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Master's Thesis

Geographic Market Definition in the German Airport Sector: Analyzing Five Major Airports

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Index of abbreviations

ACI ..... Airports Council International
AG ..... Aktiengesellschaft
BMVI..... Bundesministeriums für Verkehr und digitale Infrastruktur
CAA..... Civil Aviation Authority
CC..... Competition Commission
CE..... Copenhagen Economics
CPI..... Consumer Price Index
EU..... European Union
EUR ..... Euro
IATA ..... International Air Transport Association
ICAO ..... International Civil Aviation Organization
ITF ..... International Transport Forum
km ..... Kilometers
MP ..... Market Power
NUTS..... Nomenclature of Units for Territorial Statistics
RPI..... Retail Price Index
SSNIP ..... Small but Significant and non-transitory Increase in Price
UK ..... United Kingdom
USA ..... United States of America
USD ..... US-Dollar
WWII..... World War II

1 Introduction

The aeronautical segment is considered to be the one of the most important industries. Not only it is an enormous industry combining vast economic power with great significance for the employment market, it is also vitally connected to nearly every economic sector.

While the aviation sector is often in the focus of the media, society and research its counter-part, the airport sector, receives a lower level of attention. One of the most debated aspects of the airport sector is its degree of competition. Whereas the aviation sector is considered to be determined by a relative high degree of competition, especially after the rise of low-cost carriers, the situation within the airport sector is estimated differently by airlines, regulation authorities and airports themselves as well as among researchers.

Up to the early 90's there was a broad consensus in the research that the airport industry should be considered as a classical natural monopoly. Such a monopoly is capable of producing at a better price-cost ratio than competing firms; this is in contrast to the standard economic theory where the opposite is true. The main evidence for the airports being a natural monopoly are high fix costs resulting in the so called economy of scale effect. However in recent decades a variety of research has queried whether this assumption is still relevant due to a changed market environment. The main reason for this revision was an increase of profits in the non-aviation segment of the airport business.

The revenue generated from operations like car-parking and retail became so significant that a decrease in landing charges would eventually lead to an increase of overall profits. That is because the reduction of aviation charges result in lower ticket prices and consequently attract more passengers. Lower profits in the aviation segment would be potentially offset through additional revenue generated by new passengers in the non-aviation division. Even if the aviation segment by itself operates below the profitability level. Hence the airports began to compete among each other for passengers by reducing the landing fees for airlines. The overall level of competition increased so significantly that it would potentially call into question the natural monopoly characteristic of airport industry.

By how much these (and other) market changes have increased the level of competition and how the regulation authorities have had to react to this, re-

mains a debatable topic. Due to the enormous amount of interdependencies of different products, customer groups and internal segments, the application of usual techniques to estimate the degree of the market power cannot be easily applied to the airport industry. Instead, as airports are fundamentally local businesses deriving their economic potential from the environmental area, the focus of research has concentrated on the analysis of the surrounding geographical area.

This paper analyses the degree of the market power of five major German airports – Frankfurt, Munich, Dusseldorf, Hamburg and Stuttgart – by using a technique introduced by Malina 2006 and adjusted by Maertens 2012, further modified in several aspects.

2 Market overview

2.1 Market definition

Defining the market is the first step in every assessment of the degree of market power. The calculation of market share, which is needed for the valuation of market power, is possible only after the market is precisely defined. Although airport industry is a crucial economical sector and has oligopolistic, to some extent even monopolistic structure, there is no standard and universal approach defined by regulation authorities for exact categorization of market definition. In fact, virtually every national or international competition authority as well as scientific study uses different methods. (Bilotkach & Polk, pp. 4-5, 13)

The common practice of applying a SSNIP test to define the relevant market is not widely used for the assessment in the airport sector due to some conceptual as well as practical reasons. Among the conceptual reasons are:

- The SSNIP test assumes that the hypothetical monopolist is not subject to economic regulation which affects its price behavior. However most of bigger airports and their prices are intensively regulated.
- The test assumes that the firms are profit-maximizers, operating in the competitive market, otherwise if the prices are above or below the competitive level there is a threat of so called cellophane or reverse cellophane fallacy. Due to the government share in owner's equity most of the airports are not supposed to be typical profit maximizers also the market

is determined by natural monopolies and oligopolistic structures instead of competitive environment. (CAA 2013, pp. 44-45, 68)

- The airport industry, as a double-sided sector, is typified by the absence of a “single price”. Instead it is characterized by an, often asymmetrical, combination of own- and cross-price elasticities. (CAA Guidance 2011, pp. 12 -14)

Practical reasons for not applying the SSNIP test are, given the general complexity caused by multi-product and -market characteristic of airport industry, challenges related to the collection and analysis of relevant data.

Therefore other methods are used to define the market. One of the first, broad analyses of the airport’s market definition was the interim report of the British Competition Commission on domestic airport market in 2008. The CC identified two dimensions, the geographical and the product market.

Obviously airports are fundamentally local businesses, traditionally seen even as an infrastructure project like a bridge or dam rather than a more abstract and mobile commercial entity. As the airports can’t change their geographical location they rely on the population in its surrounding, geographical market the so called catchment area.

With that in mind, the geographic position was considered by the CC as one of the most important factors for the degree of market power. However the CC also didn’t rigidly define the geographical area.

Such dependence on geographical position leads to two consequences for the constant growth of business. Either the airport needs to enlarge its catchment area and intensify the potential utilization, and/or it has to attract transition passengers and airlines for the long-distance connections; hence consequently become a hub. While first alternative is clearly focused on the local population, the primary target group of the long-distance connections are transit passengers, who typically live well beyond the usual airport catchment area.

As for the product market, two main segment-groups were identified: the aviation and non-aviation market. The aviation market can be roughly divided into three categories: landing the plane, parking the plane and handling the passengers. All three are considered to be interdependent, with landing being the primary product and parking and handling the secondary products. Due to this feature all were included into a single market. The other main product group, non-

aviation division, was found to not affect directly the demand for aviation services and was considered to be a separate market. (Monteiro 2010, p.4) This is, however, a debatable issue. One might argue that the services provided from non-aviation sector such as car-parking or retail, must have (at least intuitively) an effect on passenger demand.

For an even more detailed analysis every service with different prices (e.g. ticket prices for low-coast and premium carriers or such affected by environmental or noise tax) could be theoretically considered as separate market whether due to different good/services structure or price discrimination for similar goods or services. Such approach is however not used in the practice. (Bilotkach & Polk, pp. 10-12) The definition of aviation and commercial services as two separate markets without further splitting in smaller product categories became a common definition approach.

In summary there are two main market categories identified for the airport industry: the geographical and the product market. The geographical market is usually the surrounding definite region, called catchment area. The product market can be further split into aviation and non-aviation market categories, both representing separate markets.

Nevertheless a separate market does not necessarily mean that, for the analysis made by regulation authority, the markets have to be assessed separately. In fact, as we will see later, combining both large product groups - aviation and non-aviation - for the assessment and calculation of regulation charges, was and remains a common approach used by regulation authorities.

2.2 Natural monopoly and the cost factor

Historically the airports were assumed to be natural monopolies. Natural monopolies arise when, contrary to the standard economic theory, the production costs for a single firm are lower than for any other, the so called subaddivity. A firm with such a cost advantage would eventually drive any potential competitor out of the market. Hence due to the absence of any actual and potential competitor it automatically becomes a monopolist. Typical reasons for such an occurrence are economies of scale and/or scope. While the former is a case of decreasing average costs with increasing output (normally up to a break-even point), the latter is the situation of decreasing average costs with increasing number of products.

However, although a natural monopoly under such circumstances is more cost efficient than competing firms, like every monopoly facing a lack of competition, distortions arise with regards to prices and output. (Starkie 2002, pp. 63-64)

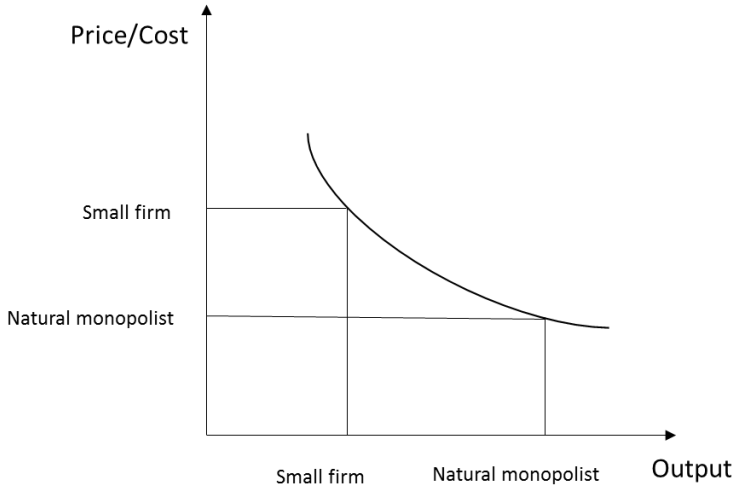

Fig. 1: Economy of scale effect on natural monopoly

The economies of scope are underscored by two-sided interdependency between passengers and airlines but also between aviation and non-aviation market.

The main indication for economies of scale in the airport market are very high fix costs (particularly capital but also functional/operational costs). However, the exact form of the long run average cost function is under debate: the precise scale of the airport where the average costs begin to decline varies between 3 and 12 mil, or in an extreme case even at 90 mil passengers (Mueller-Rostin et al., p. 8; Marques & Brochado 2008, p. 163)

The cost factor is usually assumed to be the leading determinant for the high market power of airports. Given the enormous capital costs of building an airport, high administrative burden and extensive maintenance fix costs which vary only little with the actual volume of flight traffic, the entry barriers in this sector are extensive.

According to the ACI's market report for 2010 the bulk of costs faced by European airports were capital costs making up 31%, followed by terminal and landside operations at 19%, airport security at 18%, airside operations at 13%, administration at 10%, and taxes at 4%. (ACI Report 2012, pp. 9-12) All of these

functional costs, with the exception of taxes, are composed mainly of fixed costs which do not vary with traffic. Moreover the proportion of capital costs is remarkably high and indicates high entry barriers into the sector.

Paradoxically, while high fix costs suggest a monopolistic status, they also have a simultaneously positive effect on the competition, as they provide a natural incentive for the airports to attract traffic in order to defray those costs. (ICAO Competition 2013, p. 2) Because of the burden of very high costs, the local population in the catchment area is often not large enough to cover those costs. Hence the importance of extending the catchment area to attract new passengers is even increasing. (CE 2012, p. 21)

2.3 Double sided sector

Unlike most other industries the airport sector faces a double-sided buyer's power. The airports have to compete among themselves for passengers and for airlines. A high buyer's power either of passengers or airlines results consequently in a greater competition among airports.

Though both are interconnected with each other - an increasing number of airlines serving the airport has a positive effect on the number of passengers and vice versa - a competitive advantage in one of these market areas does not necessarily lead to success in both markets.

Even so, the scale of interdependencies between both businesses is still a topic of discussion. One of the standpoints is that airports are not double- but one-sided businesses and are characterized by vertical relationship. According to this concept, passengers are not a separate side of the business, because they do not pay an entrance fee. Even the passenger charges conducted by airport are not directly paid by passengers to the airport but instead collected by airlines and in the case of fierce competition they may not be passed onto passengers but be borne by airline. (Fröhlich 2010, pp. 4-7) However this argument is questionable since paying a charge by both sides is not a necessary feature of two-sided business. In the case of credit cards which are widely considered as two-sided model, transaction fees generally are paid by vendors and not by the customers.

Nevertheless even if passengers are considered to be not a separate side but a secondary market of one-sided business, the relationship between aviation and

non-aviation segment, though not determined by a fully complementarity, is so significant that it has similar, if not identical, implications as the two-sided model. (Fröhlich 2010, p. 11)

The function as a double-sided platform with its interdependencies between two customer groups – passengers and airlines - has an additional positive effect on the competition. Assuming the buyer's power of airlines is low or even not present and it is the airport which has a strong position with respect to airlines, such a situation would not necessarily lead to a result where the airport would behave like a monopolist and raise the fees ("prices") way above marginal price. The reason for this is another characteristic feature of airports, which was lesser importance in the past but became more and more important throughout last decades – profits in non-aviation business.

3 Competition within airport sector

3.1 Competition dimensions

Airports compete with each other on multiple dimensions for several product- and customer groups with the cargo and passenger businesses being the most important arenas in this regard.

Compared to the passenger business, cargo traffic is subject to fierce competition. The conditions of this segment – a high price sensitivity, possibilities of customers (airlines) for an easy switch, capacity limitation to infrastructure only, more homogeneous structure of services, goods and customers - are much closer to classical competitive market. As such, there is a general consensus among researchers that cargo traffic is a competitive sector of the airport business, and therefore it is consequently excluded in the competition and market power analyses. (Tretheway & Kincaid 2005, p.5; Malina 2006, p. 6)

As for the passengers competition between airports is observed on three dimensions:

- Hub competition. A competition between large airports for long-distance and transfer passengers
- Spatial competition. Competition between airports for direct flights passengers, with catchment area as a main source for potential market power

- Transport competition. Competition of airports with other forms of transportation. This dimension includes only passengers for very short distances (domestic flights)

These dimensions are neither fixed nor universal. Airports can compete on different dimensions simultaneously or competition may be present within a geographical region in one or two dimensions only. For example, Frankfurt airport competes with other hubs (Munich, Paris, London, Amsterdam) on a hub level, with other airports on the spatial level and even with other transportation (short-distance domestic flights) on the transportation level. On the other hand, some airports may compete on only two or even a single level. For instance, Stuttgart competes only on the spatial and transport level due to lack of infrastructure capacity for transfer passengers; Sydney competes on the hub and spatial level due to only marginal competition on transport level in Australia compared with Europe; and finally Frankfurt-Hahn competes only on the spatial level due to absence of transfer and domestic passengers. (Niemeier 2010, p. 19)

Aside from the competition between different airports, another sort of competition is possible: the intra-airport competition. In such a case, various operators within one airport compete with each other by using different terminals. Examples for this type of competition are New York's John F. Kennedy International Airport, Perth and Toronto airports. (Marques & Brochado 2008, p. 164) However, such an operational structure is not adopted by German airports; therefore only the inter-airport competition will be analyzed within this thesis.

3.2 Factors increasing airport's market power

In addition to natural monopoly features of economies of scale and scope with closely related high fix costs, which were already described in section 1, the historically tight ties of a flagship airline with its home airport as well as close relationships between regional governments and their domestic airports are obstructive to competition.

A traditional dominance of a specific carrier in its home airport reduces an efficient allocation of the limited number of slots, thus positively affecting the market power not only of the airline but also of the airport. A more competitive slot allocation would increase the competition between airports for attracting airlines through better prices and services. Significant capacity of each airport is stretched by its flagship carrier producing a stable return. The incentive to at-

tract new airlines is low, thus reducing the competition between airports. Instead there is a high concentration of flagship airlines within their home airport: in 80% of European Top-250 airports their largest resident carrier delivers at least 40% of total capacity, ensuring a segmentation and oligopolization of airport market. (Bel & Fageda 2009, p. 10)

Another interpretation is that a high concentration ratio of flagship airlines is the mark of a high degree of buyer power and, due to threat of switching, is a factor increasing the competition among airports. (ICAO Competition 2013, p. 3) However, such an interpretation is questionable because the threat of switching the airport is not credible due to the high sunk costs incurred by the airline. The cancelation of routes by airlines is a standard procedure in the market. However, it becomes unlikely when the airline develops into a flagship carrier with a substantial capacity share, due to high time and economic investment.

Additionally, close ties with the regional governments have an anti-competitive effect. Considering the airports as strategic assets, regional governments often subsidize them directly or through various tax incentives. Changes in the ownership structure such as privatization or acquisition by a foreign company may be blocked by regional governments, either through shareholder veto or other legal means.

3.3 Growing importance of non-aviation sector

Although the aviation and non-aviation businesses represent separate markets, they are neither substitutes nor necessarily complements. Passengers who partake in the aviation segment may or may not produce revenue in the non-aviation segment. Conversely, customers generally do not come to an airport to consume non-aviation goods or services without consuming aviation services. Put another way, buying a coffee without having a ticket (or at least any connection to the airline service) is highly unlikely and does not represent a standard customer behavior.

Therefore the common interpretation is that the aviation business is a primarily market for an airport, while the revenue from the non-aviation segment are equivalent to a positive externality. (Bilotkach & Polk 2011, p. 33) A higher marginal revenue in the non-aviation sector than in the aviation segment, would lead a profit-maximizing company in a deregulated market to decrease the prices in the aviation business. Such a price reduction would attract more passen-

gers and hence increase non-aviation revenue. This occurrence is likely even if the airport is a monopolist and does not face any competition in the aviation market.

As a profit-maximizing enterprise, regardless of the monopolistic status, an airport will therefore attract new airlines and consequently more passengers by decreasing the aeronautical charges as long as the additional profits from the increased passenger traffic are higher than the reduced profits from aviation segment. Fraport AG, the Frankfurt airport operator, has explicitly mentioned the increasing importance of non-aviation revenues as one of the reasons for relatively low aviation charges, which even led to the accepted situation of costs not being covered in this segment. (OECD 2010, p. 50). Though not directly confirmed by the operator, presumably these losses were fully compensated by higher returns in the non-aviation sector from the resulting increase of passenger volume.

A logical consequence of this process is that the airports are keen to reduce the fees as much as possible in order to attract more passengers. The competition between airports is strongly increasing for the quantity but also quality (in terms of “purchasing power”) of passengers. The output in the aviation segment could be increased beyond the point where the marginal revenues cover marginal costs. The double-sided business structure of airports leads potentially to lower costs in the aviation segment as it would be in the case of a fully separated structure. While the airports were previously in a stable market environment for some time, they now have to face direct competition from other airports. Such a process reveals positive effects and externalities like an increase in efficiency and innovation ability. (Starkie 2002, pp. 69-70)

Region	Total income	Aviation	Non-Aviation	Total cost
Africa	2,800	1,900	900	1,800
Asia-Pacific	31,600	15,800	15,800	24,100
Europe	44,300	26,100	18,200	39,700
Latin America-Carribean	6,500	4,200	2,300	4,500
North America	26,300	14,300	11,000	22,400
Middle East	6,500	3,500	3,000	6,200
World	117,000	65,800	51,200	98,700

Tab. 1: Global Airport Income and Costs 2012 in mil USD (ACI 2013 Economic Preview, p. 9)

The trend of the airports earning their revenue increasingly in non-aviation businesses has weakened the natural monopoly tendency in this sector and increased the internal competition. The revenue from non-aviation segment has continuously grown over the last decades and was worldwide nearly on the same level as the revenue from the aviation segment. Over the long run it means that the fees for starts/landings and passenger tickets are less important for the airport industry than it was the case two decades ago. Instead the airports have had to concentrate on growing the volume of passengers to ensure high revenue in such businesses of the non-aviation sector like shops, car parking and catering.

Besides the growing importance of the non-aviation sector other developments (as a result of recent changes in the aviation market) increased the competition within the airport industry

- Price Sensitivity
  The overall price sensitivity increased especially due to the internet. Search and switching costs for passengers were reduced, therefore the entry costs for foreign airline companies were considerably lower when entering the local markets. (CE 2012, p. 15) Moreover the group with the highest price sensitivity, namely leisure passengers, has grown the most. (ICAO Competition 2013, p. 3)
- Airline market liberalization
  Before the mid 90's both airlines and airports were practically arms of the state, tariffs were regulated by the airlines association IATA, every single route was a subject of negotiation between governments and buying tickets was only possible in airline's ticket shops or travel agencies. (ACI Airports compete, p. 3) To unify and liberalize the airline market the EU undertook a set of reforms in 1987, 1990 and then between 1993 and 1997. The liberalization resulted in the removal of restrictions on routes, number of flights, setting of fares and ownership of airlines. The reforms effectively allowed European airlines to operate on any route within the European common aviation area. Therefore they came to be limited on their choice based on the economic restrictions only. (CE 2012, pp. 13-14.; Market Integration 2012) This liberalization eased airlines' range of

mobility with regards to switching between airports, which consequently increased the buyer's power of airlines and led to a higher competition among airports.

- Decrease in military activities
  A decline in military activities in European airports that were partly or fully used by militaries, as well as in air traffic, led to more space for civilian aircraft, has intensified the commercialization process of the airport sector and enabled the entry of new competitors into the market (CE 2012, p. 13, 98) This development was of relatively high importance in Germany where many former military aerodromes were converted into civilian airports.

In summary it can be stated that the previous assessment of airports as natural monopolies is very much in question. The changes described above led to three consequences. The number of airline and airport choices for passengers, the flexibility for airlines in establishing routes or even their home airport, and the number of local, specialized and hub airports has increased over time. All of these consequences have undoubtedly amplified the competition within the airport sector. Understandably, this narrative was advocated most vocally by airports themselves, which however collided with the interpretation of state authorities (as well as that of the airlines sector), who consider airports as still having if not natural monopoly status then at least high market power. The degree of competition and market power respectively are crucial for the type of the regulation, which in turn affects the degree of autonomy, administrative outlay and costs of airports.

4 Regulation

4.1 Forms of regulation authorities

Although a monopolist creates a market distortion, through inefficiency and resulting deadweight loss, neither the increase of competition nor the decrease of market power of an airport should be the primary objective of the regulation authority. Entrance of new competitors (probably caused by regulator's action) might have an overall negative effect on total welfare through new distortion on the economies of scale and scope of a previously dominant airport. Even with-

out an entrance of new competitors, the regulation causes its own distortions and therefore should be introduced only when its overall positive effects outweigh those of the abuse caused by high market power. (OECD 2010, p. 32).

A market distortion alone is not a sufficient reason for establishing a regulation, because negative effects from regulation might be higher than monopolistic structure. Therefore the principle goal of regulation should be to decrease the negative externalities caused by market power abuse rather than to increase of competition. There is always a trade-off in the degree of distortion produced by concentration of market power and that of regulation. A continuous monitoring of the market is necessary to assess the level of regulation required for the best possible market outcome (Starkie 2002, pp. 63-64)

Different forms of regulation authority are possible. It could be either a subdivision of a governmental body such as a ministry for economic affairs or cartel office, a separate specialized but still government controlled regulator, or a fully independent authority. Most countries use either the first or the second option.

Although most European airports are at least partially privatized, there is little support among them for an independent regulator. Possible explanations are short sighted behavior, a lack of incentives, and an indication of high rents and/or of high influence on the regulation authority from the airport industry. (OECD 2010, p. 26)

Additionally the lack of accountability, the high cost of regulation, the difficulty of regulators' effective independence, the regulation methods ambiguity, the loss of sovereignty and the conflicts with other powers are considered as disadvantages of a separate and independent regulation authority. (Marques & Brochado 2008, p. 165) This may, at least partly, explain the relative non-existance of independent regulators.

However, regulation with the various authorities is highly fragmented on the European or even on national level, as is the case in Germany. Several attempts were undertaken to standardize and unite the regulation as a responsibility of a single authority. An important step in this direction was the EU Directive from 2009 which obliges member states to nominate a national independent supervisory authority. However, being a directive rather than a formal regulation, the precise implementation is a matter for each member state to determine. (Littlechild 2011, pp. 2, 21-24)

Several reasons are cited in favor of unification of the airport regulation at the EU level:

- Different approaches of price setting used in EU countries. Several countries (Spain, Portugal) apply a rate of return approach in their regulation of the airport sector while others use incentive regulation. In several EU-members there is not even a standard approach being used within the country. (Marques & Brochado 2008, p. 169)
- Even for a particular method e.g. price-cap, the exact calculation procedure is often not harmonized between EU member's regulation authorities. This interferes with the transparency and comparability of both, the grade of airport's market power and the effect of the regulation
- A harmonized approach would significantly help to identify the most successful, efficient and innovative airport within the EU area, that can constitute the benchmark (peer) for other airports. (Marques & Brochado 2008, p. 170) This benefit is central for the application of yardstick competition.
- The regulation by a centralized EU authority would ensure a much more independent execution, with a significantly limited influence from regional and state government and authorities as it is in the case of decentralized regulation.
- Information gathering would happen on a much broader level, thus increasing the experience and expertise of such regulation authority. This is especially important for the regulation of hub airports as there is often only one hub per country in the EU. This limitation significantly impacts the comparability of data for a regional/state regulation authority.

Especially in Germany but also other European countries, attempts to standardize the regulation on an EU level have faced strong opposition. (Littlechild 2011, pp. 21-24) Hence from the current standpoint a possible unification seems highly unlikely.

4.2 Calculation basis methodologies

For the determination of charges the regulation authorities distinguish between two methods regarding the calculation basis: the single and dual till approaches. In the case of single till the costs and revenues of both airport's business sec-

tors, aviation and non-aviation, are taken into account. As for the dual till approach the sectors are separated and the charges are calculated on the basis of costs and revenues in the aviation business only.

Arguments in favor of the single till approach

- Distribution of revenues. The high revenues generated in the non-aviation business segment taken into consideration by regulation authority would lead to lower aviation charges and hence indirectly attract airlines through lower costs.
- The administration of single till is simpler than that of dual till. The calculation is less complex, which would potentially lead to a more timely decision process and lower administrative costs. (Single till 2000, p. 13)
- The effect of high market power extends not only to the aviation but also non-aviation business of airport. (Single till 2000, pp. 7-10)

Arguments in favor of the dual till approach

- The dual till approach reflects the actual economic structure more closely thus providing a more focused regulation and increasing the overall value of the airport (Marques & Brochado 2008, p. 167)
- No potential positive subsidizing of the aviation segment by non-aviation. Such subsidizing under the single till approach for airports with high traffic volume may result in potentially too low airport charges which would increase the market power even further. (Regulation 2010, p. 12) Additionally this effect leads to extraordinarily high costs combined with low profits in non-aviation segment, because the airport can decrease the landing charges in this way. The non-aviation sector could end up operating just above its operational costs to cross-subsidize the aeronautical operations due to the single till method. This might lead to a neglecting of the non-aviation business by the airport operator. (Forsyth 2004, p. 59)
- There would be no potential positive subsidizing of aviation segment by the non-aviation division. As described above the application of single till would potentially cause lower aviation charges. However for airports with high traffic volume, the charges may be under the optimal level and therefore increase the market power of the airport operator even further. Application of dual-till does not have such effect. (OECD 2010, p. 12)

- The non-aviation sector could end up in operating just above its operational costs if profits from non-aviation sector are supposed to cross-subsidize aeronautical operations due to single till method. This might lead to a negligence of non-aviation business by airport operator. A dual-till approach however doesn't have such quasi-tax effect reducing the revenue and increasing the costs on non-aviation sector. (Forsyth 2004, p. 59)
- Capital input as well as total factor productivity would be substantially higher than in the single till approach which is potentially affected by overinvestment. (Oum, Zhang & Zhang 2003, p. 242)

Traditionally the single-till was the dominant approach worldwide and likewise recommended by ICAO (ICAO's Policies, p. 7). However there is a recent trend towards the dual-till method. (Marques & Brochado 2008, p. 167) Hamburg was the first airport transitioned to a dual till approach in Europe in 2000 (Mueller-Rostin et al. 2008, p. 6)

Though the single till approach is still the dominant regulation form for European airports, there is a relatively broad consensus among the researchers that dual-till is a more appropriate and effective method in the long-run. Admittedly it would increase the charges in the aviation sector, but it would also simultaneously provide incentives for cost-savings (absent in the case of single-till due to cross-subsidizing effect), and therefore lead to an increase of the overall efficiency. In this regard it fulfills the main aim of regulation authority, which is not to regulate the profits directly but to reduce negative spillovers from the abuse of market power.

4.3 Price setting methodologies

In general the interest of airports and their customers (both airlines and passengers) collide with regards to landing fees. Whereas airports are in need of a high rate of revenue for the costly maintenance and expansion of infrastructure, or to pursue increasingly important international consolidation through acquisitions, their customers are on the other hand naturally interested to pay prices as low as possible.

Two major approaches towards regulation are rate of return (RoR also sometimes called cost based regulation) and incentive regulation. The aim of the

RoR is to link the returns on the firm's cost structure. Therefore the monopoly's revenue requirement is fix/operational cost coverage with an additional margin accepted by the regulator. On the one hand the airport gets the possibility to cover its generally high fix costs and therefore prevent losses caused by them, on the other the firms are giving up their ability to set prices far above these costs and hence are less able to exploit their monopolistic power.

The main criticism of this method is the lack of incentives for the monopolistic company to be efficient. Furthermore the monopoly is potentially interested in an inefficiently high capital cost in relation to its inputs. In the extreme case there can be more inefficiency through distortion of input choice than social gain from a lower price. (Sherman 1989, pp. 198-199). Also the omission of peak and consideration prices due to an average-weighted cost approach (Gillen & Niemeier 2007, p. 7) and high administrative costs for both airport operator and regulation authority (Hancioglu 2008, p. 10) are recognized drawbacks of this method.

The aim of the incentive regulation approach is cost reduction by the monopolist. Here the earnings are fixed to a certain level which is not based on the cost but rather external factors like consumer price indices (RPI in UK and CPI in other markets). The so called RPI-X (or CPI-X) formula is used for the calculation of charges. Here RPI is the price index and X is a limiting factor based on a range of criteria like the industry's productivity and performance, as well as incentives for cost reduction. (Starkie 2005, p. 4)

Often the incentive regulation is called a price-cap due to a fixed level of price increases as a result of the RPI-X formula. However this term is often confused because Rate of Return regulation also usually includes a maximum price level limitation via a price-cap.

Unlike RoR methodology where the prices can be manipulated by increasing or decreasing costs through internal mechanisms, the external factor based price-cap, mimics the competitive market in which producers as price takers do not have the ability to influence prices. (Hancioglu 2008, p. 11) Such a method fosters the monopoly to maximize its profits by reducing costs and thus to encourage efficiency and innovation. A time period of usually five years is used after which prices and limits are revised. (Betancor & Rendeiro 1999, p. 29) A short-term focus and tendency for under-investment are main points of criticism for this method. (Gillen & Niemeier 2007, p. 8; Oum, Zhang & Zhang 2003, p. 220)

However an incentive regulation based purely on external factors without any link to the cost element cannot be found in practice. (OECD 2010, pp. 13, 29) Instead a hybridized form is a common approach with X also based on cost forecasts (unlike typical RoR method which relies on historical costs and is therefore backward looking). This method incorporates the financial aspect but also provides fewer incentives for cost reductions as a purely external factor based price cap. (Gillen & Niemeier 2007, p. 8)

The calculation of charges for both methods could be based on a price-capped single position. Here the prices of services provided by airport are limited ex-ante by the regulator. Such a cap is often calculated for landing fees for airlines and is usually based on consumer price indices. Another method is the revenue-cap. Unlike price-caps no single positions but rather a maximum value of revenue is limited. In the airport sector the limit is often adopted on a revenue per passenger basis.

Additional determination of calculation criteria could be provided by yardstick method. This practice is based on the comparison of the performance of competitors acting in the same market. Despite several attempts undertaken in Ireland and UK to use this method, so far it has not been implemented for airport regulation. (Marques & Brochado 2008, pp. 166-167; Regulation 2010, p. 29)

The conduct regulation, which is considered by some authors as a third form (Starkie 2005, p. 4), is either the RoR or incentive regulation form applied ex-post rather than ex-ante. However the application of ex-ante method is neither for RoR nor for incentive regulation a necessary requirement, therefore the conduct regulation is considered as a sub-category of either of both forms.

A practice that is potentially applicable for both RoR and incentive methodology is the involvement of airlines within the framework of revenue sharing agreements. Airports and carriers negotiate a medium term investment program which is, with an explicit or tacit approval from the regulator, applied for a certain time period. There are several problems related to this approach such as distinctions in the preferences of low-cost and full-service carriers as well as differences in operational time horizons of airlines and airports (Starkie 2005, p. 6) along with a probability of creating of non-market clearing and hence inefficient prices (OECD 2010, p. 30). However revenue sharing agreements also provide significant enhancements such as reducing the problem of asymmetric information between airport operator and regulator.

Another method is the so-called trigger regulation; here the regulation authority does not provide any binding limitations to airports. Instead the airports can act freely in their price-settings, but they are closely monitored by regulators with a threat of being fully regulated should there be evidence of widespread market power abuse. (Hancioglu 2008, p. 12) This method was introduced in New Zealand in 90's and then later throughout Australia in 2002 and is therefore often called the Australian model.

Replacing an explicit price-setting with a regulation based on monitoring, would not necessarily end up with an increase of prices due to a possible abuse of high market power. In fact several aspects could lead to a decrease of prices even in the absence of "active" price-setting regulation. Such factors are:

- Price discrimination towards airlines in the absence of regulations
- Cross-subsidy of the aviation business by revenue from the non-aviation division. If the dual-till calculation approach is used by the regulation authority such cross-subsidy is not possible as the costs and revenues from the aviation unit alone are considered in the calculation of charges.
- Individual airlines may be in a position to demand and bargain for low charges which is normally not possible in a regulated market since price caps are applied uniformly to all carriers. (Bilotkach & Polk 2011, p. 29)

There is no consensus yet which of the effects – a potential increase or decrease in prices – is dominating in the absences of price-setting regulation. While some studies indicate a potential price increase (Fu, Lijesen & Oum 2005; Bel & Fageda 2009), others find contrary results (Bilotkach et al. 2010).

Last but not least negative incentives set up by a regulator in regards to price setting are, at least theoretically, possible. Fierce competition might lead to underinvestment among airports which can have a negative impact on total welfare through several factors such as underperformance in safety or quality. Also fierce competition might lead to a significant shift of traffic between existing airports. This can cause high unprofitability for the losing airport due to high fixed costs, which again has a negative impact on total welfare. To deal with these imbalances the regulator may intervene and set negative incentives for efficiency. (Regulation 2010, p. 33)

Due to the airport sector's importance on the macroeconomic and even security and political level, complete non-regulation should be avoided. In fact, aside

from very small airports, (Gillen & Niemeier 2007, p. 6) mid-sized and large airports are subject to explicit regulation. However many attempts have been undertaken to avoid price-setting in regulation and otherwise allow market mechanisms to enforce self-regulation to an even larger extent than is the case with the incentive regulation.

All in all the impact of landing fees on the market power is a topic of discussion because its effect is still unclear. Generally most of the researchers agree that the airlines are relatively price inelastic in regards to landing fees collected by airports. However this is incongruous with the assumption of “locked-in” effect caused by sunk costs. It is reasonable to assume that airlines are price elastic when choosing an airport for their route connection but become less price elastic after a considerable amount of sunk costs (such as marketing and negotiation) are incurred. (Tretheway & Kincaid 2005, pp. 13-14)

5 Methodological Background

5.1 Literature Overview

The assessment of airports’ market power has recently attracted a significant amount of attention from the scientific community. There is a large-scale of research being done on this topic, including theoretical and practical studies from scientists as well as regulation authorities. However the methodological base and even specification issues are far from being matters of consensus. (Pavlyuk 2012, p. 132) Only a limited number of papers use quantitative methods in analyzing the degree of airports’ market power and even those are not using a transparent approach. The actual assessment of market power was done on an individually qualitative level and therefore cannot be used for a comparable, standardized model. (Maertens 2012, pp. 11-12)

In general it can be stated that for the assessment of market power on the spatial competition dimension, the analysis of the catchment area was considered to be a sufficient approach. In its simplistic form the absence or only marginal degree of overlaps with other airports was evidence to consider it as a local monopoly. The common principle of SSNIP Tests is rarely possible to apply due to the complexity of the data. (CAA 2013, p. 45)

Perhaps the only standardized test through critical loss analysis was applied by CAA (2013) in its assessments of market power of Heathrow airport. The calcu-

lation was based on a critical loss estimation of 0.5, provided by an analysis undertaken by transport consultant company Steer Davies Gleave and an alternative value of 0.3 provided by an analysis undertaken by CC. However several drawbacks were noted by CAA, e.g. that the calculation was not derived by applying a price increase but rather on the basis of airline characteristics that are considered to be descriptive. Overall the critical loss analysis played a minor role in the analysis and was only a part of a broader assessment of market power which also includes other calculations. The most important aspect here was the assessment of the catchment area.

A study provided by Copenhagen Economics, a Denmark based consulting company, examined the competition and its development within the European airport sector. In its analyses of the relevant market, Copenhagen Economics used the availability of destinations and potential substitutes for all NUTS-2 regions within a 200 km catchment area. (CE Technical Annex 2012, pp. 4-7) Four quantitative indicators for four groups of airports determined by their size were each used for the assessment of market power: local departure market share, transfer market share, hosting multi-hub airline and buyer power. (CE 2012, pp. 104-108)

Their main finding was that the competition level within European airport sector is relatively high. Therefore it was recommended to remove controls on charges where the competition is effective and adopt an Australian model or any other kind of regulation with a monitoring approach instead of direct intervention function. However it should be noted that the study was ordered by ACI Europe, the association of European airport operators, which could be potentially interested in exploiting such results.

Bilotkach and Mueller (2012) analyzed the degree of market power of Amsterdam Schiphol airport. The assessment was based on four criteria: route overlap, amount of transfer traffic, infrastructure for cargo, and instructional flights. Based on interviews and the geographic position of Schiphol, nine surrounding airports were identified as potential competitors. The criteria were evaluated for each airport and then compared with each other. An evaluation of the catchment area as such did not take place. The main finding was that on the whole Schiphol wields significant market power.

Strohbach (2005) analyzed the scope of the catchment area of airports in and around Baden-Württemberg. He used administrative districts as geographical

units. The market power of airports in each district was measured by distance and time when using private transport as well as expense and time when using public transport. Other (minor) criteria were frequency of flights as well as terminal, parking and shopping area. His main finding was a relatively high level of competition between the airports of Frankfurt, Munich, and Stuttgart, and to a lesser degree competition between regional airports due to a quantity of catchment areas overlaps.

Bel and Fageda (2009) used price-level data from 100 biggest European airports for an estimation of the degree of market power. Due to the highly heterogeneous structure of airport charges, their prices were based with reference to A-320 aircraft with an occupancy factor of 70% as a standard case. In regards to the geographical dimension, data on GDP per capita, population and intensity of tourism were used on NUTS-2 level. The price within the EU was estimated in a regression with several factors having a positive (total traffic, airline alliance, private ownership) and negative impact (other airports within 100 km, domestic traffic, airlines concentration) on it. The empirical results imply an increase of charges with traffic (whether due to higher rents or higher cost factor), a decrease of charges with a higher share of domestic traffic (indicating competition restraints with other transportation), and, as the most surprising result, no effect from either the type (Rate on Return or incentive regulation) or scope (single or dual till) of the regulation.

Maertens (2010, 2012) modified Malina's (2006) quantitative assessment approach in his model of estimating airports' market power and applied it to the 50 largest European airports. Two calculations, one based on passengers' perspective and the other on the airlines', were conducted. For the passengers' view he used a 100 km wide catchment area graduated on NUTS 3 regions level in his analysis. The GDP of each NUTS 3 region was identified as a source of airports market power. For regions with overlapping catchment areas the number of seats offered per month was used as a proxy to distribute the GDP share to each airport. As for the airlines' view, he made a similar calculation but compared suitable airports within the catchment area which could act as an alternative for airlines. Additionally Maertens included an analysis of countervailing factors which restrain the airports' market power as an additional remark on the assessment results. Examples of such factors are the market share of an airline on total traffic in a specific airport and conversely the airports' share on total traffic of the airline, sunk costs, and a status of the airport as a base or a hub.

The result was that bigger airports usually have a very high share of market power, while smaller airports face a more substantial level of competition. As for German airports, Maertens calculated following market shares within their catchment area: Frankfurt 97.73%, Munich 98.09%, Dusseldorf 63.70%, Hamburg 93.61% and Stuttgart 83.77%.

5.2 German Airport Sector

There are generally three types of airport operators: specially regulated privately owned companies, private companies under public control (public private partnership), and operators ultimately owned by a central or regional government (directly or via a state owned company) (Marques & Brochado 2008, p. 164).

An example of a fully privately owned companies is Heathrow Airport Holdings (formerly British Airport Authority), which manages four British airports and is primarily owned by Ferrovial S.A., a Spanish conglomerate. (About Heathrow, n.d.) An example of the second category is the Athens International Airport with its operator Athens International Airport S.A., a public private partnership company established in 1996 with a 30 year concession agreement and a state share of 55% (Airport Company, n.d.) Finally, an example of the fully government owned operator is Aena which owns 6 Spanish airports and is currently the biggest airport operator worldwide. (Aena, n.d.)

Since the 1980's, two general models of airport ownership have emerged in Europe: the UK model, which sets up fully privatized airports, and the Continental Europe model, where at least all large airports are owned by central, regional or local government. However a gradual process of a reduction in governmental share (though in most cases without full privatization) began two decades ago in European countries. (Gillen & Niemeier 2007, pp. 4-5)

Although fully privatized airports are still a rare phenomenon, apart from Heathrow Airport Holdings only Belfast has such an ownership structure (Betancor & Rendeiro 1999, p. 21), a procedure of a partial privatization has become one of the mostly used models in Europe.

In Europe the number of airports increased from 441 in 1996 up to 522 in 2008. By comparison the growth in airports in North America was from 328 to 348 dur-

ing the same time period. (Reynolds-Feighan 2010, p. 19) Similar to USA but unlike other regions, the European market is determined by a high density of airports. However the majority of the airports have only a low capacity with less than 100,000 passengers annually. (Gillen & Niemeier 2007, p. 2)

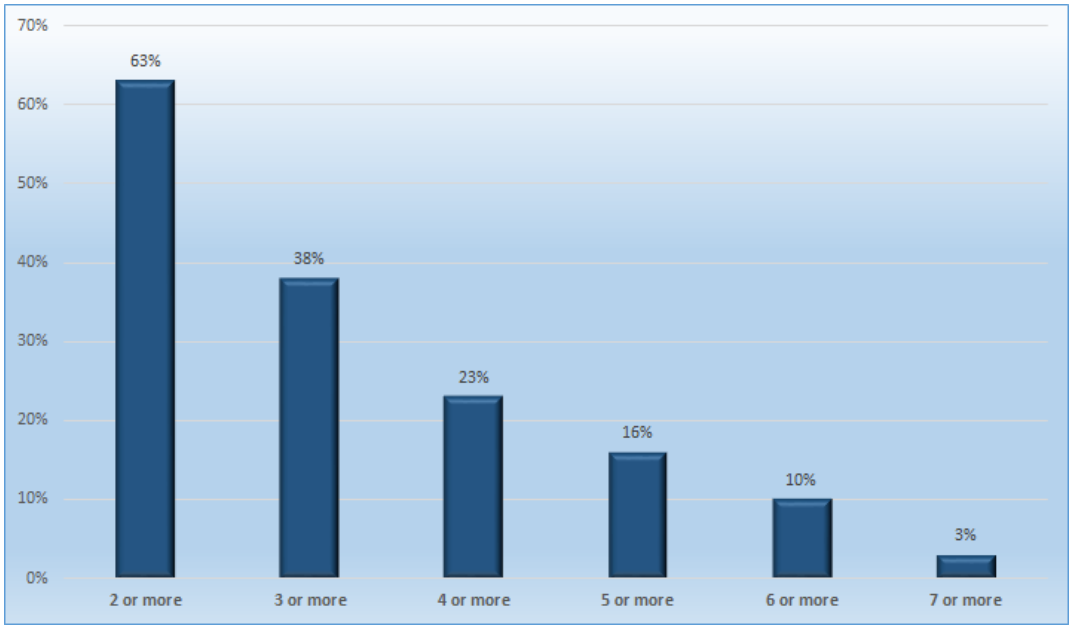

Fig. 2: Number of airports within a radius of two hours' drive (CE 2012, p. 56)

Even relative to the European airport market, Germany has a high density paired with high capacity of airports. These characteristics are partly a result of WWII and the following Cold War. Many airports were rebuilt after the war with extended runways. Additionally an extensive installment of new military aerodromes took place, many of which were converted into civilian airports in the 2000's. (Niemeier 2013, p. 7) This historical background which yielded a competitive advantage in the form of high density and capacity of airports, has also presented a strategic problem.

Since most of the biggest airports were established before WWII, development barriers due to environmental, noise and city-growth factors were not and could not have been foreseen. At the time of their construction, the airports were rela-

tively far away from the city borders. Now 7-8 decades later they are much closer or in some cases even completely enclosed by the city.

With the rise in aircraft activity, the airports have been confronted with certain problems which have significantly restricted further infrastructure development, and hence capacity and economic growth. A further expansion of some airports is improbable due to environmental restrictions or in some cases the lack of available space resulting from subsequent urban expansion. (Niemeier 2013, p. 18)

Fig. 3: 27 largest German Airports (Statistisches Bundesamt 2013, Luftverkehr 2013 p. 4)

Germany experienced a relatively large fluctuation in the number of airports between 1995 and 2005. During this time frame 5 airports ended commercial services while 9 entered the market, with Nuremberg and Karlsruhe being the largest of the newly operating commercial airports. Remarkably 6 of those 9 airports were military aerodromes converted into civilian airports. (Mueller-Rostin et al., p. 17)

Traditionally Frankfurt and Munich are considered to be the two principal airports with a hub status in Germany. However there is no exact and uniform definition in the requirements for an airport to become a hub. Lufthansa, for example, considers Dusseldorf as its third German hub besides Frankfurt and Munich. (Our hubs, n.d.)

While policy and supervisory functions for airports are exercised by the Ministry of Transport, Building and Housing (Bundesministerium für Verkehr-, Bau- und Wohnungswesen), administration and regulation are the responsibilities of each relevant State (Bundesland). (ICAO Germany 2013, p. 3) Although the Federal Department of Transport is legally allowed to intervene, it has not done so in recent years. Consequently, Germany has in practice no national regulatory authority for airports and their charging policies. Such a situation causes three main problems with respect to the regulation of German airports:

- Legitimacy. No requirements are specified by law for the admissibility of charges, which doesn't provide incentives to make the process clearer and more transparent.
- Independence. Federal states are on the one hand in charge of running the airport regulation authority but on the other they often own a controlling stake of airport.
- Cost efficiency. Regulation is fragmented into fifteen separate authorities each challenged with generating their own expert knowledge. (Littlechild 2011, pp. 3, 10)

The following major international airports (except Berlin) within Germany will be examined in this thesis:

Frankfurt

Frankfurt is the biggest airport in Germany and is one of the main hubs in Europe. The airport was established in 1936, and since then it has been continuously expanded. In 2002 a revenue-sharing agreement was reached between

the airport operator and airlines. The regulatory authority of Hesse was not actively involved in the process, though later it began to act as a facilitator. The agreement is renewed on a periodical basis, and the revenue sharing is based on the growth in passenger demand. (Littlechild 2011, p 5)

Munich

Although it was opened only in 1992 and is therefore one of the newest German airports, Munich is the second largest airport in Germany and fifth biggest Hub in Europe. The growth of Munich airport was fully unexpected, as forecasts in 2000 were for about 11 million passengers but ended up reaching 23 million. To deal with the scarce capacity with respect to a huge excess in demand, the decision to build an additional, third runway was taken and also approved by local government. However the expansion plans were stopped in 2012 due to a referendum on this issue. (Niemeier 2013, p. 17)

Düsseldorf

Düsseldorf airport was established in 1925 and is the largest airport in North Rheine Westphalia. Though in 1993 a second runway was built, the use is restricted to the capacity of one runway due to a historical agreement between the municipalities, ministry of transportation and airport operators concerning the maximal amount of aircraft activity. (Niemeier 2013, p. 14)

Stuttgart

The airport started to operate in 1939. Though the airport is marked by strong growth, plans for building of an additional runway were stopped in 2008. (Niemeier 2013, p. 17)

Hamburg

Hamburg airport was established in 1911, and as such it is the oldest operating airport worldwide. (Niemeier 2013, p. 16) It also became the first and so far only price-cap regulated airport in Germany. Simultaneously the calculation basis was also changed from single to dual till approach. The incentive regulation structure is negotiated on a contractual basis between Hamburg Airport and the Ministry of Economic Affairs of Hamburg every 5 years. The price-cap is characterized by the CPI-X formula. (ICAO Germany 2013, p. 3)

5.3 Data

The airport sector has a favorable advantage in providing a very broad, complete and exact data. This is largely a consequence of highly specific and strict safety and security requirements. Moreover due to a relatively limited and exactly verifiable number of movements the accumulation of data is much easier than in other logistic industries, for example railway or automobile transport.

The unique feature of extremely accurate, detailed and useful data allows one to draw inferences about the quality of collected surveys. While data collected by the German statistical office from airports, airlines and aviation security authority can be considered as quasi factual outcomes, the surveys lead to estimated results. In 2008 survey data of most German airports was gathered, and another though more limited survey was conducted in 2010. The unpublished data from these surveys was provided to the German ministry for transportation for its analysis on the transportation sector. (BMVI 2014, pp. 86- 88)

Flughafen	Passagieraufkommen 2010 (in 1000)	Befragungsdaten 2008	Befragungsdaten 2010
		(Anzahl Befragungssätze)	
Berlin Tegel	15.026	14.885	-
Berlin Schönefeld	7.298	7.858	-
Bremen	2.676	*)	-
Dortmund	1.748	*)	-
Dresden	1.843	2.696	-
Düsseldorf	18.988	21.482	27.585
Erfurt	322	*)	-
Frankfurt Main	53.009	24.985	23.963
Hahn	3.493	4.116	-
Hamburg	12.962	10.555	10.445
Hannover	5.060	6.499	-
Karlsruhe	1.177	1.671	-
Köln-Bonn	9.850	11.129	-
Leipzig-Halle	2.349	2.243	-
Lübeck	538	360	-
Memmingen	912	906	-
München	34.722	44.654	49.497
Münster/Osnabrück	1.332	4.246	-
Nürnberg	4.069	-	10.752
Paderborn	1.028	838	-
Saarbrücken	491	*)	-
Stuttgart	9.218	7.872	-
Weeze	2.897	481	-
Summe	**191.008**	**167.476**	**122.242**

Tab. 2: German Airport Survey (BMVI 2014, p. 88)

As can be seen, the results derived from these surveys are quite accurate in the case of both Berlin airports but highly underestimated in Frankfurt and overestimated in Munich.

For the calculation, passenger data from Statistischer Bundesamt, regional GDP from Eurostat and airline traffic on each airport from openflights will be employed within the thesis. The passenger data from Statistischer Bundesamt is taken from its yearly report “Luftverkehr auf allen Flugplätzen” for the year 2012. In the case of Eurostat and openflights its online databanks provided the required data. The datafiles were sorted and classified for the actual calculation analysis with Stata software.

The Openflights data includes detailed information about routes of specific airlines worldwide. The data is available for the year 2012 only. The route is added to any of the airports analyzed in the thesis, if it operates either as a destination or departure airport. The data for Stuttgart is however is not represented correctly. Therefore the number of routes was gleaned from a report of a local newspaper reporting about the number of routes in Stuttgart airport for the year 2013 (Stuttgarter Nachrichten 2014)

The GDP data from Eurostat does not include the year 2012. Therefore all regional GDP data used in the model, unlike the passenger and routes data which is from the year 2012, is from the year 2011. Switzerland is also not included in Eurostat data. Therefore regional GDP for Swiss Nuts-3 regions was gathered from the Swiss statistical office (Bundesamt für Statistik 2015)

The datasets available do not include any specific data about airlines using the airports. Therefore modelling some specific factors influencing the market power, e.g. passenger loyalty to specific airlines (Hess 2008, p. 8), is not possible.

6 Model

6.1 Catchment Area

The same market definition will be used within the thesis as by CC in its report about British airport market. All aviation products will be considered as the same market. The non-aviation segment is taken to be a separate market and is not included in the analysis. The main aspect for the assessment will be the

geographical area. However, unlike the CC report a standardized definition of the catchment area for all airports will be used.

Competition among airports is built upon potential passengers living within the catchment area. The analysis of catchment areas is a standard method for measuring the degree of market power. A catchment area is a geographical range around an airport in which the probability of its selection by potential passengers living inside the area is significantly higher than by those living in the outside regions. The concept of catchment area was first introduced by Lösch in his work about oligopolistic markets. He also noted that companies not successful in realizing the economies of scale have to settle in more distant regions from their larger, more successful competitors, where the catchment area covers a potentially weaker region. (Lösch 1962, pp. 71-75)

As pointed out by Starkie (2002) competition even in a limited geographical area within the catchment area is sufficient for a full transmission of price changes to the broader market. If airports have an overlap of their catchment areas, they have to compete with each other in prices and services for potential passengers living within that overlap area. However because the airports cannot discriminate between the population within an overlap area and that within the rest of the catchment area, they will offer the competitive prices and services throughout their whole catchment area.

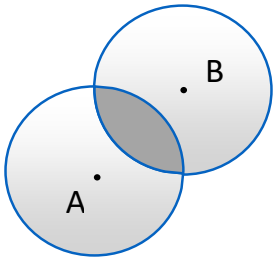

Fig. 4: Graphical example of two catchment areas with an overlap area

The availability of airports within the catchment area to potential passengers is of crucial importance. To a large extent the market power is determined by the potential of local population.

According to a UK Competition Commission survey 61% majority of respondents would travel to another airport if there would be no such flight offered from the nearest airport. 21% would consider another mode of transportation (here it

is important to mention that a high percent share of them are domestic passengers) and only 18% would not travel at all (Air Passengers in Lowland Scotland airports' BAA Airports Market Inquiry).

However for the analysis of potential passengers' two special cases are to be considered:

- Domestic passengers. Their willingness to switch to another airport is naturally much smaller, because using another, more distant airport could result in even higher total time than using alternative transport like car or rail. Consequently domestic flights unlike mid and long-haul routes compete directly with car and rail transport. (BMVI 2014, p. 22) The substitution effect of other transport is noticeably higher than in the case of long distance routes. Therefore aviation should not be considered as a separate but rather part of a broader market which includes substitutes like car, train or even bus transportation. The smaller the country and the better the infrastructure of the transportation grid the higher the substitution effect.
- Transit passengers. Obviously because the transit airport is neither the point of departure nor destination for this type of passengers, its catchment area does not affect their willingness to use this specific airport. Instead it is the infrastructure and (to a lesser degree) the global geographic location which ultimately determines the availability and volume of such passengers.

According to an EU report the travel time is a critical factor for passengers under the same prerequisites: "All customers have a preference to minimize the travel time (and costs) and prefer, other things being equal, the closer airport to the more remote one." (Case Ryanair 2007, p. 21) Even in a case of differentiated conditions where a more distant airport offers lower prices or better services, higher additional time and monetary costs of commuting could offset such advantages and alter the preference in favor of a closer airport.

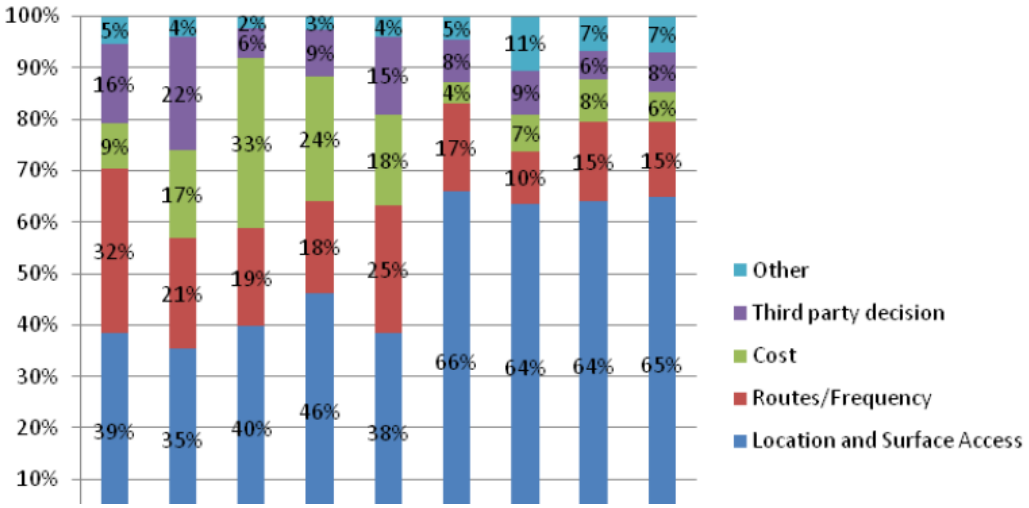

Fig. 5: Reasons for airport choice (CAA 2013, p. 80)

Therefore the most accurate metric for the size of catchment area would be the travel time. An alternative possibility to travel time is geographic distance, travel cost or a combination of these factors. A geographic definition of catchment area is supplemented with demographic indicators such as population, income, employment, GDP per capita etc. (Pavlyuk 2012, 130)

The definition of the size of an airport's catchment area varies between different parties. Airlines argue for a rather smaller catchment area which implies fewer overlapping catchment areas and therefore a higher market power of airports, whereas airports argue for a rather larger catchment area which conversely indicates more competition among airports and eventually smaller market power. The third party, regulation authorities, needs to find a middle ground between these both conflicting views.

For the purpose of research on the decision about the acquisition of Aer Lingus by Ryanair, the European Commission sent a questionnaire to 50 airports in 22 metropolitan regions. Based on its results European commission decided for a catchment area of all airports of at least either 100 km or a 1 hour drive as a benchmark. However most airports also argued or suggested that their catchment area exceeds these limits, sometimes substantially. Airlines on the other hand have suggested a lower size of a catchment area. The argument of airlines is that, especially for shorter point-to-point routes, passengers will not tolerate long travelling time to the airport.

An important factor in this regards is the behavior of business and leisure passengers. While leisure passengers are typically price sensitive, business passengers are dictated by time constraints. (Betancor & Rendeiro 1999, pp. 6-7)

Also leisure passengers, at least to some extent, are not constrained to specific routes, whereas their business counterparts are bound to fixed destinations. The practice of UK's CAA to differentiate between two groups: business and leisure travelers with 1 and 2 hours benchmark respectively was not adopted by European Commission. (CAA Catchment Area 2011, p. 8) Instead only for airports where the volume of business passengers is substantially high, the catchment area was increased on a case by case basis in the individual airport pair analysis. (Case Ryanair 2007, pp. 20-24)

There are two factors supporting a wider catchment area than the 100 km/1 hour range:

- The share of leisure passengers accounts for 63% (33.4 mil passengers out of 52.8 mil) in year 2010. (BMVI 2014, p. 214) The overall trend suggests an even further increase. The share of leisure passengers increased in UK between 1996-2006 from 59% up to 70% and in Norway 1996-2007 from 30% up to 70%. (CE 2012, p. 65) The tendency of leisure passengers to be less time sensitive and accept longer commutes was the reason for distinguishing between 1-hour business and 2-hours leisure passengers' catchment area of CC in its calculation (CAA Catchment Area 2011, p. 8).
- Transport infrastructure is potentially another reason for a wider catchment area. High-speed rail could reduce the travel time significantly; the same can be said for the freeway. Due to a well-built transport grid in Germany of both, high-speed rail and freeway, an enlargement of the catchment area for this analysis would be justified.

Following this argumentation a catchment area of 200 km is used within the framework of this thesis. However, distance as an influence factor for the willingness to use a particular airport applies only within 150 km range. The area between 150 km and 200 km is influenced by the airport's quality factor alone. A definition of the catchment area by using the travelling time (as it is applied by CAA) is not possible due to a lack of required data. The approach of using the travelling time instead of the range has an important advantage: in that case both aspects – distance and level of transport infrastructure – are taken into account. However this kind of data is provided by specific organizations (like UK

Department of Transport in the case of CAA's analysis) which normally restrict access to their database.

Though based on the Nash-Equilibrium concept square, rectangles or hexagon formed catchment area would better represent the geographic area for market power (Strohbach 2006, pp. 6-8), for a simplistic approach a circle form will be chosen, which is also a standard approach in the literature.

6.2 Competition Dimension

Five airports are analyzed within the thesis: Frankfurt, Dusseldorf, Hamburg, Munich and Stuttgart. With the exception of Berlin, they represent the top-5 in Germany with regards to number of passengers and routes. Additionally all five are not focused on a specific airline or customer segment and are strongly represented on the spatial competition dimension. The reason for the absence of Berlin is the uncertainty if the model would correctly manage a case of two directly neighboring (Schönefeld and Tegel) airports. An even more important aspect is the uncertainty about the consequences on the airlines and passenger behavior due to the impeding opening of the larger Berlin Brandenburg Airport which is replace the Tegel Airport. In contrast, the airlines and passenger behavior for the five airports analyzed within the thesis are not affected by a threat of a probable market entry of a direct competitor and therefore comparable among each other for the assessment of their market power.

Of the hub, spatial and transport competition dimensions only the spatial competition will be analyzed in this thesis. This also, as described before, represents a standard approach in the literature.

Access time is the most important factor one for short-haul routes passengers. (Strohbach 2006, p. 10) Consequently, for short-distance domestic flights the substitution effect to other means of transport is significantly higher. The non-availability of such flights would result in a switch to other transport. Most of domestic flights passengers need a specific route because they are business travelers or are visiting their relatives or friends. Using a relatively distant airport

for a short distance flight could result in a higher time cost than using such alternatives as rail or car. (Bel & Fageda 2009, p. 10)

This point is even more valid for Germany as it is, compared with some others countries especially outside of Europe, relatively small and has a highly developed railroad and freeway grid infrastructure. Due to high substitution between domestic flights and other transport, i.e. a direct competition among them, the German ministry for transportation used only the data for mid and long-haul routes in its analysis about airport market. (BMVI 2014, p. 28)

Therefore domestic passengers will be excluded from the data due to their time preferences. As described above for long-distance routes the non-availability of the flight from the nearest airport would result in a switch to another airport for business and some of the leisure (those visiting relatives or friends and hence restricted to the destination) passengers or a switch to an alternative route for another category of leisure (tourists) passengers, who are more flexible with regards to their route choice. (CAA 2011, pp. 24)

It should be noted that the competition on the hub level is considerably different from the spatial competition. It is a quasi-separate market with its own mechanisms and setting. Also the competition among hubs, at least in Europe, is assumed to be very different than that among airports within the scope of spatial competition. There are views of both substantially lower as well as higher competition on the hub level compared to those on the spatial level. Arguments for lower competition on the hub level are that firstly the competition effect is limited, because of high switching costs of flagship carriers. Additionally air service agreements restrict traffic rights in some cases, which increases the costs even further. Secondly, as many hubs are slot coordinated, slot trading is not possible in Europe so that airlines cannot easily switch their main airport. (OECD 2010, p. 21) As for the opposite view, it is argued that airport charges or air passenger duties tend to be lower for transfer passengers, in effort to raise the attractiveness of the respective national hub. (Maertens 2012, p. 13) Regardless, both perceptions assume that there is a substantial difference in competition between the hub and spatial levels.

In addition, the data about cargo will not be used for the competition analysis. As described in a previous chapter, cargo traffic is considered to be a business facing much higher competition than the passenger transport business. Also the catchment area (including overlaps) and its potential passengers, have virtually

no effect on the competition between airports in the German market in cargo segment. Cargo has to be transported by truck or railroad to a variety of destinations. Switching from one airport to another (to Munich from Frankfurt as an example) would not affect the transportation notably to most of the destinations, due to a relatively small difference in distance. The transportation costs would change only marginally even by to those destinations where a switch of the airport would lead to a significantly longer route.

6.3 Calculation

In general the model is based on that developed by Maertens in 2012. However due to two major drawbacks identified in this model and for a better representation of several details it is modified in several aspects.

The first drawback is that the distance, and its effect on passenger behavior, between the airport and NUTS3 regions is not taken into account. There is no distinction between regions located very close to the airport and those on the periphery of the catchment area. Instead all regions are handled equally, their GDP is added fully to the airport as long as they are within the catchment area. However it is reasonable to assume that due to the time constraint the willingness to use a particular airport is decreasing with distance. The fact that the region is located within the catchment area does not rule out this assumption.

The second drawback is an addition of 100% of GDP to a relevant airport if the region is located within its catchment area. Although every airport gets only a specific share in the case of an overlap of two catchment areas, it is still the whole amount of the GDP that is distributed among airports. However realistically there would be always a residual share of potential passengers willing to use an airport which is located outside the region's catchment area. Most obvious reasons for this would be that specific routes needed by passenger are not offered by the airport within the catchment area or that prices of a competing airport are far below those located next to the region so that such price difference would compensate travelling time and monetary costs.

To consider both aspects, several modifications will be introduced into the model. Additionally the model is improved in some further details.

Fundamentally economic wealth (of private individuals as well as companies) and size of population are two factors positively influencing the passenger's demand. Consequently for airports being double-sided business entities, the positive effect carry over to the aviation's supply and eventually to the overall airport's performance. Therefore the population density as used in one of the CAA analyses (CAA Catchment area 2011, pp. 11-12) will not be used, because economic power is not taken into account by such calculation.

The nominal GDP (which is used by Maertens) is unlike the population density a potential source for the market power covering both aspects. It is increasing in both the size of population and wealth. However the wealth aspect might be underrepresented in the calculation with nominal GDP. Due to coverage of living costs a region with many relatively poor households would have a lower demand on flights, compared with a region with same nominal GDP but smaller population (i.e. higher GDP per capita). To compare the effect on potential monopoly power, calculation with both source references – nominal GDP and GDP per capita – is done separately in the basic scenario.

The share of GDP per capita added to a particular airport is determined by two additive factor categories, the fix and the variable factors. The fix factor does not depend on airport's characteristics and therefore cannot be controlled by a particular airport. Hence it does not vary between any of the airports analyzed in the thesis. Distance is identified as such a fix factor. Irrespective of its qualitative characteristics a particular population's share is willing to use the airport due to the amount of the travel time. As an example consider two regions, one very close to the airport and one on catchment area's periphery. The share of potential passengers willing to use the airport from the first region is noticeably higher than those living in the second. To represent this effect the catchment area of every airport analyzed in the thesis will be split into four areas, with the highest fix factor in the area closest to the airport and the lowest for the most distant one.

A variable factor on the other hand does depend on airport characteristics and therefore varies across airports. It represents the size, or better, the qualitative performance which attracts potential passengers. Alternative interpretation is the level of infrastructure which positively influences the number of passengers

using the airport. The size of the airport is an important factor for the determination of market power of an airport towards airlines. In relative terms smaller airports are more affected by airlines switching their routes than their bigger counterparts. (CE 2012, pp. 45-46)

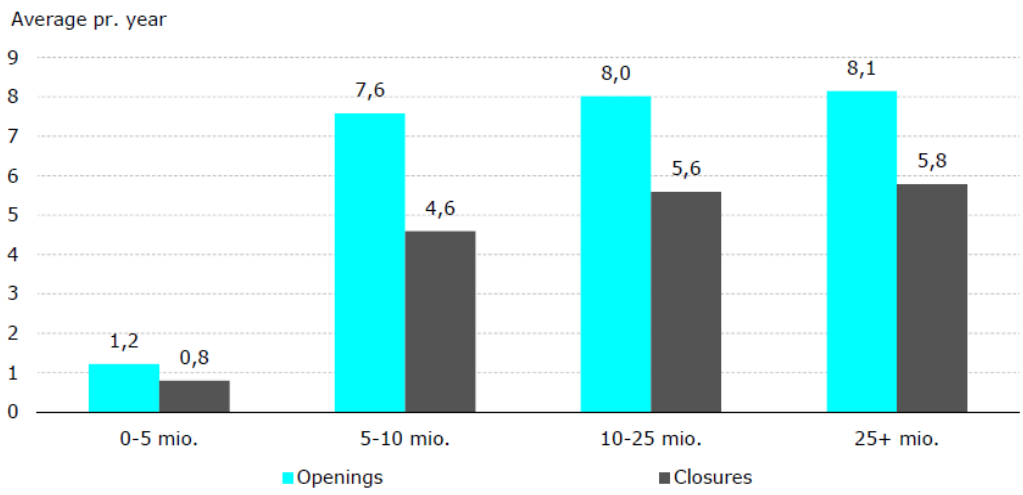

Fig. 6: Route opening and closures across airports by number of passengers (CE 2012, p. 46)

Another aspect of the size of an airport that may have an impact on its market power is the level of negotiation experience with airlines. Bigger airports possess both better experience in negotiating through the heterogeneity and frequency of negotiations they conduct and better (statistical) information than smaller ones. (CE 2012, p. 50)

Different measurements of variable factor are possible like the turnover of a particular airport, number of take-offs, length of the runway, etc. Two variables will be used to determine the variable factor: the number of passengers and the

number of airlines. The transit passengers will be excluded from the total number because they are confined to the hub competition dimension. Two variables will be used since each of them separately does not entirely represent the performance level. The airport may have a relatively high number of routes combined with low passenger traffic or large number of passengers with only limited variety of routes due to bigger airplane capacity. Both variables determine the variable factor with a weight of 50% each.

The analysis of the competition among airports is based on two reference benchmarks: the nominal market power of each airport in its catchment area and market share ratio of particular airport and its competitors within the catchment area. The first benchmark represents the potential market power directly attributed to the airport. Therefore the percentage share of all airports combined would represent the market share from the whole airport market. The second benchmark represents the market share of particular airport within its catchment area.

The following equation for the calculation of nominal market power will be used

$$MP_i = \sum_{r=1}^{N} GDP * C_t[k_m + v * 0.5(\frac{P_i}{P_F} + \frac{R_i}{R_F})]$$

where MP_i is Market Power of an airport i determined by the sum of the GDP per capita of all NUTS-3 regions r within airports catchment area multiplied on the country factor C_t. For all German region C_t is equal 1, while for foreign regions the figure decreases to 0.3. This result is multiplied by the additive sum of the fix k_m and the variable factor, that is represented by the base value v multiplied by the weighted sum of number of passengers P_i and routes R_i relative to those figures of Frankfurt airport which serve as a benchmark.

The fix factor k_m depends on the distance from the airport and therefore is determined by one of four areas m within the catchment area. The closest area has the highest fix factor, which decreases with range in other areas. This feature represents the time sensitivity of (especially business) passengers, who are willing to use an airport due to its closeness and not its qualitative characteristics. The furthest area (range between 150 km and 200 km) has a fix factor of 0, hence it is determined by the variable factor only. This feature is implemented to represent price sensitivity of (especially leisure) passengers who would not use

an airport due to the long distance under normal terms but are attracted by its level of infrastructure/qualitative performance.

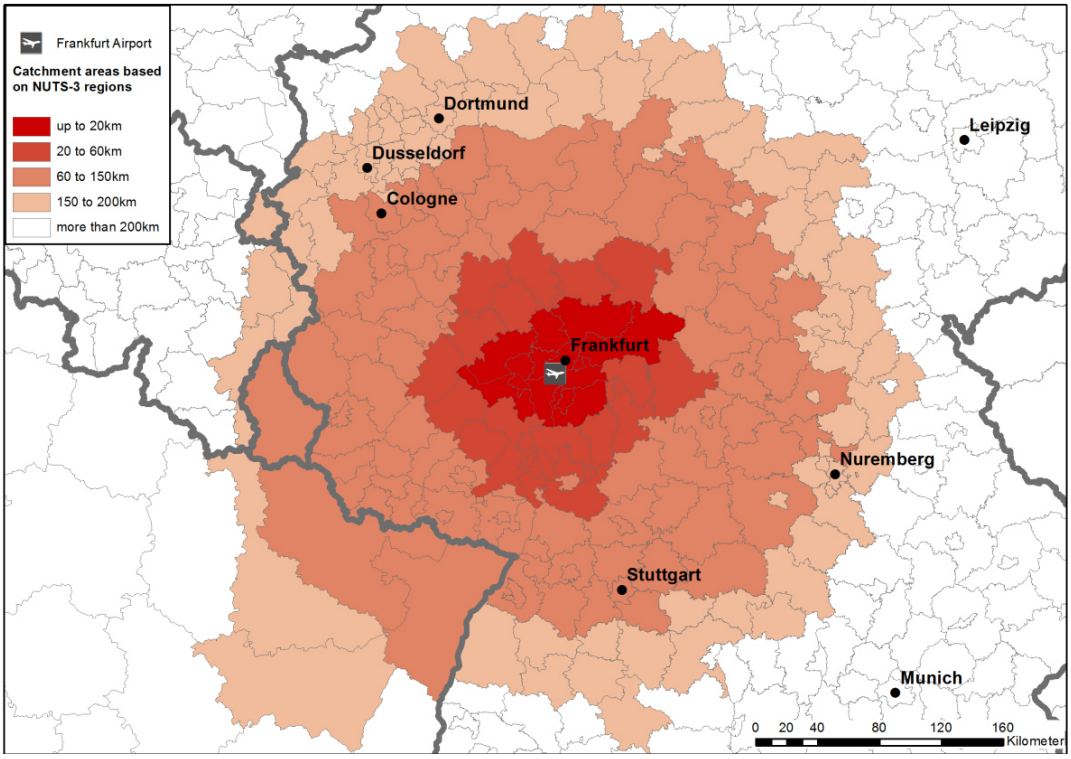

Fig. 7: Exemplary 200 km range catchment area of Frankfurt Airport

Figure 7 depicts an exemplary 200 km range of Frankfurt airport with the separation into the four 20/60/150/200 km areas (I would like to thank Mr. Andreas Blitz for creating both maps used in the thesis). Please note, that the selected sample of NUTS-3 regions used for the calculation, differs slightly from that

used for both maps (Figure 7 and Figure 9). In the map the region is included into each relevant area as long as it is (even minimally) within the required range. For the calculation, the selection into the areas was done manually and is based on the approach also used by Maertens (2010). Here only if the biggest region's city is within the range, this region is included in the relevant area and dropped otherwise.

The variable factor is determined by the number of passengers and routes with a weight of 50% each and divided by those same figures of Frankfurt, which serve as a benchmark with regards to variable factor. This is multiplied by the base rate value v of 0.6. Therefore Frankfurt as a benchmark gets a variable factor equal to the base value and all others regions have a lower variable factor by definition. This feature represents the share of passengers willing to use the particular airport due to its qualitative characteristics.

The coverage of less than 100% serves to represent within the residual share the passengers willing to use other airports (even those located outside the catchment area) due to their qualitative characteristics.

The calculation of market shares among airports operating within the catchment area is the second reference benchmark used for competition analysis. Here the GDP per capita share calculated for a particular airport with the equation above is compared with the same calculation done for other airports overlapping its catchment area. It represents the share of potential passengers willing to use the particular airport or the competitor's one either due to the distance (fix factor) or its qualitative performance (variable factor).

The potential nominal market power and its share on the catchment area are determined by:

- Qualitative characteristics. The number of routes and passengers determines the amount of variable factor positively.
- Economical geography. High GDP per capita of NUTS-3 regions within the catchment area has a positive effect on the market power. The nominal value of GDP per capita, quantity of regions and its distribution influences potential market power as well as market power share within the catchment area. The impact on the market power is (due to the fix factor) larger if high-wealth regions are located close to the airport, than if they would be more distant.

- Presence of other airports. Overlaps with other airports have a negative effect on the calculated market power index value and moreover relative market power share within the catchment area. The better the qualitative characteristics of a competitive airport and the closer the regions to its location the higher the negative effect.
- Geography. Sea and to a lesser degree mountains and regions of foreign countries within the catchment area have a negative effect on the total value of potential market power. In the case of sea and mountains obviously no (or as good as no) GDP per capita is generated in such areas. In the case of regions abroad, the number of potential passengers is lower if the airport is located abroad compared to a domestic alternative. This effect is simulated by the country factor within the model.

It is important to note that both benchmarks are informative not in their nominal but rather their proportional values. The calculated nominal monopoly power is an index value representing airports' economic basis (and indirectly the number of potential passengers and their economic power), hence the number of a single airport isn't sufficient to correctly asses the degree of market power. The most meaningful value in comparing airports to each other is the share of each airport within the whole airport market. A single airport with a considerably higher calculated nominal market power than other airports would indicate an oligopolistic or even monopolistic market, while a relatively homogeneous level among all airports is an indication for constant potential economic environment and high competition.

In the case of the catchment area's market share, the calculated share represents the minimum value that can be definitely attributed to each airport. The exact calculation could be done by including all airports into the model. Threrefore though for different reason than in case of nominal monopoly power, for competition analysis the proportional value between own and competitor's share is better suited than the nominal value.

This configuration provides three major advantages compared to Maertens model:

- First, with the introduction of the fix factor, the unrealistic assumption of no effect caused by distance on the GDP per capita (which indirectly represents potential passengers) attributed to a particular airport is removed. Instead, GDP per capita representing the number of passengers

is decreasing with the region's distance to that particular airport, until the passengers in the outermost area are attracted by airport's qualitative characteristic only.

- Second, due to additive factors it is ensured that GDP is not assigned to the particular airport (or its combination within the overlap) up to an unrealistic 100% value. As for NUTS-3 regions within the overlap area, where a sum of fix and variable factors of two or three airports may exceed 100%, the maximal value is fixed on 90% level. The residual share simulates the share of passengers willing to use other airports, which overlap the catchment area but which are not analyzed in the calculation, or even airports located outside the catchment area.
- Third, instead of calculating the share only, the analysis is done on the basis of two criteria: nominal market power and market shares among airports presented within the catchment area. While the second number represents the market power of the airport in its catchment area, the first represents the potential market power on the whole airport market. The differentiation between both results is crucial because even if an airport has a high market share on its catchment area it might still have a very limited share on the market itself.

The major drawback of the model is an arbitrary setting of fix and base rate variable factor values. However there are two reasons for considering this drawback as not to significantly distorting the results. First, though fix factor percentage values are set arbitrarily, the resulting differentiation is still better than no differentiation at all. Second, since all airports are treated equally, a big data sample and the fact that not the nominal but rather the proportion of index and additive values is used, the effect of arbitrary factor value assignment should not significantly change the results.

Nevertheless to prove whether there is a potential risk on the model's validity six alternative scenarios were additionally completed with the subsequent comparison of results and their possible deviations. In first scenario the instead of GDP per capita the nominal GDP is used. In the second scenario the variable factor base value was reduced significantly from 0.6 to 0.45. In the third scenario the fix factor was reduced in different proportions for each area. In the fourth scenario two adverse amendments were made. The variable factor was reduced in same way as in second scenario while additionally the fix factor was

increased. In the fifth scenario not the factor value but the proportion between number of passengers and number of routes was changed from 50/50 to a 30/70 value. The sixth scenario uses a completely different approach. In this scenario there is no differentiation of variable factor based on Frankfurt as a benchmark, among airports. Instead all airports have same variable factor based on the base rate of 0.6, which varies only in case of overlaps with other airports. It is distributed proportionally among relevant airports based on the total number of flights and routes to 50% each.

Another drawback is the omission of airports which are not included in the control group. This effect is only marginal because most of the German airports not covered by the model have negligible capacity in the number of passengers as well as number of routes. The only exception is represented by Berlin's both high capacity airports, which are however is located too far away and would overlap only in a limited number of regions with Hamburg airport. Additionally the passengers using alternative airports not covered in the thesis are considered in the model by an addition of potential market power below the 100% share. Consequently the passengers using alternative airports are represented within residual share. Nonetheless, it can be assumed that some of foreign airports would reduce the effect of the variable factor on a higher level as this is already represented by the residual share. This might be the case for the airports of Vienna, Zurich and especially Amsterdam Schiphol. The most accurate outcome would be produced by an extended version of the model on the European market level, covering all major airports and their interconnection on the variable factor level.

Finally the imprecise route data collected by openflights represents a caveat for the accuracy of the model's results. The soundness of the data is unknown, and the lack of data for airport Stuttgart indicates possible imprecision. Use of more accurate (but also chargeable) data would decrease or even eliminate this concern.

6.4 Results

	FRA	MUC	STU	DUS	HAM
number of regions	172	105	159	146	77
GDP total	5.563.800	3.594.300	5.977.447	4.597.300	2.057.600
GDP average	32.348	34.231	37.594	31.488	26.722
fix factor total	607.043	553.978	596.309	536.631	305.605
fix factor average	3.529	5.276	3.750	3.676	3.969
variable factor total	2.813.506	1.437.398	654.955	1.173.549	347.115
variable factor avera	16.358	13.690	4.119	8.038	4.508
MP total	3.343.478	1.807.857	1.116.902	1.274.250	652.720
MP average	19.439	17.218	7.025	8.728	8.477

Tab. 3: Catchment area characteristics – basic scenario

In detail Frankfurt's catchment area exhibits a very high GDP per capita total value, representing the high economical wealth of the surrounding area. Although average GDP per capita per region is higher in Munich and Stuttgart, both have fewer regions due to lower population and geographic circumstances than Frankfurt. High GDP per capita in Stuttgart's catchment area is partly a result of Swiss regions, especially Basel. However, when adjusted by the country factor, the figure decreases to 5.2 billion EUR. Dusseldorf, although having the highest population density in its catchment area of all airports, is confronted with lower wealth and economic power which decreases the GDP per capita and therefore the basis for its market power. Finally, Hamburg is facing two negative aspects. First, aside from Hamburg itself, all surrounding regions exhibit relatively low economic figures due to both low population density and economic power. This results in by far the lowest GDP per capita per region. Second because of geographic circumstances (North Sea on the western side and Baltic Sea on the eastern) the number of NUTS-3 regions is much smaller than for other airports.

Market power determined by the fix factor is the highest for Frankfurt and Stuttgart. Munich has the highest average fix factor value, which is attributable to high economic power of Munich city that contributes the largest part to this value. As expected Frankfurt has by far the highest value in terms the total variable factor value. Due to its low capacity Stuttgart, although having a very high GDP basis, has a lower factor value than its "poorer" competitor Dusseldorf. Finally Hamburg, although having relatively advanced fix factor's average value per region, shows the lowest nominal figure due to its catchment area's low GDP total value.

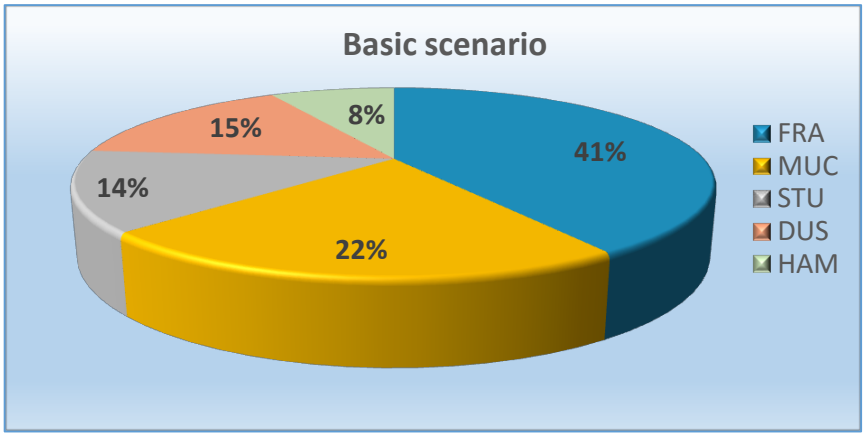

Fig. 8: Airport Market Shares – basic scenario

In terms of the relative market shares of the airport market, Frankfurt is as expected the airport with the highest market power in this basic scenario. However although it has the largest calculated share of 41%, with regards to the market structure it does not have a typical monopoly status. If anything the market seems to be determined by an oligopoly of Frankfurt and Munich.

	FRA	MUC	STU	DUS	HAM
number of regions	172	105	159	146	77
regions with 1 overla	151	61	135	76	5
regions with 2 overla	32	20	34	14	0
overlap fix	10,51	4,01	11,69	2,77	0
MP total	3.343.478	1.807.857	1.116.902	1.274.250	652.720
MP competitors	1.387.827	633.174	2.844.962	1.245.638	45.669
nom share own	62	56	22	38	32
nom share compet	26	20	55	37	2
rel share own	71	74	28	51	93
rel share compet	29	26	72	49	7

Tab. 4: Overview of competition within the catchment areas – basic scenario

With regards to the competition within each relevant catchment area Frankfurt and Stuttgart have the most overlap regions with their competitors. In the basic as well as in alternative scenarios, the competitors share in the case of Dusseldorf is potentially underrepresented. This is because neither domestic alternatives such as Cologne or Weeze, nor foreign airports such as Amsterdam or Bruxelles are included. Despite the limitations arising from the relatively low variable factor of domestic competitors and the country factor effect for foreign competitors, the results should nevertheless differ significantly. Hamburg is in the unique situation of having practically no competition in its catchment area. The very low base value due to geographic and economic geographical reasons of its potential market power, is therefore apparently counterbalanced by a monopolistic position with respect to the catchment area.

As described in the previous section due to the absence of a full data sample for all relevant airports, the relative market share within the catchment area is more appropriate for analyzing the degree of market power than nominal share values. Here Frankfurt controls 71% of the market, which is on one hand a remarkably high value but on the other may be smaller than expected in light of the enormous size of the airport. This size leads to the highest possible variable factor, which increases Frankfurt's market share significantly. Munich although operating with a variable factor of 3/4 of Frankfurt's has an even slightly higher market share of 74%. This is a result of both fewer overlapping areas with competitive airports and the fact that such overlaps affect mostly regions with relatively low GDP per capita. Dusseldorf and especially Stuttgart face very strong competition in their catchment area. As described above with inclusion of other airports in the data sample the competitors share in Dusseldorf's catchment area is assumed to be even higher. In the case of Stuttgart the competitors share is even larger than its own. This is due to its small variable factor and the highest number of overlaps, mostly with the largest airports Frankfurt and Munich.

To check the robustness of the model several different alternative scenarios were computed with different configurations, to determine if it would produce reasonable and consistent results. As mentioned previously the, to some extent, arbitrary setting of factor values might cause biased results. If the basis of the presented model is not robust, changes of factor values would lead to significantly different results. If, however, the model's fundamentals are robust, these changes shouldn't produce significant differences. Such effect would be produced if and only if the exogenous components (for example population density or nominal GDP instead of GDP per capita as market power source or number or airlines or airport's revenue as measurement for variable factor) or mechanics of the model would be changed. But even here the differences in results must be anticipated and logical.

In first scenario the effect of using nominal GDP, as it was done by Meartens, was examined. As described above both methodologies provide advantages and disadvantages. While nominal GDP might better represent the size of the population, it on the other hand probably represents the wealth effect incorrectly.

The total market share of Frankfurt, Stuttgart and Hamburg are practically unchanged. However, there are significant alternations for Munich and Dusseldorf.

While Munich lost 5% of its share and became number three, Dusseldorf gained 6% and became number two. Nevertheless this change was fully expected, due to relatively wealthier population in Munich's catchment area, combined with very high population density of Dusseldorf's catchment area. While the average GDP per capita per region is noticeably higher for Munich airport, the average nominal GDP in Dusseldorf of 11,412 is nearly twice as large as in Munich.

As for the market shares within relevant catchment areas, there is practically no difference in the basic calculation compared to the first scenario. Only in the case of Dusseldorf the relative own share increases slightly from 51% to 55%. Also this change was anticipated, because NUTS-3 regions in Dusseldorf's catchment area without overlap with competitive airports have high population density and nominal GDP, but relatively low GDP per capita.

In the second scenario the variable factor base value was reduced significantly from 0.6 to 0.45. Other components remained unchanged. The rearrangement did not cause any significant result changes. The market shares are identical with those of the basic scenario. Although, as expected, the nominal market share values decreased within each catchment area, this change was identical for own as well as competitors share. Therefore the relative market share remained unchanged.

In the third scenario the fix factor was reduced in different proportions for each area. This was done because a proportional change for the fix factor across all areas could lead to steady results across all airports. The fix factor for the 150 km range was reduced from 0.2 to 0.1 and for the 60 km range from 0.3 to 0.2 to increase randomness and variation. The closest area with range of 20 km remained unchanged with a 0.35 fix factor. As expected Frankfurt as the biggest airport performs slightly better in this scenario because the variable factor now has an overall higher impact on market share, while Stuttgart's share decreased marginally. On the overall market, Frankfurt's proportional share increased from 41% to 44% and that of Stuttgart shrank from 14% to 12%. Shares of other airports remained practically unchanged. As for the market share within the catchment area the market shares of Stuttgart and Dusseldorf decreased as expected due to the high number of overlaps with bigger competitors such as Frankfurt and Munich (whose large variable factor had with a smaller fix factor now even a bigger effect on overall results). The relative own share of Dusseldorf decreased slightly from 51% to 47% and from 28% to 25% for Stuttgart.

In the fourth scenario two opposite modifications were made. The variable factor was reduced in the same way as in the second scenario while additionally the fix factor was increased. Similar to the reduction in the third scenario, the increase was done in different proportions for each separate area. The 150 km range factor was scaled to 0.25 from 0.2, the 60 km range to 0.35 from 0.3 and the 20 km range to 0.5 from 0.35. As anticipated Frankfurt's share on the total airport market decreased from 41% to 38%.due to a combination of smaller variable and larger fix factor effects. Munich instead, gained 2% to move to 24% due to relatively small number of overlap regions. Dusseldorf saw 1% change while Hamburg and Stuttgart remained unaffected by the scenario modifications. The market share within the catchment area increased by 4% for Munich and Stuttgart and by 3% for Dusseldorf to 78%, 32% and 54% respectively. These moderate increases of market share were caused by a higher impact of fix effect and a decrease of Frankfurt's share (which overlaps all three airports) due to reduced variable factor.

In the fifth scenario not the factor value but the proportion between the number of passengers and number of routes was changed. Instead of weighing the variable factor by 50% each, the proportion was changed to 30% for passengers and 70% for routes. While the results for market share within the catchment area remained practically unchanged, Frankfurt's share of the total market decreased slightly from 41% to 39%. The reason for this change is that the difference in passengers between Frankfurt and other airports is proportionally larger than the difference in the number of routes.

The sixth scenario uses a completely different approach. Here, instead of testing the consequences of the arbitrary factor setting on the accuracy of the results, the model's mechanics are tested. In this scenario there is no differentiation of the variable factor based on Frankfurt as a benchmark among airports. Instead airports attract the same proportion of people if there are no overlaps with other competitors. Therefore the potential passengers would use the particular airport as the next best opportunity. The variable factor expressing the qualitative characteristics (or level of infrastructure) varies only in case of overlap. In such regions the variable factor is distributed proportionally among relevant airports based on the total number of flights and routes to 50% each.

This approach is not used for the basic calculation and other scenarios because the assumption of no differentiation among airports based on Frankfurt as benchmark is assumed to be unrealistic. Regardless of overlaps with other air-

ports, the number of passengers attracted by a particular airport varies with its qualitative characteristics. As an example: the number of people willing to use Frankfurt is substantially higher than the number of people willing to use Stuttgart. This is true even in the case when the region within Stuttgart's catchment area does not overlap with catchment areas of other airports.

The reason to calculate this scenario is to test the model's mechanics. If the model is robust, changes in (though arbitrary) factor values should not change the result significantly. However a change in its mechanics should potentially produce quite different results.

In fact, unlike previous scenarios, the sixth scenario produced very different results compared with the basic calculation. Frankfurt performs much weaker in this scenario with a total market share of 31% only, which is 10% less than in the basic scenario. Hamburg on the other hand gained 7% and Stuttgart 3%, with total shares of 15% and 17% respectively. Also own shares within each relevant catchment area changed significantly. While Frankfurt remained in this case practically unchanged, Munich's share increase by 5% to 79%, Stuttgart's by 12% to 40%, Dusseldorf's by 11% to 62% and even Hamburg which was practically unchanged in previous scenarios increased its share by 4% to 97%.

While the changes in the results themselves were anticipated and are logical – a variable factor which is not based on the biggest airport as a benchmark, should lead to a significant increase of other airports' own share – the mechanics, also produced intuitively overall unrealistic results. Frankfurt's total market share of 31% only, can be assumed as too low. On the other hand 15% total market's share of Hamburg, being practically equal with 17% of much bigger Dusseldorf, is unrealistically high. Also the relatively high 62% Dusseldorf's own share within its catchment area is not plausible because of high competition with Frankfurt in many overlap regions.

In summary the results show an airport market determined by a duopolistic structure of Frankfurt and Munich. However, other airports from the sample group hold significant market shares, with Dusseldorf having the biggest and Hamburg the smallest. With regards to the competition within each relevant catchment area, the results do not confirm the natural monopoly assumption. Dusseldorf and Stuttgart are facing a fierce competition, with the latter having an own share which is smaller than that of its competitors. Even Frankfurt and

Munich though having a high share of 72% and 74% respectively, cannot be assessed as typical monopolists.

To test the robustness of the thesis, the setting of factors (which were set to some extent arbitrary) was tested by changing the values variously in different scenarios. The practically unchanged results confirmed the robustness of the model. Additional calculation with nominal GDP instead of GDP per capita showed different results for Munich and Dusseldorf. Although the variations in results are logical and anticipated and in this thesis the GDP per capita is considered to be a better benchmark, there isn't a consensus which of both – a nominal GDP or GDP per capita - is better suited for the assessment of airports' market power. To test the model mechanics a calculation with a different approach was computed in the sixth scenario. If the model is robust, the results should differentiate from standard approach significantly. As exactly this happened, it shows that first the model's mechanics are robust and moreover that the model delivers much more realistic results than alternative approaches

7 Conclusion

The main aim of the thesis is the analysis of market power within the German airport market. The traditional assumption was that the airport sector is characterized by the natural monopoly traits. To evaluate the degree of market power, five major German airports – Frankfurt, Munich, Stuttgart, Dusseldorf and Hamburg – were included in the data sample. Berlin was omitted because of uncertainty regarding passengers' and airlines' behavior caused by the impending opening of a Berlin Brandenburg Airport as well as the situation with two directly neighboring (Schönefeld and Tegel) airports.

The evaluation of the degree of market power is built on the analyses of each airport's catchment area. Nominal GDP, increasing in both important aspects, total wealth and size of population, is identified as a main source for potential market power and used for the assessment in every NUTS-3 region within each catchment area. The model is generally built on the approach developed by Maertens (2012) but modified in several aspects, with the most important among them being the introduction of fix and variable factors. The calculated results are used for two reference benchmarks: the share of nominal power relative to other airports in the data sample, and the market share ratio of a particular airport and its competitors within the catchment area. The first benchmark

represents the share of the whole airport market, while the second benchmark represents the relation of a particular airport and its competitors within relevant catchment area.

To prove the robustness of the model, different alternative scenarios were calculated. That was done either with alternate factor values to test the impact of the (to some extent arbitrary) factor setting or with alternate calculation approach to test model's mechanics.

The results show firstly that the airports differ with respect to their catchment areas. Frankfurt is leading in total as well as average GDP value per region in its catchment area, with Stuttgart having a similar initial situation. Munich and Dusseldorf differ in their total and average GDP values. While Munich has relative high average GDP per region, Dusseldorf has a higher total value. Finally, Hamburg's catchment area has lowest total GDP and average value, due to the relatively low economic power and the limited number of surrounding NUTS-3 regions.

Secondly the market, at least within the sample group, does not show the tendencies of a monopoly, but rather it is characterized by an oligopolistic structure defined by Frankfurt and Munich. That said, the market shares of other airports are also significant.

Thirdly Hamburg is the only airport from the sample group having a monopolistic rank in its catchment area with a relative share of 93%. This result revises partly the previously described weakest potential economic power of Hamburg's catchment area. Other airports show a significantly lower share. While Frankfurt and Munich both have just above 70%, Dusseldorf has a smaller share of 51% and Stuttgart, with a share of only 28%, is the single airport in the sample where the competitor's share significantly surpasses its own share. These results are intuitively more plausible and represent a more realistic picture than those in Maertens 2012. Here Stuttgart was found to have a share within its catchment area of 84% and Frankfurt and Munich of even more than 98%.

All alternative scenarios confirmed the robustness of the model. As anticipated, the changes of factor values or other inputs did not significantly alter the results, while small variations were logical and expected. Likewise anticipated, an alternative calculation approach led to significantly different results which confirms the robustness of model's mechanics.

Based on the calculated results the overall findings are that, firstly, all airports differ from each other substantially with regards to their economic environment and grade of competition. This tends to support the present practice in Germany of regulating each airport by a regional regulation authorities separately. Secondly, with the exception of Hamburg, the results do not support the assumption of airports holding a monopolistic position. An explanation for Hamburg's monopolistic status is that due to the weak economic situation in that region of North Germany's region there is just a lack of demand for another airport. Other airports have shares which indicate a competitive environment within each relevant catchment area. Even Frankfurt, with the highest variable factor, possesses a relatively moderate share of 71%.

Finally, it can be assumed that a calculation with more complex and accurate data, as well as the inclusion of airports across Europe, would lead to more precise results. However this would need to be done in a separate work.

References

1. *About Heathrow Airport*, n.d. Available from: <http://www.heathrowairport.com/about-us/company-news-and-information/company-information>. [30 November 2014]
2. *Aena is the world's leading airport operator*, n.d. Available from: <http://www.aena.es/csee/Satellite/conocenos/en/Page/1237548071568//Who-we-are.html>. [30 November 2014]
3. *Air, Market integration – History*, 2012. Available from: <http://ec.europa.eu/transport/modes/air/internal_market/integration_history_en.htm>. [25 November 2014].
4. *Case No COMP/M.4439 – Ryanair / Aer Lingus*, 2007. Available from: <http://ec.europa.eu/competition/mergers/cases/decisions/m4439_20070627_20610_en.pdf>. [24 November 2014]
5. *Euro exchange rates Swiss franc*, n.d. Available from: <https://www.ecb.europa.eu/stats/exchange/eurofxref/html/eurofxref-graph-chf.en.html>
6. *Konzernlagebericht Flughafen München 2013*. Available from: < http://www.munich-airport.de/media/download/bereiche/konzernabschluss2013/konzernlage.pdf|> [10 December 2014]
7. *Mehr Flüge, aber weniger Länder*, 05.03.2014. Stuttgarter Nachrichten, Available from: <http://www.stuttgarter-nachrichten.de/inhalt.flughafen-stuttgart-mehr-fluege-aber-weniger-laender.1110ad08-dc1d-47aa-92ef-34a0c51ea5bc.html>. [04 February 2015]
8. *Our hubs in Frankfurt, Munich, Dusseldorf, Zurich and Vienna*, n.d. Available from: <http://www.lufthansa.com/de/en/Our-hubs-in-Frankfurt-Munich-Dusseldorf-Zurich-and-Vienna>. [26 November 2014]
9. *The Airport Company*, n.d. Available from: <http://www.aia.gr/company-and-business/the-company/the-airport-company/>. [30 November 2014]
10. ACI, 2013. *2013 ACI Economic Report Preview Edition*. Available from: <http://www.aci.aero/media/89639312-7c18-4362-a8a3-90cd78fb24ef/4Y8sUg/Publications/2013%20AER%20Brochure%20v4b%20Web.pdf>. [19 January 2014]
11. ACI Europe, 2014. *Airport industry connectivity report 2004-2014*. Available from: <https://www.aci-europe.org/component/downloads/downloads/4105.html>. [20 December 2014]
12. ACI Europe, 2013. *How Airports Compete*. Available from: <https://www.aci-europe.org/component/downloads/downloads/3435.html>. [23 November 2014]
13. ACI Europe, 2012. *Economic Report 2011*. Available from: <https://www.aci-europe.org/component/downloads/downloads/3267.html>. [24 November 2014]
14. Bel G. & Fageda X. 2009, *Privatization, regulation and airport pricing: an empirical analysis for Europe*, Available from: <http://www.ub.edu/graap/JRE_BELFAGEDA.pdf>. [14 December 2014]

15. Betancor O. & Rendeiro R. 1999, *Regulating Privatized Infrastructures and Airport Services*, Policy Research Working Paper, Worldbank. Available from: <http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-2180> [12 December 2014]

16. Bilotkach V. & Mueller J. 2012, *Supply Side Substitutability and Potential Market Power of Airports: Case of Amsterdam Schiphol*, GAP-Project. Available from: <http://userpage.fu-berlin.de/~jmueller/gapprojekt/downloads/gap_papers/supplyside.pdf> [11 December 2014]

17. Bilotkach V. & Polk A. 2011, *The Assessment of Market Power of Airports*, Available from: <http://www.hwr-berlin.de/fileadmin/profpages/polk/Bilotkach_Polk-Market_Power_of_Airports.pdf> [13 December 2014]

18. Bundesamt für Statistik, 2015. *Bruttoinlandsprodukt (BIP) nach Grossregion und Kanton*. Available from: <http://www.bfs.admin.ch/bfs/portal/de/index/themen/04/02/05/key/01.Document.165810.xls>. [09 March 2015]

19. Bundesministerium für Verkehr und digitale Infrastruktur, 2014. *Verkehrsverflechtungsprognose 2030 Schlussbericht, Los 3: Erstellung der Prognose der deutschlandweiten Verkehrsverflechtungen unter Berücksichtigung des Luftverkehrs*. Available from: <http://www.bmvi.de/SharedDocs/DE/Anlage/VerkehrUndMobilitaet/verkehrsverflechtungsprognose-2030-schlussbericht-los-3.pdf?__blob=publicationFile>. [15 December 2014]

20. Civil Aviation Authority, 2000. *The 'Single Till' and the 'Dual Till' Approach to the Price Regulation of Airports*, Consulation Paper. Available from: <http://www.caa.co.uk/docs/5/ergdocs/stdt(caa122000).pdf>. [04 December 2014]

21. Civil Aviation Authority, 2011. *Airport market power assessments Catchment Area Analysis*, Working Paper October 2011. Available from: < http://www.caa.co.uk/docs/5/Catchment%20area%20analysis%20working%20paper%20-%20FINAL.pdf>.

22. Civil Aviation Authority, 2011. *Guidance on the assessment of airport market power*. Available from: < http://www.caa.co.uk/docs/5/Final%20Competition%20Assessment%20Guidelines%20-%20FINAL.pdf>. [15 January 2014]

23. Civil Aviation Authority, 2011. *UK Airports Market - General Context*, Working Paper September 2011. Available from: <http://www.caa.co.uk/docs/5/20110905%20Market%20Context-FINAL.pdf>. [12 January 2014]

24. Civil Aviation Authority, 2013. *Consultation on Heathrow Market Power assessment*, CAP 1051. Available from: < http://www.caa.co.uk/docs/33/CAP%201051%20Consultation%20on%20Heathrow%20market%20power%20assessment%20(p).pdf>. [14 January 2014]

25. Copenhagen Economics, 2012. *Airport Competition in Europe*. Available from: <https://www.aci-europe.org/component/downloads/downloads/3302.html>. [30 November 2014]

26. Copenhagen Economics, 2012. *Technical Annex - Airport Competition in Europe*. Available from: <https://www.aci-europe.org/component/downloads/downloads/3269.html>. [30 November 2014]

27. Forsyth P. 2004, "Locational and monopoly rents at airports: creating them and shifting them", *Journal of Air Transport Management*, 10 (2004) 51–60, Available from Elsevier. [04 December 2014]

28. Fröhlich K. 2010, *Airports as two-sided markets? A critical contribution*, University of Applied Sciences Bremen, Available from: <http://www.infraday.tu-berlin.de/fileadmin/fg280/veranstaltungen/infraday/conference_2010/papers_prepresentati/paper---froehlich.pdf>. [12 December 2014]

29. Fu X., Lijesen M. & Oum T.H. 2010, *An Analysis of Airport Pricing and Regulation in the Presence of Competition Between Full Scale Airlines and Low Cost Carriers*, CIRJE Discussion Paper, CIRJE-F-316, Available from: <http://www.cirje.e.u-tokyo.ac.jp/research/dp/2005/2005cf316.pdf>. [14 December 2014]

30. Gillen D. & Niemeier H.-M. 2007, *Comparative Political Economy of Airport Infrastructure in the European Union: Evolution of Privatization, Regulation and Slot Reform*, Working Paper 2007-6, Centre for Transportation Studies, Available from: <http://www.sauder.ubc.ca/Faculty/Research_Centres/Centre_for_Transportation_Studies/~/media/Files/Faculty%20Research/OPLOG%20Division/OPLOG%20Publications/GILLEN/Gillen%20-%20Airport%20Infrastructure.ashx> [27 November 2014]

31. Gordijn H. & Kolkman J. 2011, *Effects of the Air Passenger Tax. Behavioral responses of passengers, airlines and airports*, KiM Netherlands Institute for Transport Policy Analysis, Available from: <http://www.kimnet.nl/sites/kimnet.nl/files/effects-of-the-air-passenger-tax.pdf> [19 Dezember 2014]

32. Hess S. 2010, *Modelling air travel choice behaviour*, in Forsyth, P., Gillen, D. Müller, J., and Niemeier, H-M. (eds.), Airport Competition: The European Experience, Ashgate, Aldershot, pp. 151-176

33. ICAO, 2004. *ICAO's Policies on Charges for 2 Airports and Air Navigation Services*. Doc 9082/7. Available from: <http://www.icao.int/publications/Documents/9082_7ed_en.pdf>. [5 December 2014].

34. ICAO, 2013. *Airport Competition*, Working Paper ATConf/6-WP/90. Available from: <http://www.icao.int/Meetings/atconf6/Documents/WorkingPapers/ATConf.6.WP.090.en.pdf>. [23 November 2014]

35. ICAO, 2013. *Case Study on Commercialization, Privatization and Economic Oversight of Airports and Air Navigation Services Providers – Germany*. Avail-

able from: <http://www.icao.int/sustainability/CaseStudies/Germany.pdf>. [30 December 2014]

36. Link H., Goetze W. & Himanen V. 2006, *Estimating the marginal costs of airport operation by using multivariate time series models with correlated error terms*, Diskussionspapier Nr. 11, Institut für Verkehrswissenschaft. Available from: <https://www.wiwi.uni-muenster.de/ivm/materialien/forschen/veroeffentlichungen/Diskussionspapier11.pdf> [03 December 2014]
37. Littlechild S.C. 2011, German airport regulation: framework agreements, civil law and the EU Directive, *Journal of Air Transport Management*, Volume 21, July 2012, Pages 63–75. Available from Elsevier. [08 January 2014]
38. Lösch A. 1962, *Die räumliche Ordnung der Wirtschaft*, 3rd Edition, Stuttgart
39. Maertens S. 2010, *Estimating the market power of airports - a European-wide approach*, DLR G.A.R.S. session, Available from: <http://www.infraday.tu-berlin.de/fileadmin/fg280/veranstaltungen/infraday/conference_2010/papers_presentations/presentation---maertens.pdf>. [19 November 2014]
40. Maertens S. 2012, Estimating the market power of airports in their catchment areas – a Europe-wide approach, *Journal of Transport Geography*, 22 (2012) 10–18, Available from Elsevier. [20 November 2014]
41. Malina R. 2006, *Market power and the need for regulation in the German airport market*, Discussion paper no. 10, Institute of Transport Economics. Available from: <https://www.wiwi.uni-muenster.de/ivm/materialien/forschen/veroeffentlichungen/malinadiskussionspapier_10.pdf> [30 December 2014]
42. Marques R. C. & Brochado A. 2008, "Airport regulation in Europe: Is there need for a European Observatory?", *Transport Policy*, 15 (2008) 163–172, Available from Elsevier. [01 December 2014]
43. Monteiro J. 2010, *Do Airports Compete?*, Available from: <http://www.ctrf.ca/conferences/2010Toronto/2010Proceedings/35MonteiroDoMonteiroDoAirpo.pdf> [09 December 2014]
44. Mueller-Rostin C. 2008, *Airport Entry and Exit: A European Analysis*, Available from: <http://userpage.fu-berlin.de/~jmueller/gapprojekt/downloads/gap_papers/Muel_Rost_Nie_Ivan_Han_Ehm_Airport%20Entry%20and%20Exit_jul_08.pdf> [18 December 2014]
45. Niemeier H.-M. 2010, Effective regulatory institutions for air transport: a european perspective, International Transport Forum, Discussion Paper No. 2010-20, <http://www.oecd-ilibrary.org/docserver/download/5km4d6gsckbq.pdf?expires=1419350389&id=id&accname=guest&checksum=E6E449674B7CF02B754A42CD0ED6C08D> [22 December 2014]

46. Niemeier H.-M. 2013, *Expanding Airport Capacity Under Constraints in Large Urban Areas: The German Experience*, International Transport Forum, Discussion Paper No. 2013-4, Available from: <http://www.internationaltransportforum.org/jtrc/DiscussionPapers/DP201304.pdf> [23 December 2014]

47. OECD/ITF 2010. *Airport Regulation Investment & Development of Aviation, 2010*. Available from: <http://www.internationaltransportforum.org/2010/pdf/Fraport.pdf> [28 December 2014]

48. Oum T.H., Zhang A. & Zhang Y. 2003, "Alternative Forms of Economic Regulation and their Efficiency Implications for Airports", *Journal of Transport Economics and Policy*, Volume 38, Part 2, pp. 217-246. Available from JSTOR. [22 November 2014]

49. Reinolds-Feighan A.J. 2010, "Characterisation of airline networks: a North American and European Comparison", *Journal of Air Transport Management*, 16 (3): 109-120, Available from Elsevier. [25 November 2014]

50. Sherman R. 1989, *The regulation of monopoly*, Cambridge University Press, Cambridge.

51. Starkie D. 2002, "Airport regulation and competition", *Journal of Air Transport Management*, 8 (2002) 63–72, Available from Elsevier. [20 November 2014]

52. Starkie D. 2005, "Making airport regulation less imperfect", *Journal of Air Transport Management*, 11 (2005) 3–8, Available from Elsevier. [20 November 2014]

53. Strobach D. 2006, *Competition between airports with an application to the state of Baden-Württemberg*, Hohenheimer Diskussionsbeiträge, Nr. 272/2006, Available from: <http://www.uni-hohenheim.de/RePEc/hoh/papers/272.pdf>. [11 December 2014]

54. Tretheway M. & Kincaid I. 2005, *Competition between airports in the new Millennium: what works, what doesn't work and why*, 8th Hamburg Aviation Conference, Available from: <http://www.intervistas.com/downloads/Competition_Between_Airports.pdf>. [08 December 2014]

Annex (additional Figures and Tables)

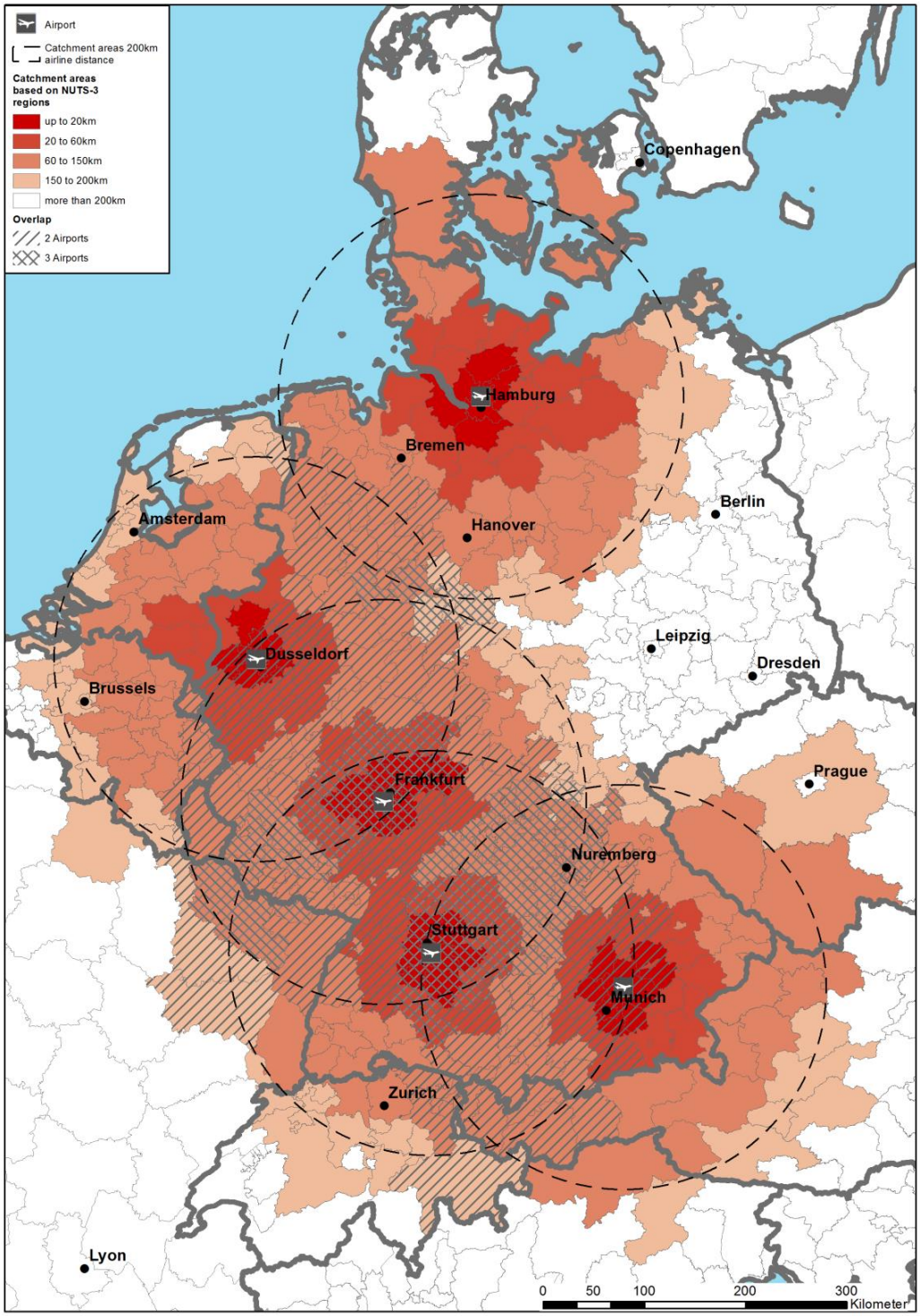

Fig. 9: Catchment area of Frankfurt, Munich, Stuttgart, Dusseldorf and Hamburg

	basic scenario	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
FRA							
MP	3.343.478	740.339	3.021.680	3.374.748	3.131.551	3.312.402	3.082.469
MP share	41%	40%	41%	44%	38%	39%	31%
CA share own	62	61	56	62	58	61	57
CA share comp	26	26	24	24	24	26	22
CA rel share own	71	70	70	72	71	70	73
CA rel share comp	29	30	30	28	29	30	27
MUC							
MP	1.807.857	314.128	1.564.774	1.614.747	1.987.069	1.831.503	2.049.504
MP share	22%	17%	21%	21%	24%	22%	20%
CA share own	56	57	49	50	62	57	63
CA share comp	20	21	18	18	17	20	17
CA rel share own	74	73	74	74	78	74	79
CA rel share comp	26	27	26	26	22	26	21
STU							
MP	1.116.902	229.056	1.073.053	931.865	1.156.823	1.266.625	1.752.368
MP share	14%	12%	14%	12%	14%	15%	17%
CA share own	22	21	21	18	22	24	32
CA share comp	55	53	49	55	48	60	48
CA rel share own	28	29	30	25	32	29	40
CA rel share comp	72	71	70	75	68	71	60
DUS							
MP	1.274.250	417.869	1.191.731	1.171.075	1.258.104	1.333.442	1.667.920
MP share	16%	22%	16%	15%	15%	16%	17%
CA share own	38	39	35	35	37	39	49
CA share comp	37	32	33	38	32	36	29
CA rel share own	51	55	52	47	54	52	62
CA rel share comp	49	45	48	53	46	48	38
HAM							
MP	652.720	164.890	566.920	521.940	640.185	673.845	1.492.469
MP share	8%	9%	8%	7%	8%	8%	15%
CA share own	32	36	28	25	31	33	73
CA share comp	2	2	2	2	2	2	2
CA rel share own	93	94	94	92	95	93	97
CA rel share comp	7	6	6	8	5	7	3

Tab. 5: Scenario results overview

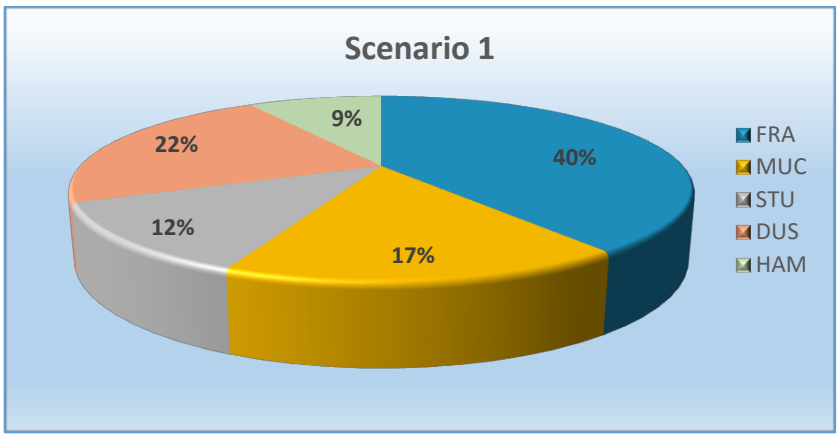

Fig. 10: Airport Market Shares – first scenario

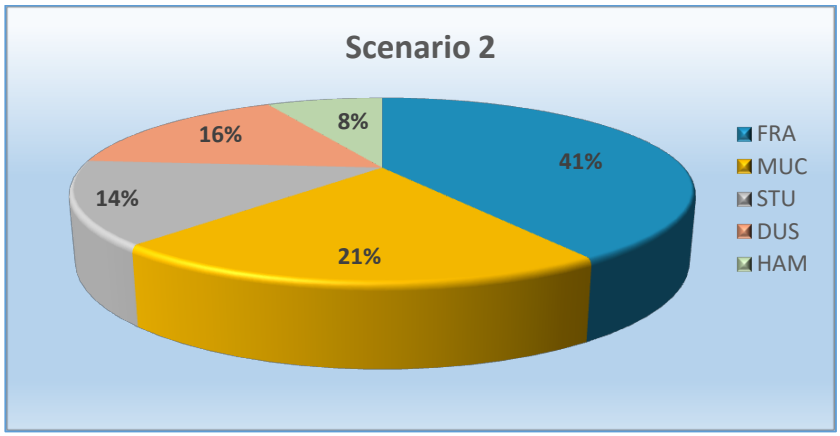

Fig. 11: Airport Market Shares – second scenario

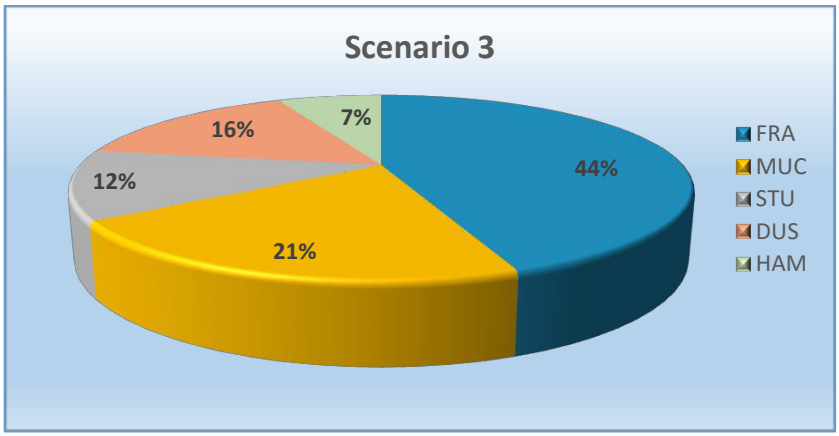

Fig. 12: Airport Market Shares – third scenario

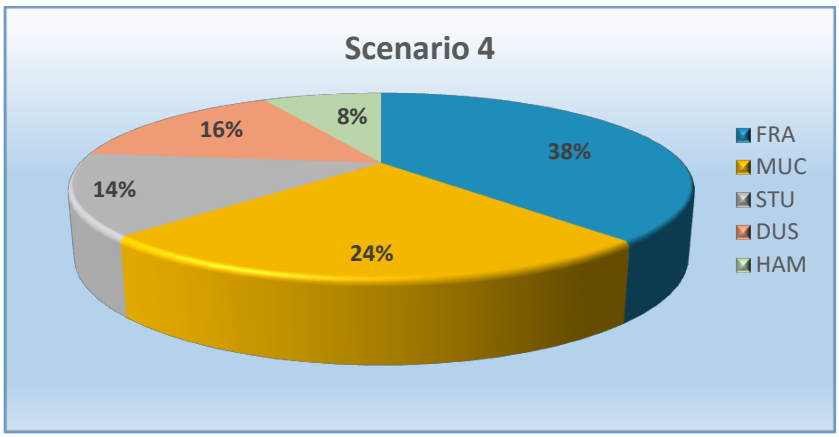

Fig. 13: Airport Market Shares – fourth scenario

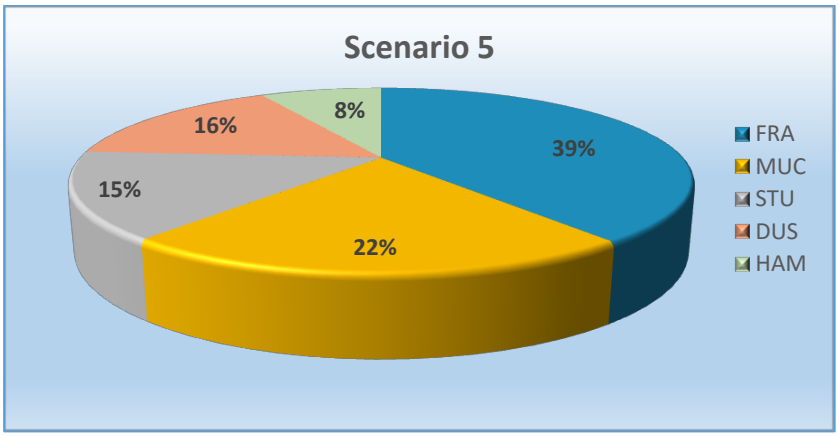

Fig. 14: Airport Market Shares – fifth scenario

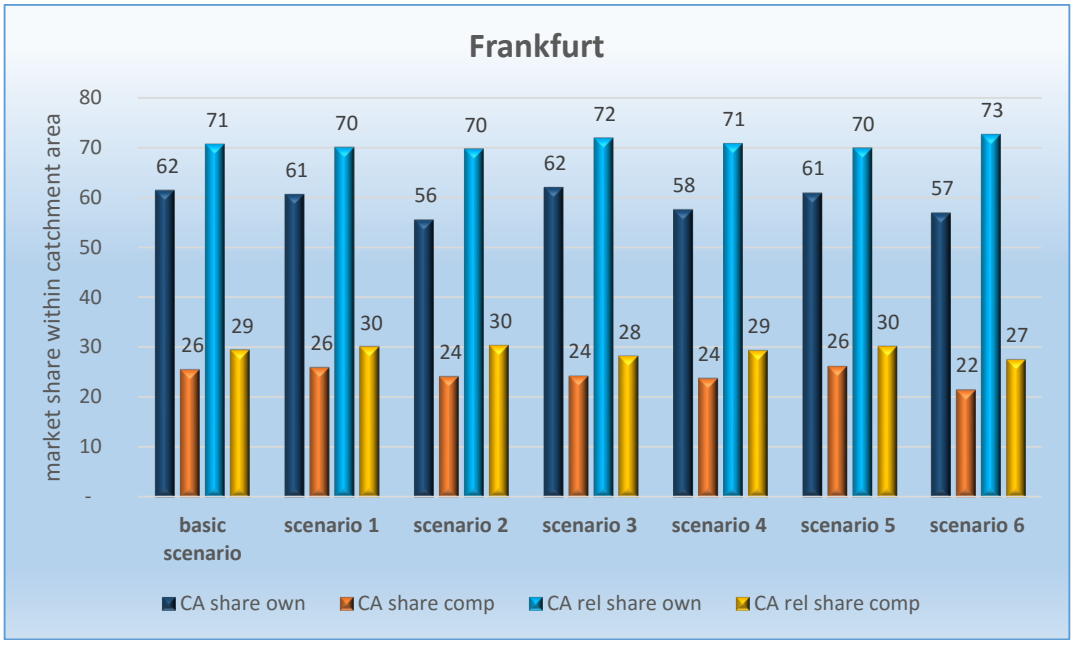

Fig. 15: Market share within relevant catchment area - Frankfurt

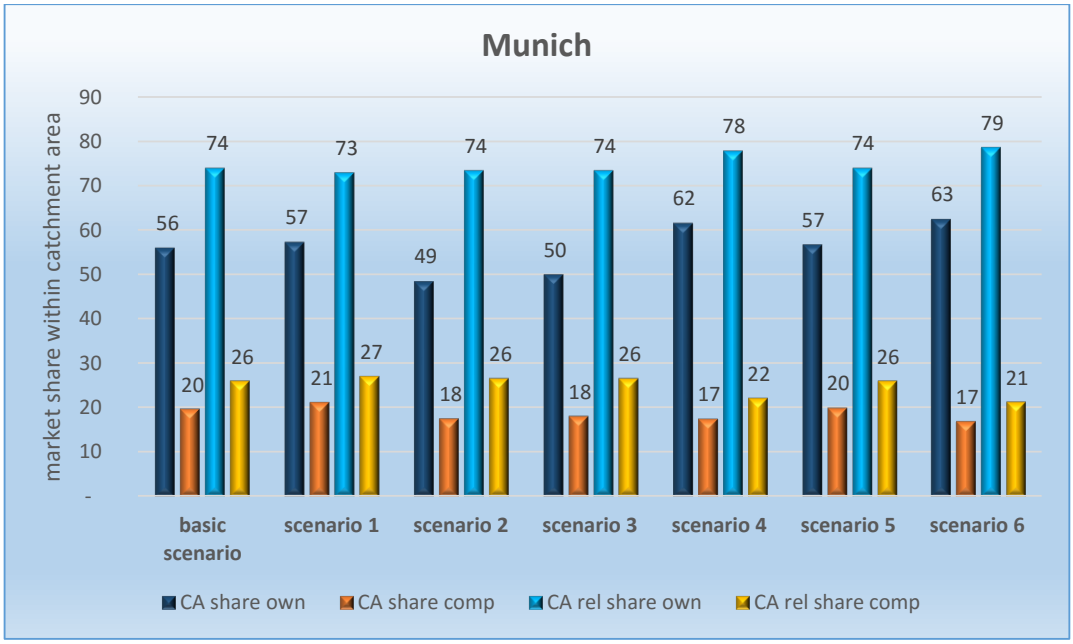

Fig. 16: Market share within relevant catchment area - Munich

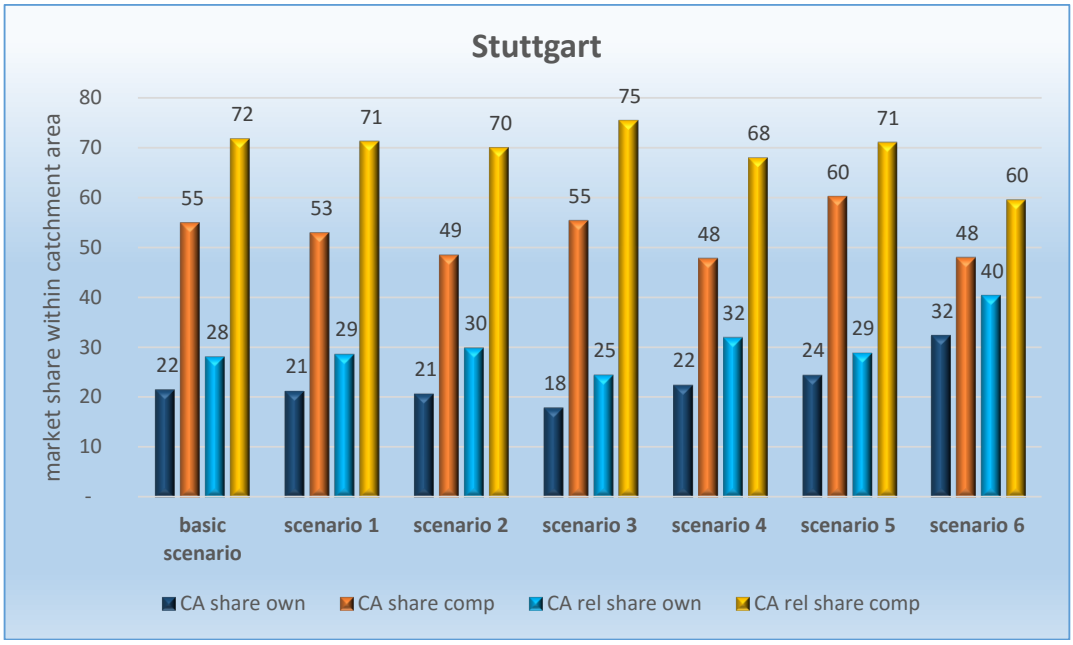

Fig. 17: Market share within relevant catchment area - Stuttgart

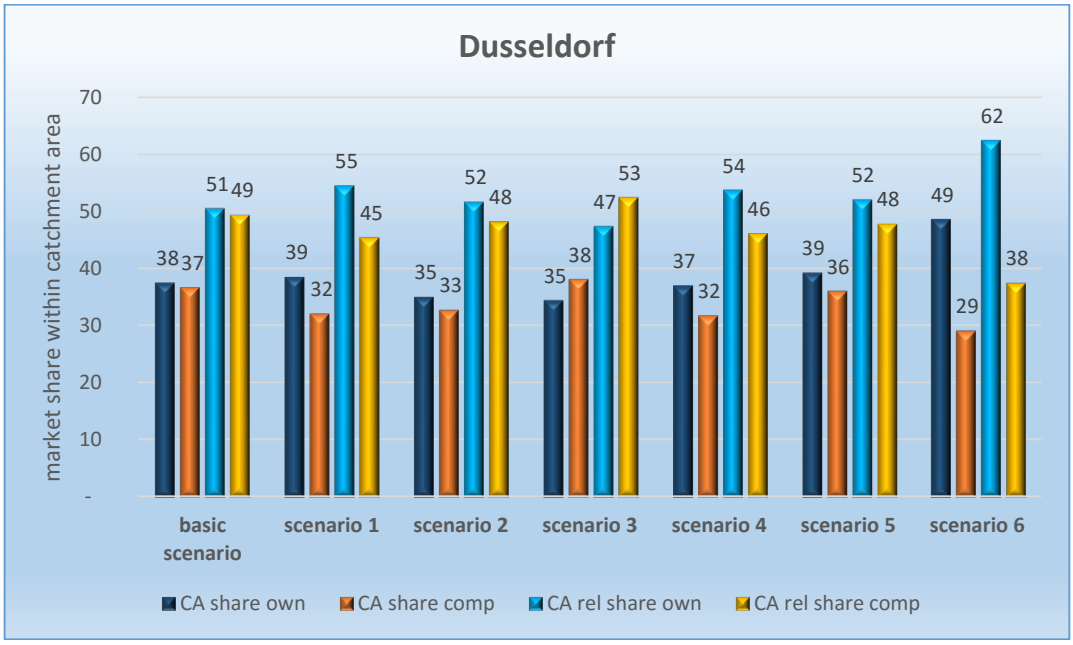

Fig. 18: Market share within relevant catchment area - Dusseldorf

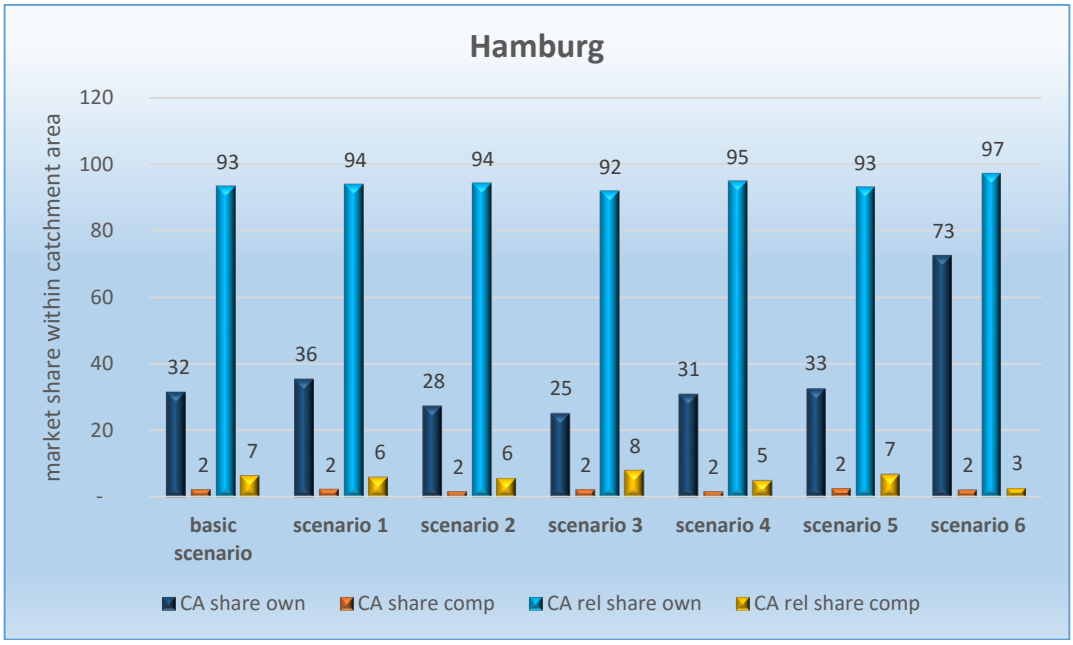

Fig. 19: Market share within relevant catchment area - Hamburg

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