calculated the revenues the airports receive in the form of induced aviation charges as in section 1.2.3 on PSO above.

Both effects together constitute the total subsidies per airport. We have also calculated the subsidy as percentages of total operating cost and have ranked the airports accordingly.

Our analysis shows that:

- Internal subsidies are much more important than the benefits received through PSO induced aviation revenues although our proxy of the internal subsidies largely underestimates the internal subsidies.
- Local and regional airports are subsidized on a large scale. These subsidies make airports very attractive for the rural areas as this transport infrastructure becomes "a free gift" for the local community. These results suggest that the Norwegian airport system operates with a weak budget constraint, where any deficits at the local level

[27] The total sum of operating deficits for the period 2003-2010 for all airports it about 3,308 million NOK and total nominal cross-subsidy over same time span is about 6,583 million NOK in nominal terms.

Airport Name	IATA	Partial Cross-Subsidy (Deficit)	Aeronautical Charges income from PSO	Total of the two subsidies	PAX	Total Revenues	Total Subsidies in % of Total Revenues
Hasvik	HAA	14.3	0.5	14.8	14,504	1.32	1,128%
Røst	RET	12.5	1.0	13.6	10,577	1.48	918%
Værøy	VRY	8.2	0.9	9.1	10,459	1.11	819%
Berlevåg	BVG	14.0	0.4	14.4	15,119	1.80	800%
Sørkjosen	SOJ	13.3	0.8	14.1	23,181	2.10	669%
Honningsvåg	HVG	14.3	0.9	15.2	27,222	2.66	569%
Sandane	SDN	12.5	1.0	13.5	22,919	2.45	549%
Båtsfjord	BJF	12.6	0.8	13.3	24,427	2.53	526%
Vardø	VAW	11.0	0.8	11.9	27,928	2.31	514%
Namsos	OSY	14.9	1.6	16.5	39,029	3.46	477%
Narvik	NVK	14.5	2.2	16.7	33,059	3.59	464%
Mehamn	MEH	11.4	1.0	12.4	24,275	2.96	420%
Røros	RRS	12.0	1.0	13.0	15,799	3.10	419%
Rørvik	RVK	12.7	1.6	14.4	37,647	3.56	404%
Fagernes	VDB	12.4	0.7	13.1	6,450	3.31	398%
Andøya	ANX	17.9	2.6	20.5	50,313	7.02	292%
Svolvær	SVJ	13.8	5.5	19.3	73,136	7.08	273%
Sogndal	SOG	12.8	3.9	16.7	88,792	6.67	250%
Mosjøen	MJF	13.7	4.1	17.8	80,023	7.77	229%
Vadsø	VDS	15.1	3.4	18.6	102,015	8.31	223%
Ørsta-Volda	HOV	12.7	5.3	18.0	98,240	8.30	217%
Leknes	LKN	13.0	6.5	19.5	99,358	9.25	211%
Banak (Lakselv)	LKL	26.2	3.4	29.6	58,331	14.17	209%
Førde	FDE	10.9	5.6	16.5	82,000	8.01	206%
Sandnessjøen	SSJ	11.6	4.3	16.0	93,686	8.50	188%
Hammerfest	HFT	17.8	2.5	20.3	123,273	11.44	178%
Alta	ALF	62.8	1.6	64.4	333,593	39.40	163%
Mo i Rana	MQN	10.8	6.0	16.8	108,860	10.58	159%
Brønnøysund	BNN	16.9	9.0	25.9	130,379	17.79	146%
Stokmarknes	SKN	12.3	0.0	12.3	106,795	9.52	129%
Kirkenes	KKN	30.3	2.7	33.1	281,487	26.30	126%
Florø	FRO	7.9	14.6	22.5	159,141	18.08	125%
Svalbard	LYR	32.1	0.0	32.1	125,781	37.62	85%
Bardufoss	BDU	12.4	0.0	12.4	190,584	20.47	61%
Molde	MOL	21.6	0.0	21.6	392,901	47.48	45%
Evenes (Harstad-Narvik)	EVE	20.2	0.0	20.2	551,573	69.05	29%
Bodø	BOO	0.0	22.5	22.5	1,611,869	173.11	13%
Haugesund	HAU	6.7	0.0	6.7	558,938	94.35	7%
Tromsø	TOS	4.3	4.1	8.4	1,649,584	165.17	5%
Trondheim	TRD	0.0	16.7	16.7	3,521,734	460.64	4%
Kristiansund	KSU	1.6	0.0	1.6	347,550	53.05	3%
Bergen	BGO	0.0	9.2	9.2	5,078,267	802.57	1%
Oslo Gardemoen	OSL	0.0	21.0	21.0	19,091,036	3.693.85	1%
Stavanger	SVG	0.0	0.0	0.0	3,674,816	654.77	0%
Ålesund	AES	0.0	0.0	0.0	833,534	110.78	0%
Kristiansand	KRS	0.0	0.0	0.0	839,916	123.32	0%

Table 1.2.3. Total subsidy structure for Avinor Airports (2010). Monetary values in million NOK, 2010 prices. Sources: Avinor, EU-Commission, OAG.

are fully covered by cross-subsidies from within the Avinor system and through PSO flight induced subsidies from the NMTC. This raises concerns for local airport management because it has few instruments and little economic incentive to make the regional airport stand on its own feet, or come closer to breaking even.

1.2.5. Cost and Revenue Drivers

1.2.5.1. Cost drivers

Employee expenses, depreciation of assets, security expenses and internal purchases constitute the main cost components of Avinor airports[28]. These four types of costs comprise approximately 75% of the total costs. For this reason we analyze the trend of these components in detail from 2002 to 2010 as well as for the different Avinor groups (OSL, large, regional and local airports).

We find that among the main cost drivers, in addition to security[29], employee costs are one of the most important factors. Total employee expenses represent approximately one fourth of total operating costs of Avinor airports and they increased by 53% from 2002 to 2010. In particular, from 2004 to 2005 there was a 22% increase in total employee expenses. Due to missing data on the number of full time equivalent (FTE) employees before 2006, a detailed analysis of the number of employees in relation to employee expenses starts only from 2006. One explanation for the increase in the number of employees (FTE) that began again in 2007 and amounted to about 10% in that year might be related to the departure of Randi Flesland, the CEO who had initiated the rationalization project "Take-Off. 05". Another and perhaps even more important determining factor of employee expenses was the increase in real salaries, whose effect can be seen in Figure 1.2.8a below. Regarding the differences among varying airport groups, the share of employee expenses in total operating costs is higher for smaller airports than for larger ones.

In 2010, for instance, it was about 18% in the large airport group and Oslo, 25% in the regional group and 40% in the local group. The higher share of employee expenses reflects, to some degree, a certain amount of labor that is required to maintain essential airport functions and that cannot be downsized in accordance with lower traffic flow at smaller airports. This tendency is also reflected in the large differences of labor productivity between large and small airports measured in passengers per employee (see Figure 1.2.8b).

[28] Note that throughout this section, all financial variables are inflation adjusted real values.
[29] Security costs rose more than proportional for the small airports and may explain some of these employee's developments we have seen above, even though security services were outsourced.

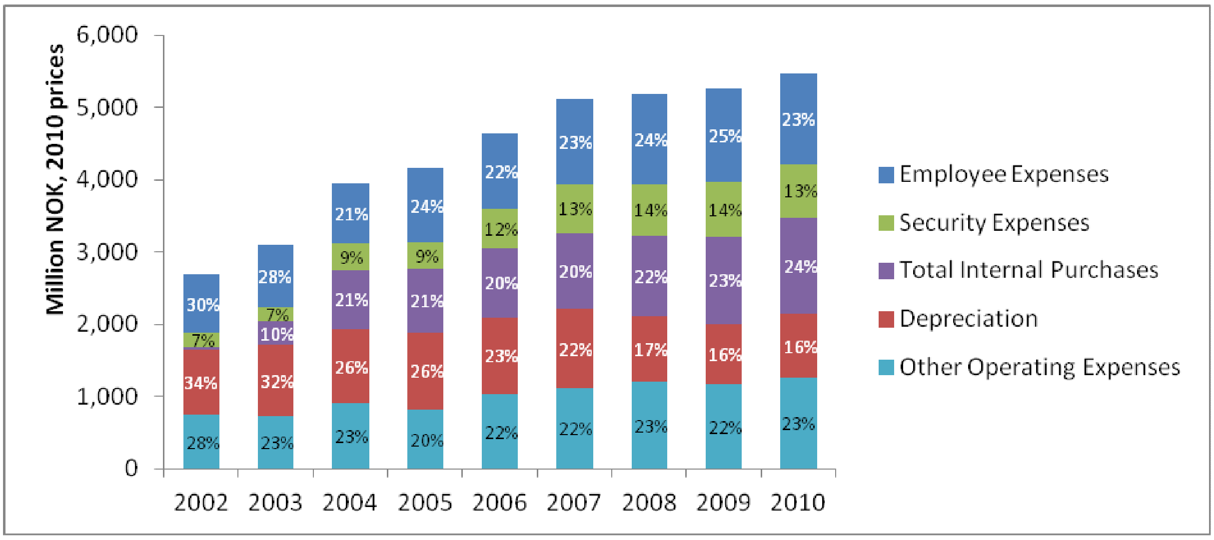
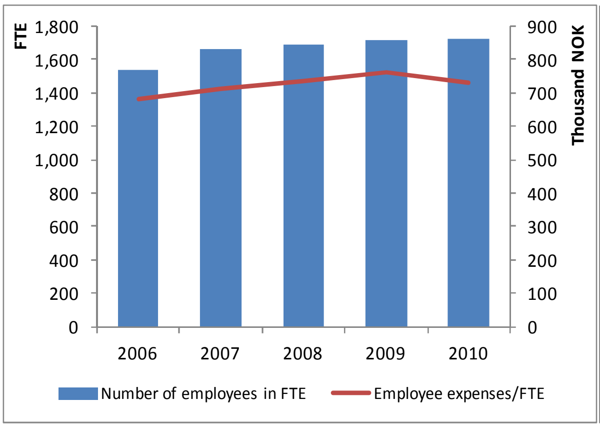


Figure 1.2.7. Structure of Total Operating Costs, in NOK, 2010 prices.



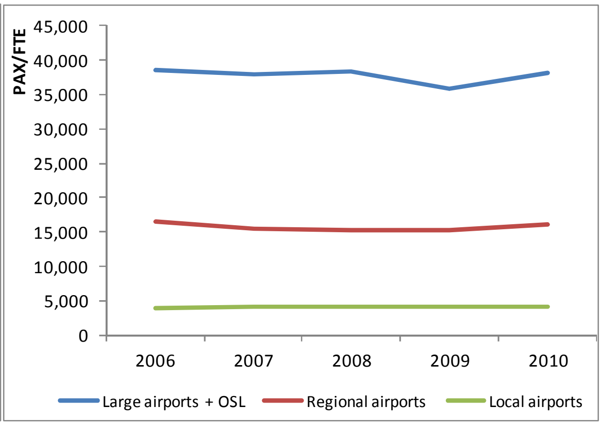


Figure 1.2.8a (left). Total number of Employees (FTE) and Employee Expenses per Employee (FTE) in thousand NOK, 2010 prices.
Figure 1.2.8b (right). Partial labor productivity (in passengers per FTE) by airport groups (2006-10).

Amounting to only 7% in 2002, the share of security expenses in total operating costs has risen to 13% in 2010. An almost 300% increase in total security expenses in real terms over this period can be explained by increasingly strict regulations after the September 2001 terrorist attacks. However, it should be noted that the costs of security services are passed on to the customers through security charges introduced in 2004[30].

In addition, internal purchases, one fourth of total operating expenses which are related to services bought within the Avinor group, such as air navigation services and rental

[30] Security issue will be analyzed in detail below in section 1.3.

payments for Oslo airport´s land, have grown from 35 million NOK in 2002 to 1.3 billion NOK in 2010.[31]

The regional and small airports have been unable to absorb cost increases; given mimimum manning requirements. At the same time, depreciation has risen following the upgrade of the airports that were taken into the Avinor (by that time Luftfartsverket) system in 1997 and 1998 to the same quality standard as the rest of the system.

Overall operating costs doubled from 2002 to 2010 for Avinor airports. One of the reasons for conducting an international benchmarking is to determine whether this increase is in line with the general trend in Europe.

1.2.5.2. Revenue Drivers

In real terms aeronautical revenues of Avinor increased by around 46% from 2002 to 2010, but this can be fully attributable to the increase in security charges. Aviation charges (i.e. passenger and landing charges) stayed constant over this period as can be seen in Figure 1.2.9, which suggests that the increasing operating costs have not been passed on through aeronautical charges. We shall explore these issues below in Section 1.5.

Similar to the general trend in the airport industry, commercial revenues of Avinor have gained importance in the last decade (Figure 1.2.10). While they represented 40% of total revenues in 2002, the share increased to 48% in 2010, mainly due to the increase in duty free revenues[32]. Newly introduced measures, such as duty free at arrival and an increase in the alcohol limit in 2006 as outlined in section 1.2.2, are the driving forces behind this rapid increase. In real terms duty free revenues tripled over the period from 2002 to 2010. In addition, revenues from car parking play an important role in generating commercial revenues and show a constant upward trend with approximately an 8% increase per year. Mainly due to the increases in duty free and car parking revenues, total commercial revenues of Avinor doubled in eight years.

At Oslo airport, commercial revenues accounted for approximately 57% of total operating revenues in 2010, achieving almost twice as much per passenger as at other large Avinor airports. Duty free revenues per passenger at Oslo are more than twice as large

[31] Around 2/3 of internal purchases for all airports except OSL is attributed to navigation services, whereas in the OSL case 2/3 of these costs (in 2010 aprx. 400 million NOK out of 583 million NOK in 2010 prices) is spent on rental payments for the airports real estate, as OSL rents the land from Avinor AS. The rest 1/3 of internal costs of Avinor airports except OSL goes to common administrative and technical tasks, as well as in the large airports group - to real estate rental payments.

[32] See also “2.5.3 Revenue generating capability: comercial revenues” below.

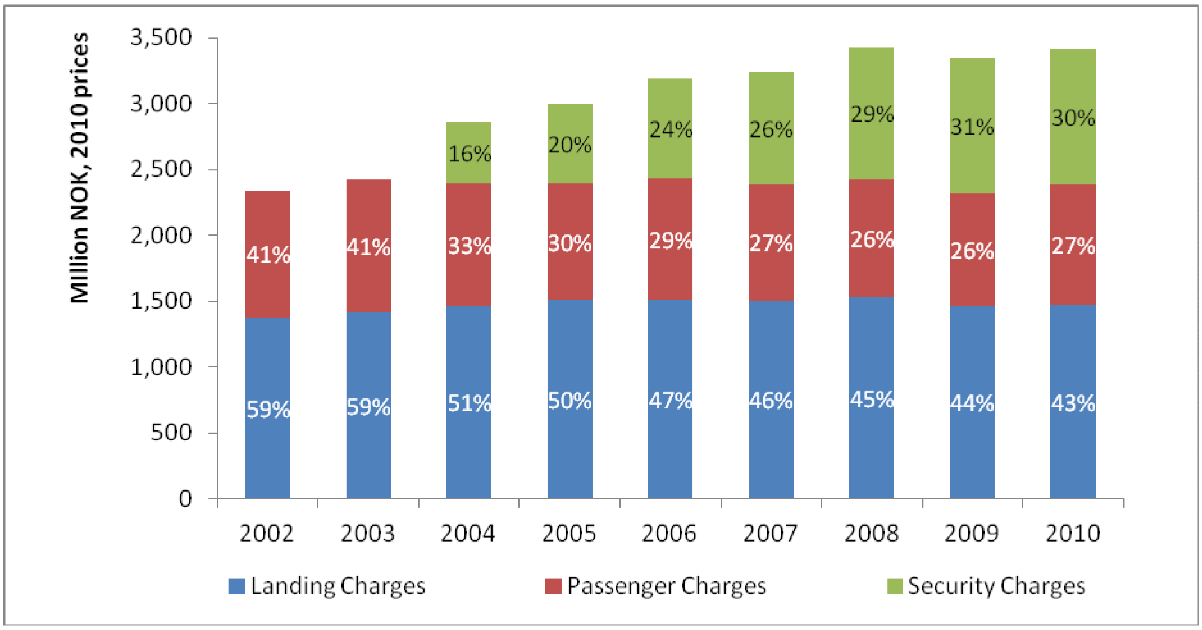


Figure 1.2.9. Structure of Aeronautical Revenues (all airports), in NOK, 2010 prices.

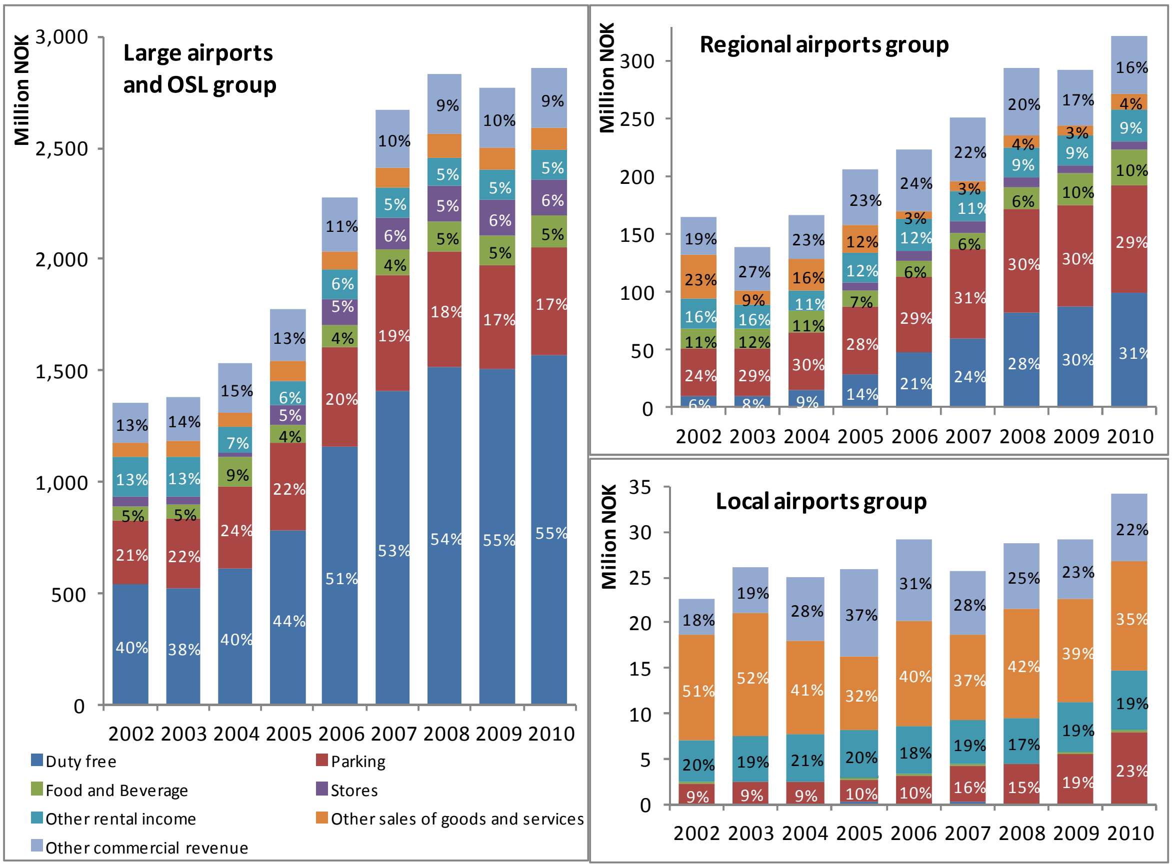


Figure 1.2.10. Structure of Commercial Revenues, in NOK, 2010 prices. (Values inside bars represent the share of the respective components in the total commercial revenue).

compared to the other large airports and are 5-10 times the revenues per passenger earned at regional airports. The increase in commercial revenues was different in various airport groups within Avinor: Oslo and the three large airports increased their real total commercial revenues by 111% in nine years from 2002 to 2010. This growth rate was 95% for regional airports, and only 51% for local airports. Oslo and the three large airports benefit from a high share of duty-free revenues due to a high number of international passengers (the number of international passengers has doubled during 2002-2010). At regional airports, in 2010 total duty-free revenues were ten times as high as they were in 2002. This can be explained by the fact that these airports served three times more international passengers in 2010 than in 2002, as well as by the above mentioned features for duty-free shops in Norway. Suffering from low traffic, local airports are unlikely to achieve high commercial revenues. Nevertheless, with a 30% increase in the number of passengers they were able to raise their commercial revenues by 50% up to 34 million NOK in 2010.

1.3. Airport Security

Given the large increase in security costs noted above it is important to analyze the effects of security regulation and current policies on security costs in detail. Following the 9/11 attacks, governments all around the world implemented a number of additional security measures. According to IATA, "in the last decade airline security costs rose to an annual estimated bill of $7.4 billion" (Schvartzman, 2011).

Regarding the new regulations, a number of authors argue that these measures may have been politically inspired, thus only making the airport system look more secure while producing increasing costs[33], rather than being based on a risk-assessment (e.g. Poole, 2008). Stewart and Mueller (2008) show that only a few of these measures undertaken in the US successively passed cost-benefit analysis, which confirms an earlier work by Schneier (2006).

The EU has implemented a number of regulations and directives[34]. The EU law explicitly distincts between the traditional airport charges and security charges. Security charges should be used exclusively to meet security costs. These costs should be determined using the principles of economic and operational efficiency and of accounting and evaluation practices. It is left to each member state[35] to determine the circumstances and the extent to which the security measures should be borne by the state, the airport entities, air carriers or other responsible agencies or users.

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[33] Before 9/11, security accounted for 5-8% of operating costs for European airports. After the various additional layers of security the figure rose up to today's level of 29% (ACI Europe and AEA, 2011).

[34] Regulation (EC) No 300/2008 of the European Parliament and of the Council of 11 March 2008 on common rules in the field of civil aviation security. For detailed measures for the implementation of the common rules there is the Commission Regulation (EU) No 185/2010 of 4 March 2010.

[35] Norway is not a member of the EU but of the European Economic Area, where EU regulation still apply.

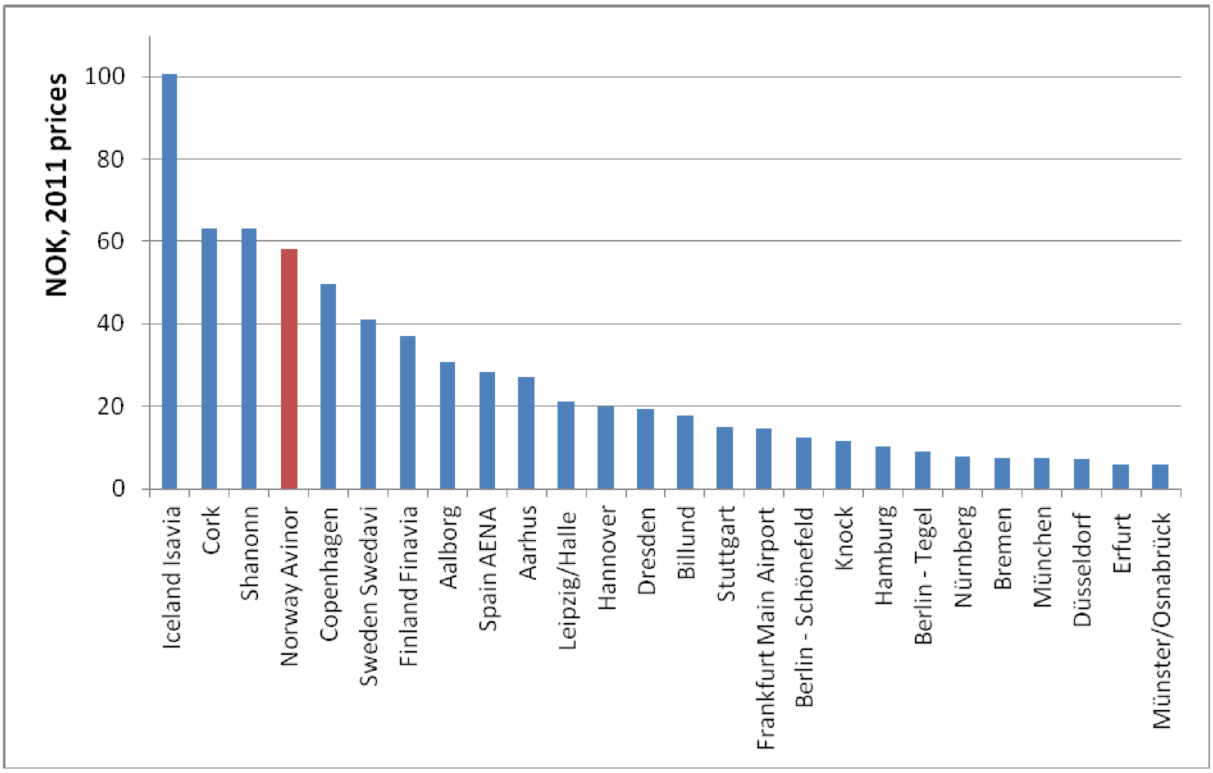

Figure 1.3.1. Year end security charges per passenger in 2011, in NOK, 2011 prices.[36]

Figure 1.3.1 shows security charges per passenger across Europe. Ideally, these charges should be closely related to the associated costs. Norway is among those countires with a relatively high level of security charges. Since security charges in Norway are based on outsourced security, costs in large part reflect the actual costs, except for the extra investment borne directly by Avinor, which are reflected in depreciation from security investment.

Akhtar et al. (2010) assess security measures at Norwegian airports and seaports by a cost-benefit and cost-effectiveness analyses. With major focus on potential terrorism fatalities, the conclusion is that the estimated implicit cost per one life saved from security costs in airports is likely to be higher than usual. However, they admit that there is a possibility that the benefits of implemented security measures are underestimated since the cost-benefit analysis excludes some impacts, one of them being indirect impacts on transport from terrorist attack.

Concerning the increasing security costs we also argue that these costs must be incurred in the light of more stringent regulatory requirements (Havarikommisjonen for sivil luftfart og jernbane, 2005). On the other hand, to avoid imposition of high security charges on low-volume regional airports, thereby diminishing their ability to attract and retain air

[36] Sources: AIP for Iceland, Norway, Spain and airports in Germany, Official websites for airports in Sweden, Denmark and Ireland and Finavia Terms of Service for Finland.

services, Avinor uses a uniform pricing model where the security costs are shared through the network.[37] [38] This flat rate security charge had been initially increased gradually but has been stabilized lately and even lowered from 60 NOK in 2009 to 47 NOK in April 2012.[39]

In order to benchmark security charges, we first examine the airport security systems in other countries. Prior to the 9/11 attacks, aviation security was usually handled on a national basis and often funded this way. According to Hainmuller and Leminitzer (2003), large airports in Germany implemented their airport security measures as mandated and were already funded by the Federal Government in the 1980s. However, the pressure on the state budget led to an introduction of aviation security fees in order to recover part of the cost of state employees and equipment costs. With rising cost pressure, the Federal Government issued the permission to allow outsourcing of security, so now "*most of the German airports employ private screening firms or conduct screening themselves*" (Hainmuller and Leminitzer, 2003). This pattern has been similar in other European countries (Poole, 2008). Already in 2001, passenger and baggage screening was handled by either private security firms or a privatized airport company at 22 of the 25 largest airports in Europe[40] (Poole, 2006).

Contrary to these trends in the operation of the security system, there is no clear pattern in Europe of how costs of aviation security are covered. For example, in the UK airports are responsible for security costs, which are usually recovered through fees and charges to airlines. But this is not always the case; for instance the very low German charges are due to the fact that the costs of security services are mainly borne by the Federal budget. Some airports recover only infrastructural costs from security charges (Belgrade), and for some small and regional airports there are no security charges at all (Montenegro airports, Bornholm).

Therefore, the comparison of charges does not reflect the real costs of security or their evolution over time. The presentation of security charges in Figure 1.3.1 above rather reflects the system as a whole: the airport security program, government involvement and authorities in charge, the general security policy and practice, traffic and passenger volumes, etc. The lack of information and transparency on security costs makes a sound benchmarking analysis

[37] Avinor's charges, included the security charges, are set by the Ministry of Tr. & Comm, with the flat rate of the security charge as the main motivation this distributional aspect.

[38] Simple comparison of different airport security pricing schemes for Australian airports also suggests some benefits of network model against *charges-per-airport* model (Access Economics, 2008).

[39] This coincides with the beginning of realization of the contract between Avinor and Securitas Transport Aviation Security AS (STAS) for the provision of security control services to all of Avinor's airports with the exception of OSL.

[40] The exceptions were in Portugal, Spain and Switzerland.

difficult. As an approximation we have therefore performed a simple comparison of security charges for countries with a national or airport system, i.e. between Norway, Finland, Sweden, Spain and Iceland, since these countries have a standardized national airport security charge[41]. This does not imply that all those systems use the same network pricing model as Avinor does, but they resemble each other in principle.

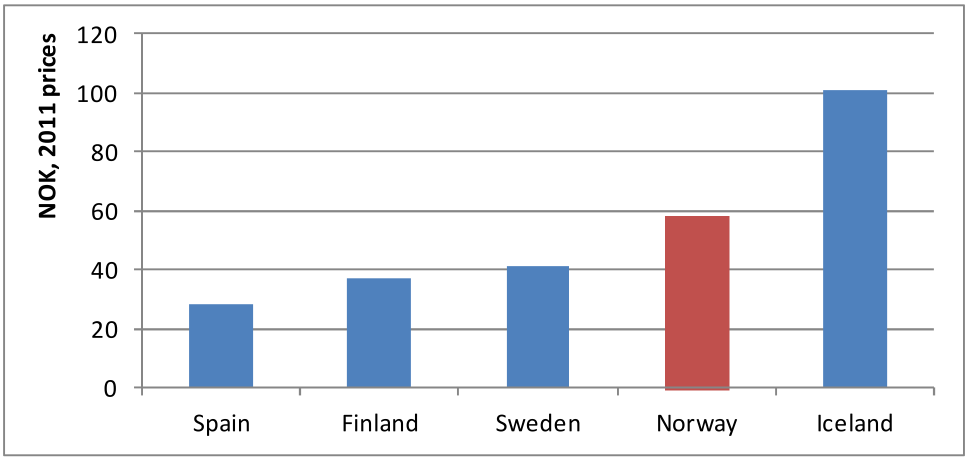

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Figure 1.3.2. Security charges per departing Pax in NOK for year 2011 in Norway, Finland, Sweden, Spain and Iceland, in NOK, 2011 prices. Sources: AIC, AIP, Finavia Terms of service 2011, Swedavia Website.

According to Figure 1.3.2, Spain with 150 million passengers in 2011 has the lowest charge/pax while Iceland has the highest with only 3 million passengers. This could be an indication for economies of scale.

At the Spanish AENA airports the security forces are a mix of Civil Guard, National Police, regional and local police and recently also private security guards. AENA annual reports show substantial investments in the airport security system for the last ten years. It seems likely that in Spain security costs are covered mostly through security charges (AENA, 2010), the same holds for Isavia international airports (Keflavik International Airport, 2006). But as Iceland is exempted from European regulation regarding security inspections for domestic flights, this lowers the total security costs for Isavia airports significantly[42].

Finavia, the Finnish airport operator, covers the security costs through security charges. Due to increasing security costs, security charges were substantially increased in 2003, 2006 and 2007, but have remained relatively stable since then. Finavia's Board of Directors even decided to reduce security charges by approximately 10% in September 2009.

[41] With some exceptions for Spain and Iceland; there are also some differences in charges for transfer and transit passengers and for those who are exempted from paying.

[42] Only Reykjavik, Akureyri, and Egilsstadir airports have international flights, and security (weapons) inspections are only performed on the international flights, not the domestic ones.

In Sweden, the Swedish Transport Agency (STA) has set the security charge by a leveling system, i.e. the fee is the same at all airports regardless of size, which is achieved by distributing the total costs over the total number of departing passengers (STA, 2009). Even though the airports Arlanda and Bromma in Stockholm reported reduced security costs (Securitas, 2011), the security charge per passenger increased overall from 30 SEK in 2007 to 38 SEK in 2011.

In summary, we find that there are different security systems across Europen airports and little detailed information, which prevents us from doing a proper benchmarking. While in Norway security charges according to the uniform pricing model are higher compared to other countries except for Iceland, the unclear cost allocation prevents us from concluding that the cost differential reflects inefficiencies.

One should bear in mind that security and safety are highly sensitive topics, meaning that the costs of provision are usually not questioned that much. On the other hand, it is still very difficult to assess what would be considered an efficient security cost for a reasonable level of quality. From what we learned, the Finavia airport security system could be regarded as a best practice benchmark.

1.4. Implications for benchmarking: Summary

For many of the small Avinor airports, profitable operations are not possible as low levels of traffic do not allow them to cover their costs. This situation has become more difficult over time, as the breakeven point seems to have shifted. As a result, fewer airports are profitable today than in the past and the need to cross-subsidize regional and local Avinor airports seems to be permanent and growing, with fears of rising amounts of subsidies in the future. This is due to, among other things, the fact that operating costs have doubled in real terms from 2002 to 2010. This increase is caused by many factors such as:

- Employment costs have increased significantly by 53% between 2002 and 2010. From 2004 to 2005 there was a drastic jump of 22%. Costs have increased more than proportionally for the regional and small airports, because their ability to absorb cost increases has been limited by given manning requirements.
- Depreciation has risen following the upgrade of the airports that were taken into the Avinor system in 2003 to the same quality standards as the rest of the system.
- From 2002 to 2010 security expenditures have risen fourfold.

- Internal purchases – mainly attributed to navigation services, and rental payments for Oslo airport´s land – have grown from 35 million NOK in 2002 to 1.3 billion NOK in 2010 in 2010 prices.

The trend of increasing costs raises the question whether Avinor could have controlled these increases or if they have been caused by factors outside of the management's control. It also raises the question if other European airports have experienced a similar trend, which could be analyzed by an international benchmarking analysis across Europe.

Over the last several years the financial responsibility for covering the losses of small airports has increasingly shifted to the Avinor system via cross subsidization, so that large airports must be highly profitable for the viability of the system. The increase in their total revenues and profits is related to the development of commercial activities rather than the rise of aeronautical revenues, which have remained relatively constant in real terms. The increase in commercial revenues has been largely achieved thanks to the more favorable regulations of duty-free shops.

In addition, the NMTC did not take out dividends in the financial years 2003, 2008 and 2009, thereby providing the company with an additional source of funds for financing operating losses of smaller airports, investment expenses, etc.

Subsidies for PSO routes have been another important financial instrument to sustain the air transport network. PSO subsidizing for airlines' operations in non-commercially viable routes made the flights to many of the loss-making airports affordable, thereby stabilizing the demand and revenues from air traffic services.

Avinor´s aviation charges have remained relatively constant in real terms, except for the required addition of security charges. To assess the current level and structure of aviation charges, they need to be benchmarked against airport charges in other countries.

1.5. Benchmarking Avinor charges

We compare charges of large and small Norwegian airports with those of other European airports of similar respective sizes. Subsequently, we will summarize and assess the airport charges and their effects.

Aeronautical revenues of the Avinor group have stayed constant since 2002, but have increased since 2004 due to the introduction of security charges. Real charges per movement have been decreasing at all airports, but this effect has been more than offset by increasing security charges. Aeronautical revenues show similar trends as charges are set uniformly across Norwegian airports. Differences in aviation revenues between large, regional and small airports are largely determined by fleet mix and the share of international passengers.

1.5.1. International Comparison of Avinor Charges

Charges manuals for small European airports are often not easily available. In addition, there is some evidence that due to discounts small airports in several European countries charge lower prices than those which are published. Therefore we use the following approaches:

1. For a comparison of charges of large airports we use the ATRS International Charges data base (ATRS, 2008, 2009, 2010);
2. For small airports we will compare Norwegian airport charges with those of small[43] UK and German airports. We have chosen these airports because they face more competition than other airports and provide some indication about the level of (imperfect) competitive charges. The comparison is based on charges manuals. As such a comparison might be distorted by discounts we also approximate average charges by calculating aeronautical revenues per movement.

1.5.2. Benchmarking of airport charges of large European airports

The sample consists of 44 airports, including Oslo Gardermoen airport. We compare the landing and passenger charges, excluding security charges for international flights with a seat-load factor of 75%; for the typical aircraft type, A320-100[44] (MTOW 74 tonnes, 150 seats), and small type, namely CRJ-200 (MTOW 25 tonnes, 50 seats).

The charges level of Oslo airport is normalized to one. We then take the deviations from Oslo charges and focus on the combined passenger and landing charges leaving aside the structure of airport charges.[45]

Figure 1.5.1 shows that Oslo airport is placed somewhere in the middle of the sample[46]. Riga, Keflavik and Tallinn and even some German, Italian, and UK airports have lower charges than Oslo. However, these airports are not substitutes for Oslo or other large Norwegian airports. In this respect the comparison with Copenhagen (CPH) and Stockholm Arlanda (ARN) is more relevant as these airports are competing in the international long-distance flights market. Oslo`s charges are also ranked in between these airports. The total charges for Stockholm Arlanda are approximately 25% lower and for Copenhagen are on

[43] Airports with less than 2 million passengers

[44] Similar results hold for larger aircraft types like the B 767-400 (see ATRS, 2009, 2010, 2011) However, when comparing charges among countries one must keep in mind that passenger charges behave linear, whereas the landing or take-off charges based on Maximum Take-off Weight (MTOW) in most charges schemes behave non-linear and reveal structural breaks at certain aircraft weights.

[45] Note that this structure is remarkably different from other European airports because Oslo has high landing charges but relatively low passenger charges.

[46] OSL is 15th cheapest for Airbus A320.

average 12% higher than for Oslo airport. To conclude, Oslo airport is ranked 15th cheapest among airports in our sample for Airbus 320 aircraft types.

It is also interesting to compare our analysis with the benchmarking of airport charges that was done for Avinor airports by the Norwegian Centre for Transport Research (TOI, 2009). The main objective of the TOI report was to rank Avinor airports among other European airports according to their charges levels. The aim was to see whether Avinor airports can be in the list of the 30 cheapest European airports. In our opinion, their approach suffers from treating airports of national airport systems separately although they have the same charges[47]. Including such airports individually in the ranking has biased the results as the number of airports in the survey increases. According to the TOI study, Oslo airport is ranked the 30th cheapest airport for international flights, but, when adjusting the TOI ranking by treating all airports from a national airport system as one airport, Oslo is now ranked 17th, which is more in line with our findings of low airport charges above[48] (for details on this issue see appendix B, Table B1).

1.5.3. Benchmarking airport charges of small airports

We use information about landing and international passenger charges from airport charges manuals to calculate the average charges per movement (Table 1.5.1). This is done for the aircraft types A320 and CRJ 200 from the ATRS database with a seat-load factor of 75%. (Charges are expressed in PPP-adjusted NOK, 2010 prices. We find that the level of airport charges in both categories, landing and passenger charges are highest in the UK. Even the cheapest airports in the UK sample, Leeds Bradford and Humberside, have higher charges than the two German airports and Avinor airports do[49].

A comparison of airport charges might be biased because some airports charge less than their posted price. Therefore, we also approximate airport charges by analyzing the airports' aeronautical revenues. In our analysis, we excluded security charges and took differences in fleet mix into account. Table 1.5.2 represents the calculation for UK and comparable Norwegian airports.

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[47] For example, AENA, the Spanish public body that owns and operates the majority of airports in Spain, sets uniform charges rates for the majority of Spanish airports, thus the levels of charges do not differ among these airports. This argument also holds for other airport groups, such as ANA, the group of Portuguese public airports, DHMI, General Directorate of State Airports Authority of Turkey; HCAA, Hellenic Civil Aviation Authority, Montenegro Airports and FINAVIA Airports.

[48] The comparison in the TOI study is restricted to one aircraft type while we base our benchmark on three aircraft types of different size.

[49] For Germany, the two airports Münster-Osnabrück and Dresden were chosen because they are the smallest German airports for which we have reliable data on charges levels. Comparing the charges levels of these two airports to those of Avinor, it can be seen that, although relatively comparable, except for small aircrafts at Münster-Osnabrück, they are lower at Avinor.

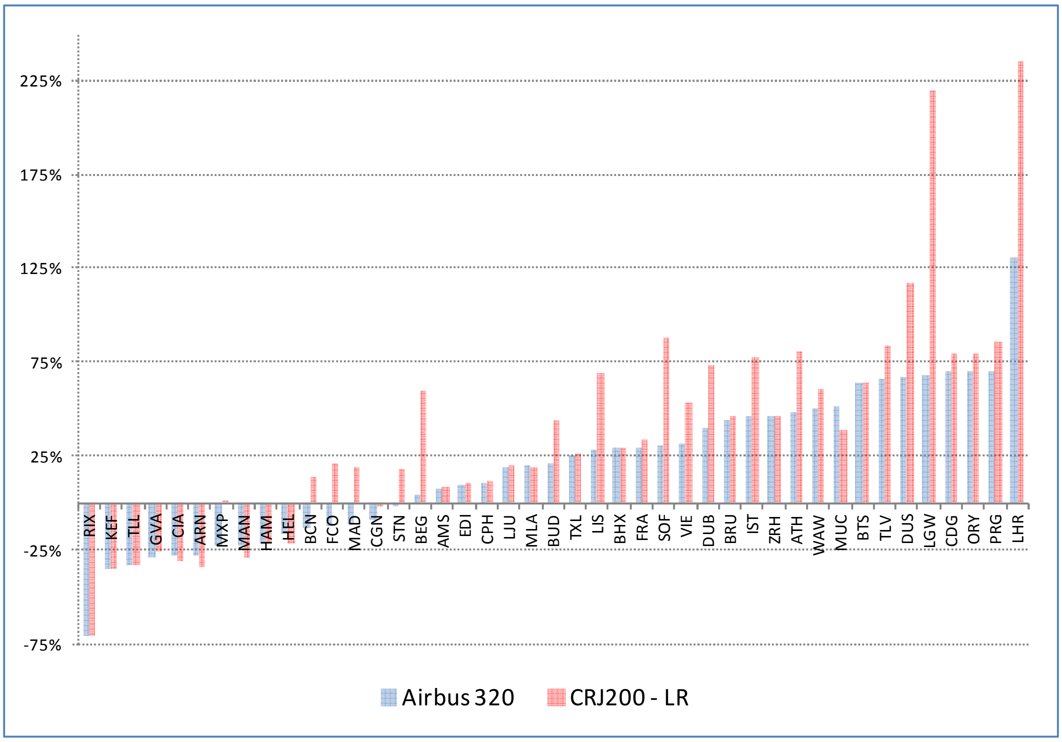

Figure 1.5.1. Percentage deviation of total charges of selected European airports from those of Oslo in 2010 (for Airbus 320 – 100 and CRJ- 200).

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Airport	Landing		Passenger		Total	
	A320	CRJ 200	A320	CRJ 200	A320	CRJ 200
			UK airports			
Exeter	20,986	4,779	21,715	7,238	42,702	12,018
Humberside	17,300	5,844	15,485	5,161	32,786	11,006
Norwich	19,348	6,536	24,745	8,248	44,093	14,785
Liverpool	20,269	6,847	24,621	8,207	44,890	15,054
London Biggin Hill	31,530	10,652	23,344	7,781	54,875	18,433
Leeds Bradford	13,492	4,558	18,053	6,017	31,545	10,576
			German airports			
Dresden	5,721	1,933	12,680	4,226	18,402	6,160
Munster-Osnabrück	5,738	1,938	8,300	2,766	14,038	4,705
			Norwegian airports			
Avinor	5,106	3,450	6,637	2,212	11,743	5,662

Table 1.5.1. Landing and passenger charges for turnaround flight for aircrafts Airbus 320 and CRJ 200, in PPP-adjusted NOK, 2010 prices. Source: Avinor charges manual.

It is worth mentioning once again that the motivation behind the comparison of Norwegian airports with UK airports is the fact that UK airports face relatively strong competition compared to other European airports, in particular because of a high airport density and footloose Low Cost Carriers. Starkie (2008) argues that the behavior of UK airports is similar to that observed in a competitive industry. We find that, if adjusted for PPP, charges of all UK airports are higher than those of Avinor airports. In order to take the differences in the fleet-mix into account, we grouped airports by the average number of passengers per movement.

Airport Name	Airport IATA Code	Total Passengers	Number of commercial ATM	Aeronautical Revenues	Average aeronautical revenues per commercial ATM	Number of PAX per commercial ATM
1. Bournemouth (UK)	BOH	750,000	7,489	62,612,592	8361	100
Hammerfest	HFT	123,273	1,188	6,684,325	5627	104
Bardufoss	BDU	190,584	1,982	8,154,973	4115	96
2. Cardiff International (UK)	CWL	1,398,000	17,258	134,244,939	7779	81
Haugesund	HAU	558,938	6,688	30,983,714	4633	84
Ålesund	AES	833,534	10,220	36,679,163	3589	82
Evenes (Harstad-Narvik)	EVE	551,573	7,763	24,610,623	3170	71
3. Durham Tees Valley (UK)	MME	225,000	6,765	37,559,255	5552	33
Svalbard	LYR	125,781	4,031	7,656,646	1899	31
Florø	FRO	159,141	5,500	11,798,718	2145	29
Ørsta-Volda	HOV	98,240	3,758	3,999,967	1064	26
4. Humberside (UK)	HUY	283,000	13,881	46,814,187	3373	20
Banak (Lakselv)	LKL	58,331	2,649	2,883,803	1089	22
Førde	FDE	82,000	3,973	3,878,567	976	21
Leknes	LKN	99,358	5,459	4,545,525	833	18
Svolvær	SVJ	73,136	4,076	3,895,689	956	18
Brønnøysund	BNN	130,379	8,546	11,066,848	1295	15

Table 1.5.2. Approximated average charges for UK and Norwegian airports in 2010, grouped by number of passengers per commercial ATM, in PPP-adjusted NOK, 2010 prices.

As shown in Table 1.5.2, the average level of charges per commercial movement in the UK tends to be higher than in Norway. For instance, for Bournemouth airport, which has a similar average number of passengers per movement as the Norwegian airports Hammerfest and Bardufoss, charges amounted to 8,360.6 NOK per movement, whereas Hammerfest and Bardufoss charged 5,626.54 NOK and 4,114.52 NOK per movement, respectively. Within the group of airports with an average number of passengers per movement of around 80 passengers, UK airports also have a higher average charges level. The same pattern can be observed in groups with a lower average number of passengers per movement.

Comparing charges on the basis of published charges as well as by aeronautical revenues clearly indicates that Norwegian airport charges at regional and local airports are relatively low[50]. Similar results emerge from a rough benchmark with a sample of other European airports (see Appendix B).

1.5.4. Assessment of airport charges

A peculiar feature of Norwegian airport charges is that they are largely the same for all Avinor airports. Charges are based on minimum take-off weight (MTOW) with a relative low share of passenger charges. While security charges have increased drastically, the combined landing and passenger charges have stayed constant in real terms. They are lower compared to competing hubs (outside Norway) and most other European airports as well. They are also lower than those of small airports facing competition from neighboring airports and countervailing power from low cost carriers. It should however be noted that this analysis does not imply that airport charges at Oslo might not be lowered to win traffic from other competing hubs. Whether such a strategy could work, depends on the elasticity of demand, on which reliable estimations are not available for Oslo[51].

Regarding the structure of charges, a weight-based system related to MTOW can be interpreted as a kind of Ramsey pricing. This approach is an attempt to cover average costs by charging a high price for customers with low price elasticity and a lower price for price elastic customers. However, a weight-based system related to MTOW does not fully maximize welfare (Martin-Cejas, 1997). Moreover, gains from perfect Ramsey pricing might be low. Jørgensen et al. (2010) analyze the effects of a Ramsey scheme for Norwegian airports. They grouped Norwegian airports in three categories and suggested to lower charges at large airports and to increase them at small airports. However the estimated increase in traffic is only around 1%, indicating that demand is rather inelastic. Furthermore welfare gains were limited.[52]

Marginal costs might differ from airport to airport. In such a case charging the same prices at all airports does not maximize economic welfare. We are not able to analyze this in this study because there is no reliable information on marginal costs on an individual airport

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[50] The comparison of aviation charges based on information extracted from charges manuals often differ from the figures reported for aeronautical revenues due to different charges schemes, special discounts and differences in seat load factor. For example, the calculated amount of charge for domestic turnaround flight for CRJ-200 based on the information from charges manuals equals to 3,265 NOK, while charge of some of the local Norwegian airports, as shown in Table 1.5.2, is lower. Clearly, this difference arises due to lower number of average passengers per movement, but one can also think of incentive schemes and special discounts playing their roles.

[51] See the presentations by three experts on this topic at the 2009 90 conference: Competition between airports (pdf) - Kjell Wilsberg, Consultant, Gravity Consult Competition between airports (pdf) - Sarah Procter, Route Development Manager, CPH Go Competition between airports (pdf) - Gorm Frimannslund, Senior Vice President SAS Ground and Handling http://www.avinor.no/en/avinor/aboutavinor/X_conferencevideo

[52] For a discussion on the Norwegian debate on the level and structure of charges see Appendix C.

basis. However, given the different length of runways and varying weather conditions, it is very likely that marginal costs do differ[53].

Another point to consider is that weight is generally not a good proxy for marginal costs as the damage caused by different aircraft types is not well related to weight. Better proxies are easily available (Hogan and Starkie, 2003). Compared to a decentralized system Avinor could more easily reform charges and adopt a better proxy for the damage caused by aircraft which would lower the maintenance of runways.

All these reforms of the structure of charges that we have discussed should in principle increase welfare and the efficiency of airports, but the largest gains are made if charges reflect the scarcity of runways, terminals and apron parking. Excess demand however is, with a few exceptions (Bergen), not observed and currently not an urgent problem of airport pricing in Norway.[54]

In summary, the level of charges at large Norwegian airports is lower than at competing hubs. At regional and local airports the charges are most likely below the level of what other European airports charge under competitive conditions. The structure of charges is also not efficient currently and could be reformed by a more disaggregated regulatory approach which reflects different marginal cost and level-of-service (like requested services levels and turn-around times) at airports.

[53] Take as an example Fagernes, which has typically excess capacity, needs only a third of the runway, but it has high snow removal costs, since it also receives a lot of snow. On the other hand Røst is an island with basically no snow and seldom ice due to high salt content in the air.

[54] Since the Avinor charges scheme does not include charges for aircraft parking, there is an incentive to waste precious apron capacity, measured in available number of parking positions, during peak hours.

Chapter 2: Avinor in an international comparison

Given the difficulties in assessing financial efficiency in cases where profitability is not the sole purpose of a business, the international perspective can be helpful. Therefore, in the following the performance of the individual airports in the Avinor system is compared to that of their counterparts in other European countries. Before turning to multi-dimensional efficiency methods to benchmark the overall airport productivity in the second chapter of this report, we first take a look at partial performance measures (PPM) as efficiency indicators.

2.1.Application of partial performance measures (PPM) for benchmarking purposes

Partial Performance Measures offer a possibility to evaluate data on airport performance in a direct way, as they do not require any model specifications. Being calculated as a ratio of two variables, they provide partial information about selected performance aspects. Managers often find such information useful, as these partial measures are intuitively easy to compute and understand. The interpretation of such measures is straightforward provided that the comparability of the data used is ensured. Graham (2005, p. 100) states that "there are a growing number of airports that are making extensive use of many of the partial performance measures".

However, PPM ignore the interaction between multiple inputs used and outputs produced. This makes any conclusions about the overall productivity of airports impossible. Different levels of vertical integration across airports used in the PPM analysis might also lead to misleading results. It rises, as more and more activity is being being outsourced. Multi-dimensional efficiency methods such as Data Envelopment Analysis (DEA)[55] or Total Factor Productivity (TFP) would therefore be the one preferred option which we pursue in chapter 3.

Keeping the limitations of the PPM analysis in mind, we have to note that it has the great advantage of shedding light on specific performance areas that remain concealed when considering the overall performance only. It also allows a good comparison over time, if the degree of vertical integration does not change.

2.2.Choice of potential PPM

PPM are ratios that relate particular outputs to particular inputs. The main inputs of an airport that can be used in the analysis are various measures of labor and capital. Outputs

[55] We will present the DEA results in chapter 3 of this report.

widely used in the benchmarking literature are the number of passengers, freight volume and the number of air traffic movements (ATM).[56] The number of work load units (WLU), a combination of the number of passengers and freight volume, can also be used as an indicator of output.[57]

These physical outputs can also be viewed as intermediary ones, if one regards monetary measures such as revenue or EBIT as ultimate outputs. In this case it also makes sense to look at ratios of monetary to physical outputs. However, it may be controversial to consider a profit measure such as EBIT to be an ultimate performance measure, since it depends on accounting systems and methods implemented at airports. Moreover, airports may have goals other than pure profit maximization. Besides, airports are subject to different regulatory regimes and operate in different competitive environments. However, it is possible to interpret this indicator as a measure of self-sustainability, i.e. the airport's ability to finance its own development or as a measure of relative independence from subsidies which can also be seen as an objective.

All PPM used in our analysis can be classified into the following four principal categories:

1. Profitability
2. Revenue generating capability
3. Cost efficiency
4. Labor productivity

As mentioned above, a major problem causing distortions when relying on PPM is that the degree of vertical integration (the level of outsourcing) varies across airports. Depending on the type of the outsourcing agreement, an airport company may or may not collect revenues and incur costs associated with particular activities. For example, providing ground handling services in-house results in ground handling revenues and corresponding costs, whereas a concession agreement with an external service provider will just lead to collection of a concession fee and does not incur costs. Labor productivity measured as some output such as the number of passengers per employee is therefore much lower, if the airport insources all activities. It rises as more and more activities are outsourced.

[56] The latter was shown to be problematic due to differences in the fleet mix, which are often not taken into account, see e.g. Graham, (2005).

[57] WLU is commonly defined as one passenger or 0.1 metric tonnes of freight (CAA; 2002, p 10). However, WLU is an arbitrary measure of output since an airport will not necessarily employ the same amount and combination of resources in handling both types of traffic or they may require different levels of service quality. Alternative WLU calculations used to mitigate these problems are also questionable.

One option to handle the problem of differences in outsourcing is to standardize the data so that each airport can be thought of as undertaking a uniform set of activities (e.g. for the airports performing ground handling in-house, costs and revenues shall be adjusted in such a way as if they outsourced this activity to reach comparability within the sample. The same procedure would apply to those airports that operate their own retail shops, car parks etc.)[58]. It is feasible to account for significant differences (such as those caused by the outsourcing of ground handling), at the very least it is possible to use the data on airports with a similar outsourcing mix only, but complete consistency is unlikely.

2.3.Performance measures considered

The main physical output used in the ratios is the number of passengers. We favor it over air traffic movements (ATM) and work load units (WLU) for the reasons mentioned in the previous section. In what follows we first, analyze profitability using EBIT per passenger as a "financial output". Since it is affected neither by the degree of integration, nor by the level of interest paid or received, nor by the income tax rates, EBIT measures profitability on the basis of the operating result only. Second, aeronautical and commercial revenues per passenger are analyzed separately in order to assess the revenue generating capability of airports. Third, total operating costs measured as the sum of all operating expenses excluding and including depreciation provide information about cost efficiency on a per passenger basis. Finally, we use two measures to assess labor productivity: number of passengers per employee (measured in FTE) and total revenues per employee (measured in FTE). Due to the limited availability of data on the number of employees, the sample for labor productivity analysis is more restricted than the one used for the analysis of other aspects of performance.

2.4.Choice of suitable airports for the benchmarking analysis

As recommended by the pre-study (Merkert, Pagliari, Odeck, Bråthen, Halpern, Husdal, 2010), the focus of the comparison with Avinor airports should be on countries with a similar airport governance structure and a large share of remote airports, such as Scotland, Sweden, Finland, Greenland and Iceland, where most, if not all airports are under federal/public authority and certain routes are operated under Public Service Obligations.

[58] In essence, one has to normalize the data to the same core activities of an airport as has been applied in studies by the University of Westminster and Cranfield University (Graham, 2005) and in the *Airport Performance Indicators* by Jacobs Consultancy (TRL, 2005).This procedure is not without drawbacks, as commonly allocated fixed costs have to be reapportioned without detailed knowledge of the accounting procedure, and any economies of scope experienced by the airport would have to be ignored. See also CAA, 2002, paragraph 112 for details.

One focal point was small and medium-size airports, which we could use for a comparison with the regional and local Norwegian airports. We were able to obtain data from some of these countries recommended in the pre-study (i.e. from Scotland[59], Iceland[60] and Greenland[61]). We also looked to countries with other forms of governance structure and considered small and medium-size airports in France, the United Kingdom, Italy and Germany among others in addition to the airports of the above mentioned Nordic countries.

Another issue was to ensure that a good-sized sample of large airports was available for the benchmarking of the larger Avinor airports. Here we relied mainly on the GAP database, which contains an adequate amount of data on large European airports. However, in what follows we do not carry out a separate PPM analysis for the groups of large and small airports, but rather consider pooled samples. Performing the PPM analysis, we do not use the entire time span of the data available, but rather observe the change over a certain time period by looking at the situation at several points in time. For some performance measures we could use data on airports not present in the DEA sample (see the list of airports in Appendix E).

2.5.Benchmarking results with PPM

2.5.1. Profitability analysis

In our initial analysis in Section 1.2, one of the findings was that most of the small Avinor airports have quite large losses per passenger, and that the break even point in terms of the annual number of passengers apparently shifted over time. While in 2002 some airports were able to break even serving a little over 200,000 passengers per annum, in 2010 this was possible only at airports that achieved an output of more than 800,000 passengers per annum. It is therefore interesting to analyze at which size an airport can break even in an international perspective. In this analysis, we differentiate between "boundary estimates" (i.e. best or exceptional results) that we find on the profitability frontier and "average breakeven points" (based on regression results).

Using a sample of 154 European airports we show EBIT per passenger figures for each airport in the sample for the selected years from 2002 to 2010 related to airport size (measured in number of passengers per year). Each point on the graph in Figure 2.5.1

[59] HIAL is the company that owns and operates 11 airports in the Scottish Highlands, the Northern Isles and the Western Isles and served approximately 1.1 million passengers in 2011. The company is wholly owned by the Scottish Ministers and is funded by the Scottish Government's Transport Directorate.

[60] Isavia is a limited state-owned company, which handles the operation and development of all airports in Iceland and manages air traffic in the Icelandic control area. 12 Isavia airports serve scheduled flights and airports in Iceland served approximately 781,000 domestic and 2.1 million international passengers in 2011.

[61] The Greenland Airport Authority (Mittarfeqarfiit) operates under the responsibility of Ministry of Housing, Infrastructure and Transport and controls 13 airports and 46 helicopter landing spaces. They served more than 430,000 passengers in 2011.

represents an airport, with different colors used for each year. The enveloping bound for the even years from 2002 to 2010 indicates the most profitable airports separately, and allows us to derive the profitability envelope for these years.

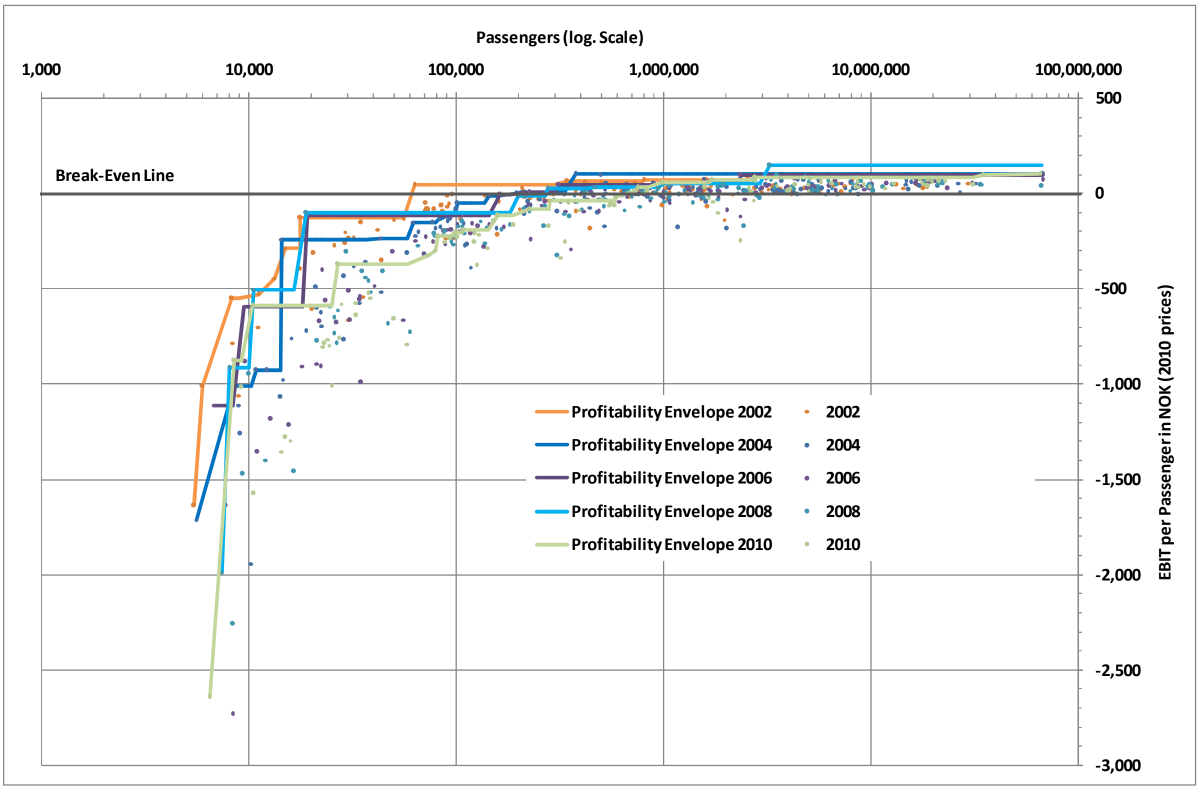


Figure 2.5.1. EBIT per passenger vs. number of passengers at 154 European airports in 2002-2010, in PPP-adjusted NOK, 2010 prices.

We find that the envelope shifted downwards, which could be interpreted that the profitability worsened for the smaller airports during this time, a trend which we had already seen above in Figure 1.2.1 for the Avinor airports. The move of the boundary breakeven point to the right suggests that over time a higher level of passenger volume is required to break even.[62] The movement is not the same in all of the countries in the sample[63].

Next we analyze how the performance of the smaller Norwegian airports fits into this break even analysis in detail. We plot the 7 data series (France, UK (non-HIAL), Germany,

[62] EBIT levels of at 60 to 100 NOK per passenger, with London-City (LCY) airport with 144 NOK per passenger being the exception.
[63] Our analysis for France indicates that some of its low-demand airports achieve a break even at lower levels. In 2002 the break-even point was between passenger volumes of 17,680 and 63,000 defined by French airports AUR and EGC In the years 2004 to 2009 the break even point for the the top performing French airports lies in the range of between 180,000 and 290,000 passengers. In Italy in 2003 it lies between about 300,000 passengers for Pescara (PSR) and Forli (FRL) airports, the latter with about 350,000 passengers. In 2010, where Italian and French airport data is missing, the break even point is shifted even more significantly to the right and lies approximately between German airport Friedrichshafen (FDH) with 590,000 passengers and British airport Exeter (EXT) with 737,000 passengers.

HIAL, Iceland, and Italy in addition to Avinor airports[64]) for the years 2002, 2005, 2007 and 2009 separately (Figure 2.5.2). Visual inspection shows that although the four curves composed of all plotted points look similar, the curve for 2005, 2007 and 2009 is positioned somewhat lower than the one for 2002. Indeed, out of 154 airports analyzed, 108 had a lower EBIT per passenger in 2009 than in 2002. The number of airports with positive EBIT per passenger went down from 74 in 2002 to 56 in 2009. This trend is also confirmed in Table 2.5.1, which shows the development of average values of EBIT per passenger for different airport size classes.

A simple linear regression analysis of 96 European airports (not including Iceland and Greenland because of the lack of reliable data) serving up to 10 million passengers p.a., where we try to approximate EBIT per passenger as the function of passenger volumes, shows that in 2002 the average airport serving at least 0.4 million passengers annually was able to cover its operating costs (including depreciation). In 2009, on average at least 1 million passengers per year were needed to break even. All this may be seen as the evidence for the result that declining profitability of small airports is a European trend. Some other conclusions are:

- There is a large variation in the profitability across the airports in the sample.
- We are very surprised about the much lower losses per pax for the small Icelandic airports, even estimating their depreciation rather conservatively. They do not seem to fit the "curve", being more profitable than expected (they earn little, but their costs are also low). The profitability spread between Iceland and other countries seems to be widening over time, it should increase further with a doubling of Isavia's aviation charges over the last two years [65].

In addition to analyzing the profitability envelope of all the airports in the sample in Figure 2.5.1, we have also done a separate financial analysis for the large airports by analyzing the profitability (as measured by return on equity (ROE)) of the largest Avinor airport Oslo[66] in comparison with a group of seven major European airports of a similar size, using a DuPont analysis.[67] Oslo airport showed the highest ROE in 2010 compared with comparable European airports, but the results are difficult to interpret because of different

[64] Greenland figures cannot be added as no EBIT figures are available due to the lack of the depreciation data.
[65] Aviation fees have risen several times since February 2009: e.g. a 12% increase of landing charges was followed by increases in June 2010 (27%), in April 2011 (29%) and April 2012 (36%) so that by today aviation fees have more or less doubled from 2009 (105% increase in landing charges, from 2008 – 76% increase in passenger charges from 2010).
[66] We could only use Oslo for this analysis, this was the only Norwegian airport, for which we had separate financial accounts.
[67] Its methodology, the underlying assumptions and interpretation of the results of the DuPont analysis can be found in Appendix G. Here we only report the main results.

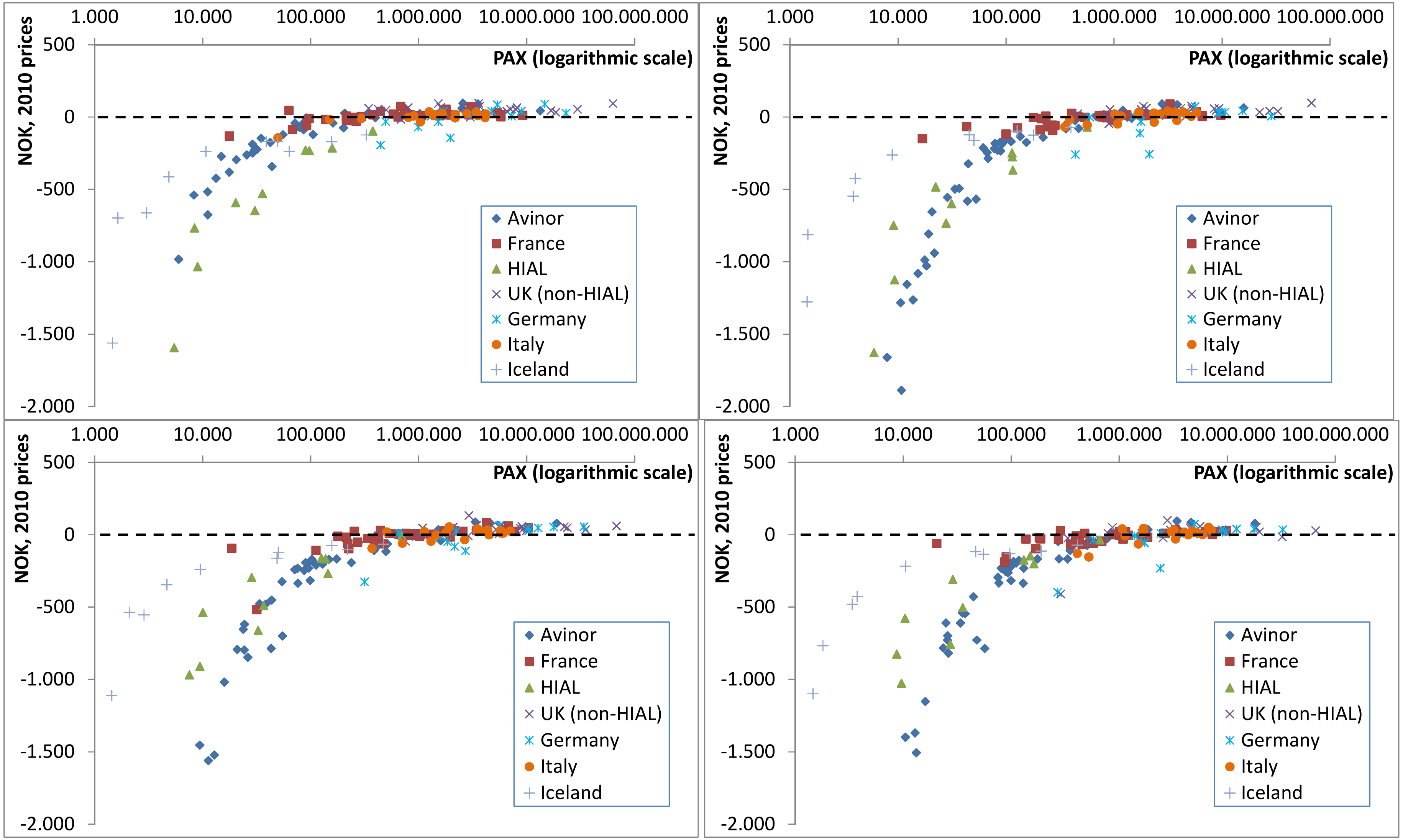


Figure 2.5.2. EBIT per passenger vs. number of passengers at European airports in 2002 (upper left), 2005 (upper right), 2007 (lower left) and 2009 (lower right). No revenue or cost adjustments.

forms of ownership (public versus private) in the sample. Oslo as a publicly owned airport does well in this analysis with higher equity returns, mainly because of large loans from its owner, the government. Privately held airports generally cannot achieve such leverage.

However, a hypothetical ROE of OSL independent of these effects is estimated to be 17%, which is still the second highest level in our sample (1st: CPH - 26%, 3rd: DUS - 14%).

Country	1.000-10.000 pax				10.000-100.000 pax				100.000-1.000.000 pax				1.000.000-10.000.000 pax				>10.000.000 pax			
	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09
France					-49	-108	-306	-135	10	-27	-23	-34	22	22	23	8			46	
Germany									-99	-130	-157	-218	6	-25	-20	-24	57	28	45	38
HIAL	-1,132	-1,168	-938	-925	-446	-605	-496	-537	-155	-241	-151	-140								
Italy					-144				-5	-48	-45	-142	12	12	13	12				
Norway	-762	-1,661	-2,085	-2,756	-194	-608	-606	-628	-19	-82	-128	-136	54	42	30	38	43	63	79	78
UK									42	11	-11	-94	52	47	47	27	55	52	49	20
Iceland	-853	-683	-577	-708	-209	-146	-147	-154	-150	-101	-83	-93								

Table 2.5.1. Average EBIT per passenger at European airports in 2002, 2005, 2007 and 2009 for different size classes, in PPP-adjusted NOK, 2010 prices.

In summary, our financial benchmarking of all Avinor airports indicates that they are average performers. Avinor airports appear to match the overall relation between size and profitability of an airport quite well, i.e. the corresponding points are in most cases located in the middle of the band composed of all observations. The dispersion between the smallest Avinor and Iceland airports was substantial both in 2002 and 2009. However, there are signs of a worsening performance of Avinor airports compared to other airports.

2.5.2. Revenue generating capability: aviation revenues

In the section above we were not concerned with full airport comparability across the sample when analyzing the changing break even point, because profitability was viewed as a performance measure irrespective of the degree of vertical integration. In this section we must take the issue of comparability into account. One of the main comparability issues is whether ground handling (GH) is performed by the airport, by the airline, or whether it is contracted out to independent ground handlers. But with the data available to us it was relatively easy to make revenue data for all airports in the database more comparable by disregarding airport revenues from ground handling.[68] For this comparison, we also used the data on five Finnish airports for 2009 (similar data for 2002, 2005 and 2007 was not available) and the new data we received from Iceland and Greenland. We disregarded ETOPS revenues[69] of Greenland

[68] A similar procedure for the adjustment of costs is in most cases not feasible at all (see below)
[69] ETOPS revenues are revenues from advance payments by airlines for the possibility of an emergency landing outside normal opening hours. They can be compared to insurance fees.

airports as a unique revenue source not available to other airports when calculating their aeronautical revenues. The data is plotted in Figure 2.5.3 and the average values for different size classes are given in Table 2.5.2.

There is a high variation in aviation revenues per pax across our sample, especially in the lower size range. Only for larger airports do the figures become a bit more similar. The aviation revenues for Avinor airports seem relatively low, i.e. disregarding exceptionally low aeronautical revenues of Icelandic airports, they are in the lower part of the whole spectrum, almost independent of the size of the airport. But the position of Avinor airports relative to some other groups in the higher size range changed and moved upwards: in 2002 aeronautical revenues per passenger at Avinor airports were clearly among the lowest in the sample, except for Iceland in the lower size range and for bigger Italian airports. But already in 2004 Italian and many UK airports earned significantly lower aeronautical revenues per passenger than did Avinor airports. Aeronautical revenues per passenger at the Finnish airports in 2009 were similar to those of Avinor airports. Greenland's airports perform better than Avinor's consistently. For some groups the changes in aeronautical revenue per passenger from 2002 to 2009 were significant: on average, aeronautical revenue per passenger grew at HIAL and French airports, and fell at Italian and UK airports. No clear time trend can be observed for Avinor and German airports. As already mentioned, Isavia has very low aviation revenues, their charges have been constant throughout most of the period, but have more than doubled since 2009, so these pricing changes do not show up in the graph.

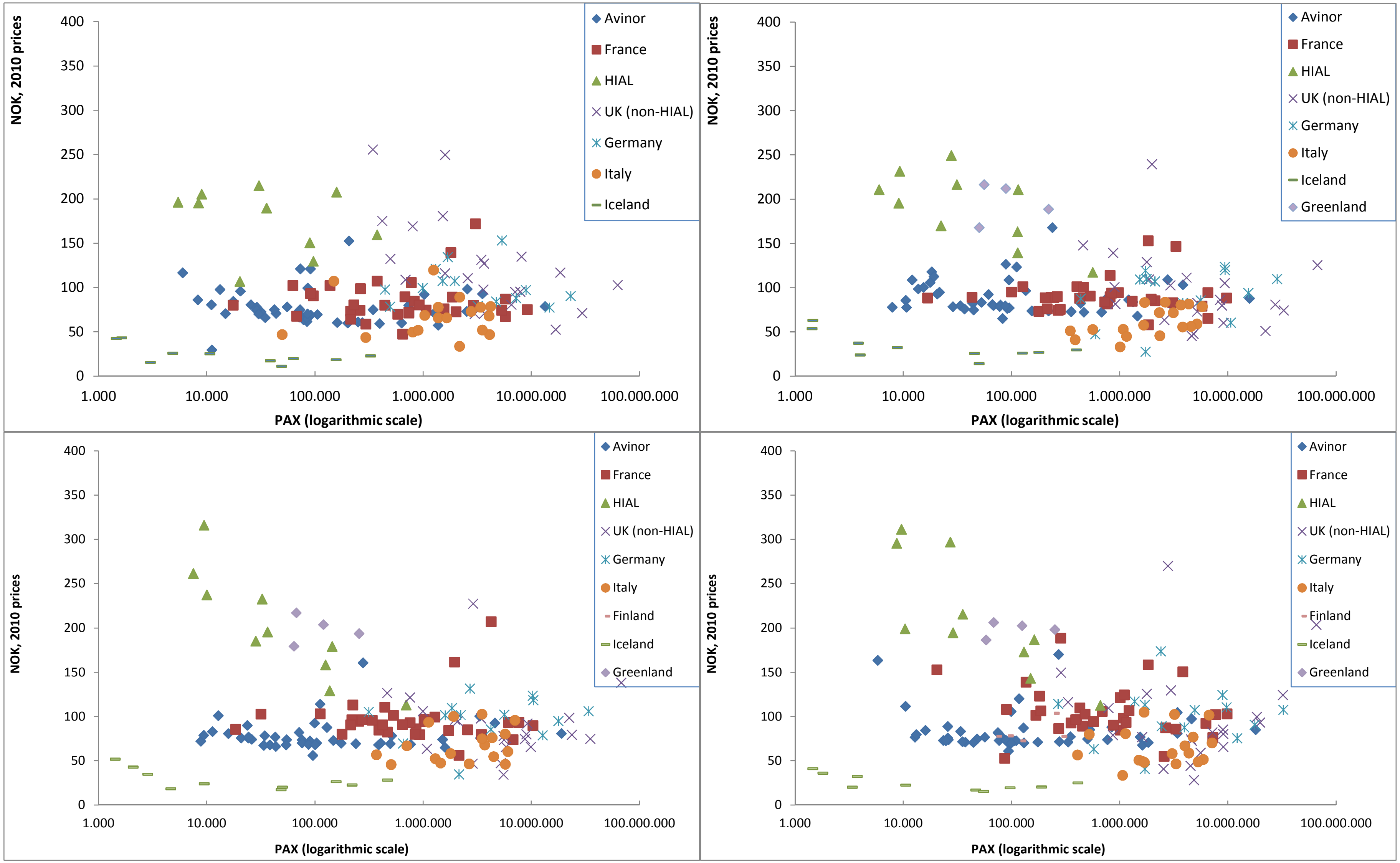


Figure 2.5.3. Aeronautical revenue (without ground handling) per passenger vs. number of passengers at European airports 2002 (upper left), 2005 (upper right), 2007 (lower left) and 2009 (lower right), in PPP-adjusted NOK, 2010 prices.

Country	1.000-10.000 pax				10.000-100.000 pax				100.000-1.000.000 pax				1.000.000-10.000.000 pax				>10.000.000 pax			
	‘02	‘05	‘07	‘09	‘02	‘05	‘07	‘09	‘02	‘05	‘07	‘09	‘02	‘05	‘07	‘09	‘02	‘05	‘07	‘09
France					87	89	94	104	80	89	93	108	91	93	102	102			90	
Germany									92	67	87	89	108	98	95	107	84	88	104	91
HIAL	199	213	289	303	158	212	213	226	183	158	145	154								
Italy					47				63	48	56	68	70	64	70	65				
Norway	101	78	75	163	77	89	76	78	74	90	81	86	81	89	80	83	79	88	81	85
UK									168	117	118	113	120	95	82	88	86	83	97	130
Finland								78				84								
Greenland						199	198	196		188	199	200								
Iceland	32	42	34	32	18	20	19	18	20	27	26	23								

Table 2.5.2. Average aeronautical revenue (without ground handling) per passenger at European airports for 2002, 2005, 2007 and 2009 for different size classes, in PPP-adjusted NOK, 2010 prices.

2.5.3. Revenue generating capability: commercial revenues

We observed in previous sections that the commercial revenues of Avinor airports – especially of the large ones – increased significantly during the period from 2002 to 2010 mainly due to the increasing importance of duty-free sales which had also been encouraged by changes in government policies. In 2010 non-aeronautical revenues at Oslo airport were above 50% of the total operating revenues. At regional Avinor airports commercial revenues have also been increasing.

Figure 2.5.4 shows commercial revenues per passenger of Avinor airports in the European context for 2002, 2005, 2007 and 2009 depending on the passenger volumes (average values for different size classes are given in Table 2.5.3). There is data on 87 such airports in our database. We disregarded fuel sale revenues of Greenland airports when calculating their non-aeronautical revenues.

In all years the overall picture was similar: with a few outliers (mostly small airports) commercial revenues increase as a function of airport size. Icelandic airports earn clearly below average revenue and some earn no revenue at all.

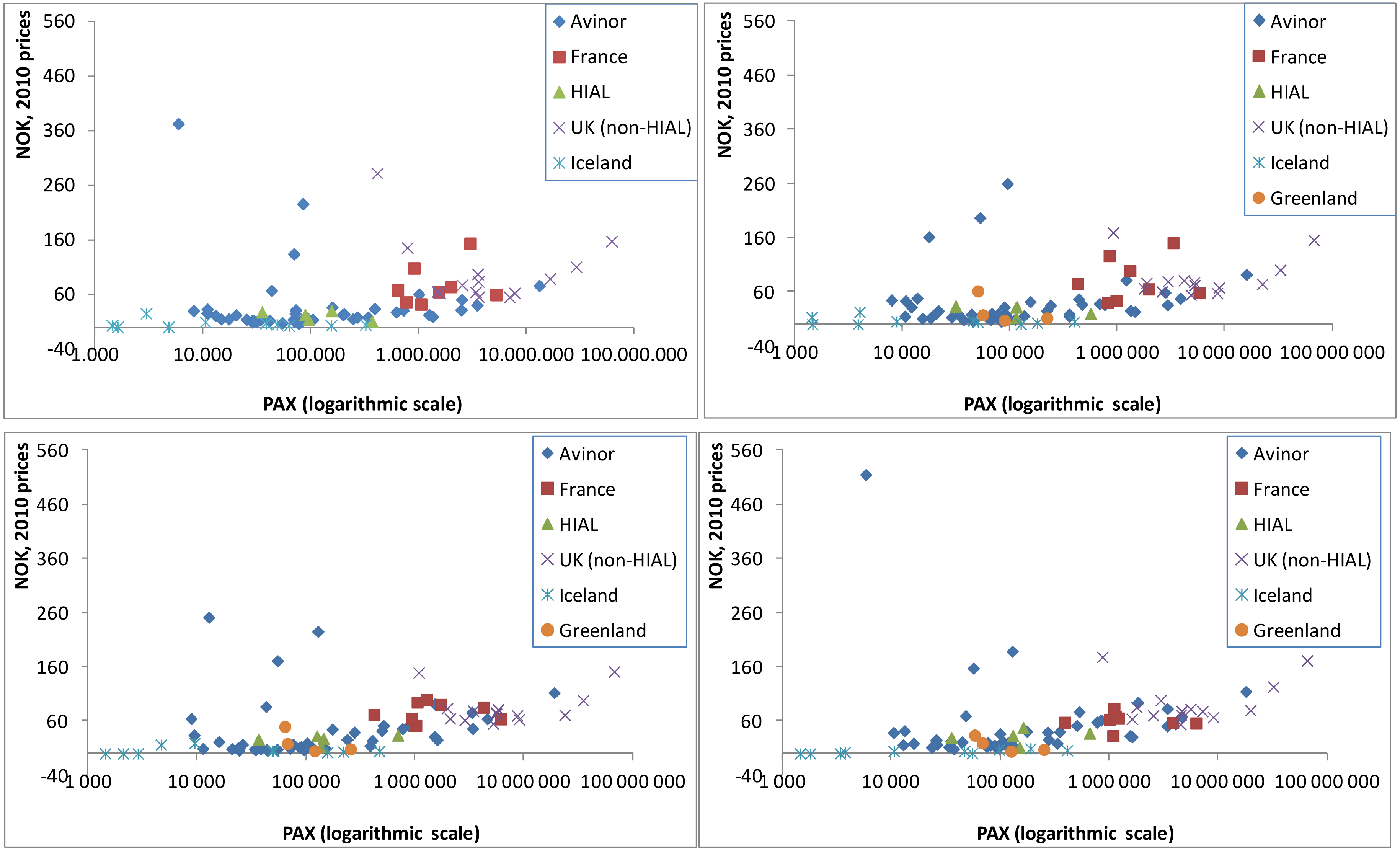
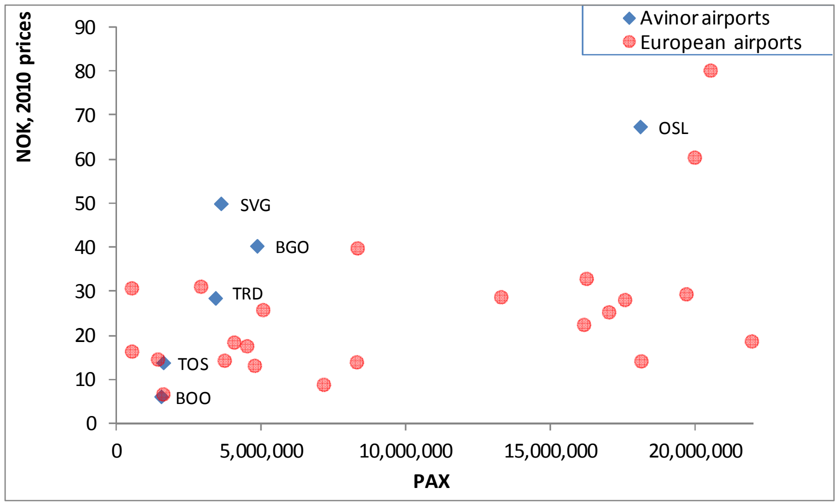


Figure 2.5.4. Commercial revenue per passenger of European airports 2002 (upper left), 2005 (upper right), 2007 (lower left) and 2009 (lower right) in PPP-adjusted NOK, 2010 prices

Country	1.000-10.000 pax				10.000-100.000 pax				100.000-1.000.000 pax				1.000.000-10.000.000 pax				>10.000.000 pax			
	2002	2005	2007	2009	2002	2005	2007	2009	2002	2005	2007	2009	2002	2005	2007	2009	2002	2005	2007	2009
France									74	71	68	58	78	93	81	61				
HIAL					21	34	26	30	20	24	27	33								
Norway	30	45	49	-	30	39	33	27	24	29	42	48	37	46	56	60	76	92	112	114
UK									145	169		178	69	69	78	75	118	110	107	125
Finland																				
Greenland						29	34	27		12	7	6								
Iceland	7	8	7	1	6	6	5	4	4	3	3	8								

Table 2.5.3. Average commercial revenue per passenger at European airports for 2002, 2005, 2007 and 2009 for different size classes (outliers not considered), in PPP-adjusted NOK, 2010 prices.



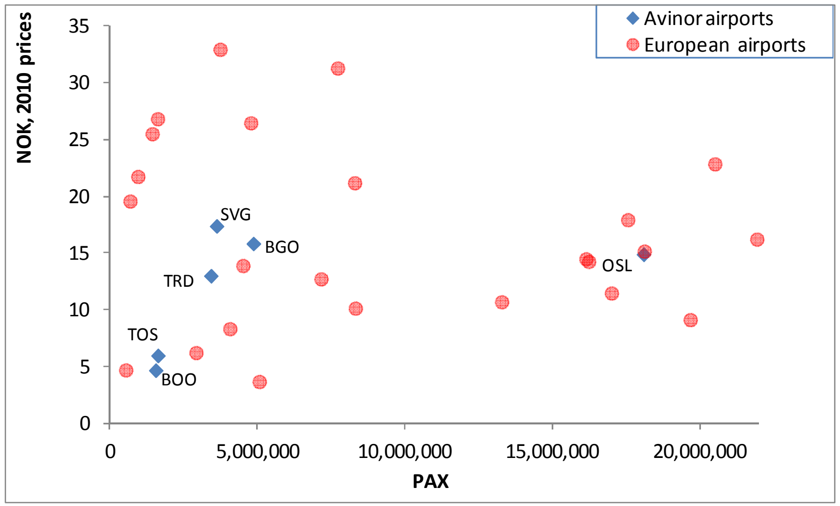


Figure 2.5.5a (left). Retail revenue (Duty free + Food & Beverage + Stores) per passenger of Avinor airports and selected large European airports in 2009, in PPP-adjusted NOK, 2010 prices.
Figure 2.5.5b (right). Parking revenue per passenger of Avinor airports and selected large European airports in 2009, in PPP-adjusted NOK, 2010 prices.

One can conclude that the performance of large Avinor airports is in line with that of their European counterparts, particularly for 2007 and 2009. However this must be seen in perspective, as the regulatory environment for duty free sales is different. Norway is not a member of the EU (but a Schengen country) and has completely different tax-free regulations on alcohol and tobacco. In addition, since 2006 airports have been allowed to offer tax free sales for arriving passengers, which is not the case for most airports in our sample[70].

The combination of non EU membership and high taxes on alcohol and tobacco makes tax free sales a more profitable business in Norway than for the other airports in the sample. Figure 2.5.5c shows the growth of duty-free sales per passenger for the four largest airports. But as we saw in Figure 2.5.4, this growth did not lead to a significantly better performance of Avinor airports in terms of commercial revenues per passenger.

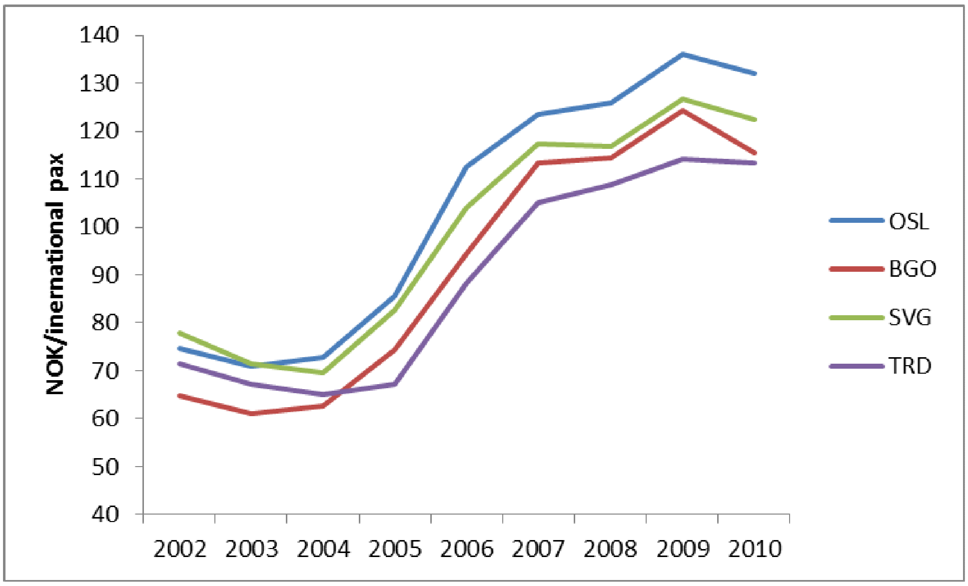


Figure 2.5.5c. Duty free revenue/international pax over time for the large Avinor airports, in PPP-adjusted NOK, 2010 prices.

It is also useful to obtain additional insights into the components of commercial revenue generation. Unfortunately, detailed data are not available for many airports, but we could use some data that had been collected within the GAP project on parking and retail revenues per passenger.[71] Comparing such figures with those of Avinor airports in 2009, (we only looked at the four large airports and two regional airports - TOS and BOO), we find that the large Avinor airports perform very well in their respective traffic group (Fig. 2.5.5a). The

[70] We estimate the effect of the introduction of duty free on arrivals with a simple linear regression: for 14 airports duty free revenue per international pax on average yielded an additional 25 NOK/pax in each year after the introduction on July 1 2006.

[71] Among the data sources were Verdict Research (2011) and Moodie (2010 and earlier years). See also the comparison with UK airports in Appendix F.

smaller airports TOS and BOO, however, performed below average, which is most likely due to the smaller share of international flights and, therefore, lower duty free revenues.

Parking revenue per passenger (Fig. 2.5.5b), another important component of commercial revenues, was at an average level at the large Avinor airports, but significantly below average in their respective traffic group at the two regional airports TOS and BOO.

2.5.4. Cost efficiency

In order to estimate cost efficiency we use operating costs per passenger excluding (Figure 2.5.6a) and including depreciation (Figure 2.5.6b). Average values for each size class are presented in Tables 2.5.4 and 2.5.5. As mentioned above, since any adjustments for the level of vertical integration are very difficult (companies often do not publish cost data for all business segments), we use the same dataset for benchmarking cost efficiency that was used for the commercial revenue analysis, but excluding Greenland (83 airports). In addition to that, we were able to obtain some cost data on five Finnish airports for 2009, but as in the case of aeronautical revenues we cannot observe their trend from 2002 to 2009.

The negative relationship between operating costs per passenger and the airport size is quite straightforward. Nevertheless, it can be clearly seen that whereas Avinor had some cost advantages in 2002 when its costs were the lowest among the airports in the sample, except for Iceland, this cost difference seemed to have vanished already in 2005, especially for the small airports. Icelandic airports seem to have a different cost function; they do not follow the European pattern[72] (Finnish airports also did achieve lower costs per passenger than Avinor in 2009). Though it is possible to say that in 2002 the costs of Icelandic and other European airports were quite close to each other, the gap widened later due to rising security costs outside of Iceland.

When adding depreciation in our analysis[73] in Figure 2.5.6b, we see a picture similar to the one in Figure 2.5.6a: in this case the operating costs of Isavia airports were quite close to those of Avinor airports in 2002, but still considerably lower by 2009.

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[72] The two largest airports in the sample, Reykjavik and Akureyri, are also outsourcing several services (such as approach services (Reykjavik only), security, firefighting and equipment maintenance).

[73] As a state-owned company, all terminals and runways of Isavia are state owned, (but after 2007 all vehicles are owned by Isavia) so it is very difficult to estimate the capital structure or depreciation. We have therefore used the algorithm suggested by Gudny Unnur Jökulsdóttir, Finance Manager of Isavia, to estimate annual depreciation figures as a basis for this. The algorithm is believed to overstate actual depreciation.

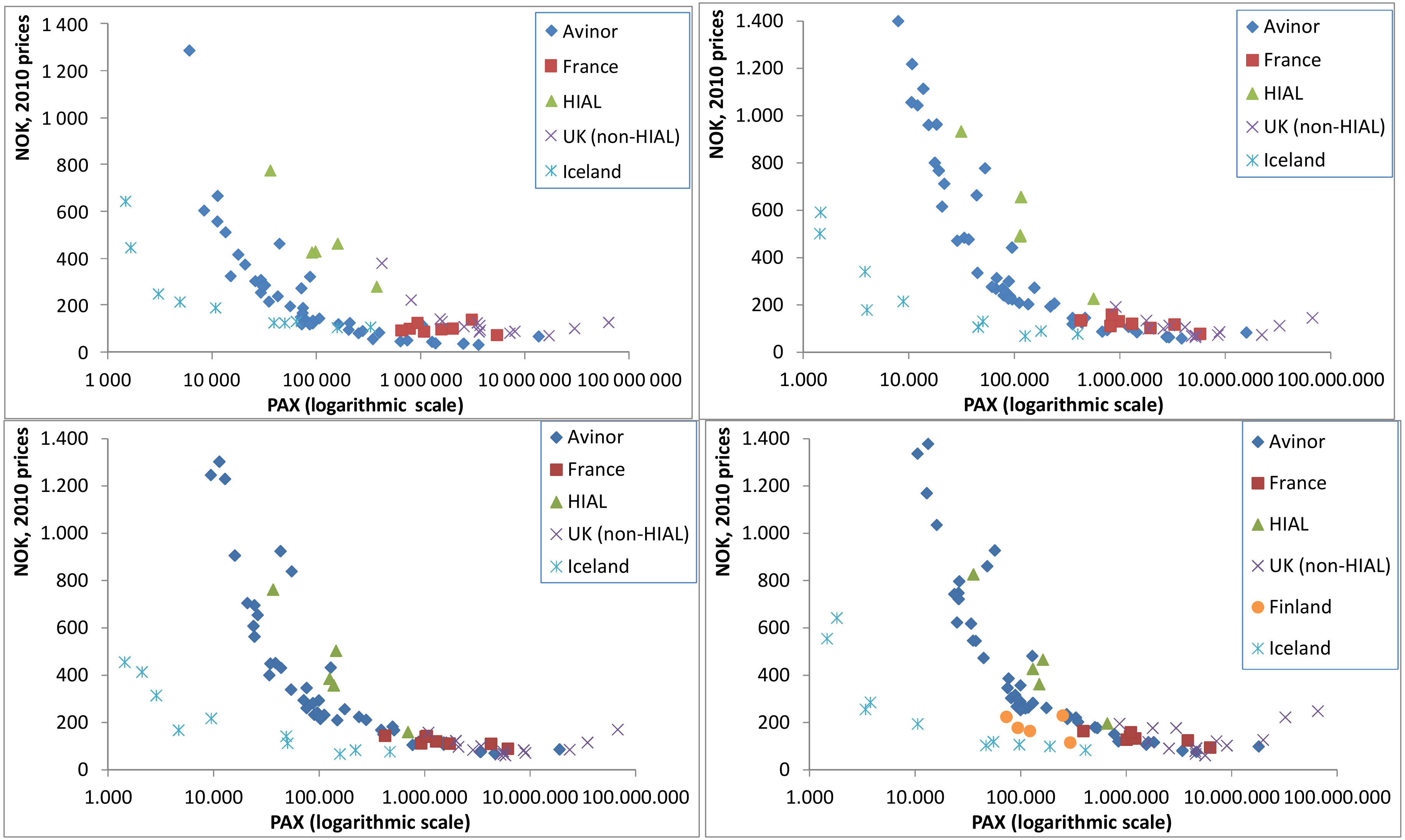

Figure 2.5.6a. Operating costs (without depreciation) per passenger at European airports in 2002 (upper left), 2005 (upper right), 2007 (lower left) and 2009 (lower right) in PPP-adjusted NOK, 2010 prices.

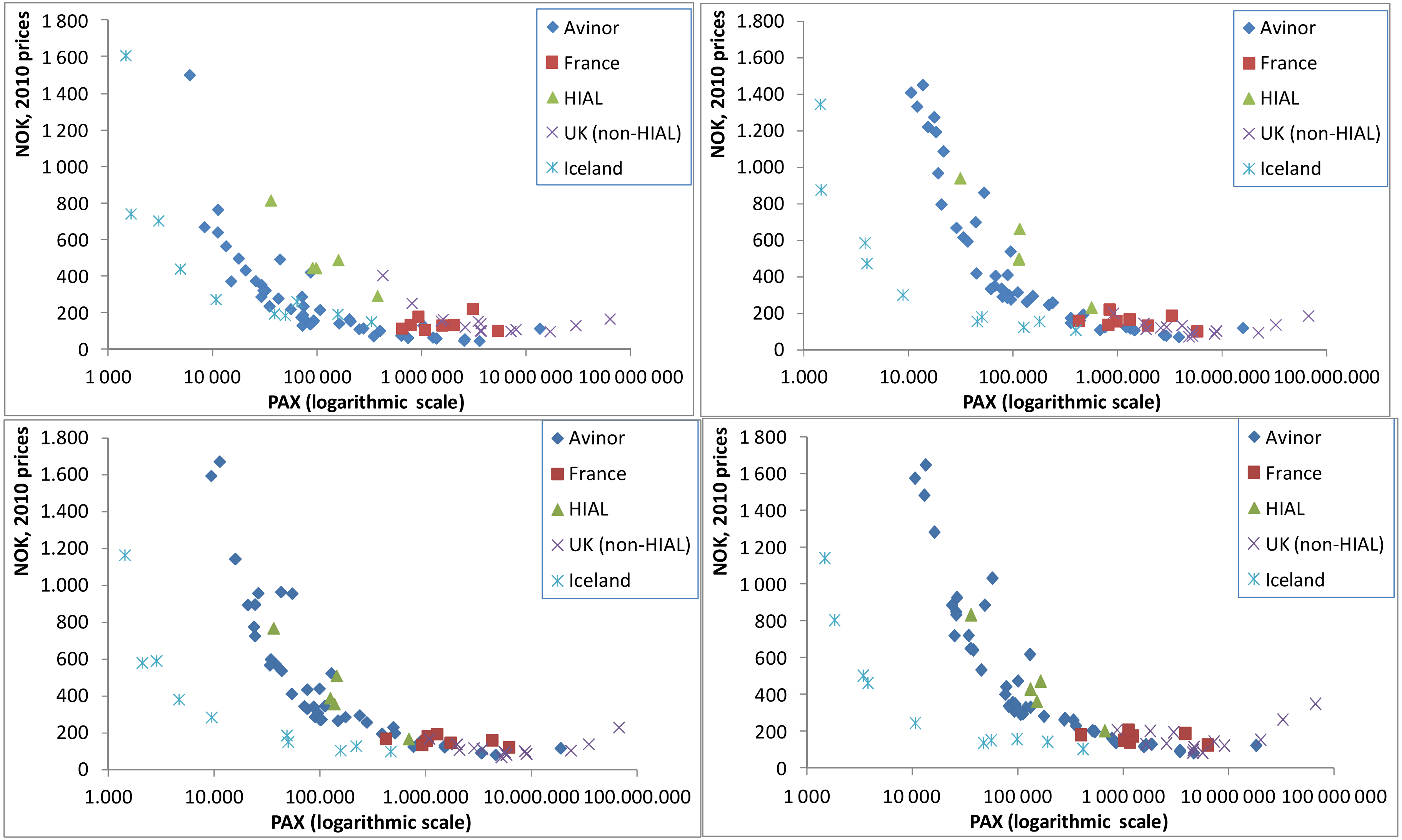

Figure 2.5.6b. Operating costs (including depreciation) per passenger at European airports in 2002 (upper left), 2005 (upper right), 2007 (lower left) and 2009 (lower right) in PPP-adjusted NOK, 2010 prices.

Country	1.000-10.000 pax				10.000-100.000 pax				100.000-1.000.000 pax				1.000.000-10.000.000 pax				>10.000.000 pax			
	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09
France									107	134	129	164	101	104	119	130				
HIAL					544	933	762	826	372	467	351	363								
Norway	947	1,399	1,531	2,830	274	574	566	639	90	163	208	237	52	79	93	96	68	83	86	99
UK									302	191		195	109	91	90	108	101	110	123	199
Finland								201				170								
Iceland	389	365	313	434	143	118	127	130	107	79	75	91								

Table 2.5.4. Average operating costs (without depreciation) per passenger at European airports for 2002, 2005, 2007 and 2009 for different size classes, in PPP-adjusted NOK, 2010 prices.

Country	1.000-10.000 pax				10.000-100.000 pax				100.000- 1.000.000 pax				1.000.000-10.000.000 pax				>10.000.000 pax			
	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09	'02	'05	'07	'09
France									143	169	152	181	139	147	160	164				
HIAL					569	940	768	832	390	472	355	367								
Norw.	1,086	1,822	2,231	3,478	314	758	729	748	121	208	258	277	67	96	108	108	114	120	116	124
UK									329	201		207	127	107	106	131	131	139	157	256
Iceland	873	716	599	727	228	168	168	173	172	129	110	123								

Table 2.5.5. Average operating costs (including depreciation) per passenger at European airports for 2002, 2005, 2007 and 2009 for different size classes, in PPP-adjusted NOK, 2010 prices.

2.5.5. Labor Productivity

Fig. 2.5.7 shows the annual number of passengers per employee (FTE) for a dataset consisting only of Avinor, HIAL, Isavia and Swedish airports[74] (71 airports in total of which 42 were Avinor airports). Icelandic airports seem to serve more passengers than Avinor airports, with the same amount of staff. On the one hand this is because they outsource labor-intensive activities such as firefighting etc. at the large airports, but on the other hand this can also mean that they are more efficient in managing their workforce and especially temporary staff. On average Avinor airports serve more passengers per employee than their HIAL peers among the smaller airports, and their performance, apart from a few outliers with a very high PAX/FTE value, is comparable to that of the Swedish airports among the larger airports.

[74] We were able to obtain partial data from public reports for some Swedish airports. For other countries, FTE data is very difficult to obtain, explaining the small sample size.

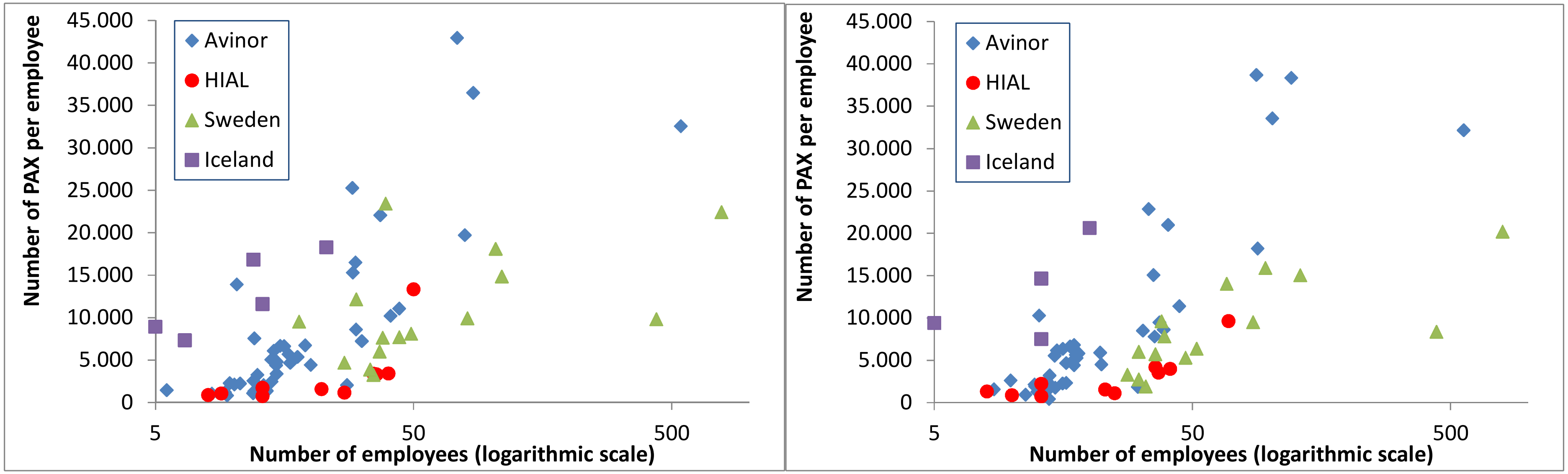

Figure 2.5.7. Annual number of pax per employee (FTE) at selected European airports in 2006 (left) and 2009 (right).

The situation was quite similar in both 2006 and 2009. All four airport groups seem to experience positive scale effects, but these effects are more pronounced for Avinor. We can reach a similar conclusion when observing total revenues per employee as a performance indicator.

2.6. Summary of Benchmarking results with PPM/ comparison with European airports

On the basis of the data assembled for the study, we applied PPM that can be classified into the following 4 categories:

1. Profitability
2. Revenue generating capability
3. Cost efficiency
4. Labor productivity

Profitability is analyzed using EBIT per passenger as a ratio of a “financial” to a physical output. We found that the declining profitability of small Avinor airports which we observed is also a European trend: the break even point had shifted by 2009 compared to 2002.[75]

Oslo had the highest ROE in 2010 compared with seven large European airports in our financial DuPont analysis, largely because of substantial loans from the government. But these results are difficult to interpret because of different forms of ownership (public versus private) being involved. However, Oslo’s ROE - cleaned of these effects - is estimated to be 17%, which is still the second highest level in our sample (1st: CPH - 26%, 3rd: DUS - 14%).

Aeronautical and commercial revenues per passenger are used separately to assess the revenue generating capability of airports. Aviation revenues per passenger for Avinor airports are relatively low, almost independent of the size of the airport. However there were many more European airports earning lower than Avinor airports revenue per passenger in 2009 than in 2002.

In terms of commercial revenue generating capability, Avinor airports fit the European trend quite well.

Total operating costs measured as the sum of all operating expenses excluding and including depreciation is used as an indicator for cost efficiency on a per passenger basis. The negative relationship between operating costs per passenger and the size is observed for all

[75] Given the increasing possibilities arising from comercial revenue sales in the last decade, we would actually not have expected this trend. However, the options to gain extra non-aviation revenue may not be so great for small airports.

airports in the sample. But we find that whereas Avinor had some cost advantage in 2002 when its costs were the lowest among the 72 airports in the sample, except for Iceland, it seemed to have vanished by 2009 and now their performance is about average compared to the total sample.

Finally, assessing labor productivity, we can conclude that Avinor airports serve on average fewer passengers per employee than Icelandic airports, but more that their HIAL peers among the smaller airports, and that the performance of Avinor airports, apart from a few outliers with a very high PAX/FTE value, is comparable to that of their Swedish counterparts among the larger airports.

As mentioned above, we have utilized partial performance measures to determine the relative position of Avinor airports in comparison with other European airports. However, these measures gave only partial information, often requiring a small sample in order to compare, and fail to make a more definitive assessment of the overall performance. To be able to do that, we next utilize Data Envelopment Analysis (DEA) in order to determine the relative overall efficiency of Avinor airports in a European context.

Chapter 3: Benchmarking Avinor with Data Envelopment Analysis

3.1. Introduction

The purpose of this chapter is to present our results from a DEA benchmark that compares Norwegian airports with other European airports of a similar size. Data Envelopment Analysis (DEA) is one of several modeling approaches which measure multi-dimensional, efficiency estimates. The model determines the relative efficiency of decision making units (DMUs) through an analysis of multiple variables defined either as inputs or outputs (Charnes et.al., 1978). DMUs (airports in a particular year) are assessed on the basis of a weighted sum of multiple outputs divided by a weighted sum of multiple inputs, without describing the production function directly. This non-parametric approach solves a mathematical model per DMU with the weights assigned to each linear aggregation producing the optimal solution to the model. The weights are chosen so as to show the specific DMU in as positive a light as possible, under the restriction that no other DMU given the same set of weights receives a score greater than 100%. The DMUs that receive a score of 100% are deemed *relatively* efficient and others lying below the Pareto frontier[76] are deemed *relatively* inefficient.

In Fig. 3.1.1, we demonstrate the modeling approach of data envelopment analysis with a simple example, where DMUs produce the single output “air traffic movements (ATM)” with two inputs, namely “staff costs” and “other costs”. Under this approach, DMUs *A*, *B* and *C* are deemed relatively efficient. The solid blue line represents the frontier derived by DEA from data collected, with each DMU utilizing different amounts of the two inputs in order to produce, in this case, a single output. The relative efficient frontier is thus a piecewise linear, empirical, external, production frontier. This frontier is thus the revealed best practice production frontier in which the minimum inputs empirically achievable are obtained per DMU given the output that must be served.

DMU *D* in Fig. 3.1.1 is not efficient and will hence receive a score less than one which in turn identifies the source and level of inefficiency for each of the relevant inputs and outputs. We argue that the inefficient DMU can move to the frontier, potentially in several ways, as described by the dotted orange lines. For example, the DMU could simply reduce the level of inputs, such as other costs and move towards point $\bar{d}$ or alternatively reduce staff costs and move towards point $\bar{\bar{d}}$ providing at least the same level of ATM. This would be

[76] In a Pareto efficient economic allocation, no one can be made better off without making at least one individual worse off. If economic allocation in any system is not Pareto efficient, there is potential for a Pareto improvement—an increase in Pareto efficiency through reallocation.

considered an input-oriented radial model. The other alternative is to search for a shorter path to the frontier such that all inputs are reduced equally, hence to point *d*. In a non-oriented, non-radial model, the inputs and outputs could be changed simultaneously and by different proportions. Additional information provided by this modelling approach enables a description of the relevant part of the frontier and the benchmarks for the inefficient DMU *D*. In this case, DMUs *B* and *C* act as relevant benchmarks for hypothetical airport *d*. Consequently, each DMU not located on the frontier is scaled against a convex combination of the DMUs on the frontier facet closest to defining the hypothetically efficient DMU *d* (Charnes et al. 1998).

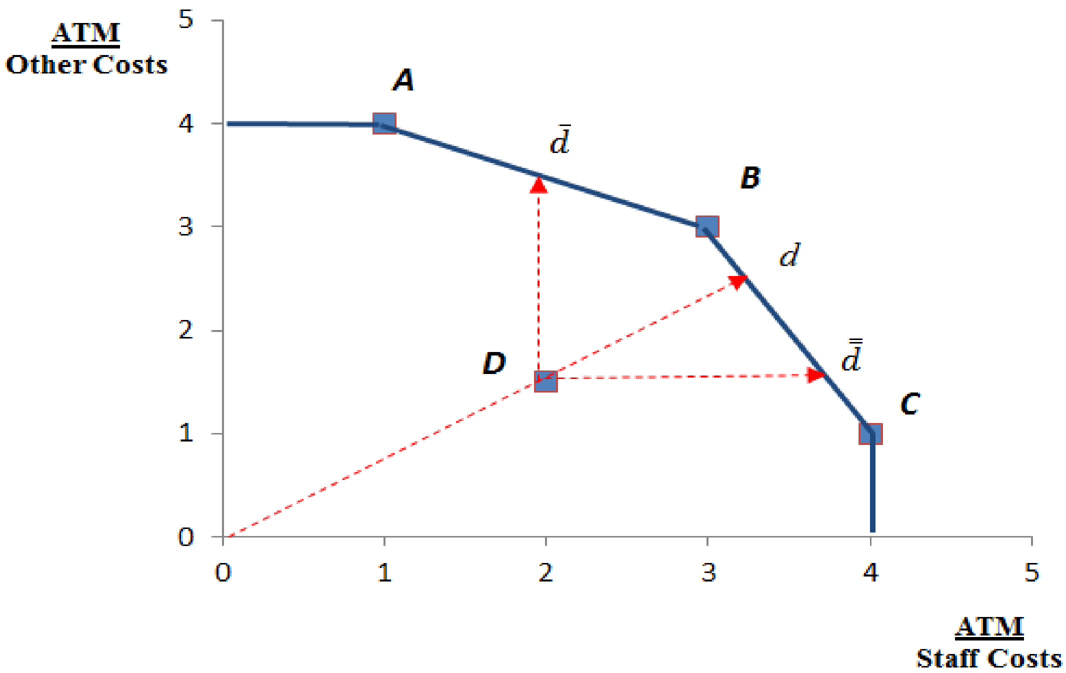

Figure 3.1.1. Data Envelopment Analysis Modelling Approach.

In section 3.2 we describe the data that has been collected for the purpose of benchmarking the Avinor airport system, including the summary statistics of airports and the variables to be analysed. In section 3.3 we describe the specific DEA model that has been chosen and Appendix H presents the DEA modeling approach mathematically. In section 3.4 we analyze the large airports and small airports in two separate models (specific mathematical results are presented in tabular form in Appendix J). In section 3.5 we present the results of a second-stage regression analysis that examines the impact of environmental variables on the efficiency estimates. In light of the regression analyses, in section 3.6 we benchmark groups of small airports based on homogeneous sets, measuring the potential levels of savings that

Avinor could have achieved if their local and regional airports were to lie on their relevant frontiers. Section 3.7 draws general conclusions based on the analyses presented.

3.2. Case Study

3.2.1. Sample Airports

The German Airport Performance (GAP) project has collected a substantial dataset of European airports based on annual reports and other public sources. The data has been supplemented by questionnaires completed by the airports. The dataset consists of airports from multiple European countries as described in Tables 3.2.1a and 3.2.1b, covering the years 2002 to 2011, although this is not fully balanced.

The efficiency of Norwegian airports has been estimated by applying DEA to a number of subsets due to diverse operational and financial structures as well as comparability issues with respect to airport size given the underlying DEA assumption of homogeneity. The availability of the 'runway capacity' measure is relevant only to slot constrained and schedule facilitated airports, hence the sample with runway capacity data is referred to as the 'large' airport dataset and the runway length as a measure of the capital asset base of the airport is referred to as the 'small' airport dataset[77]. Consequently, the four largest Avinor airports, namely Oslo (OSL), Bergen (BGO), Stavanger (SVG) and Trondheim (TRD) have been included in the large airport dataset and all remaining airports have been included in the regional and local airport dataset. Værøy (VRY) has been excluded in order not to distort the analysis, due to the fact that it only serves helicopters. In addition to Avinor airports, there are four airport groups included in the "small" airport dataset. HIAL, an acronym for Highlands & Islands Airports, is located in Scotland and operates 11 airports[78]. Other airports located in Scotland which are not operated by HIAL have been listed under the United Kingdom and appear in the large airport sample. The additional airport groups in the small airport sample include Bournemouth and Humberside belonging to Manchester Airport plc in the UK, Illulisat, Kangerlussuaq Narsarsuaq and Nuuk belonging to Mittarfeqarfiit[79] in Greenland and 11 airports belonging to Isavia[80], the Icelandic airport system. A complete list of the airports in the two samples can be found in Appendix E.

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[77]A detailed explanation of the capital asset proxy can be found in section 3.2.2.1 where we discuss the input variables applied in the data envelopment analysis model.

[78]Dundee (DND) airport belongs to HIAL only since December 2007, hence has been excluded from the group analysis.

[79] The Greenland Airport Authority (Mittarfeqarfiit) operates under the responsibility of the Ministry of Housing, Infrastructure and Transport and controls 13 airports and 46 helicopter landing spaces. They also operate 2 hotels at Kangerlussuaq and Narsarsuaqa airports.

[80] Isavia is a limited state-owned company, which handles the operations and development of all 12 airports in Iceland and manages air traffic in the Icelandic control area.

Country	Number of Airports	Number of Observations	Passengers			Air Traffic Movements		
			Average	Minimum	Maximum	Average	Minimum	Maximum
Austria	2	16	8,855,586	1,263,751	19,700,000	125,768	19,456	266,402
Belgium	1	8	16,419,769	14,446,000	18,500,000	253,054	232,000	264,000
Denmark	2	16	10,894,071	1,604,494	21,530,016	154,585	47,926	269,114
Estonia	1	8	1,267,179	606,348	1,812,791	25,873	19,397	34,319
France	3	24	5,614,830	2,482,547	7,924,063	93,490	56,244	133,769
Germany	12	96	7,739,064	994,478	34,530,593	106,883	24,043	420,866
Italy	11	88	3,645,856	1,013,288	7,160,008	43,916	16,201	80,896
Norway	5	40	5,604,307	1,025,714	19,344,459	77,237	22,063	230,799
Switzerland	2	16	14,452,204	7,583,433	22,099,233	195,174	131,739	259,149
United Kingdom	17	136	12,282,352	804,000	67,869,000	116,102	28,032	477,048
Total/Average	56	448	8,441,605			100,644		

Table 3.2.1a. Large Airport Traffic Data.

The Norwegian airports in the large airport dataset include four Avinor airports and Sandefjord/Torp (TRF). The Norwegian airports serve two-thirds of the average number of passengers in the dataset and three-quarters of the average number of air traffic movements, suggesting that the aircraft are smaller than the average and/or the load factor is lower.

Country / Group	Number of Airports	Number of Observations	Passengers			Air Traffic Movements		
			Average	Minimum	Maximum	Average	Minimum	Maximum
Austria	1	9	917,184	795,063	1,008,330	18,294	16,318	20,096
Avinor	41	369	205,986	5,850	1,649,584	5,883	647	37,821
France	22	176	493,531	14,441	1,568,382	7,911	888	24,492
Germany	2	18	468,164	234,664	657,749	12,237	6,431	19,279
Greenland	4	30	122,273	50,518	268,732	6,757	4,476	9,638
HIAL	10	90	107,211	5,450	703,371	5,828	724	20,601
Iceland	11	99	74,401	269	471,372	3,797	172	22,590
Italy	5	40	757,502	49,932	1,645,730	8,630	1,936	14,646
Slovenia	1	9	1,268,468	872,966	1,676,821	27,596	18,135	36,842
United Kingdom	5	45	533,133	3,000	1,088,000	10,665	474	52,000
Total/Average	102	885	300,500			6,921		

Table 3.2.1b. Small Airport Traffic Data.

The small Avinor airports comprise almost half the dataset and serve 69% of the average number of passengers with approximately 85% of the average air traffic movements, again suggesting that load factors and/or aircraft are relatively small.

3.2.2. Selected Variables

For both samples, three inputs and four outputs have been selected in order to capture all areas of the airport business within a single productivity analysis. The analysis aims to measure managerial efficiency; hence the variables have been differentiated according to whether the airport manager is in a position to influence the variable in the short run. Therefore, some of the variables are defined as discretionary whereas others are non-discretionary and need not be reduced (increased) when moving towards the efficient frontier.

Financial variables in the dataset have been adjusted by the PPP exchange rates to Norwegian Krone in order to account for purchasing power differences across Europe. Afterwards, the Norwegian inflation rates were used to obtain real 2010 prices.

3.2.2.1. Inputs

Staff Costs: Staff costs are defined as a discretionary input in the DEA in order to capture labor productivity. The value includes salaries, benefits, social security payments and other allowances. For the airports belonging to a group, the corresponding head office staff costs have been distributed to the airports using traffic figures as weights in order to ensure comparability of individual airports and airport groups. Furthermore, all personnel costs attributed to en-route air traffic control provision at Avinor have been removed from the data for purposes of comparability.

Other Operating Costs: Other operating costs include all costs required for airport operations, including materials and supplies, maintenance, rent, energy, hired assistants and outsourcing. In the case of Avinor, 'refundable costs' and 'internal purchases' have been included in other operating costs, but en-route air traffic control costs have been removed for purposes of comparability. For the airports belonging to a group, the corresponding head office operating costs have been distributed between the airports according to traffic figures for purposes of comparability in a similar manner to that of staff costs.[81]

Declared Runway Capacity: Capital has been defined in terms of declared runway capacity which represents a value agreed upon within a multiple stakeholder setting that takes into account the airport system configuration. For example, some airports consist of a reasonably large number of runways, however, for reasons of weather and/or geographical layout, only a smaller portion may be in use at any given time. This figure represents the

[81] The head-office costs of airports in Greenland for the whole period and Iceland for the period 2002-2006 were not available for the analysis. Since 2006, Icelandic head-office personnel costs were distributed according to the number of personnel employed at each airport, central IT costs were distributed according to the number of computers and relevant equipment utilized at ecah airport and other costs were distributed according to the total costs at each airport.

maximum number of aircraft movements that can be handled within one hour and accounts for various constraints with respect to runways, aprons and terminal gates as well as environmental constraints. Consequently, this figure captures a wide range of airport capacity components and is a good proxy for capital (Adler et al. 2013). Airport managers have limited influence over declared runway capacity in the short run, hence the variable is defined as a non-discretionary input, which is not reduced in the path towards the efficient frontier.

Total Runway Length: Smaller airports that are not slot constrained do not undertake a process that arrives at a maximum runway capacity figure, hence the value of capital has been approximated by the total runway length for the small airport sample. Past research, such as the ATRS airport benchmarking project (Oum and Yu 2004), count the number of runways. After choosing to collect data on runway length, terminal area and total airport area, we discovered that this data is not publicly available for the majority of small airports hence we utilize runway length which is obtainable through the Eurocontrol Aeronautical Information Publication reports and other public sources. As with declared runway capacity for the large airport datasets, total runway length is defined as a non-discretionary input for the small airport dataset because it is considered to be a long run variable over which the airport management has very limited control[82]. This restricts the comparator airports to those with the same length of runway or less.

3.2.2.2. Outputs

Non-aviation Revenues: Commercial revenues include all revenues not earned from passenger and landing fees that are generally defined as aeronautical revenues. Some adjustments have been necessary in order to ensure comparability across airports. For example, Italian and French airport subsidies are reported in the accounts under 'other' revenues, which were removed because the analysis focuses on operational efficiency. For the same reason, all financial related revenues have been eliminated too. On the other hand, revenues from ground handling services have been included in non-aviation revenues if the airport provides these services. Consequently, airports that produce ground-handling in-house have higher labor costs and commercial revenues, those that outsource the activity have higher other costs and commercial revenues whereas those that permit third party suppliers (generally the airlines or separate third party logistics companies) to provide the service have

[82] The most important factors affecting the size of aircraft that can be served as a function of runway length include the **weight** of the aircraft and the settings of its lift- or drag-increasing devices; **stage length** of the flight; **weather**, particularly temperature and surface wind; airport **location**, notably airport elevation and the presence of any physical obstacles in the general vicinity of the runway and **runway characteristics**, such as slope and runway surface condition (De Neufville and Odoni, 2003).

at most small concession rents that have been included in the commercial revenue computation.

Among the four outputs, non-aviation revenue is the only discretionary variable. The remaining three outputs, namely the number of passengers, air traffic movements and cargo, are defined as internal non-discretionary variables because the airport managers have limited control since they represent airline related decisions or are a function of the Ministry of Transport's public service obligations.

Total Passengers: The total number of annual passengers served including arrivals, departures, transfer and transit.

Commercial Air Traffic Movements: This variable captures the number of aircraft served annually excluding general aviation, military and other civil aviation flights.

Total Cargo: This variable includes freight and mail in tons served by the airport annually.

Country	Number of Airports	Number of Observations	Staff Costs (in NOK 2010 values)	Other Costs (in NOK 2010 values)	Capital Asset (runway capacity)	Non-aviation Revenues (in NOK 2010 values)	Passengers	Air Traffic Movements	Cargo (tons)
Austria	2	16	1,122,717,716	671,225,433	43	1,450,215,199	8,855,586	125,768	94,226
Belgium	1	8	643,811,740	1,388,374,070	72	1,372,175,350	16,419,769	253,054	640,590
Denmark	2	16	577,015,393	358,088,138	58	850,664,685	10,894,071	154,585	202,056
Estonia	1	8	84,767,386	100,975,991	20	124,638,257	1,267,179	25,873	15,067
France	3	24	210,540,745	415,392,224	44	497,178,383	5,614,830	93,490	41,388
Germany	12	96	682,741,234	938,440,301	40	1,280,363,081	7,739,064	106,883	95,325
Italy	11	88	155,958,575	235,393,336	20	275,779,952	3,645,856	43,916	21,467
Norway	5	40	121,335,189	317,584,683	33	455,673,141	5,604,307	77,237	20,523
Switzerland	2	16	677,748,352	881,285,199	53	1,118,681,389	14,452,204	195,174	221,955
United Kingdom	17	136	496,980,158	944,838,211	37	1,263,473,953	12,282,352	116,102	136,406
Total/Average	56	448	447,838,251	679,598,350	36	928,264,833	8,441,605	100,644	100,319

Table 3.2.2a. Large Airport Data Averages

Country	Number of Airports	Number of Observations	Staff Costs (in NOK 2010 values)	Other Costs (in NOK 2010 values)	Capital Asset (runway length)	Non-aviation Revenues (in NOK 2010 values)	Passengers	Air Traffic Movements	Cargo (tons)
Austria	1	9	89,177,129	77,483,825	2,740	153,426,633	917,184	18,294	7,967
Avinor	41	369	13,165,765	21,131,954	1,436	7,022,676	205,986	5,883	491
France	22	176	31,321,813	40,582,670	2,949	40,018,093	493,531	7,911	1,597
Germany	2	18	52,754,924	50,136,887	2,478	57,427,164	468,164	12,237	1,921
Greenland	4	30	12,285,518	12,838,875	1,565	12,612,859	122,273	6,757	1,690
HIAL	10	90	19,335,157	20,708,435	2,388	2,917,677	107,211	5,828	692
Iceland	11	99	3,770,860	3,378,835	1,658	317,726	74,401	3,797	260
Italy	5	40	40,766,487	62,700,745	2,658	57,812,910	757,502	8,630	1,350
Slovenia	1	9	146,141,828	100,260,861	3,300	224,202,071	1,268,468	27,596	12,052
United Kingdom	5	45	62,449,526	83,467,495	2,090	94,262,645	533,133	10,665	3,583
Total/Average	102	885	23,420,479	30,533,376	2,005	25,185,060	300,500	6,921	1,165

Table 3.2.2b: Small Airport Data Averages

3.3. Data Envelopment Analysis Model

Data Envelopment Analysis (DEA) was originally developed by Charnes, Cooper and Rhodes (1978) in which they show how to solve the Debreu (1951) and Farrell (1957) technical efficiency measure using linear programming. The efficiency measure computes a relative score in the form of a ratio of a weighted sum of outputs divided by a weighted sum of inputs. DEA is a productivity measurement technique that determines both the relative efficiency of a number of decision-making units (DMUs) and the targets for their improvement. DMUs can be any form of organization or department that performs fundamentally the same task with a similar set of variables (inputs and outputs). These variables can be of a financial (e.g. revenues), infrastructure (e.g. runway capacity) or quantitative nature (e.g. number of customers). In contrast to parametric statistical approaches, DEA measures the relative efficiency of DMUs with multiple inputs and outputs and assumes neither a specific functional form for the production function nor the inefficiency distribution. DEA is an extreme point empirical method and compares each inefficient DMU only with the best DMUs in the sample (benchmarks), exposing their individual weaknesses without attaching subjective a-priori weights on variables.

In this analysis, a bound adjusted measure of efficiency (BAM) has been applied (Cooper et al. 2011). BAM is a non-oriented, additive DEA model that considers input reductions and output augmentations simultaneously. Inputs and outputs are partitioned into subsets of discretionary and nondiscretionary variables. Nondiscretionary variables are assumed to be beyond the control of the airport manager in the short run or are exogenously restricted (Banker and Morey 1986). Since information about the optimal change with respect to nondiscretionary variables is not meaningful from an airport manager’s perspective, nondiscretionary variables are not included in the efficiency score calculation. However, they are taken into account in determining efficient targets for inefficient DMUs in the same way as discretionary variables: efficient targets should use no more inputs in order to produce at least the same amount of outputs as the inefficient DMUs (Charnes et al. 1998). In other words, small airports will only be compared with airports suffering from the same runway restrictions. Efficient targets define the frontier surface, which is expressed as a convex combination of the inputs and outputs of the reference efficient DMUs. The benchmarks draw from the efficient DMU set and usually have similar production characteristics to their inefficient counterparts. A DMU is deemed relatively efficient if, and only if, there are no output shortfalls or resource wastages with respect to the discretionary variables at the optimal solution. The DEA model also computes the level of slacks in the discretionary variables for the inefficient units. The values of the slacks identify the source and level of inefficiency in the corresponding inputs and outputs per DMU. The efficiency score combines all sources of inefficiency which are additively aggregated, therefore the model is frequently called the "additive" model (Charnes et al. (1985)). The additive BAM efficiency score is restricted to lie between 0 and 1, where 1 identifies relative efficiency. Individual weights in the efficiency score function ensure that all discretionary variables are weighted according to their relative importance to the specific DMU. The relative weights depend on the ranges from their current value to the ideal point as measured from the minimum input or maximum output within the sample. If a variable is located far from the ideal point, then this variable will be less important in the efficiency score calculation for the specific DMU according to the BAM modeling approach. This assumption is consistent with the general DEA principle in which each DMU is viewed in as positive a light as possible, given the restriction that no other DMU with the same weights is more than 100 percent efficient.

A constant returns to scale assumption means that the producers are able to linearly scale the inputs and outputs without increasing or decreasing efficiency. Drawing on discussions with airport managers and based on the academic literature, we assume a variable returns to scale (VRS) model is the most appropriate to measure airport efficiency (Adler et al 2011). For example, larger airports that provide the infrastructure for airport cities including shopping malls, hotels and other commercial activities may have relatively greater opportunities to collect revenues than their smaller counterparts. In addition, the VRS assumption ensures translation invariance, permitting zero or negative values in the analysis, which is relevant because some airports do not handle cargo for example (Lovell and Pastor (1995)). The BAM model is also units invariant which is important because costs and revenues are measured in millions of NOK currently and were they to be translated into euros, the results would remain the same due to this property.

Finally, we have computed a Malmquist index which allows us to analyse productivity changes between two selected periods per airport provided we have a balanced panel dataset. The Malmquist index compares two within-period frontiers and a meta-frontier that envelops the pooled panel data over the entire timeframe. Consequently, it is possible to separate the overall productivity shift over time into two components: one measuring the efficiency change for a specific airport (its location with respect to the relevant efficient frontier) and the other measuring the frontier shift which identifies any technological changes for the benchmark units over time. The within-period-efficiency measures the distance from the

DMU to the frontier of the observed period. The technological gap measures the distance between two within-period frontiers, given the input-output mix of the relevant DMU. For purposes of consistency, we use the same ideal point over time (Portela and Thanassoulis (2010). For the small airport dataset, which is unbalanced, we apply a second stage regression analysis with time dummy variables in order to capture the changes in the frontier over time.

3.4.Results

3.4.1. Initial Exploratory Data Analysis

The correlations across variables demonstrate their relationships, as shown in Tables 3.4.1a and b.

	Staff Costs	Other Operating Costs	Declared Runway Capacity	Non-aviation Revenues	Total Passengers	ATM	Cargo
Staff Costs	1.00						
Other Operating Costs	0.90	1.00					
Declared Runway Capacity	0.76	0.69	1.00				
Commercial revenue	0.93	0.97	0.74	1.00			
Total Passengers	0.85	0.91	0.78	0.94	1.00		
ATM	0.87	0.84	0.91	0.88	0.93	1.00	
Cargo	0.67	0.76	0.67	0.77	0.79	0.75	1.00

Table 3.4.1a. Large Airport Dataset Correlations across Variables.

	Staff Costs	Other Operating Costs	Total Runway Length	Commercial revenue	Total Passengers	ATM	Cargo
Staff Costs	1.00						
Other Operating Costs	0.74	1.00					
Total Runway Length	0.45	0.50	1.00				
Commercial revenue	0.84	0.77	0.45	1.00			
Total Passengers	0.77	0.85	0.52	0.74	1.00		
ATM	0.66	0.72	0.44	0.60	0.84	1.00	
Cargo	0.63	0.51	0.30	0.66	0.57	0.58	1.00

Table 3.4.1b. Small Airport Dataset Correlations across Variables.

We expect relatively high correlation between inputs and separately between outputs as has been demonstrated in Tables 3.4.1a and b. For example, it would be reasonable to expect passenger numbers and air traffic movements to be highly correlated and they lie in the region of 0.93 in the large airport dataset and 0.84 in the small airport dataset. The lowest correlations are connected to the cargo variable which is also reasonable because most costs directly related to the handling of cargo are organized by third party logistic suppliers rather than the airport directly. Furthermore, cargo is generally handled at hub airports which in our dataset correspond to the large airports, Cologne-Bonn and Leipzig, which serve DHL and UPS respectively and the small airport Rennes which serves UPS, TNT and Chronopost. We also note that the higher levels of heterogeneity within the small airport dataset have led to lower levels of correlation between the variables across the board. Finally, it is clear that the declared capacity is a better proxy for airport size than the runway length due to the higher correlation with respect to the other inputs, hence our choice to use this variable when possible.

The results of the DEA for the large and small airports are discussed in two separate sections. In each section we analyze the results of the DEA model in terms of efficiency and benchmarking and then we discuss general trends over time. In section 3.5 we discuss benchmarking of the small airport dataset after separating the set into sub-groups due to the heterogeneity of the production process as compared to the large airport dataset.

3.4.2. Large Airports

The four large Avinor airports (OSL, BGO, SVG and TRD) are defined as relatively efficient compared to 52 large European airports based on an annual BAM-Malmquist analysis over the time period. The complete results of the analysis are presented in Appendix J. In order to present the results graphically, we utilize co-plot, a multi-dimensional statistical approach that reduces the observations to two dimensions based on a correlation, small space analysis (Adler et al. 2007, Adler and Raveh 2008). The first plot is based on partial productivity measures with each arrow corresponding to the ratio of one output (commercial revenues, air traffic movement, passengers and cargo) divided by one input (staff costs, other costs and declared capacity). The second plot, which is superimposed on the first, locates similar observations together and diverse observations far from each other. In Fig. 3.4.1, the light-colored (yellow) points represent Avinor airports (all are DEA efficient except for SVG in 2006), the dark (blue) points represent the other DEA efficient airports and the grey (red) points represent DEA inefficient airports. The co-plot identifies the fact that all the Norwegian airports lie on the south-west section of the relative efficient frontier in Fig. 3.4.1 due to relatively low staff and other costs but also comparatively low runway utilization and commercial revenues. Oslo airport is situated further to the right than the other large Avinor airports due to relatively higher levels of non-aeronautical revenues and higher runway utilization than the other large Avinor airports in the dataset. The other efficient European airports, such as Copenhagen (CPH), lie on a different area of the Pareto frontier to the right of the plot, suggesting that they achieve efficiency through higher utilization of the airport facilities.

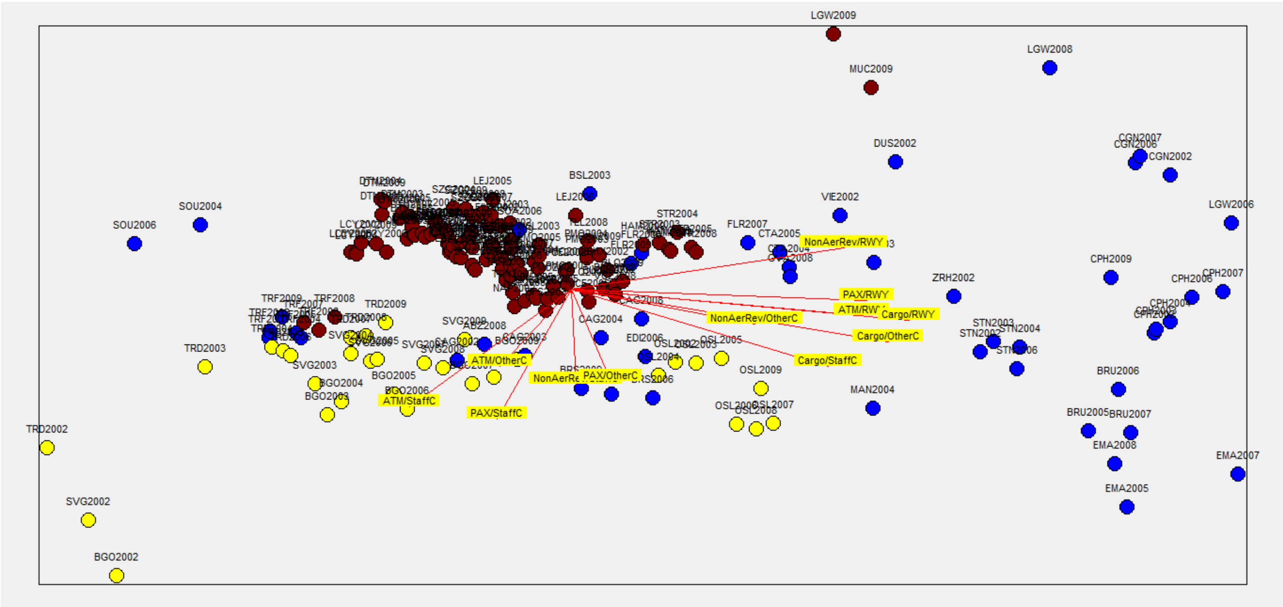

Figure 3.4.1. Large Airport Benchmarking Plot.

We also utilize co-plot in Fig. 3.4.2 in order to examine the changes in efficiency over time. Fig. 3.4.2 is a magnified snapshot of Fig. 3.4.1 with three additional arrows showing the movement of BGO, SVG and TRD for the years between 2002 and 2009. We note that the higher the observations with respect to the rays, the more positive the airports appear with respect to their relevant ratios. As the three arrows show, there is a stable movement towards the center for the three large Avinor airports, which illustrates deterioration in productivity from 2002 to 2009. It should be noted that Oslo shows a more mixed trend because the additional non-aeronautical revenue achieved as a result of the change in the regulation with regard to duty-free sales in 2005 helped the airport to improve its position. The subsequent, continual increase in costs has led to a retraction and inwards movement in 2009.

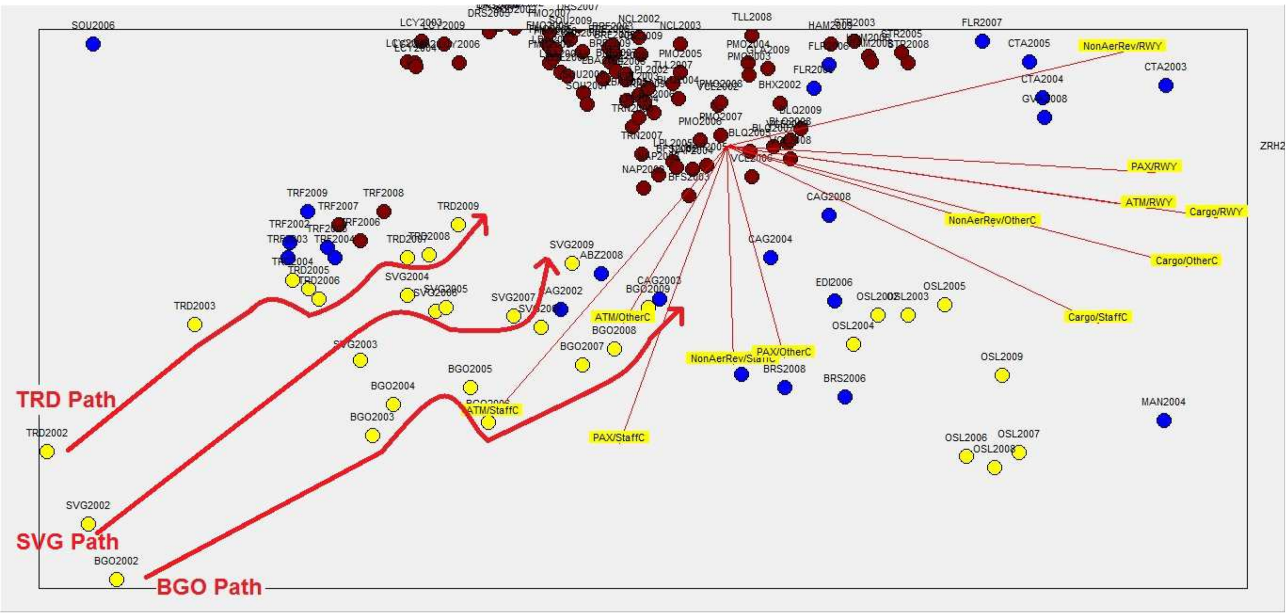

Figure 3.4.2. Large Airport Plot showing Trend.

The Malmquist index, in conjunction with the DEA, computes productivity changes as a multiple of two components: technological frontier shifts and efficiency shifts. While technological change demonstrates frontier movements defined by the benchmark DMUs, the efficiency change describes the distance of each DMU from the frontier. Table 3.4.2 presents the technological, efficiency and productivity changes from 2002 to 2009 at the country level. The values are calculated as the averages of individual airports in each country. While a value greater than 1 shows an improvement, a value less than 1 illustrates deterioration from the frontier.

Country	Number of Airports in Sample	Average Technological Change 2002-2009	Average Efficiency Change 2002-2009	Average Productivity Change 2002-2009
United Kingdom	17	0.90	1.19	1.04
Germany	12	0.92	1.05	0.96
Denmark	2	0.97	0.99	0.95
Italy	11	0.89	1.06	0.93
Estonia	1	0.92	1.00	0.92
Switzerland	2	0.91	1.00	0.91
Austria	2	0.94	0.94	0.87
Norway	**5**	**0.86**	**1.00**	**0.86**
France	3	0.84	1.00	0.83
Belgium	1	0.83	1.00	0.83
Average		**0.90**	**1.08**	**0.95**

Table 3.4.2. Large Airport Changes over Time.

The results show that the Norwegian airports (the four large Avinor airports and Torp) suffer from an average 14% technological deterioration over time and, as a result, an average 14% productivity deterioration which is worse than the average 5% deterioration compared to the average of the sample. Most airports in the dataset have suffered from a frontier retraction over time possibly due in part to the increased security costs imposed on the airports as a result of the European Union Security Directives 2320/2002 which was replaced by 300/2008.

3.4.3. Small Airports

Fig. 3.4.3 presents the small airport dataset, which consists of 102 airports in 2009 of which 41 belong to Avinor. The Avinor airports (yellow points) are mostly located in a cluster to the lower right of the plot that is enveloped by some of the Icelandic airports (white points) lying to the north east that define the relevant portion of the efficient frontier. Relatively, Avinor and Isavia airports enjoy reasonably low staff and other costs but also suffer from comparatively low utilization and non-aeronautical revenues. Consequently, unlike the large airports, the majority of small Avinor airports are not deemed relatively efficient. Bodø (BOO), Hammerfest (HFT), MoiRana (MQN) and Tromsø (TOS) are consistently efficient throughout the years as well as Røst (RET) and Vadsø (VDS) which are also relatively important benchmarks for other Avinor airports within their corresponding sets. The important non-Avinor benchmark airports include the Icelandic airports of Gjogur (GJR), Grimsey (GRY), Thorshofn (THO), Vestmannaeyjar (VEY) and Vopnafjordur (VPN). This set of airports achieves higher runway utilization and lower costs than their Avinor counterparts, given their short runway (STOL airports). However, we also note that the Icelandic airports have lower costs in part due to the low security costs on domestic flights.

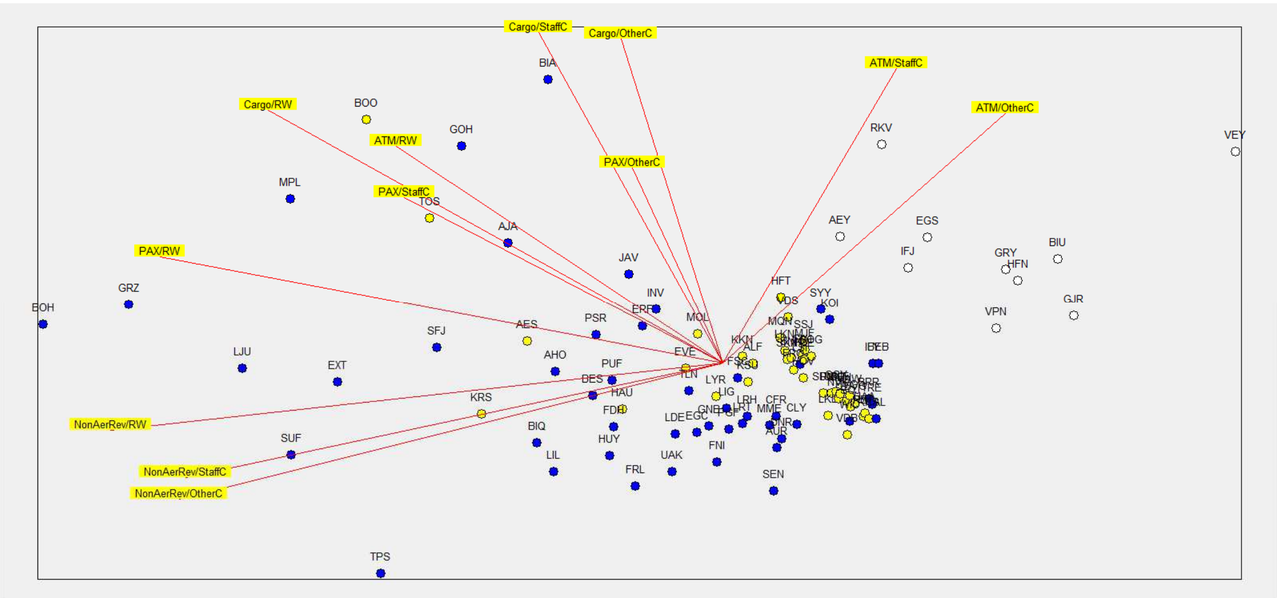

Figure 3.4.3. Small Airport Benchmarking Plot, 2009.

In Fig. 3.4.4 we present efficiency trends for each country or group of airports on an annual basis. The small Norwegian airports show a clearly decreasing trend in their efficiency estimates over time, particularly in the period up to 2005 after which the decline is more gradual. Similar patterns in efficiency can be observed for Greenland, Germany and France. Greenland airports' efficiency estimates are fairly static and clearly envelope the other airports as does Iceland. The Scottish HIAL airport group remains highly inefficient throughout the timeframe. UK airports appear to be good benchmarks for the HIAL airport system. Whilst the UK and Italian airports show small fluctuations in efficiency, the Icelandic airports have slightly decreased efficiency towards the end of the observed period. In summation, the Icelandic and Greenland airports present the highest relatively efficient performance overall although most of the small airports show decreasing efficiency levels over time.

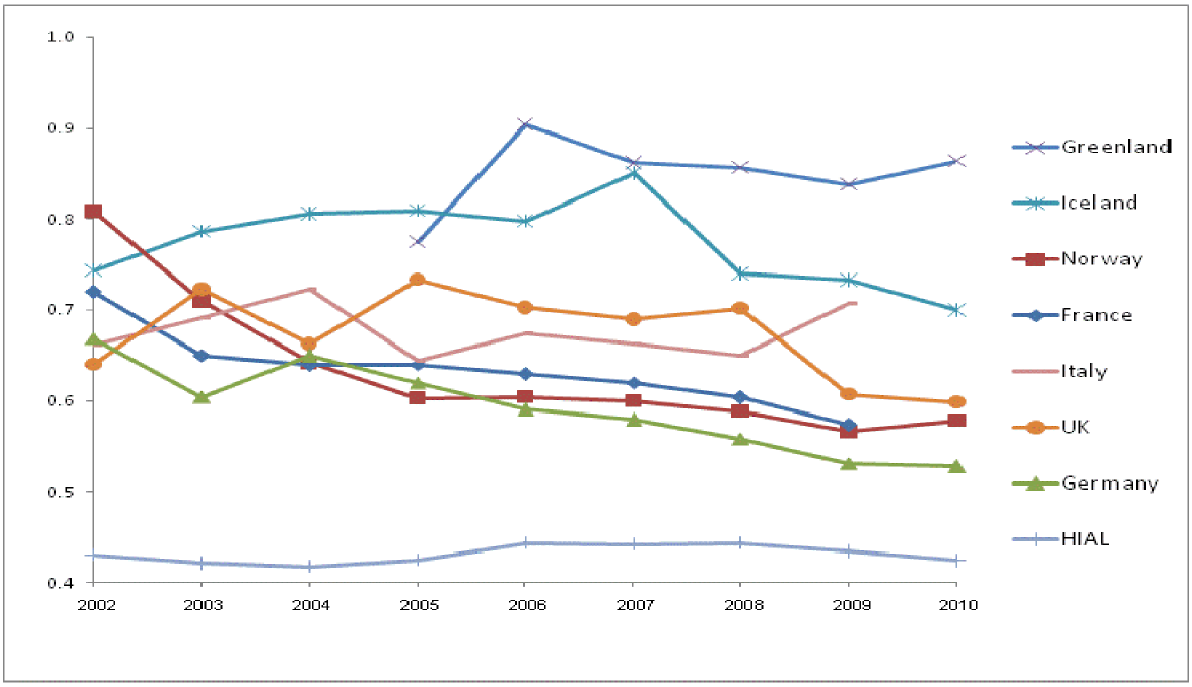

Figure 3.4.4. Small Airport Efficiency Averages over Time.

3.5. Environmental Variables

In this section we analyze the impact of additional variables that may explain the DEA efficiency estimates computed in the first stage of the analysis. The environmental variables include the average aircraft size, percentage of international passengers served and commercial revenues as a share of total revenues (Oum and Yu 2003), ground-handling or fuel sales undertaken in-house (Adler et al. 2013), airports belonging to a publicly owned system, the profits (losses) of the airport before taxes, depreciation and amortization

(EBITDA), STOL[83] runway infrastructure and dual military and civilian airports. In addition to these variables, year dummies have been included in order to capture the efficiency changes over time. An unbalanced dataset capturing the years 2002 to 2010 has been analyzed and separate regressions have been included for the large and small datasets. 2002 was used as the base year in all analyses.

Table 3.5.1 presents the results of an ordinary least square (Banker and Natarajan 2008) and truncated regression (Simar and Wilson 2007) explaining the logged DEA results as the dependent variable. The truncated regression was chosen to take into account the fact that the DEA scores lie between 0 and 1 by definition and for purposes of sensitivity analysis. Under truncated regression, the efficient DMUs are removed from the analysis and despite these differences, both regressions arrive at very similar results. We also note that the percentage of international passengers served, non-aeronautical revenue shares and EBITDA were logged, hence their coefficients are interpreted as elasticities, i.e. the percentage change in the dependent variable were the independent variable to increase by one percent. The remaining variables are in the form of dummies.

	Large Airports				Small Airports			
	OLS		Truncated		OLS		Truncated	
	Coef.	t	Coef.	z	Coef.	t	Coef.	z
Average aircraft size	**0.050**	**2.09**	**0.072**	**2.53**	-	-	-	-
Share of Non Aeronautical Revenue	**0.168**	**4.88**	**0.206**	**5.49**	**0.140**	**2.63**	**0.138**	**2.79**
Share of International Traffic	0.019	1.32	**0.073**	**3.88**	**0.026**	**5.19**	**0.021**	**4.68**
Ground handling or fuel sales in-house	**-0.167**	**-12.31**	**-0.191**	**-10.87**	**-0.096**	**-8.19**	**-0.099**	**-9.15**
EBITDA	-	-	-	-	**0.063**	**5.44**	**0.051**	**4.98**
Belongs to airport system	-	-	-	-	**-0.081**	**-3.21**	**-0.114**	**-4.93**
STOL Airport	-	-	-	-	**0.203**	**8.84**	**0.153**	**7.25**
Military involvement	-	-	-	-	**0.078**	**2.58**	0.041	1.42
d2003	-0.021	-0.71	0.010	0.28	**-0.066**	**-2.05**	-0.041	-1.32
d2004	-0.005	-0.15	0.020	0.55	**-0.107**	**-3.35**	**-0.067**	**-2.17**
d2005	-0.006	-0.21	0.041	1.16	**-0.132**	**-4.15**	**-0.104**	**-3.38**
d2006	0.004	0.13	0.029	0.79	**-0.132**	**-4.15**	**-0.094**	**-3.05**
d2007	-0.008	-0.25	0.047	1.30	**-0.134**	**-4.22**	**-0.113**	**-3.66**
d2008	-0.020	-0.67	0.021	0.59	**-0.163**	**-5.13**	**-0.136**	**-4.44**
d2009	**-0.091**	**-3.00**	-0.049	-1.42	**-0.184**	**-5.75**	**-0.126**	**-4.15**
d2010	-0.057	-1.73	-0.028	-0.71	**-0.200**	**-5.76**	**-0.162**	**-4.89**
Constant	-0.187	-1.65	-0.254	-1.92	**-1.413**	**-6.43**	**-1.223**	**-6.37**

Table 3.5.1. Second Stage Regression Results.

For the large airport dataset, the results presented in Table 3.5.1 clearly identify that the larger the average aircraft size, the higher the DEA efficiency estimate, which confirms

[83] STOL runway infrastructure is reffered to the runways no longer than 1200 meters.

previous findings (Adler et al. 2013). In addition, airports earning the majority of their revenues from commercial sources receive more positive efficiency estimates. This includes OSL for whom commercial revenues comprise 60% of the overall revenues[84]. The percentage of international passengers served proved to be positive in both regressions but insignificant in the OLS whereas significant in the truncated regression, possibly indicating that the higher the international passenger traffic, the higher the duty-free sales which impacts the non-aeronautical revenues. We also demonstrate that airports undertaking ground handling or fuel sales in-house are approximately 17% to 19% less efficient than those that outsource these activities. It would be reasonable to draw the conclusion that outsourcing is preferable from a managerial perspective. The yearly dummy variables show a gradual reduction in efficiency although none are significant except for the OLS regression in 2009.

The results of the regression for the small airport dataset show similar patterns in that airports undertaking ground handling or fuel sales in-house are 10% less efficient than those that outsource these activities. Furthermore, increasing shares of non-aeronautical revenues and international traffic contribute to higher efficiency scores. Airport efficiency elasticity to changes in profitability (EBITDA) is also positive as expected. The dummy for dual use military and civilian airports show that such airports appear to be 8% more efficient relatively, despite the removal of all military movements from the ATM variable, suggesting that these airports enjoy lower staff and other costs as a result of military staff availability. The impact of dual use airports remains positive in the truncated regression but is not significant. Under the truncated regression, efficient DMUs are removed from the analysis which in turn removed most of the dual use civilian-military airports, hence the loss in significance. The consistent, increasing decline in efficiency over time is clearly significant for the small airport dataset. Moreover, it is clear that belonging to an airport system such as Avinor and HIAL reduces average efficiency by a statistically significant 8% to 11%. This suggests that airports run locally would appear to have a higher probability of achieving a more relatively efficient outcome. Finally, the STOL restricted airports are 15% to 20% more efficient suggesting that the shorter runways reduce the costs of clearing snow and maintaining the asphalt that the longer runways require.

3.6.Benchmarking Small Airports

According to the regression analyses presented in Table 3.5.1, we find strong evidence that exogenous factors impact the efficiency frontier as a result of differences in the

[84] Bergen earns 40% of their revenues from the commercial side of the airport business, Stavanger earns 44% and Trondheim earns 39% of their revenues from the commercial side in 2010.

production functions between STOL and other airports, ground handling or fuel sales in-house versus outsourcing these activities and dual use military-civilian versus purely civilian airports. In order to find relevant benchmarks for the small Norwegian airports, we separate the dataset into more homogeneous sets according to the exogenous factors from an airport management perspective. In addition, we account for the geographical environment of Norway: sparse density, arctic climate, mountainous terrain and long coastline.

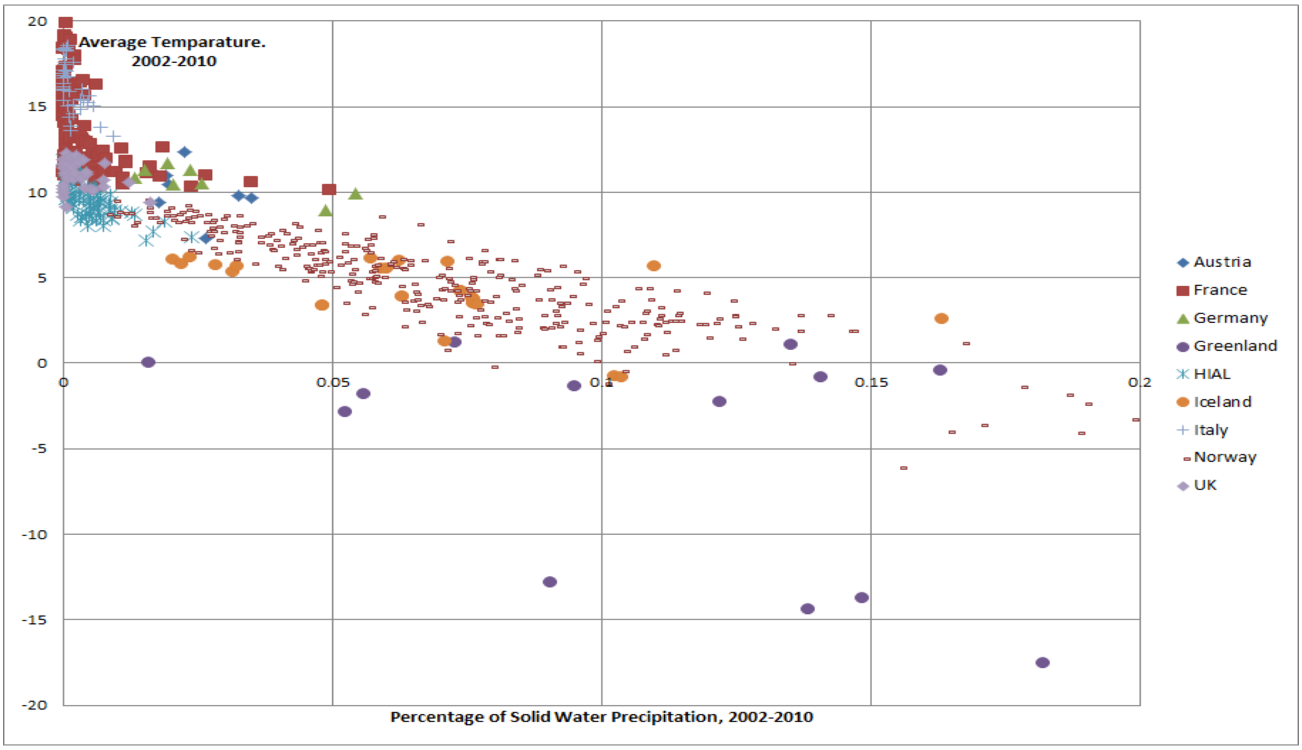

Figure 3.6.1. Small Airports Climate Conditions, 2002-2010.[85]

In countries such as Norway, Iceland and Greenland, airline access to remote areas is critical because road provision is often problematic during the winter season. Due to a lack of a publicly available remoteness or climate index, we collected data on the percentage of solid water precipitation such as hail, snow, ice and the average temperature as proxies for similarity in climate environment, as shown in Fig. 3.6.1. Consequently, the French, Italian and part of the German and UK airports were omitted from the benchmark analysis. Due to the growing cost inefficiency over time, as demonstrated by the significance of the time dummies in the regression analyses, each subset was further split into two time periods; 2002-2005 and 2006-2010. In summation, Table 3.6.1 presents the conservative estimated cost savings and non-aeronautical revenue shortfalls that Avinor could have achieved per subset were the airports to lie on their respective Pareto frontiers.

[85] http://www.wunderground.com/

		Potential Reduction				Potential Increase	
		in Staff Costs		in Other Operating Costs		in Non-Aeronautical Revenues	
Group	Year	in NOK	in %	in NOK	in %	in NOK	in %
Group 1: STOL airports ***25 Avinor airports***	2002	24,277,717	14%	10,491,164	16%	2,346,379	13%
	2003	24,883,572	14%	44,994,574	40%	4,421,856	21%
	2004	31,445,506	17%	96,944,991	54%	7,473,777	39%
	2005	54,746,382	25%	135,237,511	59%	9,086,560	44%
	2006	44,894,727	20%	38,819,949	18%	6,414,701	33%
	2007	60,366,001	24%	47,453,149	20%	11,016,828	60%
	2008	75,733,015	27%	58,665,298	22%	9,263,500	31%
	2009	78,455,340	27%	83,733,097	28%	16,542,169	60%
	2010	68,947,562	23%	71,013,441	24%	11,760,203	36%
	Total	463,749,824	22%	587,353,173	31%	78,325,974	38%
Group 2 : non-STOL with outsourced GH&F ***9 Avinor airports***	2002	33,490,528	22%	11,337,747	12%	2,623,041	3%
	2003	43,382,837	27%	76,096,617	40%	6,973,686	8%
	2004	43,975,324	25%	153,292,519	46%	6,752,031	6%
	2005	39,753,152	20%	116,993,964	35%	8,460,132	6%
	2006	41,142,216	19%	56,170,594	14%	12,617,313	7%
	2007	63,195,828	24%	84,327,321	17%	22,315,150	11%
	2008	57,221,638	22%	68,660,014	13%	20,033,104	9%
	2009	67,845,189	25%	100,166,027	18%	22,959,725	9%
	2010	52,405,157	19%	91,516,110	16%	20,250,273	7%
	Total	442,411,868	22%	758,560,912	22%	122,984,454	8%
Group 3 : non-STOL with GH&F in-house ***3 Avinor airports***	2002	0	0%	0	0%	0	0%
	2003	762,292	2%	4,184,680	13%	0	0%
	2004	712,348	2%	1,492,646	3%	0	0%
	2005	2,079,308	6%	3,326,201	5%	0	0%
	2006	1,744,526	4%	15,720,922	20%	0	0%
	2007	4,611,487	10%	19,808,768	26%	0	0%
	2008	5,965,333	12%	26,027,791	30%	0	0%
	2009	8,522,215	16%	25,615,873	30%	0	0%
	2010	8,756,744	16%	30,664,841	33%	390,694	1%
	Total	33,154,254	9%	126,841,721	21%	390,694	0,1%
Grand Total		**939,315,946**	**21%**	**1,472,755,806**	**25%**	**201,701,122**	**10%**

Table 3.6.1. Potential Savings and Revenues at Local Avinor Airports.

Appendix J provides greater details on a per airport basis including relevant benchmarks, ordered according to their importance.Table 3.6.1 presents the potential savings with respect to staff and other operating costs, as well as the potential increases in non-aeronautical revenues for 37 Avinor airports for the years between 2002 and 2010, presented separately for the 3 groups analysed. None of the four dual military civilian airports are benchmarked due to a lack of comparators.

Group 1 includes the STOL airports, all of which outsource ground handling and/or fuel sales activities. Group 2 consists of non-STOL airports which outsource ground handling and/or fuel sales activities and Group 3 focuses on the non-STOL airports that provide ground handling and/or fuel sales in-house.

It should be noted that an artefact of DEA is that the number of DMUs needs to be sufficiently larger than the number of variables; otherwise the efficiency estimates are generally high. Among our subsets, group 3 is relatively small, hence the potential percentage savings calculated for this group appears to be lower than those of the other groups, which may be explained partially by the lack of relevant comparators. The summary statistics suggest that the local and regional Avinor non dual-use airports could have saved a conservative 2.6 billion NOK over the 9 years studied through a reduction in costs of at least 20%. We would also suggest that were the STOL airports to behave in a more entrepreneurial manner, non-aeronautical revenues could have increased by 78 million NOK over the 9 years studied, suggesting the potential for an increase of 38% over their current values, and the busier non-STOL airports could have achieved 8% higher revenues.[86]

3.7.Conclusions

The large Norwegian Avinor airports (Oslo, Bergen, Stavanger and Trondheim) are efficient with respect to their own section of the Pareto frontier but have suffered from a technological frontier retraction caused by rising costs beyond those of their comparator airports. Based on discussions with Avinor management and the results of the model, it would appear that some of the cost drivers over the past decade include additional safety and security regulations both at the European Union and State levels. Furthermore, the negative trend in the large airport dataset is significant in 2009 which suggests that the airports may have endured difficulties matching supply with the downward demand trend caused by the global economic downturn beginning in 2008. Norway’s frontier shift is in line with Austria, Switzerland and Belgium but Denmark has better managed the cost increases and would appear to be a good benchmark from this perspective.

[86] It should be noted that the proposed cost savings for those airports which utilize Røst or Rørvik, located in a relatively milder climate zone, as benchmarks corresponds to approximately 5% of the total reduction of the entire group. Hence, there remains a large potential reduction even were we to disregard the within-Norway climate differences.

We note that the large airports in Norway enjoy a relative competitive advantage for sales over their European counterparts. Since 2006 they were also allowed to introduce duty free purchase on arrival and could increase the duty free alcohol limit. The change in the law resulted in an approximate addition of around 300-500 Million NOK p.a.[87].

The majority of small Avinor airports are not efficient and the frontier retraction over time is marked with identifiable potential cost wastage of over 20%. The majority of local and regional Avinor airports are not efficient as they lie behind the Pareto frontier defined for the most part by Icelandic and Greenland airports, and the level of cost wastage and revenue shortfalls has been growing over the last decade. Based on the regression analyses depicted in Table 3.5.1, it could be argued that airport systems are not an efficient ownership form given a statistically significant reduction of approximately 10% in productivity compared to their locally owned counterparts.

It is clear that the cost incentives are currently not strongly encouraging efficiency possibly due to the budgeting process and form of cross-subsidization. It may be useful to analyze the six consistently efficient Avinor airports as benchmarks for the annual budgeting process of staff, outsourcing levels and other costs. If each efficient airport acts as a benchmark to their relevant cluster, improvements in cost minimization and commercial revenue maximization may be achieved. Furthermore, all fuel sales and ground-handling activities remaining in-house should be outsourced where relevant because they contribute to a further 10% reduction in productivity. Finally, targets for the gradual reduction in the levels of cross-subsidization may be achieved, although it should be recognized that the local and regional airports serving less than 400,000 passengers annually will likely require some level of subsidies in order to break even, unless greater commercial revenues can be achieved.

Finally, we note that the Norwegian airports have a restricted set of comparators in our dataset because we have not been able to collect data from additional comparators such as Finland and Sweden. This suggests that Avinor airports may be less efficient than they appear in our analysis, as suggested by the partial productivity measures presented in Chapter 1. In general, all Norwegian airports suffer from low runway utilization, which is a result of the fact that Norway has many airports given the size of its population. It may be reasonable to consolidate some of these airports even given the preferred regional policy. As a result, we would strongly urge the regular collection of data and an on-going benchmarking process in order to encourage the airport management to strive for efficiency and possibly reverse the frontier retraction that is characteristic of the previous decade.

[87] Own calculation based on St.meld. nr. 48 (2008–2009). Om verksemda i Avinor AS.

Chapter 4: Conclusions and Recommendations

The Norwegian airport system is a centralized system in which the Avinor Group acts as a public firm to deliver airport services to the central and rural regions. It is a system which relies as much on commercial interests as on the motive to serve public goals and obligations. It is a system in which the large airports cross-subsidize regional and local airports.

This report was initiated by political concerns that Avinor does not fulfill its goals in a cost efficient manner. In the following we summarize the main results of the study and discuss potential measures to improve the performance of Norwegian airports.

4.1.Airport Finance, Pricing and some performance aspects

Our analysis of the institutional and financial system of the Norwegian airport system, together with information collected from a large number of European airports, has led us to draw the following conclusions:

- In our initial analysis we found that most of the small Avinor airports have quite large losses per passenger. Furthermore, the break even point in terms of the annual number of passengers apparently shifted over time, thus requiring more subsidies in recent years. While in 2002 some airports were able to break even serving a little over 200,000 passengers per annum, in 2010 this was possible only at airports which achieved an output of more than 800,000 passengers per annum.

- We find the same trend in our benchmarking sample. Based on an analysis of 154 European airports serving up to 10 million passengers per annum, we find that airport operations have become more costly over the last decade. An econometric break-even analysis shows that on average, about 400,000 passengers annually were sufficient to cover operational costs in terms of earnings before interest and tax (EBIT) in 2002 but by 2009, about 800,000 passengers per year were required. There is a large variance in the dataset which indicates that airport management can impact the financial performance at least to a certain degree, but that their institutional environment also matters.

- Total operating costs at Avinor have increased in real terms by over 100% from 2002 to 2010. Avinor airports had a cost advantage in comparison to the dataset in 2002 but this advantage dissipated by 2009. Taking the institutional and financial aspects of the Norwegian airport system into account, the regional and local airports will continue to need subsidies.

- The amount of cross-subsidy at Avinor airports has grown. Cross-subsidies have grown faster than the profits - about twofold in real terms and threefold in nominal terms. That is reflected in the development of the magnitude of cross-subsidies represented by their share to total EBITDA which rose from 20% in 2003 to a range of 30% to 40% during the last years.

- Avinor AS owns 22 airports that served at least 100,000 passengers in 2010, out of which 15 did not break even in terms of EBITDA (earnings before interest, taxes, depreciation and amortization). While in 2003 12 airports were commercially viable, by 2010 only 7 airports in the Avinor system covered their costs in terms of EBITDA values as shown in Fig. 1.2.6a.

- The cross-subsidies that are financing the local and regional airports are drawn mainly from profits earned on commercial activities at the large airports. Oslo is the main financial contributor, since its duty free revenues per passenger are two to three times larger than at the other major airports, and on average 10 times higher than at Avinor regional airports. The growing importance of commercial revenues was mainly driven by a rising number of international passengers which has doubled from 2002 to 2010, as well as from more flexible regulations introduced in 2006, such as duty-free shopping at arrival. In real terms duty free revenues tripled over the period from 2002 to 2010.

- The aviation charges at Oslo's airport are lower in comparison to those at other Scandinavian hubs and the majority of high-traffic European airports. Landing and passenger charges are also lower at smaller Norwegian airports than at similar sized UK airports that are also facing potential competition from neighboring airports and serving low cost carriers. Avinor airport charges are set by the Department of Transport and are constant across airports. Regulating airport charges by setting the same level and structure of charges across all Avinor airports is most likely inefficient because the marginal costs differ across airports.

- The growing number of loss-making airports is the consequence of rising costs, which for most airports meant increasing personnel and security costs. Overall operating costs doubled from 2002 to 2010 for Avinor airports. Personnel costs rose by 53% over this time period, while security expenses became a new important expenditure item, due to the increasingly strict security regulations after the September 2001 terrorist attacks.

- In order to estimate Avinor´s cost efficiency, we use operating costs per passenger excluding and including depreciation (Fig. 2.5.6a+b). Whereas Avinor had some cost advantage in 2002 when its costs were the lowest among the airports in the sample, except for Iceland, this cost difference seemed to have vanished by 2009, especially for the small airports. The large airports perform well.

- However, one needs to understand not only the cost side, but also how aviation and commercial revenues developed and identify what is their potential for reducing required subsidies in the future.

- At Oslo airport, for example, commercial revenues accounted for approximately 57% of total operating revenues in 2010, achieving almost twice as much per passenger commercial revenues as other large Avinor airports; Oslo is the main financial contributor to the Avinor system. However, despite favorable institutional environment, the large Avinor airports do not outperform other European airports in terms of commercial revenue generating capability. Given the very attractive position of Avinor airports in the duty-free business, one needs to explore to what extent this potential could be further exploited.[88]

- Concerning aviation revenues, the combined landing and passenger charges remained constant in real terms since 2002. The charges at Oslo are lower in comparison to competing hubs and most other European airports,[89]so that as a consequence, aeronautical revenues per passenger of Avinor airports appear low in European context.

- Airport charges at loss-making Norwegian regional and local airports are much lower than those at small UK airports facing competition from neighboring airports and serving low cost carriers. This provides some evidence that the revenues from charges could be increased so that the subsidies could be lowered.

- Avinor sets the same level and structure of charges across all airports,which is inefficient because the marginal costs and the degree of congestion differ across

[88] However, due to the sensitivity of this topic, this issue could not be analyzed further in the study

[89] This does not imply that lowering charges at Oslo airport could not increase revenues, which is a matter of the elasticity of demand and the dual revenue source.

airports. If one of the airports faces temporary or permanent excess demand, the structure of airport charges should be changed in order to signal the scarcity of the infrastructure. This would require different structures and levels of charges across the Norwegian airports.

4.2.Airport Overall Efficiency

Our DEA efficiency analysis of the Norwegian airport system derived the following results:

- The Norwegian airport system was relatively efficient in 2002 despite the size drawback but this advantage had been lost quickly, particularly with respect to the local and regional airports.

- The large Norwegian airports were benchmarked in a separate sample. They enjoy a relative competitive advantage over their European counterparts with respect to commercial revenue opportunities. This advantage is three-fold: Norway is not within the European Union which permits duty free sales to all international passengers; Norwegian tax rates on alcohol and tobacco are substantial, which increases the value of duty-free products relative to the Norwegian high street; and a change in the duty-free laws in 2006 permits the airports to sell larger quantities of duty free products per passenger than other airports in Europe on both outbound and inbound flights. The change in the law resulted in additional revenues of 350-500 million NOK annually.

- The four large Avinor airports (OSL, BGO, SVG and TRD) are defined as relatively efficient compared to 52 large European airports based on an annual data envelopment analysis[90]. However, there was a stable deterioration in productivity from 2002 to 2009 for BGO, SVG and TRD. Oslo shows a more mixed trend because the additional non-aeronautical revenue earned as a result of the change in the regulation with regard to duty-free sales in 2006 helped the airport to improve its position. The subsequent, continual increase in costs has led to a retraction and inwards movement by 2009

- We do temper these comments somewhat by noting that most airports in the dataset have suffered from a frontier retraction over time, due in part to the increased security costs imposed on the airports as a result of the European Union Security Directives.

[90] The modelling approach is known as a Bounded Adjusted Measure combined with a Malmquist analysis.

Norway's performance is in line with that of Austria, Switzerland and Belgium, but Copenhagen airport has better managed the cost increases and is a good benchmark for similar sized counterparts in this respect.[91]

- The small airport dataset used for benchmarking consists of 102 airports below 2 milllion passengers p.a. in 2009 of which 41 belong to Avinor. Avinor and the Icelandic airports (Isavia) enjoy reasonably low staff and other costs, but also suffer from relatively low utilization and non-aeronautical revenues.

- Unlike the large airports, the majority of small Avinor airports are not deemed relatively efficient. Of these Bodø, Hammerfest, Mo i Rana and Tromsø have been consistently efficient as well as Røst and Vadsø, which are also important benchmarks among the Avinor airports. The remaining 35 local and regional Avinor airports have not been efficient and the level of productivity has decreased over the last decade. The non-Avinor benchmark airports include the Icelandic airports of Gjogur, Grimsey, Thorshofn, Vestmannaeyjar and Vopnafjordur. These airports achieve higher runway utilization and lower costs than their Avinor counterparts although it must be noted that the Icelandic airports have lower security costs on domestic flights.

- The small Norwegian airports show a clearly decreasing trend in their efficiency estimates over time, particularly in the period up to 2005 after which the decline is more gradual. Similar patterns in efficiency can be observed for Greenland, Germany and France. The Greenland airports partially succeed in improving performance but by 2007, their efficiency estimates are fairly static. In general, the Icelandic and Greenland airports present the highest relatively efficient performance overall although most of the small airports show decreasing efficiency levels over time.

- The Malmquist index, in conjunction with the DEA, helps us to show the change of efficiency over time as it computes productivity changes as a multiple of two components: technological frontier shifts and efficiency shifts. Table 3.4.2 above showed the technological, efficiency and productivity changes from 2002 to 2009 at the country level. Norwegian airports (the four large Avinor airports and Torp) suffer from an average 14% technological deterioration over time and, as a result, an average 14% productivity deterioration which is below the 5% deterioration achieved on

[91] See Table J1: DEA Results for Large Airport Dataset in Appendix J.

average in the sample. Most airports in the dataset have suffered from a frontier retraction over time.

- We analyze the impact of additional variables that may explain the DEA efficiency estimates computed in the first stage of the analysis in Table 3.5.1. The environmental variables include the average aircraft size, percentage of international passengers served and commercial revenues as a share of total revenues, ground-handling or fuel sales undertaken in-house, airports belonging to a publicly owned system, the profits (losses) of the airport before taxes, depreciation and amortization (EBITDA), STOL runway infrastructure and dual military and civilian airports.

- For the large airport dataset, the results clearly identify that the larger the average aircraft size, share of non-aeronautical revenues and share of international traffic, the higher the DEA efficiency estimate.

- Airports undertaking ground handling or fuel sales in-house are approximately 17% to 19% less efficient than those that outsource these activities. It would be reasonable to draw the conclusion that outsourcing is preferable from a managerial perspective.

- The consistent, increasing decline in efficiency over time is clearly significant for the small airport dataset. Moreover, it is clear that belonging to an airport system such as Avinor and HIAL reduces average efficiency by a statistically significant 8% to 11%. This suggests that airports run locally would appear to have a higher probability of achieving a more efficient outcome. Finally, the STOL restricted airports are 15% to 20% more efficient suggesting that the shorter runways reduce the costs of clearing snow and maintaining the asphalt that the longer runways require.

- We used the estimated efficiency differences to the relatively efficient airports on the frontier to compute potential savings with respect to staff and other operating costs, as well as the potential increases in non-aeronautical revenues for the 42 local and regional Avinor airports. We therefore separated the dataset into more homogeneous sets according to the exogenous factors (such as weather conditions, being a STOL airport, outsourcing the ground handling services and fuel sales) from an airport management perspective. In addition, we account for the geographical environment of Norway by restricting the potential comparators to those with similar or higher percentage of snow / solid water precipitation. Furthermore, due to the growing cost inefficiency over time, each subset was further split into two time periods: 2002-2005 and 2006-2010.

- The summary statistics in Table 3.6.1 suggest significant efficiency savings compared to airports on the efficiency frontier. Local and regional Avinor non dual-use airports could have saved a conservative 2.5 billion NOK over the 9 years studied through a reduction in costs of at least 20%. Non-aeronautical revenues could have increased by 200 million NOK over the 9 years studied, suggesting the potential for an increase of 38% over their current values, and the busier non-STOL airports could have achieved 8% higher revenues.

- The efficiency analysis could be further improved by incorporating natural comparators such as Finland and Sweden. We were not successful in obtaining the relevant data for either country, notwithstanding the help of the Norwegian Ministry of Transport. We cannot therefore rule out the possibility that Avinor airports may be less efficient than appears in the current analysis.

- We also note, as did Carney and Mew (2004), that benchmarking should be undertaken on a continuous basis e.g. internal yardstick benchmarking, in order to ensure unremitting improvement.

4.3.Potential Measures to Improve Efficiency

As inefficiency is caused by a large variety of factors, there is no single instrument or measure which could improve the performance of Norwegian airports. All instruments should aim at increasing the efficiency of regional and local airports as well as preventing the large airports from becoming inefficient. It should however bestressed that these instruments need to be evaluated by further research and that they have to be combined in a comprehensive and well-designed reform program. The key point of such a program is setting incentives without distorting the fact that the airport infrastructure benefits the general public and all other stakeholders in the system.

First it is necessary to change the incentive system at local airports to increase efficiency. Local airports are like a free gift to the local community. As lower efficiency is currently compensated by higher subsidies from the large airports, it is tempting to abuse the system. However, some local communities have obviously not abused the system and their airports seem relatively efficiently managed. Nevertheless, it is necessary to design incentives to increase efficiency and to prevent the abuse of the system. This can be achieved by limiting the amount of subsidies over a certain period of time (for example over 5 years) whilst permitting the local and regional airports to keep a percentage of the savings from improved efficiency. Similar effects could be reached by a bonus and malus system.

The fact that local and regional airports have recently been given the flexibility to decide on their opening hours which enables them to adjust their supply to airline demand and improve their efficiency illustrates this principle. As mentioned above, this also should be a part of a collaborative decision making process with the inclusion of the NMTC, airport operator and the relevant airlines. Furthermore, this would allow the airport operator to implement some multi-tasking principles, in which the use of employees may be optimized.[92]

It is essential that the local management is incentivized to be entrepreneurial in order to reduce costs and increase revenues from other activities, which in turn implies that they need a greater degree of freedom in managing and pricing their airports. Currently charges are low compared to UK airports facing competition hence an increase in charges would most likely better reflect the costs of managing these airports.

We have identified cost inefficiencies and commercial revenue issues in the previous chapters and suggest that the current airport management system and the government structure that both owns and regulates the airport system is not incentivizing productive efficiency enough.

Finally, based on the benchmarking analysis undertaken and the academic literature, it would appear to be preferable to outsource many of the activities necessary at an airport, including ground-handling, fire services, ambulances, fueling, cleaning, security, car parking and snow removal (Adler et al. (2012)). This is an alternative to privatization that exposes the suppliers to competition (Hooper (2002), Poole (1997)).

4.4.Summation

In summation, we would argue that the current public airport system with cross-subsidies does not encourage cost efficiency and ought to be changed either through the use of management or franchise contracts. A share of the gains from efficiency improvements should pass to the airport management. Furthermore, the small airport operational budget scheme is not encouraging cost efficiency and limits need to be set through sensible incentive regulation that would lead to higher prices and lower subsidies, separate from that of the large four airports or at the very least Oslo.

[92] The Isavia experience is helpful on this issue. In 2009, staff levels were reduced substantially and opening hours have been limited to the hour prior to each scheduled flight. This means that an airport may open three days a week for two hours at a time if there are only three scheduled flights to that airport. At some airports, the single employee operates both the AFIS tower and covers the fire fighting activities which may help to explain the relative efficiency of many Isavia airports within our sample.

Appendices

Appendix A: Aeronautical Revenues at large, regional and local airports

In section 1.1.1, we mentioned that aeronautical revenues have developed differently at large, regional and small airports, but show similar trends. This appendix will provide further details. As charges are set uniformly across Norwegian airports, the differences in landing charges per movement or per passenger between the airports are largely due to the fleet mix. Larger and heavier aircrafts pay relatively higher charges. Fig. A1 shows the evolution of real aeronautical revenues per movement and per departing passenger in four major airports. Oslo Airport, the main hub, serves flights with higher than average MTOW - large passenger and cargo planes and thereby obtains higher revenues per movement. Real revenues per movement have been decreasing in all four major airports, but this effect has been largely offset by increasing security revenues.

The differences in revenues from passenger charges are explained by different shares of international departing passengers. Oslo has the highest share of international traffic in Norway and hence the highest passenger charge per departing passenger.

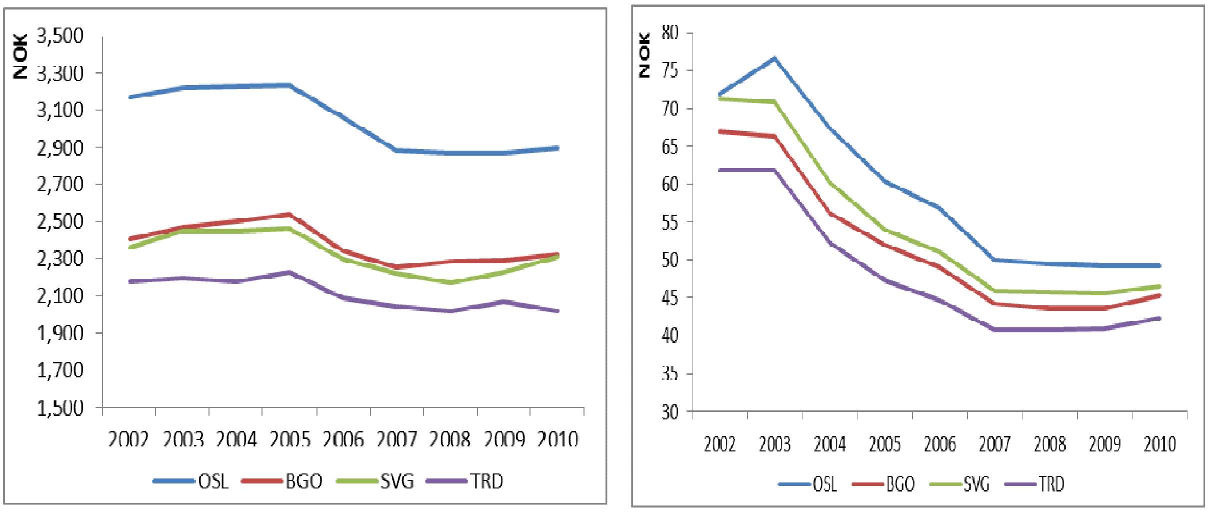

Figure A1. Revenue from Landing/Take-off charges per ATM (left) and Revenue from passenger charges per departing passenger excluding transit and off-shore passengers (right) in 2002-2010 at Large airports and Oslo in NOK, 2010 prices.

At regional and small airports similar trends can be observed.The combined revenues from passenger and landing charges have stayed constant in real terms. Landing revenues per ATM decreased or increased driven largely by changes in the fleet mix. Passenger charges per passenger decreased substantially, but the increase in security charges sterilized these effects.

Avinor Airport charges consist of passenger charges, take-off charges, security charges and air navigation charge.

During the period of 2002-2010 the nominal take-off charges were on average around 100 NOK per MTOW ton, but declined significantly in 2011[93]. Passenger charges (in current prices) for domestic flights also remained almost unchanged between 1996 and 2011, while international passenger charges decreased.

The introduction of security charges in 2004 led to an increased share of passenger-related charges and thus also the share of passenger revenues in total aeronautical revenues increased, as can be seen in Fig. A2. Along with other European airports, the share of passenger related revenues has been growing consistently starting in 2004, and amounted up to almost 60%[94] in 2010.

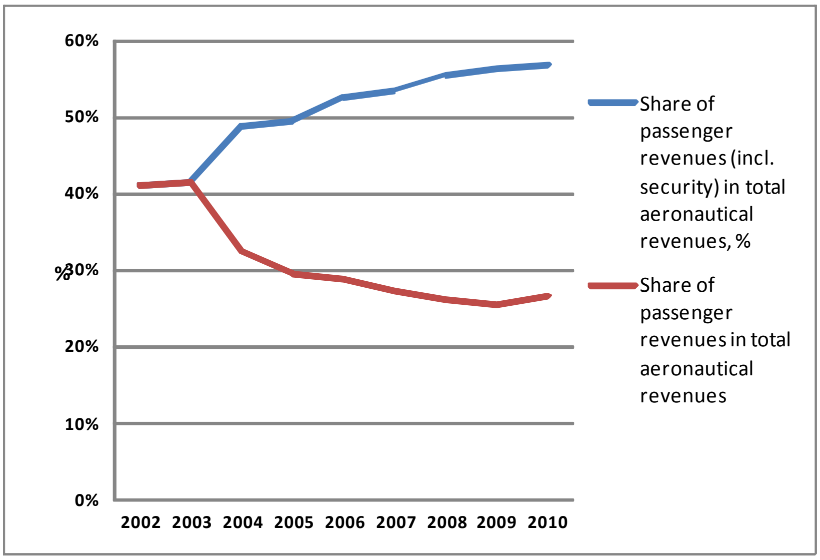

Figure A2. Share of passenger revenues with and without security revenues) in total aeronautical revenues, %.

[93] However it is worthwhile to mention that a new charging scheme was introduced which smoothed the differences in pricing between large and small aircraft types. Thus, NOK 69.00 per 1,000 kg or part thereof shall be paid for aircraft with MTOW between 6,000 kg and 75,000 kg; NOK 34.50 per 1,000 kg or part thereof shall be paid for aircraft with MTOW between 75,001 kg and 150,000 kg and NOK 14.00 per 1,000 kg or part thereof is paid for aircraft with MTOW over 150,001 kg.

[94] Note that in Germany the average share of passenger-related charges constitutes about 65-70%.

Appendix B: Selected ranking of European airports based on the total levels of charges[95]

In section 1.5.2 we compared our analysis with the benchmarking of airport charges which was done for Avinor airports by TOI (2009). In Table B1 below we present the total charges levels of Oslo airport, which are compared with other European airports[96].

Rank	Airport	Code	Total charges
1	Girona	GRO	1,597
2	Heraklion	HER	1,709
3	Barcelona	BCN	1,741
	Malaga	AGP	
	Alicante	ALC	
	Valencia	VLC	
	Palma De Mallorca	PMI	
	Gran Canaria	LPA	
	Tenerife	TFS	
	Lanzarote	ACE	
4	Madrid	MAD	1,752
5	Catania	CTA	1,947
6	Naples	NAP	2,068
7	Rome	FCO	2,218
8	Antalya	AYT	2,221
9	Milan	BGY	2,258
10	Venice	VCE	2,303
11	Faro	FAO	2,347
12	Istanbul	IST	2,357
13	Lisbon	LIS	2,413
14	Geneva	GVA	2,570
15	Stockholm	ARN	2,579
16	Izmir	ADB	2,626
17	Oslo	OSL	2,799

Table B11. TOI reduced ranking. Airport charges at airports over 5 million PAX - top third and Oslo. Flights within the EU. Absolute figures. Charges in euros for 2009.

[95] From cheapest to the most expensive.

[96] The initial ranking was made in TOI report. Here we reduced the ranking by treating airports from national airport system with the same level of charges as one airport, thus obtaining a new ranking.

Appendix C: Airport Fees in Norway and reactions to the SIB report

The level and structure of Avinor charges has also brought about criticism from the airlines, especially as Oslo and the other large airports cross-subsidize the smaller airports and thereby require higher charges. The airlines supported a study by the consulting firm Vista (2010), which called for airport charges to be based on marginal costs, which would reduce some of the charges, especially at the large airports. As a consequence, the Ministry of Transport and Communication requested their own study to assess the charges of Norwegian airports ("Airport Fees in Norway: Tariff system structure and the importance of supply and demand" (Jørgensen et al, 2010) further referred to as SIB report). This report led to a follow-up critique by Vista (Homleid, 2011).

Our comments on this debate and the SIB report are firstly related to the proposed charges system based on marginal costs and its subsequent effects and secondly on the estimation of marginal costs, which would be required to set up such a tariff system[97].

Marginal costs differ from airport to airport. In such a case charging the same prices at all airports as proposed by Vista and SIB does not maximize economic welfare. Furthermore, short run and not long run marginal costs are relevant to use capacity efficiently, in particular when airports become highly utilized at peak times.

Concerning the estimation of marginal costs in the SIB report, we find that using total costs to estimate marginal costs will be biased, as it is also necessary to analyze the costs of commercial activities, in addition to excluding security fees.

[97] As for econometric techniques applied we find that using pooled OLS and linear cost structure is quite a strong assumption. Also the multicollinearity problem is not discussed sufficiently in the report.

Appendix D: Approximation of airport charges by aeronautical revenues

In section 1.1.4 we analyzed aeronautical revenues per passenger and found that Norwegian airport charges at regional and local airports are relatively low compared to a sample of other continental and UK airports.

From data on aeronautical revenues and the number of movements, we can also approximate average charges per movement as an additional comparison. Aeronautical revenues in Avinor airports include revenues from take-off charges, passenger charges and security charges. In order to make the numbers comparable with those from the UK airports, we exclude revenues from security charges. When making the above calculations one should take into account the following:

1. Aeronautical revenues include take-off charges, which themselves contain revenues from both commercial and non-commercial aviation (like hospital flights or military aviation). The share of non-commercial movements differs across airports. It is larger in small airports and comparatively low in big airports[98].
2. According to charges regulations in Norway, cargo aircrafts are charged the same take-off charge as commercial flights are. That is why we include cargo flights under commercial aviation. This allows for a calculation of aeronautical revenues (excluding security) per movement[99].
3. One should take into account the difference in fleet-mix, however: Small airports have rather small aircraft types operating there, while at big airports we find larger aircraft types. To obtain a more accurate impression about the average level of charges we divide airports into 6 different size categories (with respect to number of terminal passengers).
4. We use the following size categories:
    - Local airports with total annual PAX less than 50,000;
    - Local airports with total annual PAX between 50,000 and 100,000 PAX;
    - Local airports with number of annual PAX over 100,000;
    - Regional airports;

[98] The amount of charges for non-commercial flights is relatively small and one can neglect non-commercial flights when calculating average charge per movement. According to “Charges regulations in Norway” (manual for 2011) there are several exemptions for civil aircrafts, including military aircrafts, aircrafts engaged in search and rescue operations, aircraft in use for diplomatic purposes, etc. Also there are different patterns of payment for general aviation flights, which include training aircrafts, continental shelf flights, ambulance flights etc.

[99] To make charges levels comparable across different countries we convert them into real NOKs and adjust the for purchasing power parity.

- Large airports;
- Oslo Gardemoen.

The average charges for the first group are presented in Table D1. The third column of the table contains figures for average charges level per commercial movement, while the fourth column represents average level of take-off charges per commercial movement. As shown in the table the mean of this group for average level of charges per commercial movement is 681.7 NOK. The group has a relatively small standard deviation, which means that in 2010 average charges levels in small local airports are quite similar. The mean of the take-off charges per commercial movement is 518.7 NOK with a standard deviation of 53.9 NOK. It is worth mentioning that after we exclude security charges, take-off charges on average constitute 75% of the total charge, which is quite in line with the widely known proposition that small airports are likely to have higher take-off/landing charges.

What is interesting from Table D2 is that the standard deviations of average charges per total movement are higher than those of commercial flights. It means that calculations somehow capture the difference in pricing commercial and non-commercial flights.[100]

Division	Airport Name	Average aeronautical revenues per commercial ATM	Average landing revenues per commercial ATM	Average revenues per total ATM
Local Finnmark and Troms	Båtsfjord	603.41	501.76	298.60
	Berlevåg	603.03	522.11	298.83
	Honningsvåg	653.70	511.13	307.23
	Mehamn	642.94	535.97	314.54
	Sørkjosen	693.01	527.19	323.27
	Vardø	624.50	507.41	307.83
Local Helgeland and Namdal	Namsos	711.08	533.86	284.65
	Rørvik	760.23	545.61	334.67
Local Ofoten, Lofoten and Vesterålen	Narvik	707.44	487.53	316.14
	Røst	638.99	495.19	300.96
Local Southern Norway	Fagernes	800.78	630.18	346.29
	Røros	582.68	386.39	181.92
	Sandane	840.84	558.33	708.26
Mean		681.74	518.67	332.55
Standard deviation		80.02	53.88	119.57

Table D1. Approximated average charges per movement in airports with less than 50,000 PAX, in NOK, 2010 prices.

[100] As mentioned above, non-commercial flights are more common for small airports and that's why the range of average charges is larger when dividing by total number of movements.

With the increasing size of an airport, the standard deviation of average charges per total ATM becomes less, which means that non-commercial aviation becomes a less important source of aeronautical revenues in large airports, i.e. – the sample is almost homogeneous. Also, for Oslo airport the average level of charges per commercial and total movement are almost the same. In line with the previously mentioned proposition about share of passenger charges, the share of landing charges becomes smaller and for Oslo constitutes on average 57%.

We can also see that average levels of charges themselves have been increasing over time, which reflect the use of larger aircraft types, as large airports operate bigger aircraft types.

	Average aeronautical revenues per commercial ATM	Average landing revenues per commercial ATM	Average revenues per total ATM
Local airports with PAX between 50,000 and 100,000			
Mean	864.10	554.67	501.41
St.dev	121.02	39.43	176.32
Local airports with PAX over 100,000			
Mean	1,174.25	843.69	590.35
St.dev	582.38	464.83	423.39
Regional airports			
Mean	2,777.96	1,644.29	2,101.20
St.dev	1,028.10	582.51	781.06
Large airports			
Mean	4,606.90	3,053.34	3,373.01
St.dev	770.37	717.62	49.07
Oslo Gardemoen			
	5,191.31	2,986.24	5,029.48

Table D2. Standard deviations and means of the other groups, 2010, in NOK, 2010 prices.

Appendix E: Airports in the Sample

Country	Airport	IATA	Country	Airport	IATA
Austria	Salzburg	SZG	Italy	Turin	TRN
Austria	Vienna	VIE	Italy	Venice	VCE
Belgium	Brussels	BRU	Norway	Bergen	BGO
Denmark	Billund	BLL	Norway	Oslo Gardermoen	OSL
Denmark	Copenhagen	CPH	Norway	Stavanger	SVG
Estonia	Tallinn	TLL	Norway	Trondheim	TRD
France	Basel-Mulhouse	BSL	Norway	Torp	TRF
France	Lyon	LYS	Sweden	Stockholm-Arlanda	ARN
France	Marseille	MRS	Sweden	Stockholm-Bromma	BMA
Germany	Bremen	BRE	Sweden	Göteborg-Landvetter	GOT
Germany	Cologne-Bonn	CGN	Switzerland	Geneva	GVA
Germany	Dresden	DRS	Switzerland	Zürich	ZRH
Germany	Dortmund	DTM	UK	Aberdeen	ABZ
Germany	Düsseldorf	DUS	UK	Belfast International	BFS
Germany	Muenster	FMO	UK	Birmingham	BHX
Germany	Hannover	HAJ	UK	Bristol	BRS
Germany	Hamburg	HAM	UK	Edinburgh	EDI
Germany	Leipzig	LEJ	UK	East Midlands	EMA
Germany	Munich	MUC	UK	Glasgow	GLA
Germany	Nuremberg	NUE	UK	Leeds/Bradford	LBA
Germany	Stuttgart	STR	UK	London City	LCY
Italy	Bergamo	BGY	UK	London Gatwick	LGW
Italy	Bologna	BLQ	UK	London Heathrow	LHR
Italy	Cagliari	CAG	UK	Liverpool	LPL
Italy	Catania	CTA	UK	London Luton	LTN
Italy	Florence	FLR	UK	Manchester	MAN
Italy	Genoa	GOA	UK	Newcastle	NCL
Italy	Naples	NAP	UK	Southampton	SOU
Italy	Palermo	PMO	UK	London Stansted	STN
Italy	Pisa	PSA			

Table E1. Large Airports.

Country	Airport	IATA	Country	Airport	IATA
Austria	Graz	GRZ	Norway	Båtsfjord	BJF
France	Ajaccio	AJA	Norway	Brønnøysund	BNN
France	Aurillac	AUR	Norway	Bodø	BOO
France	Brest	BES	Norway	Berlevåg	BVG
France	Bastia	BIA	Norway	Evenes (Harstad-N.)	EVE
France	Biarritz	BIQ	Norway	Førde	FDE
France	Caen-Capriquet	CFR	Norway	Florø	FRO
France	Calvi-Sainte-Catherine	CLY	Norway	Hasvik	HAA
France	Dinard-Pleurtuit-Saint-M.	DNR	Norway	Haugesund	HAU
France	Bergerac-Roumaniere	EGC	Norway	Hammerfest	HFT
France	Nimes-Garons	FNI	Norway	Ørsta-Volda	HOV
France	Figari, Sud-Corse	FSC	Norway	Honningsvåg	HVG
France	Grenoble-Isère Airport	GNB	Norway	Kirkenes	KKN
France	Tarbes-Lourdes-Pyrénés	LDE	Norway	Kristiansand	KRS
France	Limoges-Bellegarde	LIG	Norway	Kristiansund	KSU
France	Lille	LIL	Norway	Banak (Lakselv)	LKL
France	La-Rochelle-Ile De Re	LRH	Norway	Leknes	LKN
France	Lorient-Lann-Bihoue	LRT	Norway	Svalbard	LYR
France	Montpellier	MPL	Norway	Mehamn	MEH
France	Perpignan-Rivesaltes	PGF	Norway	Mosjøen	MJF
France	Pau-Pyrénées	PUF	Norway	Molde	MOL
France	Rennes	RNS	Norway	MoiRana	MQN
France	Toulon-Hyères	TLN	Norway	Narvik	NVK
Germany	Erfurt	ERF	Norway	Namsos	OSY
Germany	Friedrichshafen	FDH	Norway	Røst	RET
Greenland	Nuuk	GOH	Norway	Røros	RRS
Greenland	Illulisat	JAV	Norway	Rørvik	RVK
Greenland	Kangerlussuaq	SFJ	Norway	Sandane	SDN
Greenland	Narsarsuaq	UAK	Norway	Stokmarknes	SKN
HIAL	Benbecula	BEB	Norway	Sogndal	SOG
HIAL	Barra	BRR	Norway	Sørkjosen	SOJ
HIAL	Campbeltown	CAL	Norway	Sandnessjøen	SSJ
HIAL	Islay	ILY	Norway	Svolvær	SVJ
HIAL	Inverness	INV	Norway	Tromsø	TOS
HIAL	Kirkwall	KOI	Norway	Vardø	VAW
HIAL	Sumburgh	LSI	Norway	Fagernes	VDB
HIAL	Stornoway	SYY	Norway	Vadsø	VDS
HIAL	Tiree	TRE	Slovenia	Ljubljana	LJU
HIAL	Wick	WIC	Sweden	Ängelholm-Helsingborg	AGH
Iceland	Akureyri	AEY	Sweden	Jönköping	JKG
Iceland	Bildudalur	BIU	Sweden	Kiruna	KRN
Iceland	Egilsstadir	EGS	Sweden	Karlstad	KSD
Iceland	Gjogur	GJR	Sweden	Luleå	LLA
Iceland	Grimsey	GRY	Sweden	Malmö	MMX
Iceland	Hornafjordur	HFN	Sweden	Örnsköldsvik	OER
Iceland	Isafjordur	IFJ	Sweden	Åre Östersund	OSD
Iceland	Reykjavik	RKV	Sweden	Sundsvall	SDL
Iceland	Thorshofn	THO	Sweden	Skellefteå	SFT
Iceland	Vestmannaeyjar	VEY	Sweden	Visby	VBY
Iceland	Vopnafjordur	VPN	Sweden	Umeå	UME
Italy	Forli	FRL	Sweden	Stockholm-Arlanda	ARN
Italy	Pescara	PSR	Sweden	Stockholm-Bromma	BMA
Italy	Lamezia Terme	SUF	Sweden	Göteborg-Landvetter	GOT
Italy	Trapani	TPS	United Kingdom	Bournemouth	BOH
Norway	Ålesund	AES	United Kingdom	Exeter	EXT
Norway	Alta	ALF	United Kingdom	Humberside	HUY
Norway	Andøya	ANX	United Kingdom	Durham Tees Valley	MME
Norway	Bardufoss	BDU			

Table E2. Small Airports.

Appendix F: Revenue generating capability: comparing UK and Avinor airports on commercial revenues

Comparing non-aviation revenues across European airports is difficult, due to the lack of disaggregate data. However, we were able to obtain such disaggregate data for 35 UK airports to compare them with their Norwegian counterparts, i.e.the four large airports and two regional airports TOS and BOO.[101]

	Number of airports in the group	Aero-nautical revenue per pax	Non-aeronautical revenue per pax	Duty Free per pax	Parking per pax	Non-aeronautical revenue as a % of total operating revenue	Inter-national pax share out of terminal pax	Number of terminal pax
Oslo airport	1	82.2	109.5	61.2	15.2	57%	47%	19,000,000
Large airports	3	91.3	63.1	32.5	15.9	40%	28%	4,033,333
Regional airports	12	81.3	38.6	11.9	12.3	28%	8%	620,004
Local airports	27	110.3	26.4	0.0	4.9	18%	0%	51,447

Table F1: Descriptive statistics for different Avinor airport groups excl. Svalbard, Fagernes and Røros (2010).

	Number of airports in the group	Average number of total pax	Aeronautical revenue per pax (in NOK)	Non-aeronautical revenue per pax (in NOK)	Non-aeronautical revenue as a % of total operating revenue
Group 1	2	48,543,500	106.7	95.8	48
Group 2	2	18,112,500	65.5	66.4	50
Group 3	12	5,323,417	59.2	52.8	51
Group 4	9	758,217	90.6	99.5	50
Group 5	10	60,773	158.5	24.5	13

Table F2: Descriptive statistics for different UK airport groups (2010).

UK Airports in group 2 were compared with Oslo airport, UK group 3 with large Avinor airports, group 4 with the regional airports TOS and BOO, and group 5 with local airports.

Revenue for UK airports is calculated per total passenger and for Norwegian airports revenue is calculated per terminal passenger. Our results show the high non-aviation revenues we saw for Norwegian airports in Table 1.3.3 confirmed (except for group 4). Oslo and the

[101] Verdict research, Global airport retailing 2011.

large airports seem to outperform Group 2 and group 3 UK airports, but if this performance was adjusted for duty-free options on arrival sales at Oslo and the other large airports, the difference would be much smaller. As this option is not available for UK airports, Norwegian local airports also have slightly higher non-aeronautical revenue per passenger. Only group 4 has unusually high commercial revenue. Even if the outlier Blackpool International is removed from Group 4, the average non-aeronautical revenue per passenger with 76 NOK for the UK airports is still higher than non-aeronautical revenue of 39 NOK per passenger at Avinor regional airports.

Appendix G: DuPont analysis of Oslo and comparison with European airports

Apart from looking at partial performance measures which are specific to the airport industry, an analysis of common financial indicators can provide us with another useful benchmarking perspective. One of the techniques that encompasses the analysis of several aspects of a company's financial performance is the DuPont analysis, which is a decomposition of return on equity (ROE) measured as a ratio of Net Income to Equity into five factors (see for example, Bodie, Kane and Marcus, 2004) in the following way:

$$ROE = \frac{Net\ Income}{Equity} = \frac{Net\ Income}{Pretax\ Profit\ (EBT)} \times \frac{Pretax\ Profit\ (EBT)}{Operating\ profit\ (EBIT)} \times$$

$$\times \frac{Operating\ profit\ (EBIT)}{Revenue} \times \frac{Revenue}{Assets} \times \frac{Assets}{Equity}$$

By comparing the target company with similar ones, the DuPont analysis allows us to determine what stands behind superior or inferior return on invested capital.

In this analysis ROE is assumed to be an ultimate profitability measure. The DuPont analysis makes it possible to assess the degree to which each of the five factors affected ROE.

For the DuPont analysis we use data for 2010 consisting of financial information from income statements and balance sheets of Oslo and 7 other European airports that are similar in terms of annual number of passengers. These airports consist of Athens (ATH), Copenhagen (CPH), Dusseldorf (DUS), Manchester (MAN), London Stansted (STN), Vienna (VIE) and Zurich (ZRH). This financial benchmarking cannot be carried out for other Avinor airports, as they do not have independent financial statements.

Decomposition of ROE into 5 factors for all airports in 2010 is given in Table G1.

The calculations show that in 2010 Oslo had the highest level of ROE (67%) among other large airports which is significantly above the average ROE level of 17.7%.

To understand the reasons behind the exceptionally high ROE, one should look at Figure G1 below, where all analyzed airports are ranked by the explanatory factors. Oslo showed above average results for all indicators: second best on asset turnover and with the second lowest interest burden (due to cheap government loans), third best operating profitability and slightly lower than average tax burden. However, the factor that plays a major role in explaining such an abnormally high ROE level is the level of financial leverage (8.61 against 3.64 on average), which is achieved through large government loans.

	Percentage deviation from OSL in terms of PAX	ROE	EBIT/ Revenue	EBT/ EBIT	Net income/ EBT	Revenue/ Assets	Assets/ Equity
ATH	-19.8%	10.7%	43.9%	69.5%	60.9%	0.25	3.30
MAN	-7.0%	4.1%	22.8%	72.7%	71.5%	0.23	1.55
STN	-2.7%	1.5%	26.6%	34.4%	66.7%	0.14	1.77
DUS	-0.5%	14.1%	19.6%	50.1%	65.2%	0.36	6.17
OSL	0%	67.2%	38.3%	79.6%	72.0%	0.36	8.61
VIE	3.1%	6.7%	13.7%	79.0%	77.7%	0.29	2.76
CPH	12.6%	26.1%	45.4%	83.4%	74.0%	0.35	2.67
ZRH	19.8%	11.2%	28.9%	74.8%	78.6%	0.28	2.33
Average		17.7%	29.9%	67.9%	70.8%	0.28	3.64

Table G1. DuPont factors, 2010.

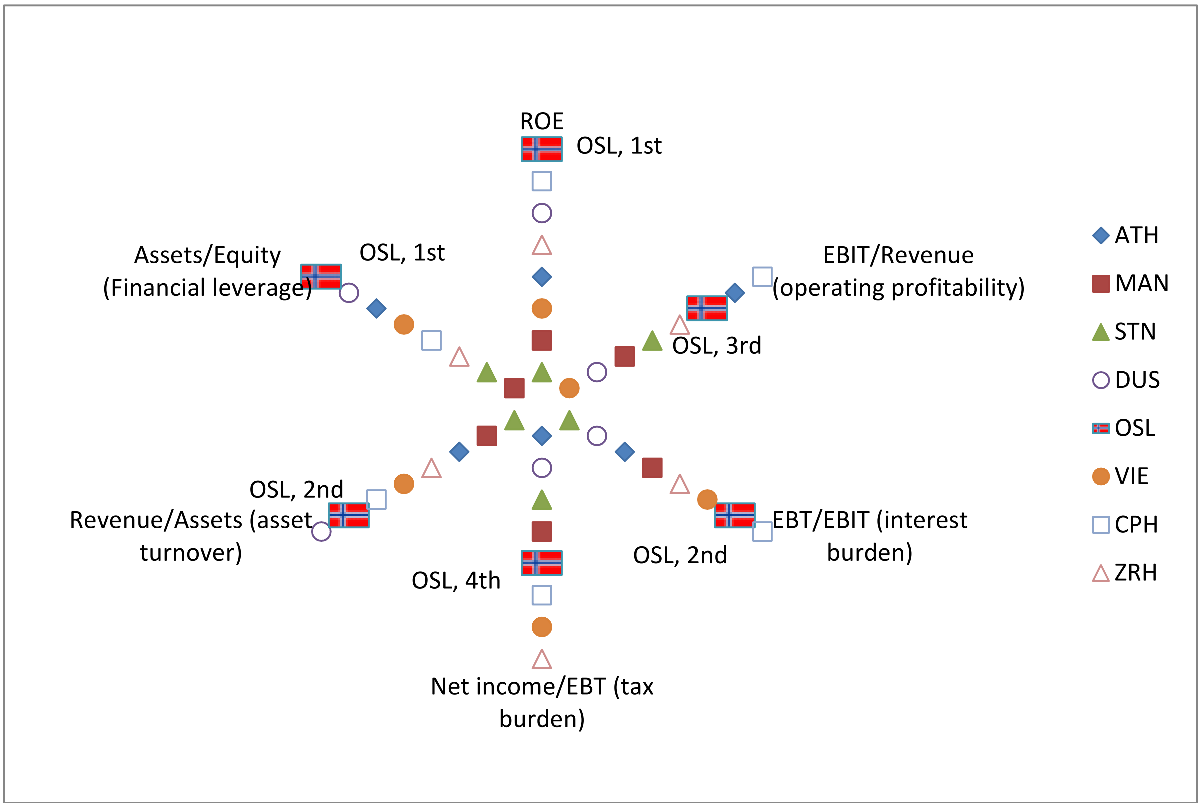

Figure G1. Ranking of airports by DuPont factors, 2010.

If we substitute an average (without Oslo) leverage level of 3 into the DuPont formula, which is about 3 times as low as Oslo's actual level in 2010, the ROE of Oslo will become 3 times lower – only 23%. In addition, if we eliminate cheap government finance effects by substituting an average (without Oslo) level of interest burden of about 66% (against actual Oslo level 79.6%), the ROE will decrease further to about 19%, which shifts Oslo behind CPH (ROE 26.1%) and closer to DUS (14.1%). Thereby Oslo's return on equity from the government's point of view as an investor is still quite high even after clearing out the effect of government financial support. The cleared second high level of ROE in the considered sample was achieved by good operating profitability (3rd place) and asset turnover (2nd place).

This discussion shows the problem of conducting the DuPont Analysis when the sample contains both state-owned and private companies because of the special role played by government loans to its own company. The DuPont Analysis has limited interpretability in such cases because of several reasons. First, ROE might be of little interest to the owner of Oslo Airport (ultimately the state) which is also a major creditor of the Avinor group and Oslo airport. In this situation the return on each part of the state's invested capital (equity or debt) can be substantially influenced by the owner itself because the capital structure is largely at the owner's discretion. This means that the ROE figure alone may not be meaningful. Besides, it is possible to claim that debt capital provided to Avinor by the state actually shows some equity-like features (granted exemptions from repayment of the government loan). It may therefore be problematic to regard this debt as debt in the economic sense. Corrections will lead to higher equity capital and lower ROE.

In addition, ROE can also be of little importance to other potential equity investors since their return on investment - were they to acquire some stake in the equity capital - would be close to ROE only if this stake were acquired at the price close to the corresponding share of the book value of equity. But such a price is not guaranteed to be achieved in practice in this situation.

Appendix H: DEA Model

Liebert and Niemeier (2010) provide an extensive review of airport benchmarking studies applied to a diverse range of activities using various methodologies. The methods most frequently applied include price index total factor productivity (Hooper and Hensher (1997), Oum and Yu (2004), Vasigh and Gorjidooz (2006)), parametric stochastic frontier analysis (Pels et al. (2003), Oum et al. (2008)) and non-parametric data envelopment analysis. DEA has been used to compare the performance of airports within national boundaries, including the U.S. (Gillen and Lall (1997), Sarkis (2000)), U.K. (Parker (1999)), Spain (Martín and Román (2008)), Murillo-Melchor (2009)), Australia (Abbott and Wu (2002)) and Taiwan (Yu (2004), (2010)) as well as airports around the world (Adler and Berechman (2001), Lin and Hong (2006)). It should also be noted that DEA has been used to analyse many industries, including water and electric utilities and the police force for purposes of benchmarking and setting price caps where relevant (de Witte and Marques (2011), Ferro and Romero (2011), Kwoka and Pollitt (2010), Thanassoulis (1995, 2000 and 2002)).

The bound adjusted measure has been used as the base model in the data envelopment analysis (Cooper et al. 2011).

$$
\begin{aligned}
&\underset{\lambda,S}{Max} \quad 1-\frac{1}{m+s}\left(\sum_{i=1}^{m}\frac{S_{io}^{-}}{L_{io}^{-}}+\sum_{r=1}^{s}\frac{S_{ro}^{+}}{U_{ro}^{+}}\right)\\
&s.t. \quad \sum_{j=1}^{n}x_{ij}\lambda_j+S_{io}^{-}=x_{io} \quad \forall \quad i=1,\ldots,m\\
&\qquad \sum_{j=1}^{n}y_{rj}\lambda_j-S_{ro}^{+}=y_{ro} \quad \forall \quad r=1,\ldots,s\\
&\qquad \sum_{j=1}^{n}\lambda_j=1\\
&\qquad\qquad \lambda_j\geq 0 \quad \forall \quad j=1,\ldots,n\\
&\qquad\qquad S_{io}^{-}\geq 0 \quad \forall \quad i=1,\ldots,m\\
&\qquad\qquad S_{ro}^{+}\geq 0 \quad \forall \quad r=1,\ldots,s
\end{aligned}
\tag{1}
$$

where superscript o is the index of DMU^o, the unit under investigation; n is the number of DMUs to be evaluated; m is the number of inputs; s is the number of outputs; x_{io} represents the input value of DMU^o; y_{ro} represents the output value of DMU^o and λ_j is the intensity variable of the benchmark DMUs. Associated with each DMU^o, $(\sum_{j=1}^{n}x_{ij}\lambda_j, \sum_{j=1}^{n}y_{rj}\lambda_j)$ are coordinates of an optimal comparison point on the frontier surface (efficient target) that is expressed as a convex combination of inputs and outputs of the reference DMUs. A reference set is a subset of efficient DMUs to which the inefficient DMU is compared. DMUs with a relatively high intensity variable represent the most important benchmarks for inefficient DMU^o. S_{io}^- and S_{ro}^+ are input and output slack variables which identify the sources and level of inefficiency in the corresponding inputs and outputs of DMU^o. A DMU is efficient if and only if it is not possible to improve any input (or output) without leading to an increase (or decrease) in one or more of its other inputs (or outputs). A DMU is deemed relatively efficient if, and only if, there are no output shortfalls or resource wastage at the optimal solution. While λ_j, S_{io}^- and S_{ro}^+ are decision variables in the BAM model, the lower bound range for input *i* and upper bound range for output *r* in the goal function in model (1) are calculated a-priori for each DMU^o as follows.

$$L_{io}^- = x_{io} - \underline{x}_i \quad \forall \quad i = 1,..., m \qquad\qquad U_{ro}^+ = \overline{y}_r - y_{r0} \quad \forall \quad r = 1,..., s$$

where $\underline{x}_i$ and $\overline{y}_r$ are the co-ordinates of the unobserved zenith-point (ideal point) based on the data set. The ideal point is defined simultaneously by the smallest inputs and the largest outputs of the given sample as follows:

$$\underline{x}_i = \min\{x_{ij} \quad \forall \quad j = 1,..., n\} \qquad\qquad \overline{y}_r = \max\{y_{rj} \quad \forall \quad j = 1,..., n\}$$

While the additive DEA model (Charnes et al. 1985) selects the point on the envelopment surface that maximizes the distance from the observed DMU to the efficient point, in the BAM model a zenith-point influences the direction of the path towards the efficient frontier. The individual weights in the objective function ensure that all variables are incorporated into the analysis and weighted according to their relative importance for the specific DMU. The factor *(m+s)* is introduced in the objective function in order to average the sum of inefficiencies which ensures that the additive BAM efficiency score is restricted between 0 and 1, such that 1 defines relative efficiency.

The variable returns to scale (VRS) BAM model has been applied as formulated in the last convexity constraint in model (1). The VRS assumption guarantees translation invariance with respect to the efficiency score, permitting the variables to include zero or negative values in the analysis which is necessary since some airports do not serve any cargo. Removing the last constraint in model (1) changes the assumption to constant returns to scale, meaning that the producers are able to linearly scale the inputs and outputs without increasing or decreasing efficiency. The extension of the BAM model to any returns to scale assumption (constant, non-increasing or non-decreasing) is presented in Cooper et al. (2011).

Appendix I: Malmquist-Type Indexes

A meta-Malmquist productivity index (Portela and Thanassoulis 2010) is defined as

$$MM^{t,t+\delta} = \frac{Q^{mf}(x_{0'}^{t+\delta} y_{0}^{t+\delta})}{Q^{mf}(x_{0'}^{t} y_{0}^{t})}$$

where $Q^{mf}(x_{0'}^{t} y_{0}^{t})$ and $Q^{mf}(x_{0'}^{t+\delta} y_{0}^{t+\delta})$ represent efficiency scores for airport *o* in periods *t* and *t+δ* according to the meta-frontier, which envelops the pooled panel data over the entire timeframe. When $MM^{t,t+\delta} > 1$, the productivity of airport *o* has improved from year *t* to *t+δ*, since its meta-efficiency in period *t+δ* is higher than that in *t*. Note that for purposes of consistency, we use a single ideal point for the entire dataset, ensuring similar priorities for airport *o* over time. A meta-Malmquist productivity indexis decomposed into two components:

$$MM^{t,t+\delta} = \frac{Q^{mf}(x_{0'}^{t+\delta} y_{0}^{t+\delta})}{Q^{mf}(x_{0'}^{t} y_{0}^{t})} = \frac{Q^{t+\delta}(x_{0'}^{t+\delta} y_{0}^{t+\delta})}{Q^{t}(x_{0'}^{t} y_{0}^{t})} \times \frac{Q^{mf}(x_{0'}^{t+\delta} y_{0}^{t+\delta}) / Q^{t+\delta}(x_{0'}^{t+\delta} y_{0}^{t+\delta})}{Q^{mf}(x_{0'}^{t} y_{0}^{t}) / Q^{t}(x_{0'}^{t} y_{0}^{t})} = E \times F$$

where $Q(x_{0'}^{t} y_{0}^{t})$ represents the within-period *t* efficiency score for DMU^{o}, i.e. the optimal value of the objective function in model (1) for period *t*. $Q(x_{0'}^{t+\delta} y_{0}^{t+\delta})$ represents the within-period *t+δ* efficiency score of DMU^{o}. *E* represents the efficiency change for airport *o* from year *t* to *t+δ*, indicating the change in its location with respect to the relevant section of the efficient frontier. *F* represents the frontier shift for the relevant section of the frontier with respect to airport *o*. The numerator of *F* reflects the distance from the *t+δ* frontier to the meta-frontier, given the input-output mix of the specific DMU in year *t+δ*. Similarly the denominator reflects the distance from the *t* frontier to the meta-frontier, given the input-output mix of the relevant DMU in year *t*. The technological gap measures the distance between the period *t* frontier and the *t+δ* frontier.

Malmquist type non-parametric efficiency indexes (Malmquist (1953)) have been widely studied and are usually based on a directional distance function or radial DEA model (Fare et al. 1994, Portela and Thanassoulis 2010). However, Grifell-Tatje et al. (1998) used a slack-based efficiency measure combined with a Malmquist productivity index in order to analyze Spanish banks. In this research, we apply a slack-based BAM efficiency measure (Cooper et al. 2011) to benchmark airports considering both discretionary and non-discretionary variables and calculating a meta-Malmquist indices (Portela and Thanassoulis (2010)) based on the non-radial efficiency scores.

Appendix J: Detailed Results of DEA Analysis

Country	IATA	Airport	2002	2003	2004	2005	2006	2007	2008	2009
Austria	SZG	Salzburg	0.75	1	0.66	0.60	0.67	0.70	0.74	0.65
	VIE	Vienna	1	1	1	1	1	1	1	1
Belgium	BRU	Brüssel	1	1	1	1	1	1	1	1
Denmark	BLL	Billund	0.78	1	0.90	1	1	1	1	0.76
	CPH	Copenhagen	1	1	1	1	1	1	1	1
Estonia	TLL	Tallinn	1	1	0.87	1	0.87	1	0.91	1
France	BSL	Basel-Mulhouse	0.93	1	1	1	0.95	0.73	0.74	0.64
	LYS	Lyon	0.81	0.80	0.88	0.89	0.84	0.84	0.78	0.95
	MRS	Marseille	0.77	0.78	0.85	0.85	0.80	0.82	0.76	0.88
Germany	BRE	Bremen	0.76	0.74	0.78	0.72	0.73	0.65	0.58	0.63
	CGN	Köln-Bonn	1	1	1	1	1	1	1	1
	DRS	Dresden	0.68	0.68	0.68	0.64	0.63	0.68	0.66	0.75
	DTM	Dortmund	0.49	0.55	0.52	0.55	0.53	0.53	0.49	0.51
	DUS	Düsseldorf	1	0.83	1	1	0.95	1	1	1
	FMO	Muenster	0.51	0.68	0.65	0.62	0.66	0.66	0.48	0.65
	HAJ	Hannover	0.88	0.90	0.97	1	0.87	0.81	0.81	0.80
	HAM	Hamburg	0.75	0.73	0.79	0.76	0.68	0.69	0.67	0.68
	LEJ	Leipzig	0.64	0.63	0.66	0.61	0.67	1	1	1
	MUC	München	0.83	0.77	0.79	1	1	1	1	1
	NUE	Nürnberg	0.84	0.90	0.99	0.88	0.82	0.75	0.72	0.73
	STR	Stuttgart	0.80	0.72	0.71	0.77	0.71	0.71	0.68	0.73
Italy	BGY	Bergamo	1	1	0.84	0.93	0.95	0.83	0.84	1
	BLQ	Bologna	0.80	0.75	0.67	0.71	0.80	0.73	0.69	0.71
	CAG	Cagliari	1	1	1	1	1	1	1	1
	CTA	Catania	1	1	1	1	0.77	1	1	1
	FLR	Florence	1	1	1	1	1	1	1	1
	GOA	Genoa	0.82	0.80	0.76	1	1	1	1	1
	NAP	Naples	0.61	0.73	0.84	0.83	0.88	0.84	0.75	0.80
	PMO	Palermo	0.74	0.70	0.71	0.64	0.79	0.78	0.65	1
	PSA	Pisa	0.96	0.93	0.89	0.77	0.78	0.78	0.97	1
	TRN	Turin	0.83	0.90	0.94	0.84	0.76	0.69	0.60	0.65
	VCE	Venice	0.70	0.79	0.84	0.77	0.74	0.79	0.71	0.75
Norway	BGO	Bergen	1	1	1	1	1	1	1	1
	OSL	Oslo Gardermoen	1	1	1	1	1	1	1	1
	SVG	Stavanger	1	1	1	1	0.97	1	1	1
	TRD	Trondheim	1	1	1	1	1	1	1	1
	TRF	Torp	1	1	1	1	1	1	1	1

Country	IATA	Airport	2002	2003	2004	2005	2006	2007	2008	2009
Switzerland	GVA	Geneva	1	0.95	0.94	0.88	0.85	1	1	1
	ZRH	Zürich	1	1	0.97	1	0.86	0.88	0.98	1
United Kingdom	ABZ	Aberdeen	0.80	1	1	1	1	1	1	1
	BFS	Belfast Int.	0.66	0.75	0.87	0.98	1	1	1	0.93
	BHX	Birmingham	0.69	0.77	0.77	0.81	0.71	0.77	0.79	0.78
	BRS	Bristol	0.96	1	1	1	1	1	1	1
	EDI	Edinburgh	1	1	1	1	1	1	1	0.86
	EMA	East Midlands	1	1	1	1	1	1	1	1
	GLA	Glasgow	0.75	0.77	0.83	0.85	0.83	0.88	0.89	0.66
	LBA	Leeds/Bradford	0.59	0.65	0.73	0.74	0.84	1	1	1
	LCY	London City	0.52	0.53	0.60	0.62	0.67	0.79	0.70	0.70
	LGW	London Gatwick	1	1	1	1	1	1	1	1
	LHR	London Heathrow	1	1	1	1	1	1	1	0.66
	LPL	Liverpool	0.56	0.59	0.77	0.90	0.85	1	1	0.81
	LTN	London Luton	0.81	0.82	0.94	0.90	0.79	1	0.85	0.89
	MAN	Manchester	0.78	1	1	1	0.83	0.89	0.87	0.95
	NCL	Newcastle	0.54	0.72	1	0.91	0.82	1	1	1
	SOU	Southampton	0.61	0.91	1	1	1	1	0.78	0.85
	STN	London Stansted	1	1	1	1	1	1	1	1

Table J1. DEA Results for Large Airport Dataset.

Airport	IATA code	Annual Potential Reductions, 2002-2005		Annual Potential Increase, 2002-2005	Important Benchmarks			
		Staff Costs	Other Costs	Non-aviation Revenues				
Båtsfjord	BJF	1,531,982	3,296,138	68,192	RET	MQN	VPN	
Brønnøysund	BNN	0	605,678	112,077	BNN			
Berlevåg	BVG	3,770,058	3,184,007	25,121	VPN	MQN		
Førde	FDE	2,476,077	3,368,053	545,069	MQN	GRY	SVJ	
Florø	FRO	1,395,525	1,596,615	659,296	HFT	BNN	FRO	
Hasvik	HAA	3,025,800	2,712,776	4,613	VPN	RET	MQN	
Hammerfest	HFT	0	0	0	HFT			
Ørsta-Volda	HOV	2,680,309	2,868,798	225,678	GRY	MQN	SVJ	FRO
Honningsvåg	HVG	4,454,529	4,004,067	339,763	VPN	MQN		
Leknes	LKN	168,432	2,915,925	195,276	MQN	LKN		
Mehamn	MEH	620,388	4,192,580	108,378	RET	MQN		
Mosjøen	MJF	720,559	3,478,448	325,237	MQN	VPN	BNN	FRO
MoiRana	MQN	217,551	1,422,980	0	MQN			
Narvik	NVK	0	1,465,771	254,819	NVK	LKN	MQN	
Namsos	OSY	1,781,363	3,856,941	163,465	RET	MQN	VPN	
Røst	RET	457,540	1,552,865	0	RET			
Rørvik	RVK	573,281	3,393,533	142,568	RET	MQN		

Sandane	SDN	2,092,742	3,785,155	245,512	RET	MQN	LKN	
Stokmarknes	SKN	363,649	2,914,175	320,964	MQN	HFT	LKN	
Sogndal	SOG	895,074	3,262,095	1,098,181	MQN	BNN		
Sørkjosen	SOJ	2,039,976	5,264,704	115,105	VPN	MQN	RET	
Sandnessjøen	SSJ	228,241	3,321,984	386,871	MQN	BNN		
Svolvær	SVJ	585,395	2,786,145	298,323	MQN	GRY	VPN	
Vardø	VAW	3,759,825	3,264,078	0	GRY	BNN	MQN	
Vadsø	VDS	0	3,403,551	197,634	VDS	HFT	MQN	
Total Annual, 2002-2005		**33,838,294**	**71,917,060**	**5,832,143**				

Airport	IATA code	Annual Potential Reductions, 2006-2010		Annual Potential Increase, 2006-2010	Important Benchmarks			
		Staff Costs	Other Costs	Non-aviation Revenues				
Båtsfjord	BJF	3,095,831	2,506,239	6,611	RET	MQN	VPN	RVK
Brønnøysund	BNN	3,114,464	133,140	1,300,692	SSJ	MQN	HFT	VEY
Berlevåg	BVG	6,154,571	4,202,534	21,731	VPN	MQN		
Førde	FDE	2,350,840	2,230,546	617,710	MQN	GRY	FRO	
Florø	FRO	255,109	1,029,114	1,416,799	FRO	SSJ	MQN	
Hasvik	HAA	5,151,682	4,818,041	4,909	VPN	RET	RVK	MQN
Hammerfest	HFT	711,105	3,762,182	263,231	HFT	SSJ	MQN	
Ørsta-Volda	HOV	3,864,219	2,057,847	393,804	GRY	MQN	FRO	
Honningsvåg	HVG	7,127,476	4,881,280	182,103	VPN	MQN		
Leknes	LKN	1,078,682	2,195,008	345,397	MQN			
Mehamn	MEH	653,840	2,435,322	15,201	RET	MQN		
Mosjøen	MJF	3,415,562	3,153,737	1,165,884	MQN	SSJ	VPN	
MoiRana	MQN	84,466	357,982	0	MQN			
Narvik	NVK	610,885	1,533,418	87,325	NVK	MQN		
Namsos	OSY	3,228,176	3,554,228	106,876	RVK	MQN	VPN	RET
Røst	RET	664,893	654,169	75,348	RET			
Rørvik	RVK	1,191,587	1,314,929	31,901	RET	MQN	RVK	
Sandane	SDN	2,164,035	2,778,026	143,659	RET	MQN	RVK	
Stokmarknes	SKN	1,062,123	1,121,725	430,743	MQN	HFT	SSJ	
Sogndal	SOG	2,624,505	1,193,391	1,555,785	MQN	SSJ	GRY	
Sørkjosen	SOJ	5,874,220	4,154,941	93,737	VPN	MQN	RVK	
Sandnessjøen	SSJ	1,522,380	1,239,329	1,243,612	SSJ	MQN		
Svolvær	SVJ	3,266,724	3,987,232	717,320	MQN	SSJ	GRY	
Vardø	VAW	5,590,887	4,119,836	20,700	GRY	MQN		
Vadsø	VDS	821,067	522,793	758,403	MQN	SSJ	HFT	
Total Annual, 2006-2010		**65,679,329**	**59,936,987**	**10,999,480**				
Total Annual, 2002-2010		**51,527,758**	**65,261,464**	**8,702,886**				

Table J2: Resource Utilization at Avinor Regional and Local STOL Airports, in 2010 NOK.

Airport	IATA code	Annual Potential Reductions, 2002-2005		Annual Potential Increase, 2002-2005	Important Benchmarks			
		Staff Costs	Other Costs	Non-aviation Revenues				
Ålesund	AES	0	8,574,705	212,183	AES	KRS	TOS	HFN
Alta	ALF	8,940,722	14,248,731	1,783,724	HFN	TOS		
Evenes(Harstad-Narvik)	EVE	7,367,088	21,626,886	1,720,356	KRS	AES	HFN	TOS
Haugesund	HAU	1,973,366	12,125,872	423,019	KRS	HFN	TOS	
Kristiansand	KRS	577,122	2,531,730	632,401	KRS			
Kristiansund	KSU	10,249,843	14,833,901	579,045	HFN	KRS	TOS	
Molde	MOL	9,380,139	10,066,047	851,495	HFN	TOS		
Røros	RRS	1,662,179	5,422,340	0	HFN	KRS		
Tromsø	TOS	0	0	0	TOS			
Total Annual, 2002-2005		**40,150,460**	**89,430,212**	**6,202,222**				
Airport	**IATA code**	**Annual Potential Reductions, 2006-2010**		**Annual Potential Increase, 2006-2010**	**Important benchmarks**			
		Staff Costs	**Other Costs**	**Non-aviation Revenues**				
Ålesund	AES	350,082	3,387,507	882,462	AES			
Alta	ALF	12,246,280	26,598,827	4,849,289	HFN	AES	RKV	
Evenes(Harstad-Narvik)	EVE	15,600,304	13,254,337	3,123,592	AES	HFN		
Haugesund	HAU	1,817,297	7,204,527	5,112,754	AES	KRS	HFN	
Kristiansand	KRS	231,135	0	1,289,297	KRS			
Kristiansund	KSU	13,122,007	17,425,454	1,139,724	IFJ	AES	HFN	KRS
Molde	MOL	9,399,204	1,724,347	3,237,994	AES	IFJ	TOS	HFN
Røros	RRS	3,595,696	10,573,015	0	HFN			
Tromsø	TOS	0	0	0	TOS			
Total Annual, 2006-2010		**56,362,005**	**80,168,013**	**19,635,113**				
Total Annual, 2002-2010		**49,156,874**	**84,284,546**	**13,664,939**				

Table J3: Resource Utilization at Avinor Regional and Local non-STOL Airports outsourcing ground-handling and/or fuel sales.

Airport	IATA code	Annual Potential Reductions, 2002-2005		Annual Potential Increase, 2002-2005	Important Benchmarks		
		Staff Costs	Other Costs	Non-aviation Revenues			
Kirkenes	KKN	0	0	0	KKN		
Svalbard	LYR	0	0	0	LYR		
Fagernes	VDB	812,532	2,267,859	0	VDB	KKN	
Total Annual, 2002-2005		**812,532**	**2,267,859**	**0**			
Airport	**IATA code**	**Annual Potential Reductions, 2006-2010**		**Annual Potential Increase, 2006-2010**	**Important Benchmarks**		
		Staff Costs	**Other Costs**	**Non-aviation Revenues**			
Kirkenes	KKN	0	0	0	KKN		
Svalbard	LYR	896,691	11,415,308	0	LYR	UAK	GRZ
Fagernes	VDB	294,203	747,626	78,139	VDB	UAK	
Total Annual, 2006-2010		**1,190,893**	**12,162,934**	**78,139**			
Total Annual, 2002-2010		**1,022,733**	**7,765,123**	**43,410**			

Table J4: Resource Utilization at Avinor Regional and Local non-STOL Airports providing ground-handling and/or fueling in-house.

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