

Assessing economic impacts of airport operations and expansions: macroeconomic effects and implications for regional economic development

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Abstract

Connectivity - i.e. the availability of infrastructure (e.g. transport, communication, energy) - is considered to be of crucial importance for regional (economic) development. A wide range of economic impacts are associated with the operation of airports. Airports are important factors for competition on financial and location choices of the public and private sector, and especially for employment opportunities. The aim of this paper is the analysis and assessment of different economic impacts related to air transportation facilities in a regional economic context. Recent empirical works are reviewed and compared with a focus on their indications and methodologies applied. A major result of the current paper is that assumptions made for the prosperity of traffic volumes and economic impacts are of crucial importance since the a priori assessments have to account for a wide range of uncertainties. Despite of fundamental differences in study design, time horizon and geographic location a comparison of values is attempted to gain a comprehensive insight. In particular the impact assessment methodologies applied are critically reviewed, and problems of methodologically inherent overestimation are outlined.

1. Introduction and background

In a modern society connectivity is a vital factor for economic competitiveness, 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 commercial but also by societal and cultural influences in the context of an increasingly globalized world (European Commission, 2007). Increasing (international) trade and income of private households have been fundamental determinants for the growth of overall air traffic (Michalski, 1999). Demand for passenger air travel depends on socio-economic dimensions of passengers, in particular age, income, occupation, stage in lifecycle and family size. In terms of leisure travel the most important variable is household income (Doganis, 2002).

From the commercial viewpoint, air transport contributes to (international) economic competitiveness by facilitating intercontinental traffic on the one hand. On the other hand, regional impacts in the context of enterprises arise by the provision of air services due to cost reduction, and market access and development (Allroggen & Malina, 2010).

The interrelations between (air) transport infrastructure and regional as well as national economic development are complex. The economic effects of improvements of the transport sector basically depend on the specific regional context. For instance, economic impacts are influenced by preexisting transport infrastructure networks, the current state and dynamics of economic development, and the level of regional competition (Lakshmanan & Chatterjee, 2005).

Green (2007) assessed the relation of 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. While airports generate employment and facilitate economic activities that rely on the availability of air services, economic development in return stimulates the demand for air transportation services (Ishutkina, 2009).¹

From the potential impacts of airports and airport-related activities on regional economies it is of particular importance to assess current impacts related to the airport's economic performance as well as potential effects comprehensively. Airports' economic impacts are assumed to be not only restricted to employment or valued added within the transportation sector, but also to affect other interrelated sectors of an economy since they provide the infrastructure "backbone" of many economic activities.

According to Hakfoort et al. (2001) temporary and permanent effects of an airport expansion on the demand as well as on the supply side of the economy can be distinguished. Investments in the expansion of airports contribute to temporary demand for construction enterprises and their intermediary suppliers therefore are associated with respective

¹ In general there is a range of different methodologies leading to different results regarding the economic effects of infrastructure investments, e.g. on productivity; for comprehensive reviews see European Commission (2003) and Moupf and de Raan (2007).

impacts on income and employment. Crowding out effects in the wider economy may, however, result from certain projects, e.g. with respect of the financing of the investments of infrastructure projects. Permanent effects of running airport facilities (due to costs of maintenance and operation) consist of employment effects (handling, transportation) on the demand side, and effects on productivity and the location of economic activities on the supply side of the economy, which mainly occur due to the reduction in transport costs and enhances the attractiveness of regions.

The dynamic supply-side impacts generated by airports result in a reduction of transaction costs, and in an increase of productivity leading to faster economic development (Percoco, 2010). Thus, there are basically two types of economic impacts related to airports basically (Graham, 2008). The first consists of the generation of employment, income, and capital investment “naturally” occurring due to the airport’s operation. The second impact refers to the dynamic economic “catalytic” or “spin-off” benefits, in particular inward (regional) investment including tourism development stimulated by airports. These effects may emerge with the presence of an airport and therefore contribute to economic development of an airport’s surroundings. Airports play a pivotal role resulting from the airport’s peculiar economic activities as well as due to the supportive function of businesses.

According to Hujer (2008) economic benefits associated with airport operations can be further subdivided into direct, indirect, induced and catalytic impacts. This comprehensive classification of impacts has been used frequently in American and European economic impact studies.

ACI Europe and York Aviation (2004) propose this classification methodology and refer to direct impacts in terms of income and employment related to airport activities for which a direct nexus exists between airport construction or operation and the associated income and employment status. Indirect impacts include employment and income related to the supply chain of goods and services. Spending (direct and indirect) income generates induced impacts by means of increased consumption of private households. Finally, catalytic impacts cover so-called wider (dynamic) economic effects, generated by the basic infrastructure (connectivities) of airports improving productivity and thus leading to inward investment as well as additional inbound tourism. Indirect and induced effects are also termed backward linkages (WIFO, 2007). For the assessment of this wide range of impacts different methodologies and approaches are used. Planners, regulatory agencies, and airport operators frequently rely on economic impact studies to identify (and monetize) an airport’s contribution to national as well as regional economies (TRB, 2008).

Based on this broad background, the current paper reviews the currently used methodologies to assess the economic impacts of airports. Thus, it presents a comprehensive overview of recent empirical studies on airport impacts, critically examines and compares economic impacts based on a common measures unit.

The structure of the paper is organized as follows. In section 2, methodological models and implications are reviewed.

Special attention is paid to input-output models due to their wide application in the literature on economic impacts of the aviation sector. International economic impact studies are analyzed in the section 3 by consolidating structural performance data on airports and the resulting impacts. The main focus of the analysis lies on the European aviation sector and its implications for regional economic development. Section 4 discusses methodological limitations as well as problems of classification and comparability of empirical results. A summary and discussion of empirical findings, complemented by potential future research fields and desirable improvements, and conclusions are presented in the final section.

2. Economic impact assessment methodology

Air travel can be considered as the fastest growing among major transportation modes (Lakshmanan & Anderson, 2001). Transportation has been seen as an economic development stimulus on the national and regional level, respectively, despite the ongoing dispute about the significance of transport infrastructure and the linkages between infrastructure provision and economic development. Depending on the theoretical position, the causality assumed and arguments used vary considerably. From a demand-side Keynesian point of view infrastructure is a result of the process of economic development and income generation. Contrary to this approach supply-side driven neoclassical economics assume a different causality with infrastructure being a fundamental input for production processes. Transport infrastructure is thus considered as crucial for the production function (Haynes & Button, 2001).

Attributes of potential locations of companies significantly determine the attractiveness of a region as a whole and in turn influence location choices and decisions of companies (Krumm et al., 2007). Various location attributes can be distinguished, depending on their spatial level. At the regional or local level transport connections (air, rail, car, ship), labor market characteristics (education level of the workforce, wages, labor supply) and provision of infrastructure play a significant role in the entrepreneurial process of location decision (Zdrowomyslaw & Bladt, 2009). Transport infrastructure airport expansions improve the existing transport infrastructure and can thus be classified as relevant location and economic factors respectively.

Direct, indirect and induced impacts based on economic activities are comprised in one economic metric, whereas improved connectivity resulting from an expansion leads to dynamic catalytic effects, namely the “quality” of the location for production, income and employment. Enterprises in a region equipped with air transport infrastructure may benefit due to reduction of transport costs, positive effects on competitiveness, improvements of productivity, and increased access and expansion of markets (Baum et al., 2004).

According to the Transportation Research Board (TRB) measurement of the economic value of airport operations in terms of aviation impacts on local and regional surroundings typically relies on the following methodological approaches: input-output models, the collection of benefits and the assessment of catalytic impacts (TRB, 2008). 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, identifying direct, indirect and induced impacts. 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 money terms. Parameters like time saved, costs avoided, and capacity improvements are included. Furthermore, stimulating effects of commercial activities as well as recreation and community benefits are captured. Spillover impacts and supply-side effects on investment, productivity and trade are assessed by applying the catalytic method.

Similarly, Uniconsult (2007) distinguishes between two methods for the assessment of airport-related effects: input-output analysis and multiplier analysis. Catalytic impacts have often been described qualitatively; while a quantification or monetization of economic impacts have not been employed to the same extent due to the problem of appropriately separating such effects, especially in terms of location factors. A weakness of multiplier analysis is that linkages between economic sectors remain unconsidered. Furthermore the estimation of coefficients that assess economic knock-on effects require restrictive assumptions and external information (Bulwien & Voßkamp, 1999).

Voßkamp et al. (2003) focus on the economic benefits related to airports and their expansion. They identify qualitative and quantitative effects based on the analysis of several expert reports related to the expansion of the Frankfurt airport. The authors draw a conceptual distinction of economic benefits and apply the concept to the valuation of the airport.

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

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

3. Recent evidence for airport-related economic impacts

In most economic impact studies regarding airports a typology of direct, indirect and induced impacts is used. The category of catalytic impacts is frequently left unconsidered due to the difficult quantification. Catalytic impacts are therefore only assessed in qualitative terms in most empirical studies available. In general, there is a broad amount of scientific literature dealing with airports significance on national and regional economic development. For the assessment of impacts of air accessibility on investment and gross domestic product growth, Sellner and Nagl (2010) applied an econometric endogenous growth model. Percoco (2010) analyzed the economic linkages of local development and airports for Italy. Regional economic impacts and future potentials associated with the continuing growth of London Stansted airport (Hart & Mccann, 2000) and impact maximizing strategies of four Irish regional airports (O'Donoghue, 2009) were assessed recently.

Current data on United Kingdom's aviation sector, in particular its contribution to economic growth, trade, tourism and investment were gathered (OEF, 2006). A critical assessment of the economics of the Heathrow expansion based on the economic benefits identified in this report, was conducted by Boon et al. (2008). The economic importance of Sacramento County Airport system in terms of effects on employment, payroll as well as visitor and total expenditures was subject to a recent impact assessment (Leigh Fisher Management Consultants, 2011). Röhl (2009) surveyed aspects of regional airport infrastructure in Germany, in particular the effects of positive interregional spillovers due to accessibility, and the constraints for monopoly positions.

Brueckner (2003) analyzed the relation of airline traffic and employment development of US metropolitan areas and found that a 10% increase of passengers leads to 1% increase of employment in service related industries. Bogai and Wessling (2010) surveyed effects on employment, especially in terms of potentials in the context of airport expansion of the major Berlin Brandenburg airport. By comparing former employment trends and regional developments they analyzed the fields of occupation areas profiting from a further airport expansion.

The necessity of expansion and the consequences of capacity constraints for traveler behavior (Gelhausen, 2011) as well as determinants of passenger demand especially in terms of consumer value (Bieger et al., 2007) were surveyed. The quantification of passenger benefits resulting from airline service improvements due to airport's capacity expansion (Wei, 2008) and the positive effects of increasing competition and deregulation were analyzed by McHardy and Trotter (2006). Malina et al (2008a) assessed the direct, indirect and induced impacts of an expansion of Dortmund airport until the year 2020. Hujer et al. (2004) analyzed employment and income effects of Frankfurt airport for the status quo of 1999 and expansion scenarios for 2000-2015. Another study of Frankfurt airport's expansion concentrated on the effects of employment structure and the regional labor market as well as on the regional economic structure (Baum et al., 2005). Besides the direct, indirect and induced effects, Malina and

Allrogen (2010) identified and forecasted purchasing power effects as well as fiscal effects (e.g. effects resulting from additional expenditure of fiscal revenues) for the Dortmund region in the case of an extension of operating times of the airport for the year 2025.

This brief overview of studies on the economic impacts highlights the broad range of assessments of airports concentrating on production and value added. Before going into more detail, it has to be emphasized that these studies only partially mirror the total economic impact of airports. For instance, the passenger benefits of travelling are not considered frequently. Stanton and Ackerman (2008) present calculations of generated user benefits related to the expansion of Heathrow airport. These benefits are measured additionally to consumer surplus and basically result from newly attracted passengers. This measure is understood as the number of flight passengers that would not have occurred without an expansion of the airport in the sense of unmet demand. Reliance on consumer surplus theory as well as its application in the case of Heathrow have been subject to critique since, in particular, uncertainty within demand forecasting, the inclusion of benefits concerning foreign passengers, and the choice of baseline scenario have been questionable. However, the following sections discuss the air transport sector as a whole, economic impact studies, and finally the catalytic effects of airports in more detail.

Air transportation sector

A recent European report by Airport Council International (2011) relativizes the air transport sector considering airport economics including aggregated data of about 190 European airports. In 2009 a total of € 28.7 billion of gross revenues were generated by European airports. These revenues can be subdivided into the categories of aeronautical, non-aeronautical and ground-handling revenues. Aeronautical revenues - comprised of airline as well as passenger-related revenues (e.g. landing fees) - amounted to € 13.9 billion. Non-aeronautical revenues particularly 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 totalled € 1.8 billion. Operating expenses amounted to € 18.6 billion with personnel costs remaining the largest single general cost item 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 modernisation of airport's infrastructure dropped during the recent economic crisis result in expenditures of € 8.9 billion.

An earlier study of Air Council International Europe surveys the economic as well as the social impact of European airports (ACI Europe, 2004). The overall economic impact of airports can be divided into direct and indirect (both on and off-site) as well as into induced and catalytic (business and tourism) effects. Considering the evidence from 25 representative European airports of the sample, weighted averages are used to estimate the likely induced and indirect multipliers for the national, regional, and subregional level. Thus, evidence indicates that per 1,000 on-site jobs there are 2,100

indirect/induced jobs on the national, additional 1,100 jobs on the regional and another 500 jobs on the sub-regional level supported by the airport. Furthermore, airports on average provide 950 on-site jobs per million passengers (workload units). Once induced and indirect jobs are factored in to this given 950 on-site jobs per million passengers, European airports support around 2,950 jobs nationally, 2,000 regionally and 1,425 jobs sub-regionally for every million passengers.

Another impact study of the Air Transportation Action Group examines the social and economic effects of world's air transport sector for the year 2006 (ATAG, 2008). The air transportation industry is comprised by a fleet of 23,000 aircrafts, operated by about 2,000 airlines, serving a route network of several million kilometres, and 3,750 airports. Social benefits of airports comprise facilitating the delivery of humanitarian and emergency aid, social inclusion due to connectivity to remote areas, cultural exchange and broadening of choices concerning holiday destinations. Globally, air transport industry generates 5.5 mill. direct, 6.3 mill. indirect, 2.9 induced, and 17.1 mill jobs due to catalytic impacts, resulting in a total of about 32 mill. jobs. The global economic impact of aviation (total production value) is estimated at USD 3,560 billion, which is corresponding to 7.5% of world gross domestic product (GDP). For Europe, the aviation sector contributes more than USD 331 billion to European GDP (direct, indirect, induced and catalytic impacts). Furthermore about 4.2 mill. jobs are generated by air transport Europe-wide.

In the remainder of this paper, we focus on studies that apply input-output models and use this typology of the four categories of impacts. From the economic input-output relations, the direct employment impact of 950 jobs per one million passengers leads to a total of 2,950 jobs in the whole economies, of which 2,000 jobs are regional and 1,425 jobs are local (in the vicinity of the airport).

Review of economic impact studies

Table 1 presents an overview of recent airport impact studies.

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 due to the operation of the airport, measured by gross value added, employment and volume of sales on the one hand. On the other hand there are economic impacts due to investments, which amount up to € 1.65 billion for the 2000-2009 period. Direct impacts are captured by an analysis of companies related to the airport. Induced and indirect effects are summarized in one category due to their conceptual inseparability. Thus, € 1.173 bill. of gross value added is assigned to direct impacts. Using model simulations a gross value added of € 3.650 bill. related to induced as well as indirect impacts are calculated, whereas 70% (€ 2.55 bill.) of this value account for the region, defined as the three Austrian provinces Vienna, Lower Austria, and Burgenland. In 2005, there are 16,031 employees (full-time equivalents; FTEs) at the airport, and 52,500 jobs are airport related in addition. Of this induced and indirect employment, 70%

Table 1. Regional economic impacts on gross value added and employment

Airport, year of observation/ Study	Direct impacts	Indirect impacts	Induced impacts	Multiplier
<i>Gross value added</i>				
Lübeck, 2005/ Abraham et al. 2007	€ 11.2 mill	€ 3.1 mill	€ 2.5 mill	0.5
Frankfurt-Hahn, 2005/ Heuer& Klophaus 2007	€112 mill	€ 56.3 mill	€ 34.8 mill	0.8
Cologne/Bonn, 2006/ ARC et al., 2008	€ 800 mill	€ 528 mill	€ 88 mill	0.77
Hannover, 2007/ Huebl et al., 2008	€ 501.9 mill	€ 190.5 mill	€ 461.8 mill	1.3
Dortmund, 2005/ Malina et al., 2007	€ 121.92 mill	€ 77.9 mill	€ 20.96 mill	0.8
Vienna, 2005/ Wifo, 2007*	€1.173 bill	€ 2.55 bill		2.2
<i>Employment</i>				
Lübeck, 2005/ Abraham et al. 2007	258	64	50	0.4
Frankfurt-Hahn, 2005/ Heuer& Klophaus 2007	2,431	1,028	690	0.7
Cologne/Bonn, 2006/ ARC et al., 2008	12,460	10,100	1,679	0.95
Hannover, 2007/ Huebl et al., 2008	7,969 (FTEs)	4,251 (FTEs)	7,647 (FTEs)	1.5
Dortmund, 2005/ Malina et al., 2007	1,531	1,248	371	1.1
Vienna, 2005/ Wifo, 2007	16,031 (FTEs)	36,750 (FTEs)		2.3

* In the Viennese study indirect and induced impacts are summarized in one single category.

(36,750 FTEs) are related to the airport region. A regional employment multiplier² of 2.3 is derived. This indicates that there are 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. If employment development is considered more closely, there are 1,000 employees per million passengers or 870 employees per million workload units³. Vienna airport thus can be classified as a medium-density airport.

Catalytic impacts are divided into supply side (airports as relevant infrastructure and location factor) and demand side (e.g. tourism) effects. Value added and employment effects associated with tourism have to be seen critically due to restrictive assumptions⁴. The authors conclude that no reliable estimation of above mentioned effects is appropriate for the effects of incoming tourists on employment and value added for the Vienna airport.

2 An employment multiplier is defined as the number of indirect/induced employees per direct employee

3 One work load unit is equivalent to 100 kg of freight or 1 passenger.

4 Two important conditions are assumed in WIFO, 2007. First, there is no difference in consumer behavior between inbound and outbound tourists assumed. Second, the pattern of expenditure is independent from the mode of transport.

Regional economic effects of Lübeck airport and a potential increase of these impacts associated with a planned expansion are assessed in a study by Abraham et al. (2007). Indirect as well as induced income and employment effects are captured by an input-output analysis. In turn, these effects generate additional tax revenues, as part of fiscal effects. Direct effects are expressed in jobs created and gross value added. For the year 2005, a gross value added amounts to € 36.4 mill, whereas € 11.2 mill. are attributable to direct effects, € 10.3 mill. to indirect effects, € 9.9 mill. to catalytic impacts and € 5 mill. to induced impacts. In terms of employment, 258 persons are employed directly and 197 indirectly. 355 employees can be assigned to catalytic, and 101 to induced (second-round) impacts. In terms of regionalization of indirect and induced effects a twofold method is utilized, combining a business survey and adjusted branch-specific regional preference rates⁵ for procurements by companies. The region is defined as the area covering a 30-minute-isochrone around the airport. Thus, a regional gross value added of € 16.8 mill (e.g. € 11.2 mill. direct, € 3.1 mill. indirect, € 2.5 mill. induced gross value added) and regional employment effects of 50 induced jobs and 64 indirect jobs are derived. 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 regional multiplier of 0.4 are derived. Compared to other study outcomes this low value can be attributed to the airport's particular structure, i.e. the dominance of low-cost carriers and the lack of commercial enterprises at the airport. In terms of gross value added, a national multiplier of 1.4 and a regional multiplier of 0.5 are assessed.

Regarding employment density, 258 direct employees referring to about 715,000 passengers are extrapolated to a million passengers resulting in an employment density of 361 per million passengers per annum.

The authors emphasize that catalytic impacts mainly result from connectivity and accessibility. Connectivity is a pivotal factor for companies in terms of company locations as well as expansions and fosters economic growth in tourism sector. Moreover, proper transport connections are an important instrument for the stimulation of the regional economy and are base for the evaluation of location quality.

The role of Cologne-Bonn airport as economic and location factor is subject to a recent survey (ARC et al., 2008). Cologne-Bonn airport is the largest low-cost carrier airport in Germany. Direct impacts are assessed by field research at the airport, using expert interviews and a questionnaire, surveying companies as well as workplaces. Indirect and induced effects are estimated on the basis of input-output models as well. The analysis of catalytic impacts involves a company survey in the region and is complemented by passenger surveys and qualitative telephone interviews among companies located in the region. The Cologne-Bonn region is defined as 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 defining the intraregional delivery quota using the national input-output table. For 2006, a total of 12,460 direct employees and a direct gross value added

of € 800 mill. are estimated. Regarding indirect impacts, the airport generates 10,100 jobs and a gross value added of € 528 mill. and another 1,679 jobs and a gross value added of € 88 mill. are induced by airport operations on the regional level. For the total economy a gross value added of € 854 mill. is derived in terms of indirect as well as another € 171 mill in terms of induced impacts. There are 3,220 jobs due to induced and 21,412 jobs due to indirect effects additionally in 2006. 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 level in terms of gross value added.

In terms of catalytic effects, the authors distinguish between jobs generated due to location decisions of companies (about 9,000 jobs in 1997-2006 period), increases in purchasing power related to incoming business and leisure travellers (320,000 foreign leisure travelers and 450,000 business travelers generate increases of purchasing power of € 270 mill. per year) and effects on purchasing power induced by additional travel activity due to the airport's existence (€- 52 mill.). These values are derived based on existing empirical studies, resulting in an estimated share of airport induced additional incoming travel of 15% and of 7.5% for outgoing tourism. These shares are only attributable to the existence of the airport; the residual travel activities would have taken place in a scenario without the airport (e.g. other transport modes or alternative airports would be used and are completely independent from Cologne-Bonn airport).

1.64 mill. incoming tourists business and leisure travelers are distinguished, with the former spending € 224 and the latter spending € 476 on average per travel; leading to an additional purchasing power of € 572 mill. for the region in 2007. Applying the 15% percent share attributable to the airport's existence, results in a total of € 86 mill. airport induced additional purchasing power. Regarding outgoing tourism 160,000 travelers spent € 700 on average per travel activity in 2007. This higher expenses result from the inclusion of ticket prices- in contrary to the incoming tourists the ticket prices spent are relevant due to the fact that in the case of a non-commencement of journeys remaining income would have added to regional purchasing power. Assuming an average saving rate of 10.8% (for non-commencement of travel activities) the loss of purchasing power amounts to € 138 mill. The airport induced loss of purchasing power of € 138 mill. due to outgoing tourists and the additional purchasing of € 86 mill. result in a total loss of purchasing power of € 52 mill.. These negative effects are explained by the higher share of outgoing tourists compared to the numbers of additional incoming travelers. These catalytic impacts are only available on the regional level.

The Frankfurt-Hahn airport is analyzed for current economic impacts as well as its potential for regional development, using the Airports Council International methodology (Heuer & Klophaus, 2007; Heuer et al., 2005). It is remarkable that passenger numbers increased from 20,814 passengers in 1997 up to 3,079,528 passengers in 2005. A similar development occurred in volume of cargo, where 5,501 tons were handled in 1997 and 228,920 tons in 2005. Overall economic impacts for Germany and the regional share of effects for the region for the year 2005 are determined in a further

⁵ Abraham et al. use estimates of Rosner & Weimann (2003).

step. The region is comprised by the four administrative districts of Bernkastel-Wittlich, Birkenfeld, Cochem-Zell and Rhein-Hunsrück. National accounts data, inputs of surveys conducted among airport related companies provided by the airport operator are combined. Input-output analysis is used for the assessment of indirect and induced employment as well as income effects. According to a conservative approach a continuation of national accounts data is not conducted to avoid over-estimations of resulting effects. In terms of direct impacts there are 2,431 employees at the airport and an estimated gross value added of € 112 mill. in 2005. Regarding regional indirect impacts, 1,028 employees and a gross value added of € 56.3 mill are generated. The estimation of these effects is based on a survey of companies at the airport covering the regional share of the order total for investments and intermediate consumption. Regionalization of induced impacts relies on the assumption that there is a linear relation between the regional share of household expenditures and the place of residence. Thus, regional induced effects account for 690 employees and a gross value added of € 34.8 mill. is assessed. Relating direct employment and the total of indirect and induced employment, results in a regional employment multiplier of 0.7 and a national multiplier of 1.5. Summing up indirect and induced gross value added and relating it to the direct gross value added leads to a regional multiplier of 0.8 and a national multiplier of 1.7.

In terms of employment density a value of 579 per million work load units is derived. The estimation of catalytic impacts is grounded on existing market research regarding traveler behavior and data of tourist's expenditure pattern. In terms of regionalization of incoming tourism effects, the percentage share of overnight stays in the four administrative districts related to the total number of stays is utilized. Due to incoming tourists, catalytic impacts arise with a gross value added of € 74.1 mill and 2,655 additional jobs within the region. In contrary to this tourism effects, impacts on location quality and potential advantages for businesses are not quantified in this study.

Current state and development potentials of regional economic effects of Rostock-Laage airport are analyzed by Klophaus (2009). The significance of the airport in terms of an economic and location factor mainly relies on its interdependent linkages due to the provision of civil and military air services. A business park also contributes to the economic role of the airport for the region. The narrower airport region is defined as the Hanseatic city Rostock and the administrative districts Güstrow and Bad Doberan. In 2008 175,392 passengers were counted at the airport and a volume of air cargo of 1.139 t. was transported. A direct gross value added of € 132.5 mill. and 2,597 employees are assigned to the airport (133 to civil air services, 1,400 to military air service and 1,064 to the business park). Due to a lack of data and an insufficient data basis on the regional level the assessment of indirect and induced impacts remains at the national level. Using input-output tables, 1,242 induced and 3,088 indirect additional jobs are derived. Indirect gross value added amounts to € 185.9 mill. and induced gross value added to € 65.7 mill. . This results in a national employment multiplier of 1.7. Considering civil aviation operations employment density amounts to 711 per million work load units in the

year 2008.

Malina et al. (2007) analyze the Dortmund airport and identify direct, indirect and induced impacts for the observation period 2005. Passenger numbers as well as flight movements increased significantly between 1998-2005. In 2005 1,742,891 passengers were counted compared to 610,640 passengers in 1998. A direct gross value added of € 121.92 mill. and 1,531 direct employees are estimated. These impacts are derived by utilizing national accounts data from 2003 and extrapolating the data for the year 2005. To regionalize the effects the computed national coefficients are adapted by certain factors for the airport region. Thus, regional factors result from a comparison of the gross value added per employee of the region and the national gross value added. On the basis of these regional factors, regional gross value added per capita for all 59 sectors of the national accounting are estimated. Multiplying these regional values with the employment numbers results in the total regional annual gross value added.

Indirect impacts of € 77.9 mill in terms of gross value added and 1,248 of additional employment are 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 mill.) for all 59 sectors. For the regionalization of economic effects, data of regional shares of demand are necessary- these shares are estimated by a business survey and combined with the data of the most recent input-output table.

Induced impacts result from additional consumption of direct as well as indirect employees of the airport. Regionalization in particular is aggravated due to the fact that an exact identification of the spatial distribution of household expenditures is not feasible. As a result of the business survey, 85% of employees live in the airport region. Thus, it is assumed that employees at the airport consume within the region. In terms of producers of intermediate products and capital goods a regional share of 0.6% is applied, 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 value added of € 20.96 mill. Thus, a regional employment multiplier of 1.8 at the national 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 results from passenger survey data, secondary data and input-output analysis. Regional impacts on purchasing power due to incoming as well as outgoing travelers are also differentiated and via passenger surveys included in the input-output model. On average incoming leisure travelers spend € 205.67, while incoming business travelers spend € 221.9 (without ticket prices). Outgoing business travelers spend € 517.98 and outgoing leisure travelers € 434.7 on average. These values include expenditures for tickets due to the fact that they lead to a decrease of purchasing in the region. In the further analysis outgoing business travelers are

neglected, because their expenditures are paid by the companies and do not lead to decreases in regional income available. According to the passenger survey 56.5% of incoming travelers spend their journey in the region. This percentage is multiplied with the additional purchasing power to regionalize effects. 44.1% of outgoing travelers live in the region and this percentage is used for the multiplication with the losses in purchasing power. Regarding alternative transport modes or other airports, 75% of incoming travelers stated that they would have used another transport mode or alternative airport for their travel activity to the region as well as 85% of outgoing travelers and 81% of travelers living in the airport region, which is used for further calculations of regional purchasing power effects. 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 mill., whereas savings in ticket and travel costs induce additional purchasing power effects of about € 8.8. mill. Summing up, this leads to an annual decrease in consumption of about € 5.6 mill. in the airport region and therefore to a negative impact on employment by 86 jobs and to a decrease of gross value added of about € 4.9 mill.

Hannover airport's role in regional development of Hannover region is questioned in a study by Huebl et al. (2008). The passenger volume amounts to about 5.6 mill. and the cargo volume to about 6,000 tons annually. The role of this cargo dimension is negligible due to rationalisation and concentration to hub airports (i.e. Munich airport). The region defined is as broad and narrow catchment area of the airport, covering the area from Cuxhaven to Kassel and from Osnabruck to Magdeburg. For the year 2007, direct, indirect and induced impacts are estimated, whereas the latter are further subdivided into consumer expenditure by the state and private households. With 7,969 employees (FTEs) at the airport, Hannover airport is one of the largest places of employment in the region. Another 11,898 jobs (FTEs) are generated through airport activity due to indirect (4,251 FTEs) and induced impacts (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 2.8, which means that for every employee at the airport there are 2.8 additional jobs in Germany's economy. Effects on gross value added for the Hannover region are determined: a direct gross value added of € 501.9 mill. and indirect effects on gross value added of € 190.5 mill. are derived. Furthermore, a gross value added induced by consumer expenditure by the state of € 48.1 mill and of € 413.7 by private households. This results in a regional multiplier of 1.3 and national multiplier of 2.6.

There are also Swiss airport impact studies, focusing on the effects of regional airports on the air transport system by analysing intangible regional economic impacts (Wittmer et al., 2009) and the economic relevance of Zurich airport (Peter et al., 2009). The economic significance of civil aviation for Switzerland is subject to a study by Peter et al. (2011), analysing 3 main airports, 10 regional airports as well as 47 airfields and 24 heliports. In 2009 37.8 mill. passengers are

transferred and 320,000 tons of cargo are handled. In terms of economic impacts, there are 35,600 fulltime equivalents (FTEs) direct at the airport. Further 16,800 FTEs are attributable to indirect impacts and 71,200 FTEs are induced by airport operation. Regarding catalytic impacts, only catalytic impacts of 55,300 FTEs are assessed. The catalytic impacts are restricted to passenger effects, i.e. are the expenditures spent by foreign incoming air travelers. Furthermore, impacts on gross value added are estimated: CHF 7.0 mill. direct, CHF 2.7 mill. indirect, CHF 11.6 induced and CHF 9.0 mill. catalytic gross value added.

A recent assessment of economic impacts of Zurich Airport analyses the current state and tries to identify further development strategies and scenarios for 2020 and 2030, using a production model covering the airport's overall activity of economic relevance and the estimated values of the base year 2008 (Peter et al., 2009). With an increasing passenger volume of 22.1 mill. and 309,000 tons of air cargo in 2008, the airport's growth 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 impacts, whereas the latter only include passenger effects and leave out quantitative business effects due to location decisions. Value added amount to CHF 5.1 mill. (2008 prices) (direct impacts), CHF 2.1 mill. (indirect impacts), CHF 8.1 mill. (induced impacts) and CHF 4.28 mill. (catalytic impacts). On the part of catalytic effects a qualitative assessment for impacts for companies and businesses are presented in this the study. These impacts are termed company-side catalytic impacts as they are reflected in the productivity of an economic system. Economies of scale, a broadening of markets and labor markets, new tourism potentials and destinations, increasing knowledge spillovers and potentials for innovation are important parameters that are related with airport activities. The authors confirm an impact on the location of business and the promotion of growth on the regional as well as on the national level. Both described studies include environmental costs (i.e. external costs due to noise exposure, air pollution and climate change) in their analyses and the Switzerland study also considers accident costs.

The role of regional airports regarding intangible regional and overall economic effects is examined by applying qualitative expert interviews, 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).

Catalytic impacts

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

The identification and measurement of these impacts is ag-

gravated due to the problematic nature of isolating catalytic impacts from other factors. Nevertheless, to make a rough outline of this impact category two main classes of catalytic impacts are typically assessed within analyses. Impacts regarding economic competitiveness are differentiated from social development and regional accessibility (Halpern & Brathen, 2011).

In order to get a better understanding on underlying nature of interaction qualitative approaches like surveys and interviews with relevant agents, scrutinizing the significance of airport's presence to investment and location decision, and competitiveness, are frequently used (Graham, 2008). According to Braun et al. (2010) catalytic impacts can be differentiated into consumer surplus, environmental and social impacts as well as economic spillovers. Positive economic spillovers on the supply-side comprise increasing inward investments, inbound tourism and productivity improvements, whereas negative spillovers refer to outbound tourism and outward investment respectively. Consumer surplus, e.g. 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 the monetary measure of welfare. For the assessment of this effect and the estimation of consumer surplus, the average price elasticity for the demand for air transport is proposed and used within this study.

Cooper and Smith (2005) aim to define a robust methodology for the measurement of catalytic impacts associated with air transport. In a first step, different main channels of catalytic effects are distinguished. On the one hand there are demand-side impacts, describing the effects on net demand of goods. These impacts are further differentiated into tourism and trade impacts. On the other hand there are supply-side impacts, also known as supply-side spillovers or externalities, which are composed of impacts on investment, labour supply, productivity, market structure and innovation as well as on congestion and local business costs. In terms of these effects it is necessary also consider potentially adverse supply-side effects. In their analysis, the authors derive catalytic impacts 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) for the last decade.

Arndt et al. (2009) survey the impact of connectivity on development of German regional economies. For the assessment of the various aspects of catalytic impacts business and passenger surveys, estimations of willingness to pay and calculations of purchasing power effects as well as econometric methods are commonly used. Catalytic impacts, 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 is ensuring

391,670 jobs in the year 2007. This results in an overall economic gross value added of € 8.31 billion.

Malina et al. (2008b) used a contingent valuation approach to analyze the catalytic impacts of a secondary German airport within a multi-airport region for regional economy. By asking companies about their willingness to accept a permanent airport closure the monetary value of an airport's significance for businesses is estimated by linear regression of the sampled per-employee values. The annual overall claim for compensation amounts to € 82 mill., which can be understood as the annual prospective or actual profits resulting from an airport's presence.

A direct causality between airports and wider business as well as tourism development is difficult to assess. Therefore it is typically not feasible to indicate exact numbers of income or jobs within empirical analysis, though there are estimates relying on different base assumptions.

4. Critical examination and comparison of values

Despite the wide application of the impact typology methodological constraints and problematic comparability aggravate comprehensive analyses. Regarding employment impacts, Bogai and Wesling (2011) analyze major airports. Especially the application of input-output analysis methodology for the valuation of employment effects is subject to critique. The range of multipliers, especially those covering employment effects varies considerably, and the assessment of time-depending development of the attested employment effects differs between the studies.

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 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 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 determination (Uniconsult, 2007). However, for a comparison of various airports, it is meaningful to connect traffic throughput and direct employment of an airport, resulting in 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 utilisation and development opportunities as there are low, medium, high and very high density airports as table 2 shows.

A rule-of-thumb assumption of 1,000 jobs for every million passengers or workload units (wlu) equal to a density figure

Table 2. Typology of employment density

Typology	Employment numbers/ mppa or mwlu*	Airport examples
Low density	350-750/ mppa or mwlu	Barcelona, Milan
Medium density	750-1,100/ mppa or mwlu	Zurich, Oslo
High density	1,100-1,500/ mppa or mwlu	Schiphol, Paris CDG, Heathrow
Very high density	> 1,500/ mppa or mwlu	Hamburg, Brussels

* A workload unit is equivalent to the annual movement of one passenger or 0.1 tonnes of mail/freight

Source: based on ACI Europe, 1998; own depiction

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 regarding employment density (see table 3).

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.

Differences between the considered impact studies are not only due to the distinction of the analyzed area, data bases and time frames, but also in definition and categorization of various impacts. There are empirical works using the four different categories, but summarizing induced and indirect impacts in one single category. Especially catalytic effects remain difficult to assess and to differentiate. In particular the definition and resulting estimation of catalytic impacts varies considerably. Several reviewed studies completely leave out the assessment of this impact class, 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 catalytic impacts are often defined 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 for 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 aggravated. Another complicacy concerns regional accessibility and social impacts, which are also summarized in the broad category of catalytic impacts.

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 due to neglecting the position of airports in the air transport market regarding the provision of fundamental goods and services for other companies, as Wollersheim (2011) points out. These external benefits and costs cannot be considered properly due to the fact that they are not part of national accounting systems. In the case of airports costs related to environmental and health impacts are of importance in the valuation of different projects by policy makers (Schmid et al., 2003; Schipper et al., 2001; Getzner & Zak, 2012).

Vickerman (2002) refers to another problem of 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 due economic growth.

Despite the fact that broad 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 of the regional economic structure and (more or less problematic) assumptions (Maier et al. 2006). Niemeier (2001) criticizes the application of impact analysis in the valuation of airport expansions. According to his work, 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. 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 vary considerably. The analytical frameworks differ widely, as the areas of interests are often single airports

Table 3. 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)	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

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 impacts associated with air transport sector are assessable in principle.

5. Discussion and concluding remarks

Airports are considered to be an integral part of modern transport infrastructure. The assessment of economic impacts of associated with airports activities is widely used. Major airports, hub airports as well as regional airports (regional airport systems, regional case studies) have been subject to economic impact analyses. Most of the reviewed studies combine input-output models and different forms of surveys, e.g. business and passenger surveys, for the assessment of economic impacts related to airports. Underlying assumptions, difficulties in integrated classification and interpretation modes as well as methodological constraints and limitations have been subject to critique and ongoing discussion.

Nevertheless, the majority of the reviewed studies outcomes indicate positive economic impacts associated with airport's operation and activities, in particular regarding impacts on employment and gross value added.

Regional data is not available frequently or can only be used with restrictions. Many studies therefore rely on national data and attempt to "regionalize" after an overall economic assessment for the total economy. Therefore, the majority of empirical works draws the attention to specific regional parameters after deriving overall economic impacts. The application of economic impact studies in justification for expansion projects should be considered critically. The review has shown that even the assessment of actual economic impacts is complex and aggravated by various difficulties as there are questionable methodological assumptions, constraints and interdependencies. Relying on this data basis implies that forecasts of developments and impacts impede conclusions. The problem of potential overestimation of positive effects thus should be taken into account.

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

All studies discussed and reviewed in the current paper carry a major methodological problem. The economic impacts are calculated on the basis of gross effects; this means that it is not straight forward to value additional effects (marginal net effects) of airport expansions. The impact studies reviewed in general try to argue for a significant economic importance of air transport. However, such conclusions can only be drawn if economic impacts between different scenarios (e.g. options of satisfying travel demand) are compared. For instance, airports are said to attract new businesses due to improved connectivity. Connectivity may be, though, achieved by a range of other policies such as high-speed railways or new communication and information technologies. Thus, the current assessment shows that impact studies do not provide cost-benefit analyses of scenarios regarding connectivity or attractiveness of a region.

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

The review of existing literature and their analyses related to definite economic impacts is aggravated by non-uniform classification systems and interpretation. Harmonized instruments and typologies are still required. A comprehensive impact assessment would particularly gain from standardized guidelines and applications. An additional difficulty arises in the distinction of induced and indirect impacts. Several studies do not propose a distinct categorization and summarize both effects within one category, so definite propositions are difficult to make.

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

Focusing on catalytic impacts our analysis shows 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 impacts. Further research as well as methodological adaptations, especially regarding catalytic effects, are thus required to assess the economic impacts 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 into account sufficiently. The consideration of environmental impacts 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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