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Master Thesis

Retail management structures and retail revenues in North American airports

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Abstract

The significance of non-aviation revenues, especially from retail outlets, has grown greatly. For many airports today non-aviation revenue has become as important as traditional aviation earnings. Then the natural question is “how to organize retail operations to satisfy the airport’s targets?” This study specifies this question as follows: “If the retail revenue is taken as a measure of performance, which airport retail management structure performs better?”

Thereby the aim of this study is to find out the character of a relationship between different structures of airport retail management organization and the level of retail revenues. The additional task is to distinguish these relationships between airports of different size and capacity. Based on a sample of about 100 North American airports the study implements statistical and econometrics techniques to achieve its goal.

Contents

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Introduction

The last decades saw significant transformations in the airport industry. Changes in the ownership structure, the understanding of an airport's mission and the influence of new market players (for instance, low cost carriers or shopping malls in the airport) have modified the priorities of airport management and led to an increased focus on non-aeronautical revenue.

This has happened because of two simultaneously working factors: newly appeared barriers to aeronautical revenues' level increase and total change of airport's retail image. Considering the first factor one needs to mention two main points. Firstly, the trend of increased passenger and cargo traffic creates the problem of congestion in airports, which by-turn sets upper limit on aeronautical revenues or demands to make considerable investments in airport's expansion. And secondly, the development of low cost carriers and their grown popularity have decreased negotiation power of airports. If managers want a particular low cost airline to operate in their airport they have to charge a lower price accordingly to such strict costs control policy of such airlines. This makes airports to look for other sources of income to cover these investments and missing revenues. The second factor appeared as soon as development of airport retail had overcome a threshold when the very idea of airport retail business had been changed from supplemental for the aeronautical activity (coffee machines and newspapers kiosks to ease passengers' discomfort while waiting for a plane) to a separate one with great potential of revenue. Moreover, this new interpretation of airport retail had been readily accepted by passengers. From that moment many airports started to run their retail businesses in a way to fulfill higher expectations of passengers about products and services' range they can reach during their travel.

Combination of these factors has made non-aeronautical revenues today as significant as traditional ones. But in contrast to aeronautical business there are more uncertainties for airports in choosing how to run retail business. The fact, that for the period of time 2002 – 2008 around 35 out of 100 airports from the research sample of this study have changed their retail management structures, tells about the lack of airports' clear vision of management options.

In spite of the fact that profitability is not the ultimate aim of retail for airports, it's still most common, so we take it as a guideline for this study trying to assess the performance of different retail management structures.

Thereby the aim of this study is to find out whether there is a relationship between different types of retail management organization and the level of retail revenues obtained and what form it has. Retail revenue here is used as a proxy for retail business profitability of airports (pros and cons of this choice are discussed later in the part "Research"). The additional task is to distinguish these relationships for the following kinds of airports: large hubs (those which process at least one percent of revenue passenger boardings annually), medium hubs (those which process between 0.25 percent and one percent of revenue passenger boardings annually), small hubs (which process between 0.05 percent and 0.25 percent of

revenue passenger boardings annually) and non-hubs (those which process more than ten thousand (10000) but less than 0.05 percent of revenue passenger boardings annually).

There has been very little research of this problem, mostly because of the limitations of the data. We were fortunate to overcome the problem of data availability by having access to retail measures of a significant sample of North American airports.

The lack of studies, their mostly non-quantitative character (surveys or single expert opinions) and the growing economic importance of airport retail activities require a profound research. The current study tries to satisfy such needs.

The paper is organized in the following way:

1. The part “Retail management structures” presents an overview of most common in the industry retail management structures, performance of which is going to be assessed;
2. For construction of research hypotheses concerning our target results of the study some theoretical literature is reviewed in the part “Background theory: vertical (value) chains”;
3. Previous achievements in this topic, which will also contribute to above mentioned constructions of hypotheses, can be found in part “Literature review: main findings”;
4. The list of hypotheses, based on theoretic and research literature review, and the logics, which stands behind them, can be found in part “Summary of research hypotheses”;
5. Description of main preferences of the database used in the current study is presented in part “Data”;
6. The main part “Research” discusses the problem of retail revenue as a performance measure for airports. Then statistical analysis and econometric modeling is applied to the data to answer the research question of the study;
7. In part “Results” all the findings from two research approaches are summarized;
8. Finally, part “Conclusion” presents some ideas for future research;

1. Retail management structures

According to the literature[1] main retail management structures are the following:

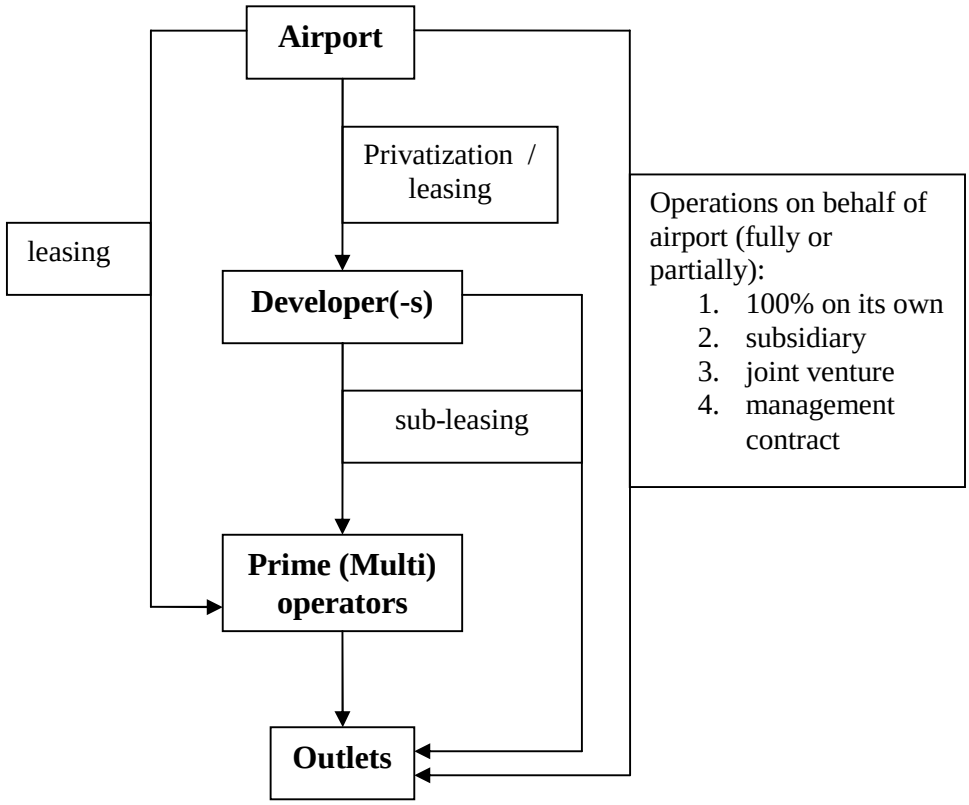
- *Multiple operators (or concessionarires).* Commercial space is leased to retailer operators, or concessionaires (retailer with the right to sell goods in a particular airports), which are obliged to develop, finance, and manage concession facilities. The airport collects rental fees in term of fixed or stepped percentage rates from gross sales or square based rate. Along with this structure a risk of lower lease income and high administrative costs associated with managing multiple lease agreements can arise;
- *Prime operator (or master concessionaire).* Some airports award contracts for particular categories of concessions, whereby the principal concessionaire develops and operates a substantial portion of the space. The main advantage is that the airport can take advantage of the know-how of the master concessionaires in their sales, merchandising, and marketing. A disadvantage is the resulting lack of individuality in the operations of the various concessions;
- *Wholly-owned subsidiary.* Under this structure the airport hires off a retail activity from the airport authority to a subsidiary and creates a separate corporate identity, thereby attracting more experienced staff and managers;
- *Direct operation.* Airports directly control all retail operations including running commercial outlets. It is used in cases, where commercial activities require limited commercial skills or they involve a level of investment, which retail operators (or concessionaires) are not ready to undertake. The main problem with this structure is most likely an insufficient commercial knowledge of airports' staff;
- *Joint venture.* To attract investments in commercial space development the airport and its partners can create a joint venture company. This allows airport to save part of operational control and not to bear all the risk on itself;
- *Fee management contract (or Management company).* One or more management companies are hired to operate concessions, and the airport authority compensates the management company the monthly fees and a percentage of the net operation incomes derived from the concession operation. The airport authority is in charge of financing, providing space, capital improvement, facility design, development and updates, developing operation standards, keeping inventory, tenant relationship, and financial accounting of profitability;
- *Developer approach.* A commercial developer can be hired to design and develop the concession facilities. The developer provides the required financing and administration of all phases of concession operation as well as subleasing of spaces to qualified retailers. The developer can lease the commercial space from the airport or to privatize it. Advantages are streamlined

[1] Hong-bumm Kim, Jee-Hye Shin (2001): "What retail governance structure fits better to different retail sectors?"

management and administration and unified capital development of facilities. Disadvantages are the airport's lack of direct control over concession operators.

As far as these structures are partially connected it's convenient to present all of them on the following scheme. It's worth noting that mixtures of these structures are knows as hybrids.

Figure 1. Conceptual overview of airport retail management structures



Because of data constraints in this study we will focus only on the following structures:

1. Prime operator;
2. Multiple operators;
3. Direct operation;
4. Developer approach;
5. Management company;
6. Hybrids.

2. Background theory: airport retail vertical (value) chains

To understand distinctive characteristics of different retail management structures, at first, we need to overview the underlying theory. This chapter is supposed to provide the background, namely, a single topic of vertical (or value) chains from the theory of industrial organization. In addition, parallels between theory of vertical chains and airport retail case will be drawn where it's needed. Those readers who are familiar with this topic can skip this chapter. Later, airport retail management structures will be applied to the theoretic context of vertical chains to look at possible positive and negative effects on retail revenues which they can have. Thereby theoretic background helps us to build first expectations (or hypotheses) concerning the results of the study. In the beginning the main definitions must be given. The theory of vertical chains in this chapter is mainly taken from D. Besanko, D. Dranove, M. Shanley, S. Schaefer "Economics of strategy" (fifth edition).

Definition 1. Vertical (value) chain

The process that begins with the acquisition of raw materials and ends with the distribution and sale of finished goods and services is known as the vertical chain. Early steps in the vertical chain are upstream in the production process and later steps are downstream.

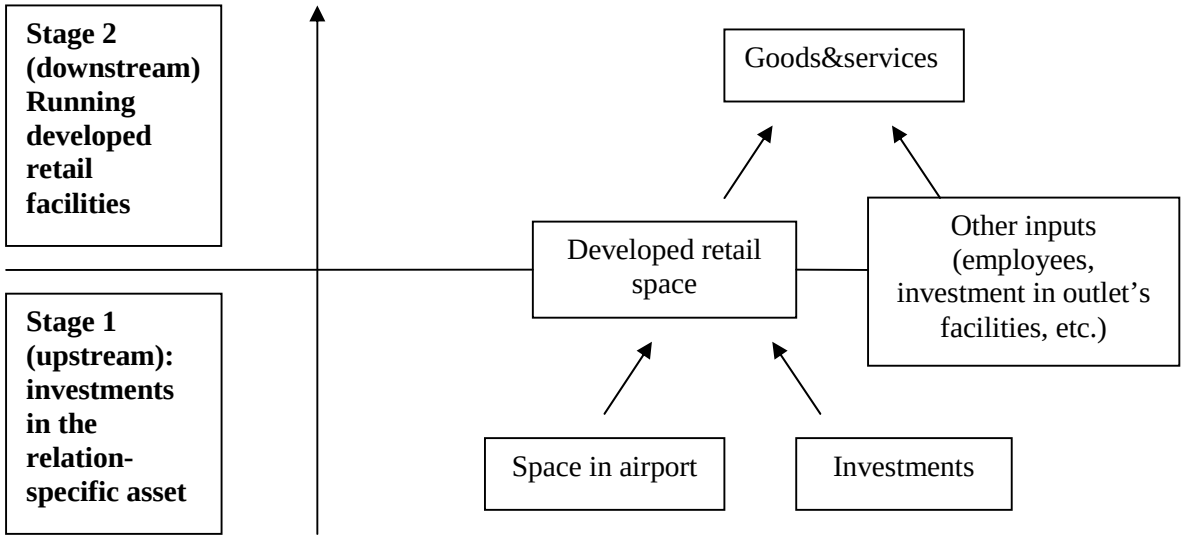
Definition 2. Investments in a relation-specific asset

Such investments made to support a particular transaction have a higher value to that transaction than they would have if they were redeployed for any other purpose.

Thus the vertical chain of airport retail consists of two stages:

1. investments in retail space general development;
2. investments in specific retail facilities and operation of all developed retail facilities.

Figure 2. Value chain of airport retail



Now let us consider the production-related effects which relate to airport retail vertical chain. Later we will correlate these effects with different structures of airport retail management.

Definition 3. Economies of scale

The production process for a specific good or service exhibits economies of scale over range of output when average cost declines over that range.

Definition 4. Economies of scope

Economies of scope exist if the firm achieves savings as it increases the variety of goods and services it produces.

There are four major sources of scale and scope economies:

1. *Indivisibilities and the spreading of fixed costs.* Indivisibility means that an input cannot be scaled down by a certain minimum size, even when the level of output is very small. Reduction in average costs due to increases in capacity utilization are short-run economies of scale. Reduction due to adoption of a technology that has high fixed costs but lower variable costs are long-run economies of scale. Indivisibilities are more likely when production is capital intensive;
   Note for airport case: Investment in retail space development or in outlet's development is an example of indivisibilities. They can not be avoided by stopping operations in outlets. These are sunk costs which have to be taken by the airport, operators, developer or jointly. It follows that airport retail chain might be characterized by economy of scale.
2. *Increased productivity of variable inputs.* It can happen due to learning of employees, better contracts with suppliers, etc.;
3. *Inventories.* Inventory costs drive up the average costs of the goods that are actually sold. In general, inventory costs are proportional to the ratio of inventory holdings to sales. The need to carry inventories creates economies of scale because firms doing a high volume of business can usually maintain a lower ratio of inventory to sales while achieving a similar level of stock-outs;
4. *Engineering principles associated with the "cube-square rule".* It states that as we increase the volume of the vessel by a given proportion, the surface area increases by less that this proportion. In many production processes production capacity is proportional to volume of production vessel, whereas the total cost of producing at capacity is proportional to the surface area of the vessel.
   Note for airport case: The idea relates to the first stage of airport retail vertical chain. Smart and unified development of retail area should allocate outlets more efficient as far as goods inside them. In contrast if the airport just offers its free space for different agents who develop it independently the distribution of retail space most likely won't be optimal in regard to volume of goods and services provided there.

Special case – Economies of Scale and scope in purchasing

Big businesses that make large purchases from their suppliers may obtain discounts for three possible reasons:

1. It may be less costly to sell to a single buyer if each sale requires some fixed cost, say in writing a contract, setting up a production run, or delivering the product;
2. A bulk purchaser has more to gain from getting the best price and therefore will be more price sensitive;
3. The supplier may fear a costly disruption to operations or even bankruptcy if it fails to do business with a large purchaser.

But sometimes small shops don't stock products for which they are unable to obtain favorable wholesale prices.

Note for airport case: Different management structures are characterized in general by different scale of purchase from their suppliers. Hence, the more the quantity and range of products they purchase the larger their benefits from economies of scale and scope.

Complementarities and Strategic Fit

Organizational practices display complementarities (or strategic fit) when the benefits of introducing one practice are enhanced by the presence of others. It's essential to firms seeking a long-term competitive advantage over their rivals.

Note for airport case. This very general idea can refer to many processes which overall can be described as a strategy. For example, higher outlets' concentration makes their maintenance and supply cheaper. Also some types of outlets can serve as magnets of customers for other types of outlets which should be taken into account when planning a retail mix. An optimum strategy is more likely to be implemented by agents with experience and not by airport itself.

Make-or-buy decision

Definition 5. Make-or-buy decision

A firm's decision to perform an activity itself or to purchase it from an independent firm.

Note for airport case: Among the management structures of this study "Prime operator", "Multiple operator" and "Management company" represent outsourcing decisions (or "to buy") for only the second stage of the vertical chain, whereas "Developer" approach represents outsourcing for both stages. "Direct control" approach is a fully vertically integrated option (or "to make") and "Hybrids" structures can be involved in every stage.

Definition 6. Agency costs

These are the costs associated with slack effort and administrative controls to deter it.

Definition 7. Influence costs

These are costs of manager's influence on allocation of scarce internal resources among departments or divisions.

Benefits of using the market ("buy" decision):

- Market firms can achieve economies of scale, learning economies that in-house departments producing only for their own needs cannot. They also eliminate "bureaucracy" (agency costs and influence costs);
- Market firms are subject to the discipline of the market and must be efficient and innovative to survive. Overall corporate success may hide the in efficiencies and lack of innovativeness of in-house departments.

Costs of using the market ("buy" decision):

- Coordination of production flows through the vertical chain may be compromised when an activity is purchased from an independent market firm rather that performed in-house;
- Private information can be leaked. Reluctance of trading partners to develop and share valuable information.
- Additional cost of transacting with independent market firms may exist because of:

    1. Relation-specific assets (An investment made to support a given transaction. Firms that have invested in relation-specific assets cannot switch trading partners without seeing a decline in the value of these assets). Forms of asset specificity:
        - Site specificity (refers to assets that are located side-by-side to economize on transportation or inventory costs or to take advantage of processing efficiencies);
        - Physical asset specificity (refers to assets whose physical or engineering properties are specifically tailored to a particular transaction);
        - Dedicated assets (an investment in plant and equipment made to satisfy a particular buyer);
        - Human asset specificity (refers to cases in which a worker, or group of workers, has acquired skills, know-how, and information that are more valuable inside a particular relationship than outside it).

Note for airport case. If an airport invests in retail area development (specific asset), for example on terms of joint venture of the airport with operators or developers, then these additional risks are

relevant. In our database there is no separate option for joint ventures, but they can be included in other options, such as “Prime operators”, “Multiple operators” and “Developers”.

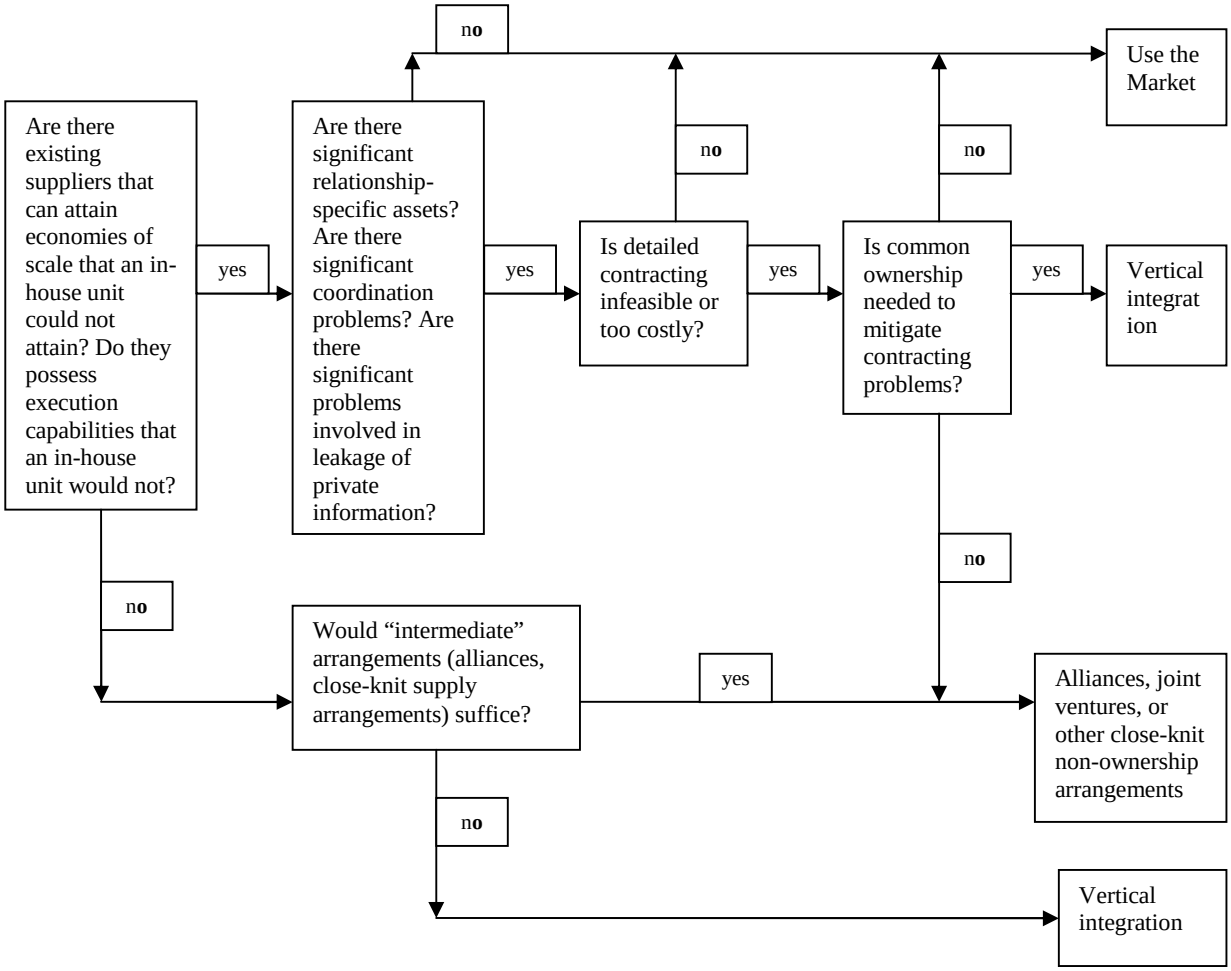
2. Quasi-rents. It’s the extra profit in case the deal goes ahead as planned, versus the profit in case of next-best alternative;

Note for airport case. For example, if a commercial space was developed (together by an airport and a partner) for a restaurant but because of opportunistic move of the partner only the second best option - a news & gifts shop - was implemented there, then the airport looses quasi-rent.

3. Holdup problem. A firm holds up its trading partner by attempting to renegotiate the terms of a deal. A firm can profit by holding up its trading partner when contracts are incomplete and when the deal generates quasi-rents for its trading partner. It raises the cost of transacting in four ways:

- More difficult contract negotiations and more frequent renegotiations.
- Investments to improve ex post bargaining positions (costs of hedging against holdup);
- Distrust (first, it raises direct costs of negotiating as parties insist on more formal safeguards be written into the contract; second, it impedes sharing information or ideas to achieve production efficiencies or quality improvements);
- Reduced investment in relationship-specific investments (the result is likely to be lower productivity and higher production costs).

Figure 3. Summary of Make-or-Buy (vertical integration-or-outsourcing) decisions



Asset ownership and vertical integration

GHM (Grossman, Hart, Moore) model establishes that the form of integration affects the incentives of parties to invest in relationship-specific assets. By having control over other unit's assets, a unit has a better bargaining position when it negotiates with the other unit over the operating decisions that they could not contract on. With a better bargaining position, the unit can capture more of the economic value created by the transaction, thus boosting its willingness to make relationship-specific investments.

The theory implies that vertical integration is desirable when one unit's investment in relationship-specific assets has a significantly greater impact on the value created in the vertical chain that the other's investment does. When the investments of both units are of comparable importance, non-integration is the best arrangement.

There are three ways to organize the transaction:

1. Non-integration: The two units are independent firms, each with control over its own assets;
2. Forward integration: The upstream unit owns the assets of the downstream unit;
3. Backward integration: The downstream unit owns the assets of the upstream unit.

Note for airport case: The model concerns the first stage of our chain where agents invest in relation-specific asset. These could be the following cases:

1. Developer which lease the space in the airport (non-integration);
2. Developer which privatizes the space in the airport (backward integration);
3. Retail operators lease the space in the airport (non-integration);
4. Management company operates the space in the airport (forward integration).

From technical and agency efficiency based analysis we can learn the following:

1. If the firm is considering whether to make or buy an input requiring significant upfront setup costs, and there is a large market outside the firm for the input, then the firm should buy the input from outside market specialists;

Note for airport case: Taking into account that the number of operators, management companies, developers is quite large, which tells about high level of the market development, airports are supposed to benefit from technical and agency efficiencies. Airport should choose these market options when planning retail management structure.

2. A firm with a larger share of the product market will benefit more from vertical integration than a firm with a smaller share of the product market. A firm with multiple product lines will benefit more from being vertically integrated in the production of components for those products in which it can achieve significant market scale;

Note for airport case. In general the retail scale of large operators or developers is much bigger than of a single airport, but it's possible that airports with critical mass (large enough) can simultaneously benefit from efficiencies of market agents and avoid costs of disintegration approaches.

3. A firm gains more from vertical integration when production of inputs involves investments in relationship-specific assets.

Note for airport case. Investment in the first stage (in total retail space development) can be made by the airport or by the developer and it has a higher degree of specificity than investments only in outlets in the second stage (can be made by operators, developer or airport). So, if airport has already made investment in the first stage it should use the integration option (direct control) in the second stage.

In-between forms of organizing production processes

Definition 8. Tapered integration

Tapered integration - a firm may produce some quantity of input and purchase the remaining portion from independent firms. It might sell some of its product through an in-house sales force and rely on independent representatives to sell the rest.

Benefits:

1. It expands the firm's input/output channels without requiring substantial capital outlays. This is helpful to growing firms;
2. The firm can use information about the cost and profitability of its internal channels to help negotiate contracts with independent channels;
3. The firm may also develop internal input supply capabilities to protect itself against holdup by independent input suppliers.

Disadvantages:

1. Both internal and external channels may not achieve sufficient scale to produce efficiently;
2. Shared production may lead to coordination problems because the two production units must agree on product specifications and delivery times;
3. The firm may mistakenly establish the performance of an inefficient internal supplier as the standard to be met by external suppliers;
4. Managers may maintain inefficient internal capacity rather than close facilities that had formerly been critical to the firm.

Note for airport case: Tapered integration is represented by different types of hybrid structures, where airport direct operations exist with other agents' contracts, for example with operators. According to previous researches this type of retail organization may be very efficient[2].

The case of strategic alliances

Strategic alliances can be of tree types:

- Horizontal (in one stage of the vertical chain);
- Vertical (in different stages of the vertical chain);
- Neither horizontal nor vertical.

[2] Ahron B. Herring (2002): "Current structures to the development of airport retail: a sales performance analysis and case study"

Transaction-candidates for alliances:

1. The transaction involves impediments to comprehensive contracting (because of uncertainty and the parties' bounded rationality, the parties cannot write a proper contract);
2. The transaction is complex, not routine. Standard commercial and contract law could not easily "fill the gaps" of incomplete contracts;
3. The transaction involves the creation of relationship-specific assets by both parties in the relationship, and each party to the transaction could hold up the other;
4. It is excessively costly for one party to develop all of the necessary expertise to carry out all of the activities itself. This might be due to indivisibilities and the presence of an experience curve;
5. The market opportunity that creates the need of transaction is either transitory, or it is uncertain that it will continue on an ongoing basis. This makes it impractical for the independent parties to merge or even commit themselves to a long-term contract;
6. The transaction or market opportunity occurs in a contracting or regulatory environment with unique features that require a local partner who has access to relationships in that environment.

Potential disadvantages:

1. Information leakage;
2. Compromised coordination between the firms;
3. Agency costs (free-rider problem);
4. Influence costs (because of the absence of a formal hierarchy and administrative system within an alliance employees might be engage in influence activity, such as lobbying, to augmenting their resources and enhance their status);

Note for airport case: alliances could be in different cases of hybrids (for example vertical alliance of the airport and operators or vertical alliance of airport and developer, when airport invests in general commercial space development and developer invests in outlet's development and in charge of running all retail facilities).

3. Literature review: main findings

The topic of airport retail management efficiency is comparatively rare in research papers. Moreover, in contrast with, for example, a close topic "drivers of airport retail revenues" there are almost no industry experts' views on the problem. This chapter provides the overview of the related papers and different opinions about performance of management structures which give us a clue about the study's expected results. The list of research hypotheses based on these previous findings will be summarized later in the corresponding chapter.

Hong-bumm Kim, Jee-Hye Shin (2001): "What retail governance structure fits better to different retail sectors?"

In this paper a survey of 12 selected experts of the airport retail industry was carried out. The results are presented in the following table.

Table 1. Appropriate management type of airport concessions in different product categories

	Duty free			F&B			Retail amd convenience		
	Profitability	**Managerial efficiency**	**Customer satisfaction**	**Profitability**	**Managerial efficiency**	**Customer satisfaction**	**Profitability**	**Managerial efficiency**	**Customer satisfaction**
Prime operator	7	8	7	7	8	7	5	7	6
	58,3%	66,7%	58,3%	58,3%	66,7%	58,3%	41,7%	58,3%	50%
Management company	1	2	1	1	2	1	1	3	2
	8,3%	16,7%	8,3%	8,3%	16,7%	8,3%	8,3%	25%	16,7%
Developer approach	-	2	2	-	2	2	-	1	1
	0%	16,7%	16,7%	0%	16,7%	16,7%	0%	8,3%	8,3%
Multiple operators	4	-	2	4	-	2	5	1	3
	33.30%	0%	16,7%	33,3%	0%	16,7%	41,7%	8,3%	25%
Direct control	-	-	-	-	-	-	1	-	-
	0%	0%	0%	0%	0%	0%	8,3%	0%	0%
	Column (%) represents percentage sum of 12 respondents								

The results imply that the prime operator approach is the best overall alternative for the future operation and management of airport concessions, irrespective of both concession types and performance measures. The multiple operators method is found to be the second most referred management type in airport concessions, and in the case of retail and convenience stores it appears to be a good method for increasing the profitability of airport concessions. In authors' opinion, one reason may be that retail and convenience stores usually do not require high specialty in producing, merchandising, and selling the product items, compared with that of duty-free shops and F&B catering services.

The direct control approach is found to be the lowest preferred method of managing airport concessions from every aspect of performance.

Ahron B. Herring "Current approaches to the Development of Airport Retail (2002): A sales performance analysis and case study"

Using the data from ARN Factbook 1997 – 2000, the author organized airports in groups by types of retail management structure and compared these groups' average values of "retail sales per enplaning passenger" which stands for a measure of performance. The following managements structures were analyzed:

1. Airport directly;
2. Prime operator (or master concessionaire);
3. Developer;
4. Airport/Operator hybrid;
5. Other/developer hybrid.

The main results are the following:

- In general developer structure outperforms others;
- Distribution of outcomes for developers was much broader. (difference between 4^{th} a 1^{st} percentiles of "sales per EP" measure);
- Dynamics of efficiency growth is comparably high for developers;
- Hybrids perform better that alone (than just airport directly, prime operator or developer).

Unfortunately, the study didn't apply econometric modeling which could support these results. Some crucial factors were not taken into account. Firstly, heterogeneous character of airports must be considered. Secondly, management structures' performance should be compared inside hub sizes' groups (in spite of the fact that it decreases number of observations in samples and makes result less accurate). Thirdly, significance of management structures was not compared with other drivers of retail revenue (for example, ratio of leisure passengers to business passengers).

V. Bamberger, A. Bettati, S. Hoeffinger, T. Kuruvilla, V. Wille (2009): "Mastering airport retail"

Representing the consultancy agency Arthur D. Little the authors of the article assert that "direct operation, where the airport bypasses operators to deal with brands and operate shops itself, remains embryonic and tends to be implemented only in airports with critical mass and established retail operations (staff, logistics, etc)".

According to the research direct control of concession operations should remain limited for three main reasons:

- Direct operation requires a critical size (traffic, surface) to ensure return on investment. This limits the model to major hubs.

- Direct operation represents an opportunistic move and cannot result in a long-term diversification strategy. Airports that operate their own retail platform will not be able to gain a competitive advantage that will enable them to operate abroad or extend their retail activities beyond the airport.
- The ability of direct operation to generate higher revenues and margins through more competitive prices has still to be proven. Attractive prices alone are not sufficient to increase revenues and margins; they must be supported by innovative concepts. In addition, opportunities for achieving economies of scale in buying and logistics, etc. are limited in this model.

According to the authors' opinion operators' local know-how and the way they leverage it to propose the highest concession fees is no longer as important as it has been; airports are increasingly looking for operators who can demonstrate financial robustness, strong offer flexibility, international know-how and high-quality operational performance. All these qualities can be met by large global operators:

- *Financial robustness.* The concession fees level remains a major selection criterion for airports. However, the growing pressure on retail operators to achieve higher targets and invest in offer renewal and shop concepts means airports are being more careful in assessing the robustness of the operator's business plan;
- *Flexibility and international know-how.* A dynamic and wide-ranging brand portfolio, strong offer flexibility, new merchandising techniques and concept innovation are becoming key to satisfying both airports' and passengers' expectations. Operators need to demonstrate these attributes in order to respond to fast-changing consumer trends, to react more quickly to brands' performance and to optimize the use of space without affecting shop attractiveness and product visibility for passengers;
- *Good performance.* Offer flexibility requires a good level of operational performance, including logistics and supply chain efficiency, and flexible and high-quality human resources management. The research highlights process standardization as key to successful airport retail operations, along with consistent IT systems and applications. As a result, operators' local know-how is becoming less critical while the extent to which operators can add value to the airport's existing assets through their organizational and operational expertise is becoming a major aspect of retail performance.

4. Summary of research hypotheses

As the conclusive part of theory and literature review here we summarize all the expectations concerning results of current study in the form of research hypotheses. In addition, some comments go along to clarify the logic which stands behind the construction of these hypotheses. They will guide us in choosing research methods and estimation of results adequacy.

Hypothesis 1: Airport retail management structures (in performance decreasing order):

1. Prime operator;
2. Multiple operators;
3. Management company;
4. Developer;
5. Airport directly.

Comments: According to the survey of experts from Hong-bumm Kim, Jee-Hye Shin (2001): “What retail governance structure fits better to different retail sectors?” (see part "Literature review: main findings" for details).

Hypothesis 2: Airport retail management structures (in performance decreasing order):

1. Developer;
2. Hybrids;
3. others.

Hypothesis 2.1: Developers increase their performance comparatively faster.

Comments: According to Ahron B. Herring “Current approaches to the Development of Airport Retail (2002): A sales performance analysis and case study” (see part "Literature review: main findings" for details). Other management structures except Developer and Hybrids show close to each other performance.

Hypothesis 3:

- In general large prime operator structure is recommended.
- Direct control structure is recommended for large hubs.

Comments: According to V. Bamberger, A. Bettati, S. Hoeffinger, T. Kuruvilla, V. Wille (2009):”Mastering airport retail” (see part "Literature review: main findings" for details). Prime operator option (especially in large hub airports) in our database is most likely represent large global operators which are recommended and which according to the authors’ opinion demonstrate financial robustness, strong offer flexibility, international know-how and high-quality operational performance. Large hubs sub-sample in our database contains airports with critical mass (large enough) which authors talk about in the article.

Hypothesis 4 (based on theory of vertical chains): Airport retail management structures (in performance decreasing order):

1. Developer / Prime operator (in large hubs)/ Hybrids;
2. Airport directly (in large hubs) / Hybrids;
3. Multiple / Management company / Hybrids.

Comments: The ranking is based on the number of positive effect which different management structures are supposed to show according to the theory (see chapter 4). Unfortunately, sources of negative effects on retail revenues are hard to estimate. For example, for outsourcing cases (operators, management company, developer) they are: compromised coordination or private information leakage in case of outsourcing, decreasing value of relation-specific assets, loosing quasi-rents or holdup problem.

So, only positive effects on retail revenues were taken into account. They are the following:

Developer related

1. Because of large investments in retail space development (which are an example of indivisibilities or sunk costs) developer has an opportunity to exploit economies of scale and scope. To do that and to return those investments the quantity and range of products sold and services provided should be as high as possible, hence the revenue's level is also supposed to be higher in comparison with no-specific-investments cases. In contrast with Airport direct control, which is also involved in large investments in commercial area development, developer doesn't have other sources of income, such as aeronautical, to cover investments;
2. Because of unified design and development of the whole commercial area (using know-how) developer can benefit from engineering principles associated with the "cube-square rule;
3. The large the scale of business of a developer the more benefits he can extract also from economies of learning;
4. Having vast experience in designing commercial space, developers can benefit from complementaries and strategic fit. For example, more outlets' concentration makes their maintenance and supply cheaper or some types of outlets can serve as magnets of customers for other types of outlets which should be taken into account when planning retail mix;
5. As a representative of an outsourcing option for an airport, developers are subject to the discipline of the market and must be efficient and innovative to survive. This should positively affect retail revenues;
6. According to GHM (Grossman, Hart, Moore) model developers which privatize (not lease) retail space in the airport has better bargaining position over operating decisions and as a result can capture more of the economic value created by the transaction. This stimulates to create more economic value and retail revenues are supposed to increase. In spite of the fact that we don't

have such information, we can assume that part of the given airports which use developer programs prefer to make commercial area privatized rather that leased;

7. Developed market of private developers in North America make us believe in their experience which should positively affect retail revenues;

Prime operator structure in large hub group related

8. To obtain discounts from suppliers operators should by in bulk, this motivates them to expand their scale of business – to serve many airports and to sell as much as possible in every airport. Hence the level of retail revenue is supposed to be higher in this structure;
9. To exploit economies of learning (which is an example of increased productivity of variable inputs) and hence economies of scale, operators have to expand their business. This might reflex in large level of retail revenues. Large global operators can achieve it best;
10. Selling more, cost of inventories (which is proportional to the ratio of inventory holdings to sales) decreases and profitability level grows;
11. Because of unified development of outlets prime operator can benefit from engineering principles associated with the “cube-square rule or complementaries and strategic fit of facilities (but less than developer who is in charge of the whole commercial area development);
12. As far as operators represent the market, they should be innovative and efficient to survive. This might positively reflex in retail revenues;

Airport directly structure related

13. This structure is also involved in large investments in commercial area development and tend to target large revenues to cover them and to exploit economies of scale and scope, but airport has less incentives to do that, because it has other sources of income, mainly aeronautical revenues;
14. In contrast with large operators or developers airports can’t expand their business beyond their own territory, so even for airports with critical mass direct structure limits economies of scale, scope;
15. Airport can benefit from unified design and development of commercial area using engineering principles associated with the “cube-square rule, but in most cases they don’t have know-how, unless services of consultants are used;

Multiple operators structure related

16. Same effects as for prime operator but weaker;

Management company

17. Theory doesn’t point on any significance positive effects, except those, general for outsourcing options. Firstly, this structure must lead to a decrease in agency and influence costs. And secondly, management companies are supposed to be efficient and innovative to survive in the market (in comparison with airport direct control option). These factors may positively affect retail revenues.

Hybrids

18. Successfully organized hybrid structure, which represents a mixture of different structures, is supposed to show many positive effects on retail revenues from those listed above. So they can appear in every place of performance ranking.

5. Data

In our analysis we use data from **ARN Fact Book,** which is published on annual basis by the Armbrust Aviation Group (AAG). The sample consists of 77 US airports and 4 Canadian airports in 2002. Every following year the sample grows and reaches the amount of 96 US airports and 8 Canadian airports in 2008. All data is on a terminal-by-terminal basis, but in this study we are interested in airport-level aggregate data. To obtain it we have simple summarized the corresponding terminals' measures.

Main information included in this database is the following:

- Name and location of the airport;
- Contact information of airport management;
- Management structure;
- Airport configuration;
- Number of enplaning/ deplaning passengers;
- Number of international / domestic enplanements;
- Business to leisure passengers ratio;
- Ratio of Origin & Destination passengers to total;
- Total square footage, gross sales, rent revenue to airport (broken by divisions: food & beverage, specialty retail, news & gifts, duty free, advertising);
- List of outlets in airport with owner's name and location description, size if these outlets;
- Lease expiration date;
- Info about parking facilities and car rental companies in airport;
- Pre/post security ratio;
- Advertising costs;
- Population of metropolitan area to which airport belongs and its income per capita.

Unfortunately, many observations for values from this list are missing. So we have to drop some airports from the considered sample for the next part to explore descriptive statistics of a measure "retail revenues per enplaning passenger". And for the following part devoted to econometric modeling of retail growth we have to drop even more airports to obtain a balanced panel and, hence, adequate results.

6. Research

The main part of this study tires to compare the performance of retail management structures through estimation of their effects on retail revenue. For the beginning we will explain why "retail revenue per enplaning passenger" can be a measure of performance and under which assumptions. Then two approaches, statistical and econometric, are used to achieve the goal of this study.

6.1 Measure of performance

All the airports from our sample (which is typical for North America) are publicly owned. This means, that the primary target of such airports – perform their transportation function. Hence, deciding which management structure to implement, the airport is guided by other performance measures than profit it can earn. For example, these could be – product mix which is offered to passengers and which increase their satisfaction of using a particular airport or investment's size a partner can spend for development of commercial space and so on. In these cases, anyway, the airport should be interested in values that particular management structures can create. Thereby estimation of their performance still makes sense, giving to airports secondary arguments. Moreover the process of privatization of airports is gaining power nowadays, so it leaves no doubt that the share of private airports will become significant with a lapse of time, lifting the profit-based arguments on the primary level when choosing retail management structure.

In this case the best possible measure which could reflex performance of management structures is, of course, airport's retail profit. Unfortunately, we don't have such data. So, to use retail revenue as a proxy of profit we need to make several assumptions. To figure them out, let's look at general profit functions of airports using different structures:

1. In cases of leasing commercial space to operators or a developer profit is a sum of different types of lease payments:

$$\pi_{lease} = (\text{Retail revenue})*r_{sales} + (\text{Leased space})*r_{space} + MAG - \text{Investments} \quad (1)$$

where first rate stands for stepped or fixed percentage rate of gross sales as a fee for leasing space and the second stands for per square rate for leasing space (Stepped percentage rents - fees expressed as a percentage of gross sales increasing at various sales thresholds; fixed percentage rents - the fee is set at a fixed percentage of gross sales). MAG – is a minimal annual guaranties, which may exist or not. In some cases an airport uses only one rate and in others - a combination of rates.

Investments here are related to the development of commercial space, which can be made fully or partially by airports.

Unfortunately, there is no information about payment structure in case of a developer which privatizes commercial space, but it doesn't change our assumptions.

2. In case of Direct control structure, the profit looks like:

$$\pi_{direct} = (\text{Retail revenue})_{direct} - (\text{Variable Costs})_{direct} - \text{Fixed Costs} \quad (2)$$

where Fixed Costs contain investments in commercial space development.

3. In case of management company structure:

$$\pi_{management} = (\text{Retail revenue})_{management} - (\text{Management Fee} + \text{Other variable costs}) - \text{Fixed Costs} \quad (3)$$

To represent the profit our proxy measure must be highly correlated with it. So for "retail revenues" to become a performance measure the following assumptions must hold:

1. Retail profitabilities of airports which belong to the same retail management structure must be equal;
2. Retail profitabilities of airports with different retail management structures must be equal.

The acceptance of the first assumption for the first case of leasing the space is comparatively easy and doesn't distort the reality much. The reason underlies in the lease payment structure which turns out to be pretty stable for North American airports. According to Airport retail study 2006/2007 by Moodie Report the majority of airports in North America (83%) prefer percentage rates (both fixed and stepped) applied to gross retail sales. Only small number of airports use per square rates or fixed percentage of retail sales. Concerning minimum annual guaranties the majority of airports (89%) still use them, which tells about the economic power that airports still have in their relationships with concessionaires. The structure of minimum annual guaranties is also stable – absolute fixed guaranties is the most popular type in North America.

Of course, the level of these rates and minimum annual guaranties differs between airports. But taking into account that these levels depend on negotiation power of airports, which by-turn depends on the size and passenger capacity of airports we can assume that inside hub-size groups airport have approximately the same negotiation power and hence charge approximately the same rates and minimum annual guarantees. So, estimation of performance of retail management structures inside hub-size groups and not in total sample is supposed to decrease the level of distortion brought by our first assumption.

Splitting airports in hub-size groups must also help us with the approximation of fixed costs (including level of investments). We can assume that inside every hub-size group all the airports have approximately the same variable and fixed costs and has to make approximately equal investments. Of course, it a very strict assumption and it's far from reality, but it makes least troubles in our study case where we have faced data restrictions.

Thereby, approximately the same lease payment structure for all North American airports, approximately the same levels of rates and minimum annual guaranties, variable and fixed costs and investments for airports inside a particular hub-size group (according to the additional assumption) makes the profitability of airports with the same management structure equal to each other. This means that correlation between retail revenues and retail profit is very high under assumptions.

To make the second assumption without a large distortion of reality, we must believe in some kind of an effective market of airport retail. This means that following the aim of maximizing retail profit the airport should choose the management structure which is most profitable for it. But as far as we observe different management structures in airports, all of them can maximize airport's profit only in one case – when their profitability for airport is the same.

After we have made assumptions 1 and 2, we can consider retail revenue as a good proxy of airport's profit (because of high correlation between them) and hence, we can use retail revenue as measure of retail management performance.

We use the modification of retail revenue, namely, "Retail revenue (or sales) per enplaning passenger" to clear the performance measure from positive effect of various levels of passenger capacities in airports. This gives us more qualitative characteristic, which allow to compare airports, completely different by size. These measures along with "Retail revenue per sq. foot" are common in the related research literature. Enplaning passengers are taken into account instead of total passengers, because most of the retail revenue is generated by passengers while waiting for departure and only insignificant amount is generated by deplaning passengers. Transferring passengers who wait in the airport for the next flight are considered as half enplaning and half deplaning. Hence, such a measure, scaled by enplaning passenger, is more accurate and informative.

We use total revenue, because there is no point in considering retail management structures' effects on revenues of specific divisions, such that Food & Beverage, Specialty retail, News / Gifts, Duty free and General services, presented in the database, because we are not provided with information about cases, where airports assign most suitable management structure for every division. If such cases exist, they might belong to a Hybrid structure, according to the classification of ARN Factbook.

6.2 Statistical approach

The statistical approach, applied here, compares average values of retail revenue per enplaning passenger for six groups of airports, organized by types of management structures, which are "Prime operator", "Multiple operators", "Airport directly", "Private Developer", "Management company" and "Hybrids". This approach allows to assess and compare effects in general of every management structure, but this assessment assumes underlying significance of management structure's influence. In other words it doesn't take into account other factors which could explain the observed performance. To minimize the distortion of results we have studied the revenue measure in hub-size groups, inside which other factors (characteristics of airports) are supposed to be close to each other and the variation of performance measure is more likely explained by management structure.

For the beginning we need to note, that all of the considered management structures have improved their performance during the time period 2002 – 2008 (see table 2). The first evidence in support of the idea of hub-size groups separate analysis is the difference in average annual growth rate of performance. In the following statistical analysis other evidences will appear, such that differences in management structures' popularity, performance and dispersion of performance measure (represents riskiness of structures).

Table 2. Average annual growth rates of sales per EP

	large hubs	**medium hubs**	**small hubs**
Prime	4.5%	7.3%	4.2%
Multi	2.0%	2.0%	4.0%
Developer	6.0%	3.8%	#
Directly	1.0%	5.5%	8.7%
Hybrid	6.0%	3.6%	2.0%
Management	#	9.3%	#

stands for cases, in which observations are insufficient for calculation.

General sample

To obtain more accurate values of average performance for management structures the size of the sample should be as large as possible. In spite of the fact, that some airport were filtered out because of the missing data, in this chapter we don't drop airports with data available not for the whole time period. Thereby our sample changes its size from year to year. In contrast, in the econometric approach we will use stable panel data.

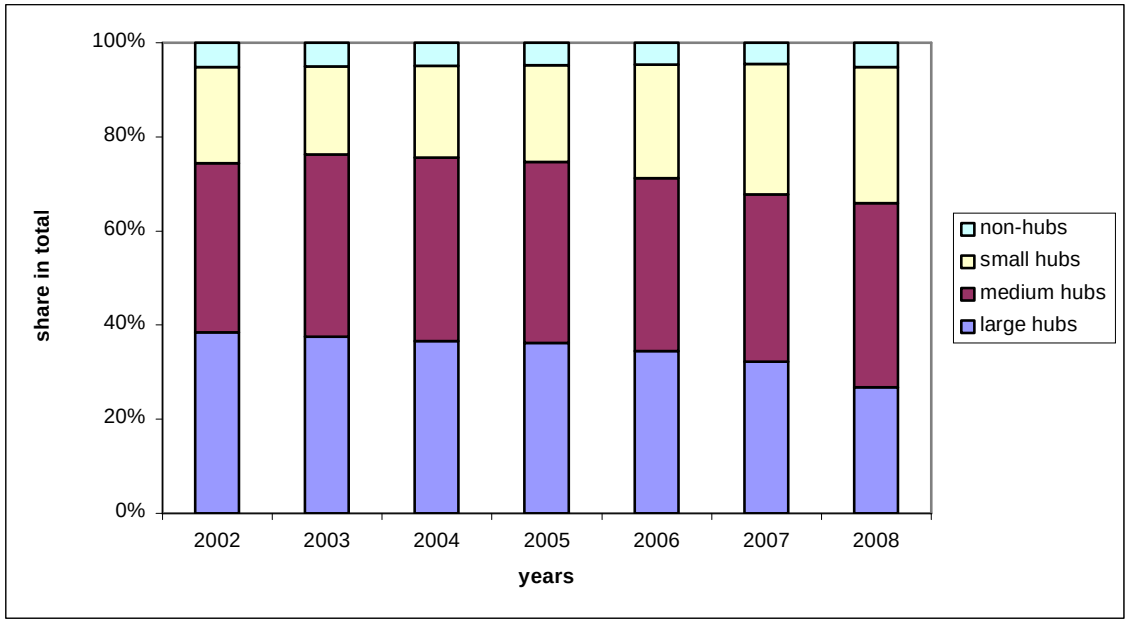
At first, we characterize the general sample's size through a time period 2002 – 2008.

Table 3. Dynamics of general sample's size

	2002	2003	2004	2005	2006	2007	2008
Number of airports	78	80	82	83	87	90	97
Total growth rate							24%

So, the general sample has grown on 24% during 2002 – 2008. Let's show how this dynamics correlates with hub-size groups changes through time period.

Figure 4. Dynamics of hub-size groups' shares in general sample



We see, that total gain in 24% of the sample size is explained by additional inclusion (in last years) of medium hubs (their number have increased from 28 to 38 within the time period) and small hubs (their number have increased from 16 to 28 within time period), whereas non-hubs have increased in number proportionally to hub size (from 4 to 5 within the time period). Large hubs under our consideration have decreased in number from 30 in year 2002 to 26 in year 2008 because of the missing data.

Now we will look at popularity of different retail management structures (share of airports' number in management-structures' groups to total number). Because of unstable sample dynamic estimation of popularity of different structures gives us misleading results; hence we will look at values averaged by time.

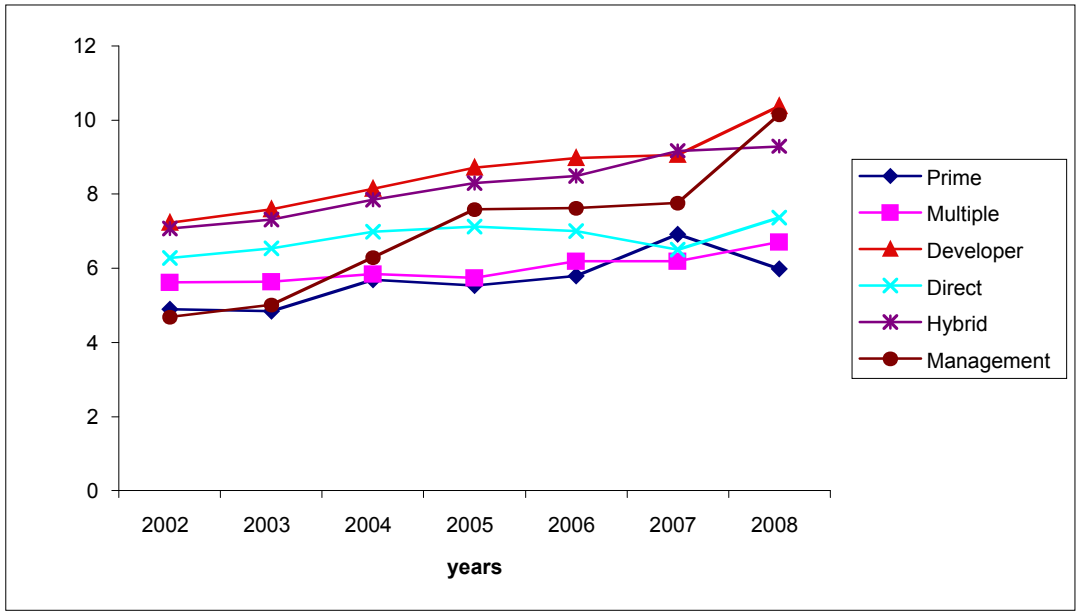
Table 4. Average management structure popularity in general sample

Rank	Management structure	Popularity
1	Airport directly	36%
2	Hybrids	21%
3	Multiple operators	19%
4	Prime operator	14%
5	Developers	7%
6	Management company	3%

Traditional structure "Airport directly" is still the most frequent. Taking into account the fact that only around one third of such airports belong to the large hub group, only where, according to the theory and experts' opinions, this management structure makes sense for a profit-maximizing airport, there is still large potential for airport retail market development.

To estimate the performance of management structures, we compare average retail revenue per enplaning passenger in corresponding groups.

Figure 5. Performance of management structures in general sample



Interpretation:

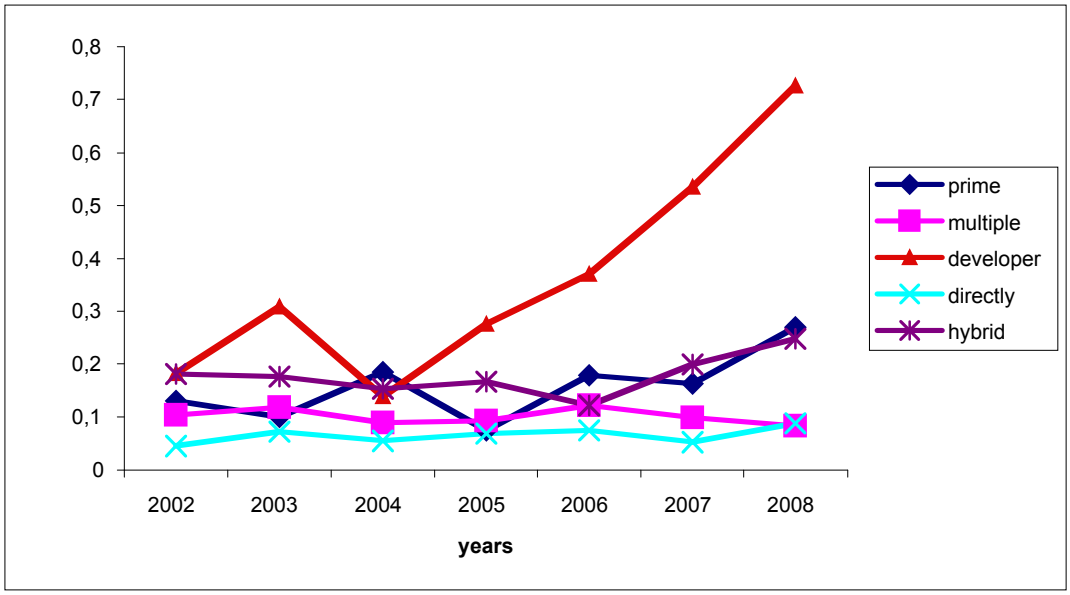
- Hybrids and developers show the highest performance in general and reach the level of over $10 of sales per EP. Developer approach slightly outperforms hybrid structure in all years except 2007, but improves its performance faster;

- Management company structure improves performance faster than others (from $4.7 to $10). But these observations are just a few, so its performance estimation is not trusted;
- Traditional direct control structure shows average results ($6 - $7 of sales per EP) and almost doesn't develop, which eventually decreases its relative performance;
- Prime and multiple operators show worst results (around $6) and also decrease their relative performance.

Essential measure which comes along with performance is riskiness of management structures, or in other words, the indicator of revenue per EP dispersion. As far as the size of the sample is not big, the weight of a single extreme value is too large, which can leads to volatile estimations of variation as a measure of riskiness. So we will take an alternative indicator – interquantile range (difference between 1st and 3rd quintiles of the observations' sample). Considering such form of riskiness measure we need to note, that in case of small-size samples (and this is exactly our case) interquantile range is highly correlated with a number of observations. To obtain an adequate measure of riskiness we divide the interquantile range by the number of observations in the corresponding group to get adjusted interquantile range.

Let's look at the dynamics of riskiness. Management company structure is not considered here because its observations are too few to calculate an adequate interquantile range.

Figure 6. Riskiness of management structures in general sample



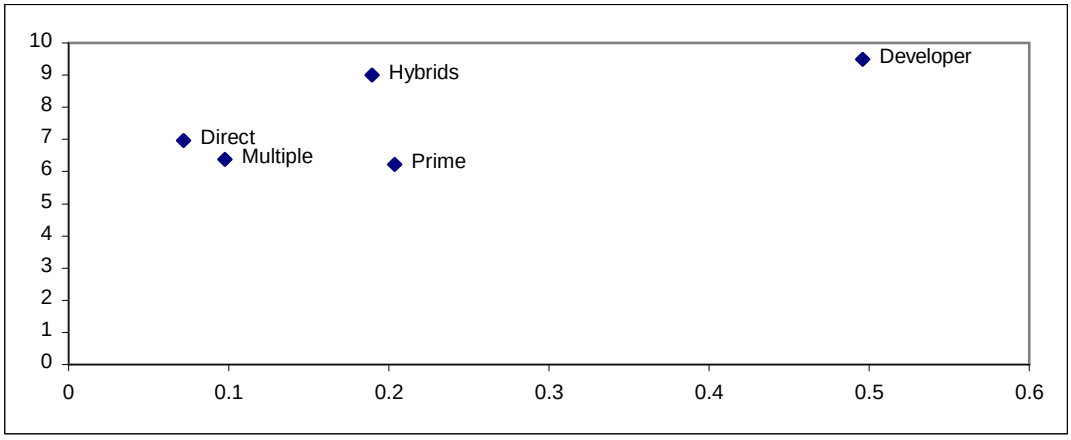
Interpretation:

- Adjusted interquantile range, which represents riskiness per observation, is dynamically stable and takes the lowest values for multiple operators and direct structures;
- Middle-risk options, which are hybrid and prime operator, tend to increase their riskiness;

- Developer has the largest dispersion, which increases rapidly.

To figure out, whether the larger risk is rewarded by the higher level of revenue we need to combine the last two graphs. As far as some of their input measures are not dynamically stable, we compare average values for the last three years.

Figure 7. Sales per EP and riskiness of management structures in general sample



Interpretation:

- Direct approach outperforms multiple operators structure in low-risk class;
- Developers approach is most risky but outperforms others;
- Hybrid structure outperforms prime operator in middle-risk class.

Large hubs sample

Definition 9. Large hubs

These are the airports which process at least one percent of revenue passenger boardings annually.

The size of large hubs sample is pretty stable over time except the last year, in which it has to be reduced because of several missing values. One needs to note that this sample almost fully represent large hub airports in USA.

Table 5. Dynamics of the size of large hubs sample

	2002	2003	2004	2005	2006	2007	2008
Number of airports	**30**	**30**	**30**	**30**	**30**	**29**	**26**
Total growth rate							**-13%**

Again, we estimate the popularity of management structures on average, because the size of the sample changes over time and calculations for every year will result in misleading measures of popularity.

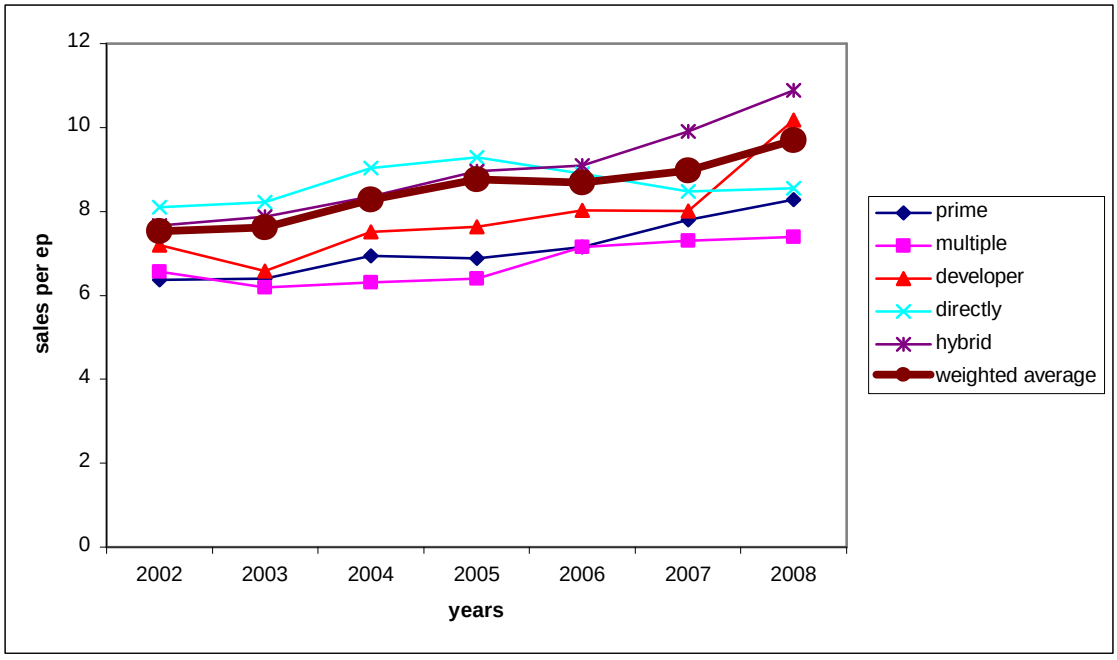
Table 6. Average management structure popularity in large hubs sample

Rank	Management structure	Popularity
1	Hybrids	43%
2	Direct	33%
3	Developers	10%
4	Prime operator	8%
5	Multiple operators	4%
6	Management company	2%

We need to note, that frequency of hybrids and direct structures is significantly higher, than others' in the large hubs sample. Hence, the results regarding these management structures are most trusted.

Not we will look at average retail revenue per enplaning passenger as a measure of management structures' performance in large hubs sample.

Figure 8. Performance of management structures in large hubs sample

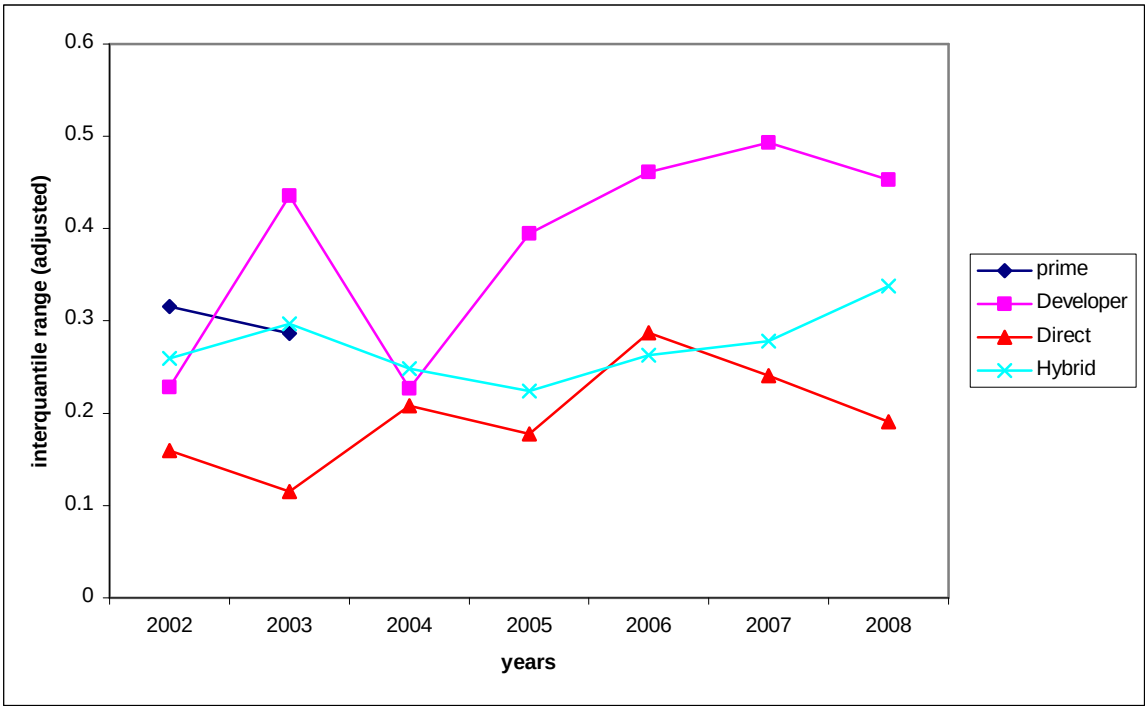


Interpretation:

- The average level weighted by the size of management structures' groups represents the industry's average level of performance;
- During the period 2002 - 2005 Direct control by the airport stays to be the most effective between large hubs. This result is well supported by the theory and experts' opinions, but the lack of performance improvement have led this structure only on the 3rd place by 2008;
- Hybrid structure shows close to direct control results, but it has increased performance greatly during the last two years and has become the leader;
- Developer approach shows average results, except the last year, in which it reached the second high result. Still it's too naive to expect continuation of this trend.
- Multiple and prime operators options are among losers, but, as it was expected, prime is slightly better.
- Management companies are represented by just a few observations, so they are dropped out from the analysis.

According to average management structure popularity in large hub group (see table 6) two structures, Direct and Hybrids, are far more numerous that others. Hence, they have more weight and constitute the biggest part of average performance value.

Figure 9. Riskiness of management structures in large hubs sample

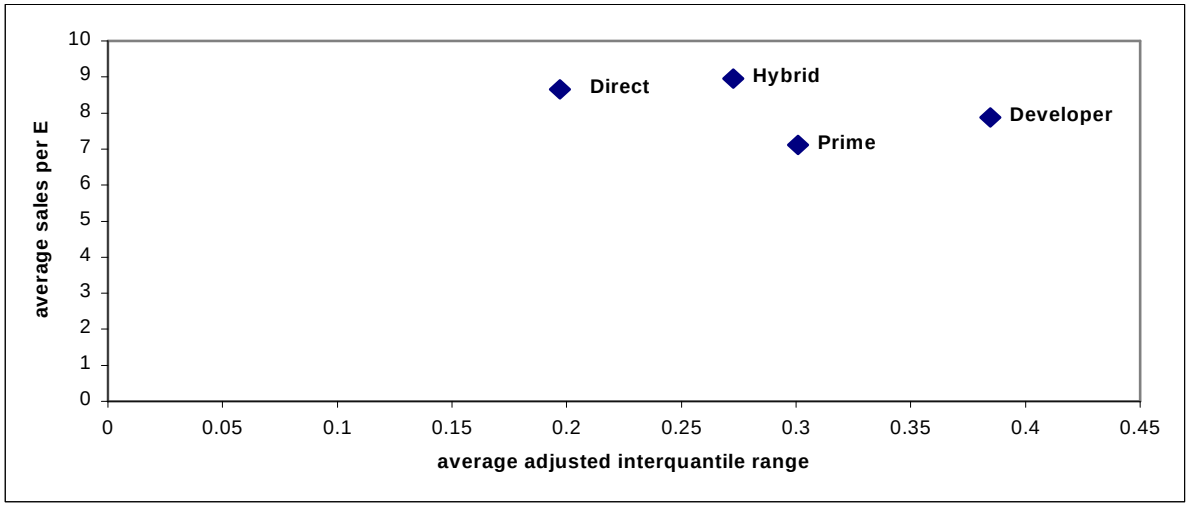


Interpretation:

- As in general sample direct control presents the low-risk structure;
- Hybrid structure shows middle level of riskiness;
- Developer approach is the most risky;
- Unfortunately, number of observations allows us to estimate measure of riskiness of prime operator structure only for years 2002 and 2003 – it belongs to middle-class;
- Multiple operators and management company structures are dropped from analysis because of the same problem.

And finally we look at relation between average performance measure of management structures and their riskiness.

Figure 10. Sales per EP and riskiness of management structures in large hubs sample



Interpretation:

- Direct and Hybrid structures outperform Prime operator and Developer by higher level of retail revenue per enplaning passenger with lower risk of obtaining this revenue;
- Direct structure has the lowest risk and suits for risk averse large hubs;
- Hybrid structure's higher risk is rewarded by higher revenue, which is an option for risk lovers.

Medium hubs sample

Definition 10. Medium hubs

These are the airports which process between 0.25 percent and one percent of revenue passenger boardings annually.

The size of the sample has grown significantly (36%) during the time period 2002 – 2008.

Table 7. Dynamics of the size of medium hubs sample

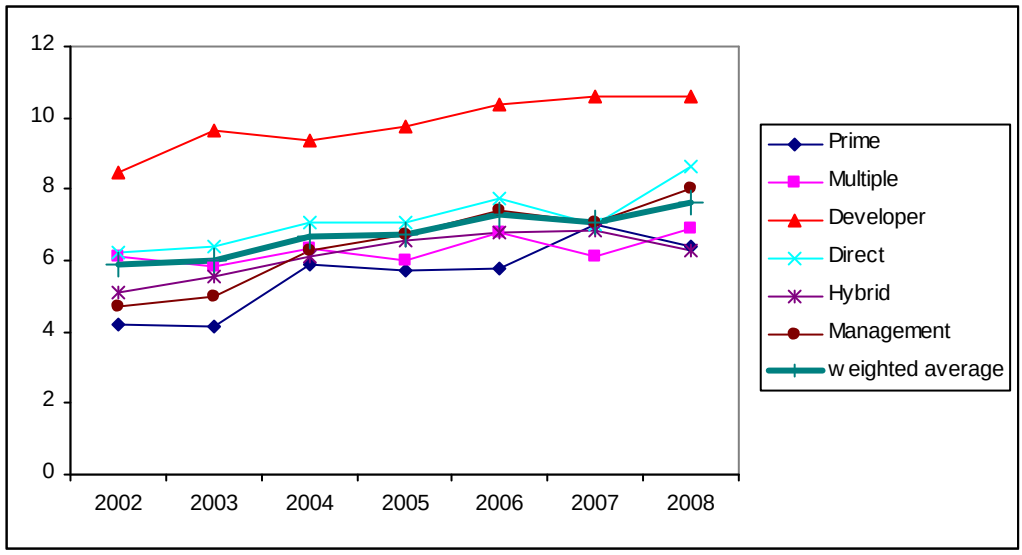
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Number of airports	28	31	32	32	32	32	38
Total growth rate							36%

Table 8. Average management structure popularity in medium hubs sample

Rank	**Management structure**	**Popularity**
1	Airport directly	40%
2	Multiple operators	20%
3	Prime operator	19%
4	Hybrid approach	10%
5	Developer approach	7%
6	Management company	4%

Direct control by the airport is traditionally most common. In contrast with large hubs, hybrid structures are not very popular here. Their place is taken by operators' options. As before, developer and management company structures are rare.

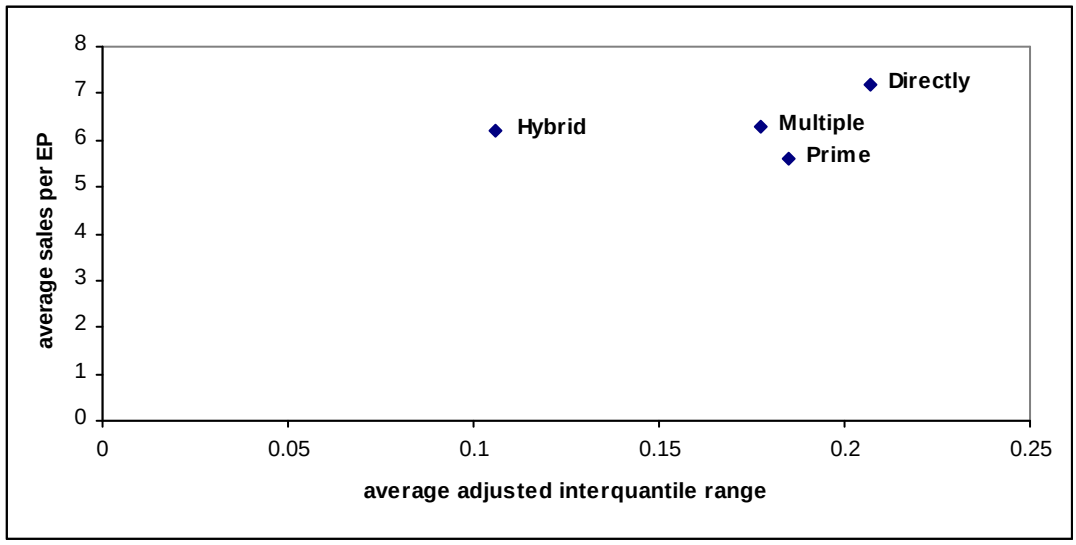
Figure 11. Performance of management structures in medium hubs sample



Interpretation:

- Developer approach is remarkably productive in medium size group. It gradually improves its result;
- Direct control structure shows slightly higher than weighted (by number of observations) average results. The development trend is also upward;
- Hybrid and multiple operators structures lie below the average line and improve their performance comparatively slow;
- Management company is the only structure which has developed from underperformed option to over performed starting from 2006;
- Prime structure in general shows worst results.

Figure 12. Sales per EP and riskiness of management structures in medium hubs sample



Interpretation:

- Hybrid is the low-risk structure;
- Multiple operators outperform prime operator structure by lower risk and higher retail revenue. It is slightly productive than Hybrid structure and represents middle-risk option;
- Direct structure is the most risky option but it's rewarded by higher level of sales.

Small hubs sample

Definition 11. Small hubs

These are the airports which process between 0.05 percent and 0.25 percent of revenue passenger boardings annually.

The size of the sample has grown on 75% during time period 2002 – 2008 (see table 9).

Table 9. Dynamics of the size of small hubs sample

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Number of airports	16	15	16	17	21	25	28
Total growth rate							75%

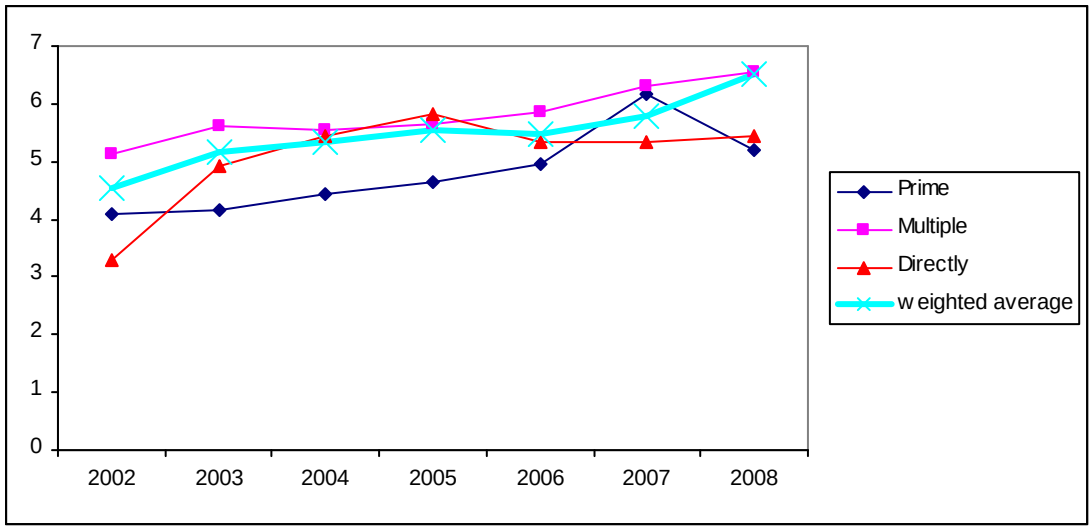
Because of the non-fixed list of airports in the small hubs sample estimation of management structures' popularity on annual basis will give us distorted tendencies. Hence, we will look only at averaged by time values.

Table 10. Average management structure popularity in small hubs sample

Rank	**Management structure**	**Popularity**
1	Multiple operators	40%
2	Airport directly	35%
3	Prime operator	17%
4	Hybrid approach	5%
5	Developer	2%
6	Management company	1%

Direct control by the airport is also very popular among small hubs, but the most common here is Multiple operators structure. As in case of medium hubs Prime operator structure is significant, but takes only the 3rd place. Other structures are very rare, so we have to ignore them in the following analysis.

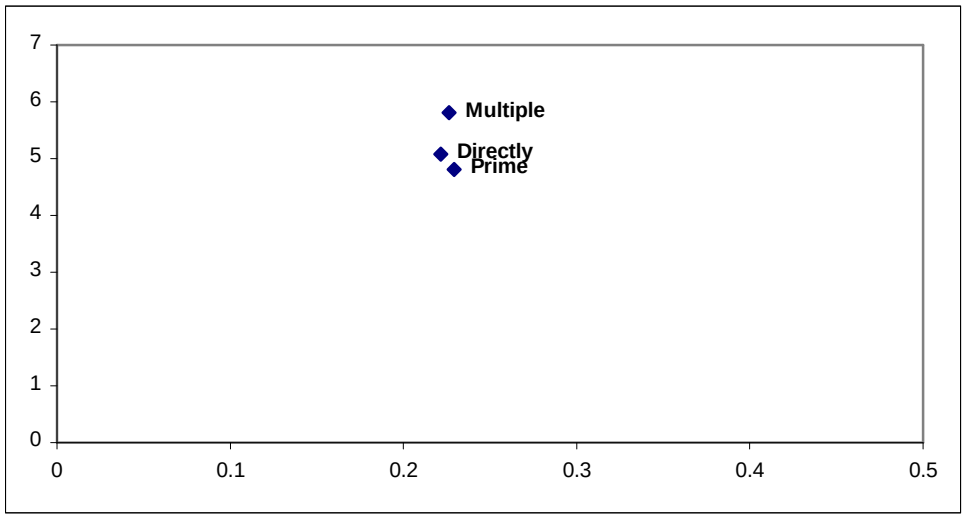
Figure 13. Performance of management structures in small hubs sample



Interpretation:

- In general Multiple operators structure shows the best result;
- Prime structure is least productive except year 2007, when in showed above group's average result;
- Direct control structure shows average results. It shows impressive rates of improvement but it can be caused by significantly increased during the time period number of observations.

Figure 14. Sales per EP and riskiness of management structures in small hubs sample



Interpretation: Under almost the same risk Multiple structure outperforms Direct control and Prime operator structures.

Non-hubs sample

Definition 12. Non-hubs

These are the airports which process more than ten thousand (10000) but less than 0.05 percent of revenue passenger boardings annually.

Unfortunately, in our sample there are only a few airports belong to this group, so there is no point to describe it statistically. Anyway, almost all of the given airports in the non-hubs sample prefer Direct control structure, which showed dynamically stable result between $3 and $4 of sales per EP.

6.3 Econometric approach

The main disadvantage of statistical approach is that we analyze only resulting values and we don't know exactly, what factors explain them. So, in our case we observe retail per EP measure for different groups of airports joined by management structure, but we can't be sure that it's the management structure, which underlies the value. In the same observations it could be that other factors, for example, share of international passengers or income per capita of the airport's metropolitan area, contribute to the result more. And the smaller our sample under analysis is the higher the probability of such misleading coincidences. To obtain more trusted result we need to take also other factors, which affect the performance measure (drivers of retail revenue), into account. To achieve this goal the following econometric approach is applied.

Sample

To deal with balanced panel data we have to drop airports which have missing observations in some years of the time period 2002 – 2008. Therefore large hubs group here consists of 30 airports, medium size group – 32 airports and small size group – only 14 airports.

Method

Firstly, we need to determine which factors (drivers of retail revenue) to take. There are many research papers devoted to the problem of determining them. The summary of these factors is on the scheme 3 in the appendix. The choice of drivers will be described later.

Secondly, we choose the functional form and type of our model consisting of drivers of retail revenue. There are several models-candidates to consider, namely:

- No fixed effects;
- Cross-section fixed / random effect;
- Fixed time effect;
- Both cross-section and time effects.

We won't consider Between model because around 35% of airport have changed their management structures during the period 2002 – 2008, so estimation of the effects of different management structures' dummy-variables, each averaged by time, makes no sense. The most suitable model and its specification will be determined through econometric testing of the corresponding hypotheses.

Finally, when the true model based on retail revenue's drivers is found for every hub-size group, we can easily estimate effects of management structures on revenue with the help of corresponding dummy-variables, which we will add to the model. As far as estimated resulting values of the model which consists of initial drivers of retail revenue represent only the part of actual retail revenue values, putting

dummy variables one by one in turn in the model will reveal their separate effects on our performance variable and their significance.

Model specification

The dependent variable in our regression is, as before, retail revenue (or sales) per enplaning passenger (EP). As far as, according to the logic described above (in part "Performance measure"), we have chosen such a dependent variable which reflexes not only quantitative (total revenue), but also qualitative characteristic of the airport retail (like "productivity" of retail per passenger), the factors which will try to explain this variable should also be partially qualitative. According to the available data they are the following:

1. Sq. foot per EP;
2. Income per capita (of airport's metropolitan area);
3. Share of O&D passengers in total (O&D stands for origin and destination passengers);
4. Share of leisure passengers in total;
5. Share of international passengers in total;
6. Dwell time.

The first value represents the level of commercial space development. The more this value is the more opportunities to spend money a passenger has. The second one is the essential proxy for a passenger's ability to pay for goods and services in the airport. Origin and destination passengers are the passengers on a flight who are either boarding or deplaning at a particular stop, as distinct from those remaining on the plane to go to another destination. Leisure passengers whose aim of the trip is leisure tend to spend more in the airport than business passengers. International passengers tend to spend more than domestic passengers. Unfortunately, because of mostly domestic transport operations in USA airports, the majority of the values are close to 1%, so the variation of this measure is very small. Dwell time measure shows how much time a passenger needs to spend in the airport before departure. The longer a passenger waits in the airport the more goods & services he purchases. The signs of all expected effects of these factors on the dependent variable are positive.

According to results of the Ramsey's RESET test we also need to add powers of above listed factors to capture the non-linear relationship between dependent variable and factors of retail revenue. Polynomials of power four should be enough to describe the variety of non-linear effects on revenue per EP. In spite of the fact that this test also recommends to add power of dependent variable in the regression, we ignore it not to distort the underlying logic of the model. Unfortunately, powers of dependent variables are correlated with each other, so the problem of multicollinearity can exist, but it's not damaging for results.

To capture the possible time effect we use dummy-variables for years of considered time period.

In the final stage of this approach we will add dummy-variable for different management structures to estimate their effect on retail revenue per EP.

Model estimation

Descriptive statistics have shown that preferences of hub-size groups differ significantly. This relates to performance measures, rates of performance improvement, riskiness and popularity of different management structures. Hence, there is no point to consider general sample, where all these preferences mix with each other providing most likely misleading results. Also, as in statistical approach, non-hub group is not considered here because of the small number of observations.

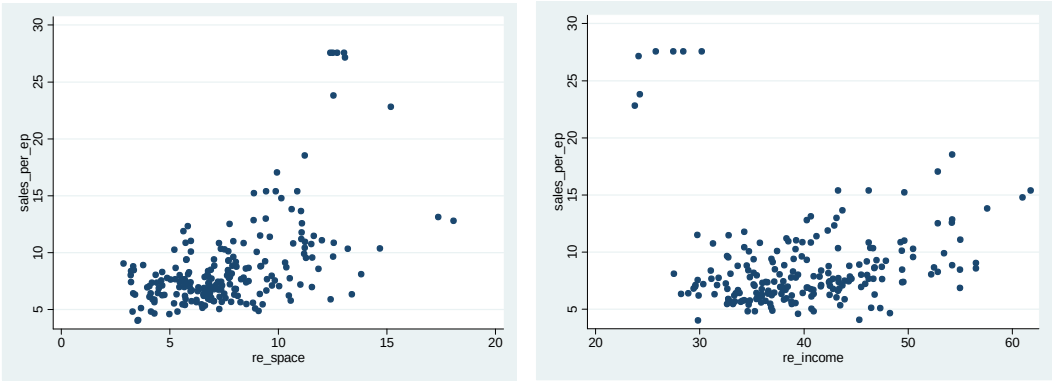
Large hubs

At first, we have looked at distributions of variables inside large hubs sample and found that none of them are normally distributed. This finding is supported not only visually (Histogram, P-P plot, Q-Q plot and etc.) but also by all corresponding statistical tests (Shapiro-Wilk, Shapiro-Francia, Skewness/Kurtosis). In general non-normality of variables is not critical but it's preferable and without it some statistical tests doesn't make sense (for example, t-test). To normalize variables we have to transform them in the most suitable way. The following types of transformations were considered:

- Log transformation;
- Square root transformation;
- Inverse transformation.

Unfortunately, no option appeared to be able to normalize all the variables. Best result was shown by log transformation, which fixed 3 variables: sq. foot per EP, income per capita and dwell time. Moreover, this option is supported by findings from scatterplots (sales per EP against each dependent variable) which were drawn in effort to figure out the functional form of regression. It gives us a clue about possible logarithmic functional form.

Figure 15. Scatterplots: sales per EP vs. sq.ft. per EP (left) and income per capita (right)



So, we replace measures of levels by log-values for sq. foot per EP, income per capita and dwell time. And as far as we assume possibility of non-linear relationships between dependent and all

independent variables without exceptions, we also need to add powers of log-transformed variables up two four power.

Now we need to find the most suitable model. Hausman test rejects the hypothesis that Random effect model (where additional cross-sections' effects don't depend on regressors) is more efficient than Fixed effect model (where additional cross-sections' effects depend on regressors) so we choose the latter. According to Wald test the hypothesis that all cross-section fixed effects equal to zero is rejected, hence we choose Model with cross-section effects instead Pooled regression model (which doesn't take into account heterogeneity of the sample). To test whether fixed time effects are all simultaneously equal to zero in Cross-section fixed effects model we apply simple F-test, which reject this hypothesis, hence we must add dummy-variables for every year in our regression. Thereby the optimal model for the large hubs sample is Double fixed effects model.

After dropping out redundant (insignificant) variables we, finally, obtained the model of retail revenue creation based on above mentioned factors. Then we add management structure dummies by one if the regression and re-estimate it. We managed to capture two significant effects: positive effect of Hybrid structure (+$0.57) and negative effect of Direct approach (-$1.28). These effects are supported by statistical approach implemented before and their significance is most expected, because of the largest size of their samples in large hubs group.

The estimated regression with Hybrid structure is the following (see details of estimation result in the Appendix, table 11)**:**

estimated Sales per EP = - 990.1 + 0.57 * Hybrid + 10.8 * log(Space) – 2.57 * log^2(Space) – 0.1 * (International share)^2 + 843.3 * log(Income per capita) – 238.2 * log^2(Income per capita) + 22.2 * log^3(Income per capita) + 0.94 * (year 2004) + 1.7 * (year 2005) + 2.3 * (year 2006) + 2.95 * (year 2007) + 3.5 * (year 2008) **(4)**

R-sq (63.5%) and F-test indicate about good explaining power and significance of the model in general. The main result is that Hybrid management structure outperforms the average level of revenue explained by different drivers. It contributes additional **$0.56** to the total revenue per EP measure. For large hubs with annual number of enplaning passenger between 4 million to 20 million the choice of Hybrid structure brings them additional retail revenue in amount of $2 mil. - $11 mil. a year. This result is fully supported by the corresponding finding of statistical approach (see figure 8).

Marginal contributions of time dummies have increased from $0.94 in year 2004 to $3.5 in 2008. Hence, there is an upward trend of performance improvement general for large hubs.

Among considered drivers of retail revenue only "Space" (sq, ft. per EP), "International share" (share of international passengers to total) and "Income" (income per capita of airport's metropolitan area) turned out to be significant. All of them explain retail revenue in non-linear functional forms.

Total contributions to retail revenue per EP are:

Total contribution of "Space" = 10.8 * log(Space) – 2.6 * $\log^2$(Space) (5)

Total contribution of "Income" = 843.4 * log(Income) – 238.2 * $\log^2$(Income) + 22.2 * $\log^3$(Income) (6)

Total contribution of "International share" = - 0.01 * (International share)^2 (7)

Marginal effects are derivatives of Total contributions with respect to corresponding factors:

Marginal contribution of "Space" = 10.8 – 5.2 * log(Space) (8)

Marginal contribution of "Income" = 843.4 – 476.4 * log(Income) + 66.6 * $\log^2$(Income) (9)

Marginal contribution of "International share" = - 0.02 * (International share) (10)

Taking into account, that log(Space) varies in the interval [1.06 ; 2.09], its marginal contribution is positive as expected and lies between values of **5.3** (for the smallest value of sq. ft. per EP) and almost **0** (for the largest value of sq. ft. per EP). As soon as metrics of dependent and independent variable are different it should be interpreted as 1% increase in Sq, ft, per EP leads to a maximum increase of $0.053 dollars of revenue per EP. This effect gradually vanishes with the measure's growth. Analogically, marginal effect of income is positive as expected and differs from $**0.03** to **$0.11** of revenue per EP after 1% increase of income per capita (in thousands). The effect of international passengers' share is small and negative (from **– $0.02** to **-$0.57**) which contradicts our expectations. But as it was noted before, this measure has very small variation and majority of values are close to 1%, because of domestic traffic's prevalence in our sample. This could explain the wrong result.

The estimated regression with Direct control structure is the following (see details of estimation result in the Appendix, table 11)**:**

estimated Sales per EP = - 1162 - 1.28 * Direct + 11.7 * log(Space EP) – 2.7 * $\log^2$(Space) – 0.1 * (International share)^2 + 986.5 * log(Income per capita) – 278 * $\log^2$(Income per capita) + 26 * $\log^3$(Income per capita) + 0.9 * (year 2004) + 1.7 * (year 2005) + 2.2 * (year 2006) + 2.8 * (year 2007) + 3.4 * (year 2008) **(11)**

The negative effect of Direct control structure (-$1.28) is not fully supported by statistical approach (see figure 8). As far as level of revenue per EP for direct control group is higher than for an average airport, it seems that other drivers of retail revenue, in general, contribute to the revenue more for airports under direct control, than for an average airport. Actually, that makes sense. Large hubs are located near big cities, which are characterized by high level of income per capita, and large hubs operate large commercial areas, so their sq. ft. per EP measures are also higher. These factors make direct control structure comparatively underperforming. Other factors' influence on revenue is almost the same as in case of previous regression with Hybrid structure factor, there is no point to re-calculate their marginal effects here.

Medium Hubs

As far as the process of searching for the true model goes in the same way for medium and small hubs as for large hubs, in following part we skip details and make only a few comments before getting directly to the results.

At first, we need to note that no transformation of variables from listed above have worked out with the problem of non-normality of data. But log transformation have helped to fix skewness at least partially and made our data still non-normally distributed but closer to it. Thereby, we consider logarithmic values for independent variables as substitutes. To avoid multicollinearity we will leave only one type (levels or logs) for every variable, which fits our model best.

As before we have tested Pooled regression model, Fixed effect model and Random effect model each for both cases – with and without time effects. The Wald test showed again the superiority of Model with effects in comparison with Pooled regression model, but, in contrast with large hubs sample, Hausman test has indicated that the model with random cross-section effects is more efficient than Fixed effects model. F-test proved the significance of coefficients in front of time effect dummy-variables.

So, the most suitable model is Random cross-section effects model with time effects. This choice makes perfect sense. In contrast with large hubs group, where differences between airports are very significant, airports in medium hubs group are more homogeneous. For example, if in the first group the gap in number of enplanements between airports can reach 500%, in the latter group this difference is 5 times lower. Assigning fixed effect for every airport with low variations in measures can make independent variables insignificant. The Random effect model is a compromise between Fixed effect and Pooled regression model when we deal with low-heterogeneity data.

After all redundant variables were filtered out we found the assumed true model of retail revenue creation. Unfortunately, this specification allowed us to find only one significant effect for management structures, but it conforms to low variation in medium hubs' measures. The resulting estimated model has the following form (see details of estimation result in the Appendix, table 12):

$$\text{estimated Sales per EP} = 19.8 - 0.58 * \text{Prime} - 0.95 * (\text{O\&D share}) + 0.012\,(\text{O\&D ratio})^2 - 0.00005 * (\text{O\&D share})^3 + 0.97 * \log(\text{Space per EP}) + 0.0026 * (\text{Space per EP})^2 + [0.216 - 0.02 * (\text{International share}) + 0.00059 * (\text{International share})^2] * (\text{International share})^2 + [0.45 - 0.01 * (\text{Dwell time}) + 0.00009 * (\text{Dwell time})^2 - 0.0000003 * (\text{Dwell time})^3] * (\text{Dwell time}) + 0.4 * (\text{year 2004}) + 0.7 * (\text{year 2005}) + 0.9 * (\text{year 2006}) + 1 * (\text{year 2007}) + 1.29 * (\text{year 2008}) \quad (12)$$

The effect of Prime operator management structure on retail revenue per EP is **-$0.58** which is supported by descriptive statistical analysis. We see, that non-linear interconnection between independent variables and dependent one is more sophisticated in comparison with large hubs' model – the forth powers are observed for "Dwell time" and "International share". But the list of significant factors has

changed. Income per capita is not significant anymore, but new factors, such that O&D share, International share and Dwell Time, have shown a significant effect on revenue.

Let us calculate marginal effects, which contributed with addition of these factors into regression. The marginal effect of O&D share of passengers on retail revenue is negative when the level of O&D ratio is small (less than 71%). The maximum marginal damage to retail revenues is about $1 per enplaning passenger (after 1% increase in O&D measure), which gradually disappears when O&D share level grows and totally vanishes by 71%. For higher O&D values its effect becomes positive and reaches the value of $0.01 when O&D equals to 88% where the total revenue created by this factor is maximal. Until this moment the effect follows our expectations. But after the threshold of 88% the effect becomes negative again and reaches -$0.05. As before this wrong estimation is most likely have occured because of low variability of O&D measure (majority of airports in this group show values over 90%).

"Space per EP" and "International share" shows positive effects [$0.14; $0.4] and [$0.3; $3.3] accordingly, so an increase in these factors leads to higher level of revenue for all airports, differentiated by levels of these measures". Under a more detailed analysis the marginal effect of commercial space on retail revenue becomes weaker for small levels of the measure (less than 13.6 sq.ft per EP) and starting from $0.4 it falls to the minimum of $0.14 at 13.6 sg. ft per EP. For higher levels of the measure its positive effect becomes stronger and reaches $0.2 for an airport with the level of commercial space to EP about 31 sq.ft. For medium hubs the marginal effect of International share of passengers has the following non-linear form: for small values of the measure (between 1% and 4.2%) its positive marginal effect grows starting for our sample from $0.34 of revenue per EP. It reaches the maximum of $0.76 at 4.2% and then gradually falls to -$0.76 at 15.7%. Then it grows again becoming positive at 20% and reaches $3.3 at 25%. The contradiction of this estimation to the literature is in the detected negative effect's part. But as in large hubs case the possible underlying reason is in low variation of this factor for US airports.

An interesting result is found for the "Dwell time" measure. For airports with low values of dwell time an additional increase in this measure leads to a corresponding increase in revenue (about $0.1). This effect was expected and described in literature. But after a threshold of 33 minutes (where the revenue created by dwell time is maximal) of dwell time, an additional increase in this measure leads to a decrease in retail revenue up to $0.5 per enplaning passenger. This can be explained by passengers' expectation. When people expect to spend half an hour in the airport they don't think in advance what they will need during their waiting. Therefore, in the airport when it appears, that they want to eat they have to buy food or, if they are bored, they buy a newspaper in outlets located inside. When people are heading to the airport where they expect to spend 2 hours, they possibly would like to prepare to it: to buy food or a book somewhere else outside the airport at a cheaper price.

The upward time trend contributes to revenue per EP from $0.4 in 2004 to $1.29 in 2008. It represents dynamics of the performance improvement effect, mutual for all airports.

Small hubs and non hubs. Unfortunately, the samples' sizes of small hubs and non hubs don't allow us to detect effects of management structures on retail revenue of airports.

7. Results

The results of this study represent two approaches which were used to analyze target effects of airport management structures on retail revenues. The findings obtained from econometric approach are more reliable and the findings of statistical are questionable, which anyway deserve attention.

Target results:

1. For large hubs the choice of Hybrid management structure is favorable and creates on average $0.57 of additional retail revenue per enplaning passenger in comparison with other structures. The total benefit of such decision for different airports is between $2 mil - $11 mil of retail revenue a year, from which the airport extracts around $0.4 mil - $2.2 mil of additional profit annually;
2. For large hubs the choice of Direct control destroys on average $1.28 of retail revenue per enplaning passenger in comparison with other structures.
3. For medium hubs the choice of Prime operator structure destroys on average $0.58 of retail revenue per enplaning passenger.

Additional results:

4. For large hubs the marginal effect of commercial space on retail revenue is positive: maximum $0.05 of gain in revenue per enplaning passenger after 1% increase of the measure sq. ft. per enplaning passenger. This effect gradually vanishes along with the growth of commercial space;
5. For large hubs the marginal effect of income per capita (of airport's metropolitan area) on retail revenue is positive: 1% increase in income per capita (in thousands) creates from $0.03 to $0.11 of retail revenue per enplaning passenger. The effect is increasing in relation with income per capita.
6. For large hubs the following factors' influence on airport retail is insignificant: O&D share, Dwell time, share of leisure passengers;
7. For medium hubs the marginal effect of commercial space on retail revenue is also positive: for small levels of the measure (less than 13.6 sq.ft per EP) its effect becomes weaker and from $0.4 it falls to the minimum of $0.14 at 13.6 sg. ft per EP. For higher levels of the measure it's positive effect becomes stronger and reaches $0.2 for an airport with level of commercial space to EP about 31 sq.ft.
8. For medium hubs the effect of Dwell time is two-fold. For airports with low values of dwell time an additional increase in this measure leads to a corresponding increase in revenue (about

$0.1). This effect was expected and described in literature. But after a threshold of 33 minutes (where the revenue created by dwell time is maximal) of dwell time, an additional increase in this measure leads to a decrease in retail revenue up to $0.5 per enplaning passenger. This can be explained by passengers' expectation. When people expect to spend half an hour in the airport they don't think in advance what they will need during their waiting. Therefore, in the airport when it appears that they, for example, want to eat they have to buy food or, if they are bored, they buy a newspaper in outlets located inside. When people are heading to airports in which they expect to spend, for example, 2 hours, they are sure what they will need during this time and possibly would like to prepare to it: to buy food or a book somewhere else outside the airport at a cheaper price.

9. For medium hubs the following factors' influence on airport retail is insignificant: share of leisure passengers, income per capita;

<u>Questionable results:</u>

10. For large hubs Hybrid structure is the best middle-risk option and Direct approach is the best low-risk option: they outperform Prime operator and Developer structure by higher average revenue per EP with smaller dispersion of this revenue (higher probability to obtain average revenue). Additional risk of Hybrid structure's revenues is rewarded by extra-revenue it creates (see figure 10 for details). No results are obtained here concerning other structures.
11. For medium hubs Hybrid structure is the best low-level option, Multiple operators is the best middle-risk option and Direct structure – best high-risk option (see figure 12 for details) in comparison with Prime operators. No results are obtained here concerning other structures;
12. For small hubs Multiple operators structure outperforms Direct and Prime operators structure by higher revenue under the same risk (see figure 14 for details). No results are obtained here concerning other management structures;

<u>Contradictory results:</u>

13. For large hubs the marginal effect of international passengers to total on retail revenue per enplaning passenger is negative. It is estimated between -$0.02 and -$0.57 after 1% increase in share of international passenger. For medium hubs the marginal effect of International share of passengers has the following non-linear form: for small values of the measure (between 1% and 4.2%) its positive marginal effect grows starting for our sample from $0.34 of revenue per EP. It reaches the maximum of $0.76 at 4.2% and then gradually falls to -$0.76 at 15.7%. Then it grows again becoming positive at 20% and reaches $3.3 at 25%. The contradiction of this estimation to the literature is in the detected negative effect's part. But this wrong result might

have occurred because this measure has very small variation and majority of values are close to 0% (domestic traffic's prevalence in USA airport).

14. For medium hubs the marginal effect of O&D share of passengers on retail revenue is negative when the level of O&D ratio is small (less than 71%). The maximum marginal damage to retail revenues is about $1 per enplaning passenger (after 1% increase in O&D measure) which gradually disappears when O&D share level grows and totally vanishes by 71%. For higher O&D values its effect becomes positive and reaches the value of $0.01 when O&D equals to 88% where the total revenue created by this facto is maximal. After this threshold the effect becomes negative again and reaches -$0.05.

Conclusion

To analyze the effect of airport retail management structures on retail revenue two approaches are applied, statistical analysis and econometric modeling. The main problem which this study faced is a lack of data. A lot of missing values made us to drop many airports out from the research. This is most likely the reason of discovering only three significant effects of airport retail management structures on retail revenue. They are:

- Positive effect of Hybrid structure in large hubs;
- Negative effect of Direct control in large hubs
- Negative effect of Prime operator in medium hubs

In spite of the fact that it's not enough to constitute the comprehensive answer on the research question of this study "If the retail revenue is taken as a measure of performance, which airport retail management structure performs better?", it's still can help airports' authorities to narrow the range of options to take into account when deciding how to organize their retail operations. In addition, effects' estimations of different factors often considered in the literature as drivers of retail growth are carried out, which can also provide some guidance in retail strategy building.

For future research it would be useful to re-estimate the influence of management structures on retail revenues using larger sample of airports from North America and try to discover some new significant effects. Moreover, similar studies must be carried out with airports from other regions. The differences between aeronautical and retail industries in USA, Europe, Asia and etc. are very significant, and the composite resulting effect of these industries' differences is hard to predict at this stage.

Appendix

Figure 16. Drivers of airport's retail revenue

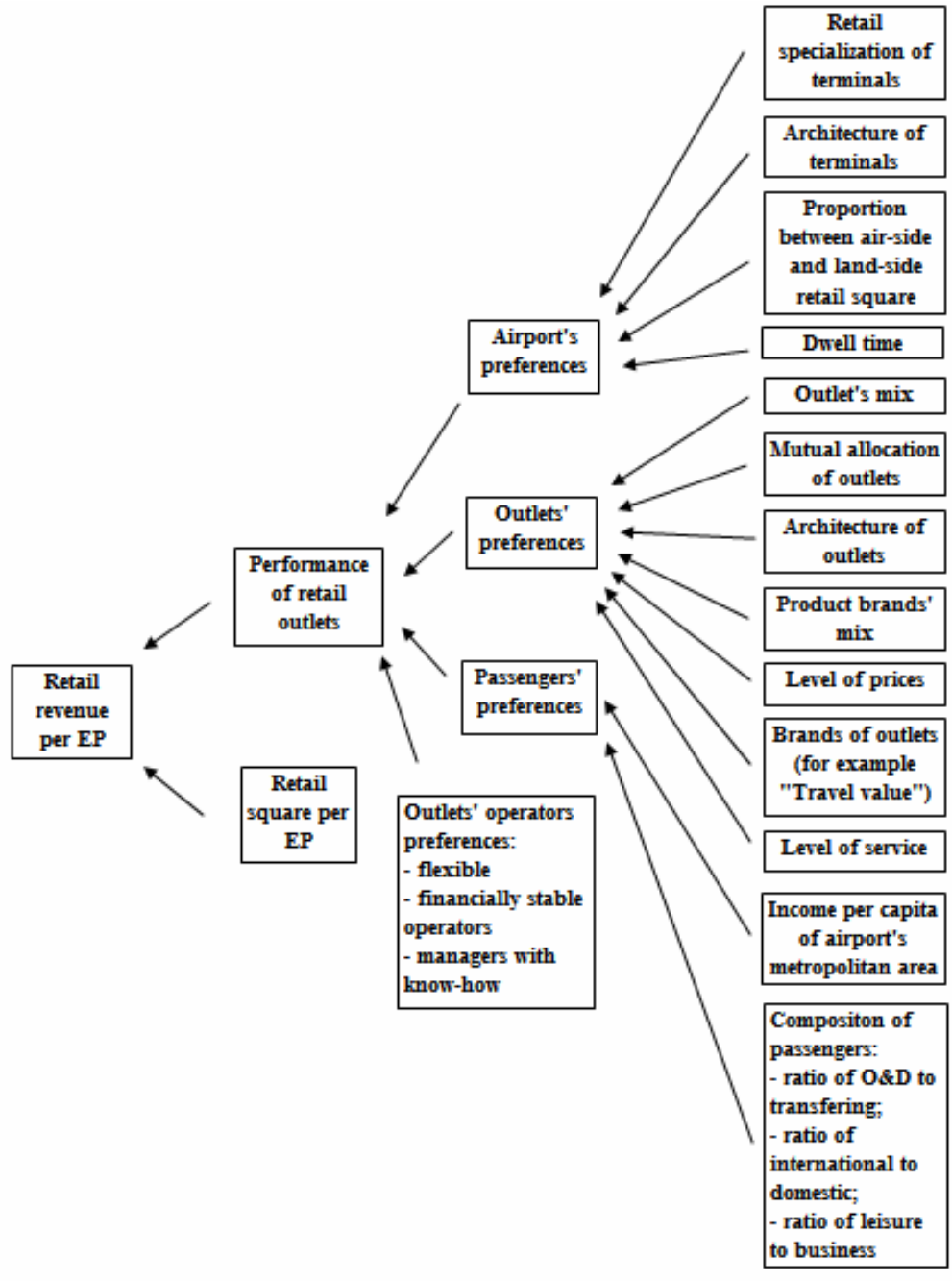


Table 11. Estimation results for the model with Hybrid structure (first) and Direct control (second) in large hubs

```
Fixed-effects (within) regression               Number of obs      =       210
Group variable:  airport                        Number of groups   =        30

R-sq:  within  =  0.6351                        Obs per group: min =         7
       between =  0.0853                                       avg =       7.0
       overall =  0.0203                                       max =         7

                                                F(12,168)          =     24.36
corr(u_i, Xb)  =  -0.5721                       Prob > F           =    0.0000
```

sales_per_ep	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
hybrid	.568422	.3226112	1.76	0.080	-.0684722	1.205316
l_re_space	10.84684	2.06862	5.24	0.000	6.762999	14.93068
sq_l_re_sp~e	-2.576108	.5387952	-4.78	0.000	-3.63979	-1.512427
sq_re_int	-.0106567	.0052377	-2.03	0.043	-.0209968	-.0003166
l_re_income	843.3865	259.2839	3.25	0.001	331.5121	1355.261
sq_l_re_in~e	-238.1688	70.77443	-3.37	0.001	-377.8906	-98.44696
cube_l_re~me	22.24166	6.430634	3.46	0.001	9.546398	34.93692
y2004	.9391787	.2497935	3.76	0.000	.4460401	1.432317
y2005	1.708622	.3894042	4.39	0.000	.9398664	2.477378
y2006	2.309621	.5289934	4.37	0.000	1.26529	3.353951
y2007	2.949558	.6485551	4.55	0.000	1.66919	4.229926
y2008	3.502249	.7045315	4.97	0.000	2.111373	4.893125
_cons	-990.1121	316.3457	-3.13	0.002	-1614.637	-365.5871
sigma_u	4.9587401					
sigma_e	.83320143					
rho	.9725422	(fraction of variance due to u_i)				

F test that all u_i=0: F(29, 168) = 53.52 Prob > F = 0.0000

```
Fixed-effects (within) regression               Number of obs      =       210
Group variable:  airport                        Number of groups   =        30

R-sq:  within  =  0.6687                        Obs per group: min =         7
       between =  0.1263                                       avg =       7.0
       overall =  0.0506                                       max =         7

                                                F(12,168)          =     28.25
corr(u_i, Xb)  =  -0.6812                       Prob > F           =    0.0000
```

sales_per_ep	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
direct	-1.283977	.2838734	-4.52	0.000	-1.844396	-.7235583
l_re_space	11.66713	1.978258	5.90	0.000	7.761682	15.57258
sq_l_re_sp~e	-2.72596	.5126788	-5.32	0.000	-3.738083	-1.713837
sq_re_int	-.0139656	.0050453	-2.77	0.006	-.023926	-.0040053
l_re_income	986.4721	244.5948	4.03	0.000	503.5966	1469.348
sq_l_re_in~e	-277.9872	66.72493	-4.17	0.000	-409.7146	-146.2598
cube_l_re~me	25.94806	6.061426	4.28	0.000	13.98168	37.91443
y2004	.9005632	.2381718	3.78	0.000	.4303681	1.370758
y2005	1.680888	.3710215	4.53	0.000	.9484233	2.413354
y2006	2.203119	.5035193	4.38	0.000	1.209079	3.197159
y2007	2.806169	.6175645	4.54	0.000	1.586982	4.025356
y2008	3.366036	.6698538	5.03	0.000	2.043621	4.688452
_cons	-1162.122	298.6616	-3.89	0.000	-1751.736	-572.5091
sigma_u	5.4747055					
sigma_e	.79391362					
rho	.97940382	(fraction of variance due to u_i)				

F test that all u_i=0: F(29, 168) = 59.64 Prob > F = 0.0000

Table 12. Estimation results for the model with Prime operator structure in medium hubs

```
Random-effects GLS regression                   Number of obs      =       224
Group variable:  airport                          Number of groups   =        32

R-sq:  within  =  0.3500                          Obs per group: min =         7
       between =  0.8333                                         avg =       7.0
       overall =  0.7584                                         max =         7

Random effects u_i ~  Gaussian                    Wald chi2(18)      =    282.89
corr(u_i, X)       =  0 (assumed)                 Prob > chi2        =    0.0000
```

sales	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
prime	-.5839115	.310277	-1.88	0.060	-1.192043	.0242202
od	-.9508312	.246222	-3.86	0.000	-1.433418	-.4682449
dwell	.4535523	.2430101	1.87	0.062	-.0227387	.9298433
l_space	.973303	.4271717	2.28	0.023	.1360619	1.810544
sq_space	.0026164	.0012554	2.08	0.037	.0001558	.005077
sq_od	.0123611	.0036762	3.36	0.001	.0051559	.0195663
sq_inter	.2164111	.029889	7.24	0.000	.1578297	.2749925
sq_dwell	-.0103995	.0047496	-2.19	0.029	-.0197086	-.0010905
cube_od	-.0000518	.0000176	-2.94	0.003	-.0000864	-.0000173
cube_inter	-.0227337	.0032087	-7.09	0.000	-.0290227	-.0164448
cube_dwell	.0000948	.0000382	2.48	0.013	.00002	.0001696
four_inter	.0005905	.0000834	7.08	0.000	.0004271	.0007539
four_dwell	-2.95e-07	1.08e-07	-2.73	0.006	-5.06e-07	-8.33e-08
year2004	.4139799	.2126139	1.95	0.052	-.0027356	.8306954
year2005	.7072457	.2149183	3.29	0.001	.2860135	1.128478
year2006	.9046317	.215031	4.21	0.000	.4831787	1.326085
year2007	1.003496	.2147971	4.67	0.000	.5825013	1.424491
year2008	1.299145	.2155565	6.03	0.000	.8766623	1.721628
_cons	19.85105	6.706847	2.96	0.003	6.705874	32.99623
sigma_u	.77599921					
sigma_e	.91690697					
rho	.41733843	(fraction of variance due to u_i)				

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Federal Aviation Administration (http://www.faa.gov)

Declaration of authorship

I do hereby solemnly declare that I have completed the preceding master thesis independently, and have not used any other sources or aids apart from those listed.

Date Signature