

Economic Effects of Airports in Central Europe: A Critical Review of Empirical Studies and Their Methodological Assumptions

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Abstract The availability of an adequate infrastructure (i.e. transport, communication facilities, power supplies, logistics) to provide certain essential services is indispensable for economic development. The organization and provision of services of an airport have a wide range of effects on the economy of the region and for the whole country. The public and private sectors, especially companies and households in general take the proximity of an airport into consideration when making decisions with regard to the location of a business or to investments in private property, such as a residence. In this paper, a review is made of a number of studies that have been carried out already to identify and to assess the different economic effects related to air transportation facilities in a regional economic context. A comparison is made of the empirical results, assumptions and methods which are used to make these assessments in the studies that have been recently published. In this paper, it is revealed that, of the determinants that were found, the great volume of traffic at airports is one which does indeed have a very marked effect on a region. However, in these studies, there is much diversity in the design of the study, the methods used and, consequently, the assumptions, and location, which makes a comparative analysis very difficult. Especially the methods that were used to assess the effects are critically reviewed, and the problems arising owing to methodologically inherent overestimations are discussed.

Keywords Airport Infrastructure, Airport Expansion, Regional Economics Effects of Airports, Methods and Assumptions

1. Introduction and Background

In a modern society, connectivity of a region to the rest of the world is a vital factor for international competitiveness, when selecting a location or whether to make an investment of international companies, and for social as well as regional

cohesion. The demand for air travel and the growth of the air transport sector is not only stimulated by economic but also by social and cultural influences in the context of an increasingly globalized world (European Commission, 2007; Lakshmanan & Anderson, 2001). Increasing (international) trade in goods and services, and the growing income of private households have been fundamental determinants for the growth of overall air traffic (Michalski, 1999; Bieger et al., 2007). The demand for passenger air travel depends on the socio-economics of passengers, such as their age, income, occupation, and size of the family. In terms of leisure travel, the most important variable is the household income (Doganis, 2002).

From the commercial viewpoint, air transport infrastructure provides not only fundamental services to households and companies, and contributes to international economic competitiveness by facilitating (intercontinental) traffic, but also benefits regions by increasing accessibility for and to enterprises, and thus higher productivity, reduced costs, as well as access to markets where their goods and services can be traded, besides the necessary factors for production (Allroggen and Malina, 2010; see also European Commission; 2003; Moump and de Raan, 2007; Haynes and Button, 2001). The attributes of a potential location for a company significantly determine the attractiveness of a region as a whole and this, in turn, influences the choice of location of companies (Krumm et al., 2007). The attributes of a location that are taken into consideration by a company include the transport connections (via road, rail, air, waterways), the characteristics of the labor market (e.g., education and qualifications of the workforce at hand, level of wages, labor supply) and the provision of an infrastructure that meets the needs of an enterprise play a significant role in the entrepreneurial process of deciding on a location (Zdrowomyslaw & Bladt, 2009). Capacity constraints of infrastructure might thus lead to significant economic problems (Gelhausen, 2011).

The interrelation between (air) transport infrastructure, the provision of essential services, and regional as well as national economic development is complex. The economic

effects of improvements in the transport sector depend basically on the specific regional context. For instance, economic effects are influenced by pre-existing transport infrastructure networks, the current state and dynamics of economic development, and the level of regional competition (Lakshmanan & Chatterjee, 2005). The economic effects of an airport are not restricted to employment nor to added value in the transportation sector. Airports also significantly affect other interrelated sectors of an economy, as they provide the infrastructural “backbone” of many economic activities.

Green (2007) assessed the relationship between airports and economic development by concentrating on the econometric difficulty of simultaneity. The question of causality, i.e., whether airports are a cause or a function of growth and economic development, remains complex. The linkages between the air transportation sector and economic activities can be seen as interdependent. Airports generate employment and facilitate economic activities that rely on the availability of air services, and, in turn, this economic development stimulates the demand for air transportation services (Ishutkina, 2009).

According to Hakfoort et al. (2001), when an airport expands, both temporary and permanent effects on the demand as well as on the supply side of the economy can be ascertained. Investments in the expansion of airports contribute to a temporary demand for construction enterprises and their intermediary suppliers. Crowding-out effects in the wider economy may, however, be a consequence of certain projects, for example, with regard to the financing of the investments of infrastructure projects. The permanent effects of running airport facilities (on account of the costs of maintenance and operation) are those concerned with employment (handling, transportation) on the demand side, and those on the productivity and the location of economic activities on the (dynamic) supply-side as a consequence of a reduction of transportation costs (Percoco, 2010).

Thus, there are basically two kinds of economic effects related to airports (Graham, 2008, Hujer, 2008). The first kind ensues through the generation of employment, income, and capital investment “naturally” occurring in the process of producing airport services. The second kind of effects are the dynamic economic “catalytic” or “spin-off” benefits, in particular the direct/inward investment including tourism development stimulated by airports. Economic benefits associated with airport operations can be further subdivided into direct, indirect, induced, and catalytic effects (ACI Europe and York Aviation, 2004). Indirect and induced effects are also referred to as backward linkages (WIFO, 2007).

For the assessment of this wide range of effects, different methods and approaches are used. Planners, regulatory agencies, and airport operators frequently rely on studies on economic effects to ascertain (and monetize) the contribution to national as well as regional economies (TRB, 2008).

Based on this general background, the current paper

reviews recent empirical studies with a specific focus on Germany, Austria, and Switzerland, and the methods used to assess the economic effects of airports. The main topic of this paper is on assessing the regional economic effects in terms of short- and long-run effects on production and value added, and on catalytic effects for the regional economy. Of course, airports may have many other effects which may also be negative; such effects include noise and air pollution, health impacts, extensive use of energy, resources and land. However, these effects have been dealt with, for instance, by Getzner and Zak (2012). As the current paper will show, studies on the regional economic effects rarely include negative environmental effects (and vice versa). One important conclusion of this paper is thus to call for an integration of these diverse effects – both negative and positive – to enable a broader perspective on airports from the viewpoint of infrastructure economics.

The structure of the paper is organized as follows: in Section 2, different models and the consequences that are to be expected are reviewed. Special attention is paid to input-output models because of their wide application. The economic effects described and assessed in international studies are analyzed in Section 3 by consolidating the structural performance data on airports and the resulting effects. The main focus of the analysis is on the European aviation sector and the consequences to be expected for regional economic development. In Section 4 the limitations of the different methods are discussed as well as the problems encountered in the attempt to classify and compare the empirical results obtained in the diverse studies. A summary of the empirical findings and discussion, complemented by potential future research fields and desirable improvements, and conclusions, are presented in the final section.

2. The Methods Used to Assess Economic Effects

The direct, indirect, and induced economic effects of air transport services on a region are usually expressed in economic metric terms (employment, production value), whereas improved connectivity, resulting from the expansion of an airport, leads to dynamic, catalytic effects, namely the “quality” of the location for production, income and employment (Baum et al., 2004).

According to the Transportation Research Board (TRB), measuring the economic effects of airport services typically relies on the following approaches (see also e.g. Uniconsult, 2007; Bulwien and Voßkamp, 1999; Voßkamp et al., 2003): input-output models (multipliers), the assessment of costs and benefits, and the analysis of catalytic effects. Other approaches, such as general equilibrium models or econometric regional economic models do not play a major role. The most prevalent method is the input-output method, which identifies direct, indirect and induced effects. The benefits and costs associated with aviation are measured

quantitatively and qualitatively by means of the ‘collection of benefits’ method, but are usually not calculated in monetary terms. Parameters, such as time saved, costs avoided, and capacity improvements are included. Furthermore, the stimulating effects of commercial activities as well as recreation and community benefits are ascertained. Spillover effects and supply-side effects on investment, productivity and trade are assessed by applying the catalytic method.

However, as noted previously, input-output models are the most commonly used method in the analysis of airport services. Input-output analysis is, of course, an analytical framework developed by Leontief in the 1930s and has been subject to several methodological refinements. Applications of input-output models have traditionally centred on the national level, but modifications of the method on account of the increasing interest in the inclusion of specific local characteristics or of regional economic development are popular (Miller and Blair, 2009).

Input-output studies use, basically, a Keynesian demand model on the grounds of consumption matrices and input-output tables, which are part of national accounting systems and are usually revised every few years. Input-output tables mirror the supply demand linkages of the different production sectors of an economy. The separation of overall into sectoral demand is measured by expenditure flows through the economy and its sectors. By using this method, the effects of an increase in the final demand for employment, added value and income are computed at the regional as well as on national levels (Wollersheim, 2011). The emphasis of this analysis is on the studies on economic effects based on the use of input-output models. The majority of the studies have used this method,¹ despite several constraints and ongoing criticism on the questionable simplification of such models.

3. Recent Evidence of Economic Effects of Airport Services

As mentioned already, a typology of direct, indirect, and induced effects is used in most of the economic impact studies on airports. The category of catalytic effects is often left unconsidered owing to the difficulties in quantifying them. Catalytic effects are therefore assessed only in qualitative terms in most empirical studies. Table 1 provides a rough overview of recent studies on economic effects.

This brief overview of studies on the economic effects draws attention to the wide range of assessments of airports concentrating on economic growth and employment. Before going into more detail, it has to be emphasized that these studies only partially mirror the total economic effects of airports. For instance, the passenger benefits of travelling are frequently not considered. Stanton and Ackerman (2008) present calculations on the generated user benefits related to

the expansion of Heathrow airport. These benefits are measured in addition to the consumer surplus and result from newly attracted passengers measured by the number of flight passengers that would not have travelled (unmet demand). Reliance on the consumer surplus theory, as well as its application in the case of Heathrow, has been subject to criticism since there has been, in particular, uncertainty with regard to demand forecasting, the inclusion of benefits concerning foreign passengers, and the choice of the baseline scenario has been questionable. However, in the following sections, the discussion includes the air transport sector as a whole, the economic effects of single airports, as well as the catalytic effects of airports in more detail with the focus on Germany, Switzerland and Austria.

3.1. The Economic Effects of Air Transportation and Service Sector on a Region

A recent European report, which includes the aggregated data of approximately 190 European airports (Airport Council International, 2011), puts the air transport and service sector into perspective. In 2009, the total gross revenues of € 28.7 billion were generated by European airports. These revenues can be subdivided into the categories of aeronautical, non-aeronautical and ground-handling revenues. Aeronautical revenues are comprised of airline as well as passenger-related revenues (e.g., landing fees) and amounted to € 13.9 billion. Non-aeronautical revenues, particularly those stemming from retail concessions, real estate management, and car parking have become essential for the economic viability of airports with a volume of € 12.1 billion. Ground-handling revenues totaled € 1.8 billion. Operating expenses amounted to € 18.6 billion with personnel costs remaining the largest single general cost item and accounting for 42% of the total expenses, followed by outsourced services (23%) and costs for communication, administration, and utilities (6%). Investments in the development and modernization of the infrastructure of airports fell to € 8.9 billion as a result of the recent economic crisis.

An earlier study made by the Air Council International Europe (ACI Europe, 2004) is a survey of the economic, as well as social, effects of European airports. Taking into account the evidence obtained from 25 representative European airports, weighted averages are used to estimate the induced and indirect multipliers for the national, regional, and sub-regional levels. The evidence indicates that for 1,000 on-site jobs, there are 2,100 indirect and induced jobs on the national level, an additional 1,100 jobs on the regional level, and another 500 jobs on the sub-regional level. Furthermore, on average, airports provide 950 on-site jobs per million passengers (workload units). Including indirect and induced effects, European airports support around 2,950 jobs nationally, 2,000 regionally and 1,425 jobs sub-regionally for every million passengers.

¹ A rare exception is the study by Sellner and Nagl (2010) who applied an econometric endogenous growth model.

Table 1. Selected recent studies on the economic effects of airport services

Reference (study)	Airport/country	Focus of study and effects
Leigh Fisher Management Consultants (2011)	Sacramento County Airport (US)	Effects on employment, payroll, as well as visitor and total expenditure
Bogai and Wesling (2010)	Berlin Brandenburg airport (GE)	Employment effects owing to airport expansion
Malina and Allroggen (2010)	Dortmund airport (GE)	Purchasing power effects, fiscal effects
Percoco (2010)	Several airports in Italy	Local development
Röhl (2009)	Regional airport infrastructure in Germany	Interregional spillovers owing to accessibility, and constraints for monopoly positions
O'Donoghue (2009)	Several airports in Ireland	Strategies for airport development
Boon et al. (2008)	London Heathrow expansion (UK)	Economic benefits
Malina et al (2008)	Dortmund airport (GE)	Direct, indirect and induced effects of an airport expansion
OEF (2006)	UK aviation sector	Contribution to economic growth, trade, tourism and investment
Baum et al. (2005)	Frankfurt airport (GE)	Employment structure, regional labor market, regional economic structure
Hujer et al. (2004)	Frankfurt airport (GE)	Employment and income effects of an airport expansion
Brueckner (2003)	US metropolitan airports	Relation of airline traffic and employment development
Hart and Mccann (2000)	London Stansted airport (UK)	Regional economic effects and future potentials associated with the continuing growth of the airport

Source: Authors' compilation.

Table 2. Selected regional economic effects on gross added value and employment (Germany, Austria)

Airport (reference)	Pass. (thsd. per year)	Production (added value, € million)			(Implicit) multiplier	Employment (no. of jobs)			(Implicit) multiplier
		Direct	Indirect	induced		Direct	Indirect	Induced	
Lübeck, 2005 (Abraham et al., 2007)	780	11.2	3.1	2.5	0.5	258	64	50	0.4
Frankfurt-Hahn, 2005 (Heuer and Klopheus, 2007)	3,080	112	56.3	34.8	0.8	2,431	1,028	690	0.7
Cologne/Bonn, 2006 (ARC et al., 2008)	9,300	800	528	88	0.77	12,460	10,100	1,679	0.95
Hannover, 2007 (Huebl et al., 2008)	5,600	501.9	190.5	461.8	1.3	7,969 (FTE)	4,251 (FTE)	7,647 (FTE)	1.5
Dortmund, 2005 (Malina et al., 2007)	1,743	121.92	77.9	20.96	0.8	1,531	1,248	371	1.1
Vienna, 2005 (Wifo, 2007)	19,000	1,173	2,550		2.2	16,031 (FTE)	36,750 (FTE)		2.3

FTE: Full-time equivalents; multiplier: indirect/induced added value (employment) per unit of direct added value (employment).

"Regional" refers to the study-specific assumptions made regarding the boundaries of the affected region (e.g., political districts or federal provinces).

Source: Authors' compilation.

In the remainder of this paper, the focus is on the studies that use input-output models and also use this typology of the four categories of effects to discuss the effects of airports as providers of important infrastructure services on (regional) production and employment

3.2. Review of Studies on Economic Effects of Airports in Germany, Switzerland and Austria

Table 2 presents an overview of selected recent studies on the effects of airports which are focused specifically on German, Swiss and Austrian airports.

The effects of Lübeck Airport on the regional economy and a potential increase of these effects associated with a potential expansion are assessed in a study by Abraham et al. (2007). Indirect, as well as induced income and employment effects are included in an input-output analysis. In turn, these effects generate additional tax revenues (fiscal effects). For

the year 2005, gross added value amounted to € 36.4 million, whereas € 11.2 million were attributable to direct effects, € 10.3 million to indirect effects, € 9.9 million to catalytic effects, and € 5 million to induced effects. In terms of employment: 258 persons were employed directly and 197 indirectly. 355 employees could be attributed to the catalytic effects, and 101 to induced (second-round) effects. In terms of the regionalization of indirect and induced effects, a twofold method is utilized, which combines a business survey and adjusted branch-specific regional preference rates for procurements by companies. The region is defined as the area around the airport which is within a 30-minute-isochron. Thus, a regional gross added value of € 16.8 million (i.e. € 11.2 million direct plus € 3.1 million indirect and € 2.5 million induced gross added value) and the regional employment effects of 50 induced jobs and 64 indirect jobs were computed. Based on the estimates of these effects the relation of direct employment and the sum of indirect and induced employment, a national employment multiplier of 1.2, and a regional multiplier of 0.4 were computed. Compared with other studies this low value can be attributed to the particular structure of the airport, i.e. the dominance of low-cost carriers and the absence of commercial enterprises at the airport. In terms of gross added value, a national multiplier of 1.4 and a regional multiplier of 0.5 have been assessed.

The authors emphasize that catalytic effects are the result mainly of connectivity and accessibility of the region. Connectivity is a pivotal factor for companies in terms of company location as well as expansion and fosters economic growth in the tourism sector. Moreover, proper transport connections are an important instrument to stimulate the regional economy.

The Airports Council International methodology was used to analyze the current economic effects Frankfurt-Hahn Airport also has a potential for regional development. (Heuer & Klophaus, 2007; Heuer et al., 2005). It is remarkable that passenger numbers increased from 20,814 passengers in 1997 to 3,079,528 passengers in 2005. A similar development was registered in the volume of cargo; 5,501 tons were handled in 1997 and 228,920 tons in 2005. The relevant region consists of the four administrative districts of Bernkastel-Wittlich, Birkenfeld, Cochem-Zell and Rhein-Hunsrück. The national accounts data and the inputs of surveys carried out among airport related companies were combined to obtain these figures. Based on an input-output analysis, a total of 2,431 employees at the airport and € 112 million (added value) were the direct effects in 2005: The indirect regional effects were a total of 1,028 employees and the generation of the gross added value of € 56.3 million. The regionalisation of induced effects relies on the assumption that there is a linear relation between the regional share of household expenditures and the place of residence. Regionally induced effects account for 690 employees and a gross added value of € 34.8 million. The ratio of direct employment to the total of indirect and induced employment produces the regional employment multiplier of 0.7 and the

national multiplier of 1.5. Summing up indirect and induced gross added value and expressing it as a ratio to the direct gross added value produces the regional multiplier of 0.8 and the national multiplier of 1.7.

The role of Cologne-Bonn Airport as an economic and location factor is subject to a recent survey by ARC et al. (2008). Cologne-Bonn Airport is the largest low-cost carrier airport in Germany. Direct effects are assessed by carrying out on-the-spot research at the airport, through interviews with experts and surveying companies as well as working conditions. Additionally, indirect and induced effects are estimated on the basis of input-output models. The analysis of catalytic effects requires a company survey in the region and is complemented by passenger surveys and qualitative interviews per telephone with companies located in the region. The Cologne-Bonn region includes the cities Bonn, Cologne and Leverkusen as well as the districts of Rhein-Sieg, Rhein-Erft, Rheinisch-Bergisch and Oberbergisch. The indirect effects are regionalized for the Cologne-Bonn area by quantifying the intraregional delivery quota using the national input-output table. For 2006, a total of 12,460 direct employees and a direct gross added value of € 800 million were estimated. As to the indirect effects, the airport generated 10,100 jobs and a gross added value of € 528 million, and another 1,679 jobs and a gross added value of € 88 million were induced by airport operations on the regional level. For the total economy, a gross added value of € 854 million was generated as an indirect effect as well as another € 171 million as an induced effect. Based on the estimated effects, the underlying multipliers are 0.95 regionally, and 1.98 nationally in terms of employment; and 0.77 on the regional and 1.28 on the national levels in terms of gross added value.

In terms of catalytic effects, the authors distinguish between the jobs generated as a result of the location companies selected for their enterprises (approximately 9,000 jobs were created in the period from 1997 to 2006), increases in purchasing power related to incoming business and tourists) (320,000 foreign tourists and 450,000 business travelers generate an increase in purchasing power of € 270 million per year), and (negative) effects on purchasing power induced by additional travel activity on account of the existence of the airport (€ -52 million). These values are based on existing empirical studies, and the result is an estimated share of the airport-induced additional incoming travel as 15%, and as 7.5% for outgoing tourism.

The role of Hannover Airport in the regional development of the Hannover region is questioned in a study by Huebl et al. (2008). The passenger volume amounts to approximately 5.6 million persons and the cargo volume to about 6,000 tons annually. This is an insignificant amount of cargo and is a consequence of rationalization and the concentration of cargo on hub airports (i.e. Munich airport). The region includes both a broad and a narrow catchment area for the airport, covering the area from Cuxhaven to Kassel and from Osnabruck to Magdeburg. For the year 2007, direct, indirect and induced effects were estimated, whereas the latter are

further subdivided into consumer expenditure by the State and private households. With 7,969 employees (FTE) at the airport, Hannover Airport is one of the largest places of employment in the region. Another 11,898 jobs (FTE) were generated through airport activity as indirect (4,251 FTE) and induced effects (1,206 induced by State expenditures and 6,441 induced by household expenditures). The underlying employment multiplier for the region is 1.5 and for Germany it is 2.8, which means that for every employee at the airport there are 2.8 additional jobs in Germany's economy. The effects on gross added value for the Hannover region have been ascertained as a direct gross added value of € 501.9 million and indirect effects on gross added value of € 190.5 million.

Malina et al. (2007) analyzed Dortmund Airport and identified direct, indirect and induced effects observed throughout the year 2005. Passenger numbers, as well as flight movements, increased significantly in the period from 1998 to 2005. In the year 2005, 1,742,891 passengers were counted compared with 610,640 passengers in 1998. A direct gross added value of € 121.92 million and 1,531 direct employees were estimated. These effects were identified by utilizing national accounts data from 2003 and extrapolating the data for the year 2005. To regionalize the effects, the computed national coefficients were adapted to the airport region.

The indirect effects of € 77.9 million, in terms of gross added value, and the additional employment of 1,248 persons were computed for the region. The employment numbers are based on sector specific employment coefficients (i.e. a sectoral employment coefficient is defined as the number of employees required for a production value of € 1.0 million.) for all of the economic branches that were taken into consideration. For the regionalization of the economic effects, the data of the regional shares of demand were necessary, and so these shares were estimated by means of a business survey and combined with the data of the most recent input-output table.

Induced effects result from the additional consumption of goods and services by direct as well as indirect employees of the airport. Especially, regionalization is difficult as an exact identification of the spatial distribution of household expenditures is not feasible. As a result of the business survey, 85% of the airport employees and those in the companies in the vicinity live in the airport region. Thus, it is assumed that most of the employees at the airport purchase goods and services within the region. In terms of producers of intermediate products and capital goods, a regional share of 0.6% is used, based on the assumption that most employees of these enterprises do not live in the defined airport region. The resulting regional consumption expenditures are again combined with the input-output tables leading to an induced employment of 371 jobs and a gross added value of € 20.96 million. Thus, a regional employment multiplier of 1.8 at the national level, and of 1.1 at the regional level, is applied by relating summarized induced and indirect employment and direct employment.

Furthermore, effects on purchasing power on the regional level are described, and included in the input-output model by using the results from passenger survey data, secondary data and input-output analysis. Regional effects on purchasing power owing to incoming as well as outgoing travelers are also differentiated and included in the input-output model via passenger surveys. On average, incoming tourists spend € 205.67, while incoming business travelers spend € 221.9 (not including ticket expenses). This is to be compared with outgoing tourists, who spend € 434.7 on average, and outgoing business travelers, who spend € 517.98, on average. These values include the expenditure for tickets owing to the fact that they lead to a decrease of purchasing in the region. According to the passenger survey, 56.5% of the incoming travelers spend some time in the region. This percentage is multiplied by the additional purchasing power to regionalize the effects. 44.1% of the outgoing travelers live in the region, and this percentage is used for the multiplication including the losses in purchasing power. With regard to alternative modes of transport or other airports, 75% of the incoming travelers, 85% of the outgoing travelers and 81% of the travelers living in the airport region stated that they would have used another mode of transport or an alternative airport for their journey to or from the region. These statistics were used for further calculations of the regional effects on purchasing power. In addition, non-commencement of travel activities leads to savings of income (not automatically to an identical purchasing power in the region) and thus a saving rate of 15.4% is assumed. Thus, the primary regional purchasing power effects result in a decrease of purchasing power by about € 14.4 million, whereas savings in ticket and travel costs induce additional purchasing power effects of about € 8.8 million. Summing up, this leads to an annual decrease in consumption of about € 5.6 million in the airport region and therefore to a negative impact on employment by 86 jobs and to a decrease of gross added value of about € 4.9 million.

A recent study focusing on the Vienna International Airport assesses the regional economic importance of airport activities by utilizing a model including nine regional input-output tables, an interregional matrix of trade linkages and time series data (WIFO, 2007). The authors distinguish between the annual economic effects as a result of the operation of the airport, measured by gross added value, employment and volume of sales, on the one hand, and, on the other hand, the economic effects resulting from investments totaling € 1.65 billion for the period from 2000 to 2009. Direct effects are ascertained through an analysis of companies which are related to the airport amounting to € 1.173 billion of gross added value. Using model simulations, a gross added value of € 3.650 billion related to induced as well as indirect effects were calculated, whereas 70% (€ 2.55 bill.) of this production value had its origin in the region, which covers the three Austrian provinces of Vienna, Lower Austria, and Burgenland. In 2005, there were 16,031 employees (full-time equivalents; FTEs) at the airport. In addition, 36,750 employees (FTEs) were related to the

airport region. A regional employment multiplier of 2.3 was computed. This indicates that there were 2.3 employees in other economic sectors per person employed at the airport on the regional level. In comparison, the national multiplier is 3.3.

There are also studies on the effects of airports in Switzerland. These studies focus on the effects of regional airports on the air transport system by analyzing the intangible regional economic effects (Wittmer et al., 2009) and the economic relevance of Zurich Airport (Peter et al., 2009). The economic significance of civil aviation for Switzerland is the subject of a study by Peter et al. (2011), in which 3 main airports, 10 regional airports, 47 airfields and 24 heliports are analyzed. In 2009, 37.8 million passengers were transferred and 320,000 tons of cargos were handled. In terms of economic effects, there were 35,600 jobs (FTE) directly at the airport. A further 16,800 FTE were attributable to indirect effects and 71,200 FTEs were induced by airport operation. Catalytic effects amounted to approximately 55,300 FTE. The catalytic effects are defined restrictively with international (incoming) passengers. Furthermore, the effects on gross added value were estimated: CHF 7.0 million direct, CHF 2.7 million indirect, CHF 11.6 induced and CHF 9.0 million catalytic gross added value.

A recent assessment of the economic effects of Zurich Airport analyzes the current state of the airport and tries to identify further development strategies and scenarios for 2020 and 2030. For this purpose, a production model covering the overall activity and economic relevance of the airport, as well as the estimated values of the base year 2008, were used (Peter et al., 2009). With an increasing passenger volume of 22.1 million and 309,000 tons of air cargo in 2008, the growth of the airport is expected to continue. In terms of employment, numbers are available in full-time equivalents (FTEs) for the total Swiss economy: 20,140 FTEs are due to direct, 13,260 FTEs to indirect, 51,160 FTEs to induced and 26,690 FTEs to catalytic effects, whereas the latter only include passenger effects and leave out quantitative business effects resulting because of the location. Added value amounted to CHF 5.1 million (2008 prices) (direct effects), CHF 2.1 million (indirect effects), CHF 8.1 million (induced effects) and CHF 4.28 million (catalytic effects). A qualitative assessment of the catalytic effects on companies and businesses are presented in this study. These effects are termed company-side catalytic effects as they are reflected in the productivity of an economic system. Economies of scale, a broadening of markets and labor markets, new potentiality for tourism and destinations, increasing knowledge spill-overs and potentials for innovation are important parameters that are related to airport activities. The authors confirm that airports have a number of effects on the location of businesses and the promotion of growth on the regional as well as on the national levels. Both studies described above include the environmental costs (i.e. external costs as a result of exposure to noise, air pollution and climate change) in their analyses, and the second study also considers the costs

of accidents.

The role of regional airports with regard to intangible regional and overall economic effects is examined by applying qualitative interviews with experts, surveys of companies and a quantitative assessment. Network effects, structural effects (accessibility, relief of other airports), educational and technological effects are identified (Wittmer et al., 2009).

3.3. Catalytic Effects

Quantification and measurement of direct, indirect and induced economic effects are relatively straightforward tasks. However, air transport is supposed to generate catalytic effects, also referred to as wider economic benefits. Catalytic effects are more complex and therefore difficult to ascertain in analytical frameworks. Besides the studies already discussed above, there are papers which refer specifically to catalytic effects.

The identification and measurement of these effects is made difficult owing to the problematic nature of isolating catalytic effects from other factors. Nevertheless, to make a rough outline of this category of effect, two main classes of catalytic effects are typically assessed within the analyses: those which have to do with economic competitiveness, and those which have to do with social development and regional accessibility (Halpern & Brathen, 2011).

In order to understand the underlying nature of qualitative approaches, such as surveys and interviews with the relevant agents, a close examination of the significance of an airport's existence with regard to decisions on the location of a company or on investments, and to competitiveness, is usually required (Graham, 2008). According to Braun et al. (2010) a distinction can be made between catalytic effects which are consumer surplus, those which are environmental and social effects, and those which are economic spillovers. Positive economic spillovers on the supply-side are increasing inward investments, inbound tourism and productivity improvements, whereas negative spillovers refer to outbound tourism and outward investment, respectively. Consumer surplus, i.e. the difference between consumer's willingness to pay and the air fare or cargo rate, is one of the key economic benefits associated with air transport. Therefore consumer surplus is considered to be the monetary measure of welfare based on travelling. For the assessment of this effect and the estimation of consumer surplus, the average price elasticity of the demand for air transport is proposed and used in the study carried out by Braun et al. (2010).

Cooper and Smith (2005) wanted to develop a reliable method by which catalytic effects associated with air transport could be measured. The first step was to make a distinction between the different main channels of catalytic effects. On the one hand, there are demand-side effects, describing the effects on the net demand for goods. These effects are further differentiated into tourism and trade effects. On the other hand, there are supply-side effects, also

known as supply-side spillovers or externalities, which include effects on investment, on the labor supply, productivity, market structure and innovation, as well as on congestion and local business costs. In terms of these effects it is also necessary to consider potentially adverse supply-side effects. In their analysis, the authors computed the catalytic effects for the EU 25 and identify small demand-side effects (e.g. net air tourism and trade) but significant supply-side effects (e.g. investment and underlying productivity increases) for the last decade.

Arndt et al. (2009) survey the effect of connectivity on the development of regional economies in Germany. For the assessment of the various aspects of catalytic effects, business and passenger surveys, estimations of the willingness to pay and calculations of purchasing power effects as well as econometric methods are commonly used. Catalytic effects, e.g. effects on employment, location and investment decisions, productivity, innovation and tourism are analyzed by applying a three-fold approach, namely, a business survey, a regression analysis and a quantitative assessment of tourism data and effects.

The European Centre for Aviation Development uses sector-specific production values to assess the catalytic effects for Germany's economy, based on incoming tourist's expenditures (ECAD, 2008). The computed purchasing power of € 15.55 billion generated by incoming tourists ensured employment for 391,670 persons in the year 2007. This results in an overall economic gross added value of € 8.31 billion.

4. A Critical Examination and Comparison of Values

Despite the wide application of the different effects considered, methodological constraints and problematic comparability impede comprehensive analyses. Especially the application of input-output analysis methods to evaluate the effects on employment is subject to criticism. The range of multipliers, especially those covering employment effects, varies considerably, and the assessment of time-depending development of the attested employment effects differs from one study to the other.

An explanation for the variations in employment multipliers is the inclusion of different assumptions concerning forward and backward input-output linkages. The geographical size of the area covered by the measurement, as well as the potentially different economic patterns at the airport per se may account for differences (Hakfoort et al., 2001). Data on related employment effects is collected in empirical studies, but either expressed in full time equivalents or in actual job numbers. It is therefore difficult to draw final conclusions in terms of a definite comparison.

Considering the direct employment effects and employment density, respectively, capacity utilization and core activities (e.g. national or international scheduled flights,

freight, charter transport) are crucial factors for their assessment (Uniconsult, 2007). However, for a comparison of various airports, it is to the purpose to combine the data on traffic volume (throughput) with that on direct employment at an airport to obtain an employment density figure. These figures usually use the number of employees per million passengers per annum (mppa) or per million workload unit (mwlu; for freight transport). In order to classify employment density, four different categories can be used. According to ACI Europe (1998) employment density is highly dependent on capacity utilization and development opportunities as there are low, medium, high and very high density airports, as shown in Table 3.

Table 3. Typology of employment density

Typology	Employment (no. of jobs, FTE) per mppa or mwlu	Examples of airports
Low density	350-750/ mppa or mwlu	Barcelona, Milan
Medium density	750-1,100/ mppa or mwlu	Zurich, Oslo, Vienna
High density	1,100-1,500/ mppa or mwlu	Schiphol, Paris CDG, Heathrow
Very high density	> 1,500/ mppa or mwlu	Hamburg, Brussels

Mppa=million passengers; mwlu=million work load units (one work load unit corresponds to one ton of freight transported).

Source: based on ACI Europe, 1998; own depiction.

A rule-of-thumb assumption of 1,000 jobs for every million passengers or workload units (wlu) equal to a density figure of 1,000 appears to be widely acknowledged by the industry for high density airports (Graham, 2008). However, by analyzing 17 German airports another 500 on-site jobs per additional million passengers are calculated (Klophaus, 2008). This indicates that there is a broad range of results with regard to employment density (see table 4).

Table 4. Comparison of recent employment density values per million passengers per annum (mppa) and/or million work load units (mwlu)

Study	Location/year	(direct) employment density
Graham (2008)	European Aviation Industry	1,000/ mppa
ACI & York Aviation (2004)	25 European Airports	950/ mppa
WIFO (2007)	Vienna Airport	1,000 /mppa; 870/mwlu
Klophaus (2009)	Rostock-Laage/ 2008	711/ mwlu
Abraham et al. (2007)	Lübeck/ 2005	361/mppa
Heuer & Klophaus (2007)	Frankfurt-Hahn/2005	579/mwlu

Mppa=million passengers; mwlu=million work load units (one work load unit corresponds to one ton of freight transported).

Source: Authors' compilation.

Klophaus (2007) refers to several structural, economic as well as methodological differences explaining the variations of values. In particular, the structure of passengers (long-distance flights are more personnel-intensive than short-distance flights) and air services (dominance of

low-cost carriers and role of freight volume) determine employment density.

The differences between the studies on effects in this abstract are accounted for not only by the distinction of the analyzed area, data bases and time frames, but also by the way the various effects are defined and categorized. There are empirical studies with four different categories, but in the summary the induced and indirect effects are in one single category. Especially the catalytic effects remain difficult to assess and to distinguish the one from the other. In particular, the definition and resulting estimation of catalytic effects varies considerably. Several of the studies that were reviewed leave out completely the assessment of this category of effect, but mention their assumed importance in the regional development context and the need for appropriate methodological determination as well as practical application. The scientific literature often defines catalytic effects as effects on additional purchasing power induced by incoming tourists or effects of increased business activity. It is common to consider catalytic effects qualitatively, or to focus on only one part of the two interdependent dimensions of tourism and business development. There is evidence of negative spillover effects as well, e.g., outward investments, losses in purchasing power or outbound tourism. Although this widens the available data and information bases, distinctions and comparisons of different studies are complicated. Another complication concerns regional accessibility and social effects, which are also summarized in the broad category of catalytic effects.

The application of input-output models in the assessment of effects related to airport activity is questionable as well. The particular nature of airports as transport infrastructure is not taken into account properly within the input-output framework owing to the fact that the position of airports in the air transport market is neglected with regard to the provision of fundamental goods and services for other companies, as Wollersheim (2011) points out. These external benefits and costs cannot be considered properly owing to the fact that they are not part of the national accounting systems. Potentially significant external costs of airports related to environmental and health effects are of specific importance in the valuation of different airport projects (Schmid et al., 2003; Schipper et al., 2001; Getzner and Zak, 2012).

Vickerman (2002) refers to another problem in the application of input-output models, namely their reliance on fixed production coefficients. This impedes substitution between transport and other inputs, which is problematic in the context of a dynamic transport infrastructure in terms of expected changes in coefficients as a result of economic growth.

Despite the fact that a broad range of data is available on the national level, the lack as well as insufficient quality of input-output data on the local and regional level is another difficulty, as this review has demonstrated. In the majority of cases regional input-output models are based on their

national counterparts and are broken down by using information on the regional economic structure and (more or less problematic) assumptions (Maier et al. 2006). Niemeier (2001) criticizes the application of effect analysis in the valuation of airport expansions, on the basis that a methodological strength of input-output analysis is the consideration of all changes related to backward linked sectors of an economy, whereas a weakness lies in the assumptions of a technology with constant returns to scale and a stable technology. Such an assumption might be realistic for “small” projects but not for “large” ones which, themselves, may alter the intermediate demand and production system. Moreover the actual application differs between countries and, in the context of airport analysis, between airports as well between the different airport sites.

Comparing different studies in terms of regionalization, the depth and scope of analyses and the methodological implementation also vary considerably. The analytical frameworks differ widely, as the areas of interests are often single airports as well as airport systems on the regional level. However, in terms of regional comparison of economic values, recent studies indicate that direct, indirect and induced effects associated with air transport sector can, in principle, be assessed.

5. Discussion and Concluding Remarks

Airports are considered to be an integral part of modern transport infrastructure as they provide essential services for both private households and companies. A representative number of international airports, hub airports as well as regional airports (regional airport systems, regional case studies) have been analyzed with regard to their effects on regional economies. Most of the studies that were reviewed combine input-output models and different forms of surveys, such as business and passenger surveys, for the assessment of economic effects related to airports. Underlying assumptions, difficulties in integrated classification and interpretation modes as well as methodological constraints and limitations have been subject to criticism and ongoing discussions.

Nevertheless, the majority of the studies that were reviewed indicate significantly positive economic effects associated with the functioning of the airport, in particular with regard to the effects on employment and gross added value for the region in which the airport is located.

Very often regional data is not available or can be used only with restrictions. Many studies therefore rely on national data in an attempt to “regionalize” the national economic effects. Thus, most of the empirical studies draw attentions to specific regional parameters after the general economic effects have been ascertained. Any reference to these studies on the economic effects of airports to support airport projects should, however, be considered critically. The review has shown that even the assessment of actual economic effects is complex enough without the addition of

various difficulties in the form of questionable methodological assumptions, constraints and interdependencies. Relying on this data basis implies that forecasts of developments and effects impede conclusions. The problem of potential overestimation of the positive effects should thus be taken into account since the past (average) effects might be much larger than the marginal (additional) effects of airport extensions.

Only the Swiss studies take into consideration the environmental effects (i.e. negative externalities) in the analyses. As these negative effects depend, at least indirectly, on the number of passengers and flight movements, the assessment of environmental costs would be of great interest for airports in particular against the background of potential expansion projects.

In all of the studies discussed and reviewed in the current paper there is a major methodological problem. The economic effects are calculated on the basis of gross effects which mean that it is not possible to make a straightforward evaluation of the additional effects (marginal net effects) of airport expansions. In the studies that were reviewed there is, in general, an attempt to argue for a significant economic importance of air transport. However, such conclusions can be drawn only if the economic effects described and assessed in different scenarios (i.e. alternative options of satisfying travel demand) are compared. For instance, airports are said to attract new businesses as a result of improved connectivity. Connectivity may, however, be achieved by other means, such as high-speed railways or new communication and information technologies. Thus, the current assessment shows that studies on the economic effects of airports do not provide comprehensive cost-benefit analyses of scenarios with regard to the connectivity or attractiveness of a region.

Naturally, forecasting is complex and the choice of a base case and future scenarios is crucial for the outcome of an analysis. It is hardly feasible to predict exactly economic performances or developments. Thus, the use of such forecasts in planning processes should be treated with extreme caution because of the above-mentioned problems as a result of the underlying assumptions and methodological limitations.

The review of recent literature and the analyses related to definite economic effects is hampered by non-uniform classification systems and interpretation. Harmonized instruments and typologies are still required. Standardized guidelines and applications would facilitate a comprehensive assessment of effects. An additional difficulty arises in the distinction between induced and indirect effects. Several studies summarize both effects and therefore place them in just one category.

Fiscal effects induced by airports are assessed and outlined in several of the reviewed studies, but had to be left out in the further analysis owing to different national tax systems.

Focusing on catalytic effects our analysis reveals that recent evidence varies regarding the level of their consideration and their specific implementation. These

effects are completely left out of the analysis, or only limited to a description of their qualitative nature. If monetary values are derived they are highly reliant on basic assumptions and also on uncertain developments or future trends, which aggravates gaining a comprehensive and comparable image of aviation industry's economic effects. Further research as well as methodological adaptations, especially regarding catalytic effects, are thus required to assess the economic effects of airport operations comprehensively.

In the process of planning investments in airport infrastructure and further expansion plans, the effects on surrounding communities should be taken sufficiently into account. The consideration of environmental effects would be of interest in analytical frameworks, comprising an important cost category and an interregional impact in terms of health and related expenditures.

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