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A Literature Review and Methodological Recommendations to Measure the Economic Impact of Air Transport

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Abstract

This paper reviews 96 studies on the economic impact of air transport, focusing on four key methodologies: input-output analysis, cost-benefit analysis (CBA), computable general equilibrium (CGE) models, and econometric techniques. Our findings show that input-output analysis and CGE models are best suited for studying the broad economic effects of air transport on the entire economy. Input-output analysis reveals that air transport creates jobs and economic value, with a stronger backward linkage—its effect on upstream industries—than a forward linkage. It also plays a key role in tourism, logistics, and freight. CBA and econometric methods are more effective for analyzing localized effects. The CBA literature indicates that airport expansion projects significantly increase social welfare. CGE models show that subsidies and taxes on air transport can benefit the economy by boosting government revenues, and that capacity expansions help both core and peripheral regions. Econometric studies confirm a positive link between air transport and various economic indicators, including GDP, employment, trade, and foreign direct investment. The methodologies themselves have advanced to overcome certain limitations. Input-output analysis has been extended with multi-period and multi-region models. CBA now uses alternative discounting techniques. CGE models have become more sophisticated with spatial and dynamic applications, and some even integrate air transport networks and game theory. Econometric techniques have adopted more robust models like heterogeneous time series cross section Granger causality, difference-in-difference, propensity score matching, seemingly unrelated regression and spatial econometrics to better address endogeneity. These advanced methods can provide a more robust approach for future research.

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Keywords: Economic impact of air transport; literature review; methodological recommendations; input-output analysis; cost-benefit analysis; computable general equilibrium; econometric estimation of the economic impact of air transport

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1. Introduction

Evaluating the economic impact of new infrastructural elements at an airport, new connections or changes in operation is an essential part of policy-making in aviation. Every air transport-related project requires an economic assessment due to generally high costs, whether for airports, manufacturers or other aviation companies. New regulations like the ReFuelEU initiative (European Parliament and European Council, 2023) or Clean Aviation (Clean Aviation, 2023) lead to many technological and operational changes. Policymakers, such as the EU, seek to maximize socioeconomic benefits by imposing these new regulations but also through strategic funding (Hader and Sachdeva, 2022).

Due to the limitations of market regulation alone (Weitzman, 1974), public investment and subsidies are needed for projects where the public institution financially supports an industry or a specific company with the overarching goal of achieving social and environmental benefits. In the case of transport, public entities like the EU or national governments also use subsidies for societal benefits, such as regional economic growth or transport-specific benefits like rural connectivity (Forsyth, 2007; Nguyen and Shimizu, 2017). Furthermore, regulations like the EU's TenT regulation impose major infrastructure requirements on airports, from railway connections to providing ground-based power to the parking position (European Parliament, 2024). To maximize socioeconomic benefits, prior to the implementation of these regulations or allocation of their respective limited funds, policy makers have to assess the potential welfare effects of the infrastructural and technological projects they support/set in motion. These assessments might also become necessary on the other side: The TenT regulation for instance obliges airports to provide a socioeconomic cost-benefit analysis in order to get exempted from the, now mandatory, PCA (Pre-Conditioned Air) units at the parking positions. As new regulations and the changes they impose on aviation can differ significantly in terms of complexity, cost and impact, several different methodologies are employed to analyze their effects. The most common models are the input-output models (IO), cost-benefit analysis (CBA), computable general equilibrium models (CGE) and econometric estimation models.

Subject of this review is the literature about these methodologies in aviation. Unlike Lenaerts et al. (2021), Elburz et al. (2017) or Yetkiner and Beyzatlar (2020), who typically limit their assessment to a single methodology, we provide a comprehensive review of the four methodologies, discussing their respective strengths and weaknesses, and conclude with a guide to which methodology to use for which type of analysis. In total, we review 96 studies on the topic of the economic impact of air transport.

The paper is organized as follows: Section 2 provides a description of the methodologies and an overview over the existing literature; Section 3 conducts the literature review to identify the important results related to the economic impact of air transport; Section 4 provides methodological recommendations and Section 5 concludes by highlighting the most important and common results that have been obtained in the literature and leans into recent methodological advances.

2. Methodologies Used to Estimate the Economic Impact of Air Transport

2.1. A Brief Description of the Methodologies

Input-output analysis can be used to estimate the direct, indirect, induced and catalytic effects of a project or policy shift (Huderek-Glapska, 2020; ACI Europe, 1998). The analysis can thereafter estimate multipliers such as the income and employment multipliers. As the name suggests, cost-benefit analysis measures costs and benefits and thereafter can be used to accept or reject a project based on the net present value. While a financial cost-benefit analysis aims to maximize profits, a socioeconomic cost-benefit analysis maximizes economic welfare (Campos and Betancor, 2020). A computable general equilibrium model analyzes representative agents such as households, firms and the government and solves a system of equations with the market equilibrium prices being derived at the point where quantity demanded equals quantity supplied across all markets (Njoya and Forsyth, 2020; Thissen, 1998). The econometric estimation literature consists of three types of analyses namely production or cost function analyses that study total factor productivity, Granger causality analyses and regression models with instruments in order to address endogeneity.

2.2. Comparison of the methodologies

Table 1. A comparison of the methodologies used to measure the economic impact of air transport.

Method/Criteria	Input-Output Analysis	Cost-Benefit Analysis (CBA)	Computable General Equilibrium (CGE)	Econometric Evaluation
General Equilibrium	[Red]	[Red]	[Green]	[Red]
Dynamic	[Red]	[Green]	[Green]	[Red]
Consideration of Catalytic Effects/ WEBs	[Green]	[Red]	[Green]	[Green]
Computational Demand	[Blue]	[Blue]	[Orange]	[Yellow]
Limitations	[Orange]	[Yellow]	[Blue]	[Yellow]

Source: Own compilation based on the literature, WEB = Wider Economic Benefits; Red=’No’, Green=’Yes’, Blue=’Low’, Yellow=’Moderate’, Orange=’High’

Table 1 provides a comparison over our set of methodologies. Input-output analysis has many limitations including making inaccurate assumptions when data is not available, a conventional model is static in nature, price changes are not considered, efficient use of factors are not addressed, negative externalities are not considered, causality is not addressed, impacts are often double counted, the model does not provide the right measures of economic welfare and the model does not discriminate between generative and distributive effects (Huderek-Glapska, 2020). In our set of reviewed studies, inaccurate assumptions are not an issue because the data on the input-output tables is almost always available and utilized. With respect to the model being static, the limitation has been overcome by using dynamic multi-period input-output analysis as has been done by Kronenberg et al. (2018). With respect to price changes, Logar and van den Bergh (2013) apply an input-output price model to estimate price changes as well as the effects of price changes. Efficiency can be addressed by having a second stage Pareto frontier model as has been done by Abbood et al. (2025). With respect to negative externalities, two exceptions are Liu et al. (2022) and Roman et al. (2016). Liu et al. (2022) study air transport carbon emissions in China and Roman et al. (2016) study ozone precursor emissions in Spanish international trade. Causality has not been addressed by any of the papers reviewed. With respect to double counting, we find that the reviewed papers have carefully considered this issue in order to prevent this as much as possible. With respect to the measurement of economic welfare and discrimination between generative and distributive effects, the reviewed papers do not deal with these issues because the model is not capable of handling such issues.

CBA is the second partial equilibrium technique we consider. Unlike input-output analysis, a standard CBA is unable to measure catalytic effects that exceed the analyzed market. As a result, the reviewed papers do not estimate the magnitude of these catalytic effects. Other limitations of CBA are incompleteness, uncertainty and the relatively weak position of effects that are difficult to estimate and monetize (Mouter et al., 2015). Here too, we find that the reviewed papers do not address these issues because cost-benefit analysis is not designed to handle these issues.

The limitations of the CGE model include application at a very highly aggregated level, applications ignore the distributional aspect, studies often assume perfect competition, applications in transport often do not include a detailed transport model, the interaction between the transport network and the spatial economic system is not appropriately modelled in spatial CGE models and there are challenges with respect to the modelling of transport costs and agglomeration effects (Njoya and Forsyth, 2020; Tavasszy et al., 2011). While generally being the most accurate, CGE models tend to require a high degree of computing power. Ueda et al. (2005) overcome the first shortcoming by applying a spatial computable general equilibrium model which is capable of analyzing regions within Japan at a highly disaggregated level. Distributional aspects have been considered by Njoya and Nikitas (2020) who look at how different household groups are affected by air transport capacity expansion in South Africa. Ueda et al. (2005) model an oligopolistic aviation market using non-cooperative game theory which is practically more realistic in comparison to the assumption of perfect competition. Ueda et al. (2005) also include an aviation network model within their spatial computable general equilibrium model which overcomes the shortcomings of the conventional version of this model. Transport costs and agglomeration effects have not been considered by any of the papers that we have reviewed.

The econometric estimation methodology has three main drawbacks which have been highlighted in Lakshmanan (2011) and Lenaerts et al. (2021). The first is that there are sharp differences and conflicts among these models on the magnitudes and direction of economic impacts. In the reviewed literature, this is indeed the case. The elasticities that are obtained are almost always different. Different elasticites have been reported within the same study based on the model and variables used. Causality analyses that we have reviewed show that there could be no relation, a bi-directional relation, air transport causes regional development and regional development leads to increased air transport. The second drawback is that these models offer little clue to the mechanisms linking transport improvements and the broader economy. This limitation has also not been overcome by any of the reviewed studies mainly because this is a partial equilibrium model and one regression can only provide an indication on one dependent variable that has been analyzed. The third weakness is that inappropriate functional forms may not account for all possible impact mechanisms in the case of studies that estimate a production or cost function. The third weakness has not been addressed in the reviewed literature with studies applying only one functional form in the analysis. A suitable next step could be to try out different functional forms and to report on the results that are the most appropriate in the context of air transport economics.

2.3. Sample Characteristics

Appendix A shows the distribution of studies by methodology and time period. As can be seen from the figure, studies on the economic impact of air transport became popular from 2000 onwards. From this time period onwards, the most popular methodology is econometric estimation. This is followed by input-output analysis. The highest number of econometric studies were published between 2010 and 2019. It should also be noted that the highest number of input-output studies were also published between 2010 and 2019. Computable general equilibrium studies have been published from 2000 onwards and this is mainly because of the high computing power requirements which means that these studies were possible only after we had sufficient computing power.

Appendix B contains a map of the countries studied in the literature. The lighter the shade of blue, the higher the number of studies on the respective country. What stands out in this figure is that the United States has been extensively studied in the literature. This is mainly because of better data availability on this country. Countries like China, Japan and Spain have also been studied more often in the literature. While many countries have been represented in the literature as can be seen from Appendix B, it should however be noted that a vast majority of Africa, South America and North America has not been studied in the literature. In the case of Asia, large countries such as Russia, China and India have been studied but there is still scope for further research.

3. Survey of the Literature

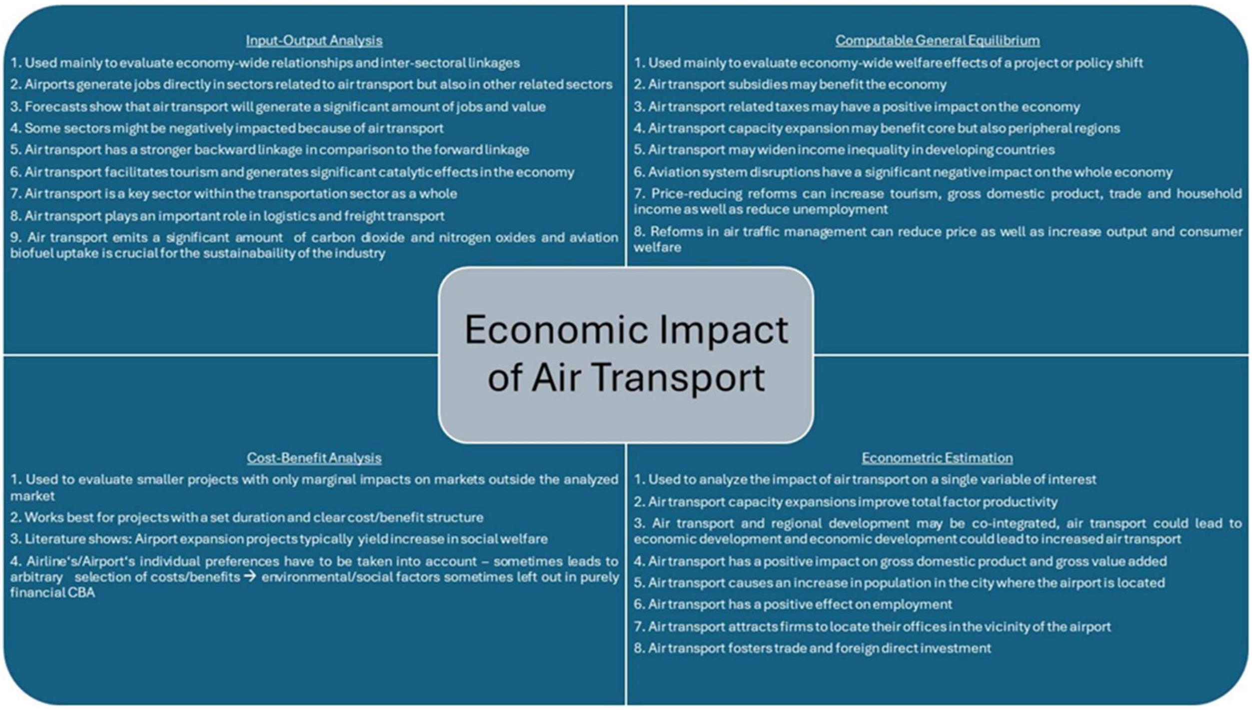


Fig. 1. A synthesis of the literature review on the economic impact of air transport

This section performs the literature review of the four methodologies that are used to study the economic impact of air transport. Figure 1 contains a synthesis of the literature review which will be further explained in the next sub-sections. Appendix C contains a summary of the topics, regions and indicators that have been analyzed in the literature by methodology. It can be noticed that various topics have been analyzed which shows that these methodologies have a very broad scope. While Appendix B is a map of the countries studied using all of the methodologies, the third column of the table in Appendix C shows the particular countries studied under each methodology. The indicators column of the table in Appendix C shows that these methodologies can be used to study various economic aspects which are of major interest to policymakers, academics and firms.

3.1. Input-Output Analysis

3.1.1. Significance of Airports

Airports can be a source of employment and income generation. The literature has shown that airports generate jobs directly in sectors related to air transport but also in other related sectors. It has been shown that airport expansion generates jobs in the United Kingdom (Batey et al., 1993); the Schiphol airport is shown to generate jobs in related sectors (Hakfoort et al., 2001); and Frankfurt airport is shown to generate direct, indirect and induced jobs in related sectors with the service industry dominating with respect to benefits (Hujer and Kokot, 2000).

Input-output analysis can be used to quantify the number of jobs that will be generated as has been done by Batey et al. (1993) in the case of the United Kingdom, Dimitriou et al. (2011) in the case of a tourist airport in Crete, Dusek et al. (2011) in the case of tourism jobs facilitated by the Budapest airport, Hakfoort et al. (2001) in the case of high and low skilled jobs generated by the Schiphol airport, Huderek-Glapska (2013) in the case of total jobs generated by the Warsaw Chopin airport, Hujer and Kokot (2000) in the case of the Frankfurt airport who estimate the employment multiplier and Dewulf et al. (2023) in the case of Brussels airport who estimate the direct, indirect, induced as well as catalytic jobs generated including those generated by Brussels Airlines, DHL Aviation and TUI Airlines.

Airports also contribute to output and value added and input-output analysis can be used to measure these effects. Dimitriou et al. (2011) provide figures for the new tourist airport in Crete, Dusek et al. (2011) provide these figures for the Budapest airport, Hakfoort et al. (2001) provide estimates for the Schiphol airport, Huderek-Glapska (2013) provides numbers for the Warsaw Chopin airport, Hujer and Kokot (2000) provide regional income multipliers for the Frankfurt airport and Dewulf et al. (2023) analyze the value added by the Brussels airport.

3.1.2. Analysis of the Entire Air Transport Sector

While input-output analysis has been used to analyze the significance of airports, the methodology has also been used to analyze the air transport sector as a whole. An interesting approach is to use input-output analysis for forecasting and this was first done by Filani (1973) for 14 major cities in the United States. This approach has thereafter been applied by the Air Transport Action Group (ATAG, 2024) for the whole world and the study shows that in 2043, air transport will support 135.4 million jobs and generate $8.5 trillion in economic activity. A similar approach has been followed by Oxford Economics (2024) for aviation in Dubai and the forecasts are provided for the year 2030. This study also includes forecasts for Emirates and the Dubai International Airport.

The United States Department of Transportation Federal Aviation Administration (US DoT/FAA, 2020) provide estimates of the total jobs generated by the civil aviation sector in the United States in 2016. This study also looks at the direct and catalytic impacts of the sector which is estimated to be 5.2% of the gross domestic product of the country, which is equal to $1.8 trillion in economic activity. However, they do not provide a forecast. InterVISTAS (2013) focus on how Mexican air services at John Wayne Airport impacts the economy. They provide estimates for employment and economic output.

Just as has been done for airports, George (2013) shows the sectors that are positively boosted by the whole air transport sector in the United States. What is interesting here is that the study shows that there are also other sectors which may receive a negative boost because of the activities of the air transport sector and it also shows that the sector has a declining importance over time. These sectoral connections have also been studied in the case of China by Zhao et al. (2022a), who show that air transport has become more closely connected with tertiary industries and less connected with secondary industries. Another interesting finding in their study is that air transport in China has a stronger backward linkage in comparison to the forward linkage.

3.1.3. Air Transport and Tourism

As air transport is a major facilitator of tourism, there are studies on the role that air transport plays in tourism. Kronenberg et al. (2018) show that air transport has the largest growth in the output multiplier in the region of Jämtland, Sweden. Logar and van den Bergh (2013) analyze how tourism in Spain is affected due to peak oil. They show that price of air transport increases due to peak oil, which reduces output of air transport as well as tourism. In the case of Japan, Nguyen and Shimizu (2017) show that air transport is vital for both inbound and outbound tourism. Nuryadin and Purwiyanta (2023) show that air transport is key for the tourism sector in Yogyakarta, Indonesia with a significant output multiplier, gross value-added multiplier, household income multiplier and labour multiplier. Tantirigama and Taniguchi-Singh (2009) study air transport and tourism in New Zealand showing that air transport has the highest direct and indirect economic effects in relation to tourism in the country.

3.1.4. The Role of Air Transport in the Transport Sector

Input-output studies have also analyzed the transport sector as a whole and the role that air transport plays within the entirety of the transport sector. Varnavskii (2021) finds that the air transport sector's gross output as a whole is very stable in Russia. Chiu and Lin (2012) show that air transport has a strong backward linkage to the Taiwanese economy in comparison to the other transport related sectors. Zhao et al. (2022b) also get the same result for China and they show that the forward linkage is shrinking while the backward linkage has increased in the country. In the case of Latvia, Auzina-Emsina and Pocs (2019) show that air transport has an inelastic response to demand and they argue that this is because Latvian households do not spend much on air travel services. Kecek et al. (2022) analyze the case of Croatia and find that air transport has the highest output multiplier, gross value-added multiplier and employment multiplier in comparison to other modes of transport. In the case of Malaysia, Sauian et al. (2013) show that labour productivity of the air transport sector has been growing over time in comparison to other modes of transport. Lee and Yoo (2016) study the case of South Korea and they show that air transport is crucial for the economy by estimating the production-inducing effect, gross output, net production and the supply shortage effect.

3.1.5. The Role of Air Transport in Freight Transport and Logistics

The literature also delves into the role that air transport plays in logistics and freight transport. Kim et al. (2021) show how air transport has a stronger backward linkage in comparison to the forward linkage in relation to the logistics industry in South Korea. Abbood et al. (2025) analyze the freight transport industry in the major European economies, showing that Germany and Netherlands are the most sustainably efficient while Spain is the least sustainably efficient.

3.1.6. Air Transport and the Environment

The last theme in the literature is related to environmental aspects. Liu et al. (2022) study air transport carbon emissions in China and find that they are the highest with respect to exports. They suggest that the export structure should be changed in order to reduce the indirect carbon dioxide emissions from air transport. Roman et al. (2016) study ozone precursor emissions in Spanish international trade and find that NO_x emissions are highest in relation to Spanish trade with EU countries. They recommend using SMART Fixed Wing Aircraft and strict emissions requirements at airports. Wang et al. (2019) is a case study of aviation biofuel production in Brazil which shows that the macauba-HEFA supply chain leads to the highest level of employment creation and gross domestic product generation while the sugarcane-ATJ supply chain has the largest import effects.

3.2. Cost-Benefit Analysis

3.2.1. CBA in Air transport: Infrastructure and Novel Technologies

Investments in infrastructure emerge as a major theme, with multiple studies focusing on airport expansion projects. Examples of large-scale infrastructure projects include the construction of the Brucargo air freight terminal at Brussels National Airport (Blauwens and van de Voorde, 1985), the expansion of Oporto airport (Costa, 2020) and Delhi's Terminal 3 (Chaudhuri and Chaudhuri, 2017). These projects aim to increase capacity, improve passenger flow, and accommodate larger aircraft. Furthermore, CBA is used to justify the adoption of new technologies. Bazargan et al. (2013) analyze the use of Towbarless Towing Vehicles, also called supertugs, to move aircraft on the ground. Their study is a prime example for small-scale infrastructural investments at the airport level, where, in this case, fuel savings are weighed against vehicle acquisition and maintenance costs. Another example is the study of Rodríguez-Sanz and Andrada (2023) which analyzes the deployment of Automatic Dependent Surveillance-Broadcast (ADS-B) technology for air traffic control, which offers benefits like improved safety and efficiency. Other papers evaluate the economic impact of procedural and operational changes of airlines and airports. Hopkins and Wharton (1976) were among the first to study the economic viability of measures/technologies that aim towards lower energy consumption of the aircraft by comparing their respective costs and benefits. They do this by analyzing several fuel-conserving operational procedures for Lockheed aircraft like the "Tristar" and "Electra". Mundy et al. (2015) conducted an economic analysis on replacing the Essential Air Service (EAS), a state program that aims to improve connectivity in rural areas, with subsidized ground transportation. Other authors like Welch (2015) use CBA to assess economic viability of completely new concepts; such as Amazon Prime Air's drone delivery system. This is an example of a case study of how a CBA-like approach can be used to evaluate the potential of an emerging technology and business model in aviation.

3.2.2. CBA: Calculation of the NPV and different cost types

Costs are broken down into several types which differ heavily from author to author due to the heterogeneity of their respective projects. There are initial investment and acquisition costs, which include capital outlays for new equipment or infrastructure, as seen with projects like the Brucargo terminal, where expropriation costs were a significant factor (Blauwens and van de Voorde, 1985). Operational costs are ongoing expenses, such as fuel, maintenance, personnel, and insurance. Furthermore, studies like those involving new air traffic often include environmental costs, such as emissions, which are considered negative externalities. On the benefits side, projects generate monetary gains from direct operational income and cost savings. Time savings are a frequent and quantifiable benefit for both passengers and airlines, justifying investments in improved infrastructure. The core economic concepts of consumer and producer surplus are also central, with Blauwens and Van de Voorde (1985) and Costa (2020) monetizing the benefits to both existing and new traffic. In summary, projects can lead to increased capacity and frequency, as well as a variety of non-monetary benefits like enhanced safety and improved customer comfort.

The methodological approaches to CBA in this field are quite varied as each case comes with its own set of challenges. Most authors calculate a Net Present Value (NPV) to account for the time value of money, as Bazargan (2013) and Blauwens and van de Voorde (1985) have done.

3.2.3. CBA: Limitations and Modifications

CBA is a partial equilibrium technique that focuses on one single industry, setting aside all other markets (Hallren et al., 2019). A notable challenge in calculating the NPV is selecting an appropriate discount rate, with some authors like Rodríguez-Sanz and Andrada (2023) even suggesting the use of a hyperbolic discount rate to better reflect behavioral factors. Critics such as Forsyth et al. (2021) argue that CBA fails to capture broader economic effects and propose using more comprehensive CGE models that follow a general equilibrium approach, considering all industries in the economy and how they are linked with each other (Hallren et al., 2019). Campos and Betancor (2020) suggest expanding CBA to include cross-border and regional effects to account for economic integration. Uncertainty is also a key consideration, as shown by Costa (2020) on the Oporto airport, which used different traffic growth scenarios to determine the traffic volume needed for a zero NPV. Bazargan (2013) recommended a two-vehicle strategy over the one with the highest NPV to avoid excessive waiting times. Studies by Mundy et al. (2015) and Welch (2015) use static calculations, which fail to consider dynamic factors like inflation and changing fuel costs, thereby limiting the scope of their findings.

3.3. Computable General Equilibrium Models

3.3.1. Air Transport, Subsidies and Taxes

Computable general equilibrium models have been applied to study various economy-wide impacts of air transport. One interesting theme is the study of subsidies and taxes and their impact on the economy. In the case of Australia, Forsyth (2006) shows that air transport subsidies may benefit the country in case the region offering the subsidy is relatively depressed and the other regions of the country are not depressed. In the case of taxes, the Australian air passenger movement charge has been studied by Forsyth et al. (2014). They show that this tax has a positive impact on the economy because it acts as a transfer payment from tourism to non-tourism industries. Norman-Lopez et al. (2024) study the impact of a carbon tax on the global economy. They find that this is beneficial from a sustainability perspective because air transport output reduces which in turn reduces CO_2 emissions.

3.3.2. Air Transport Capacity Expansion

Air transport capacity expansion has been extensively studied using computable general equilibrium modelling. Ishikura et al. (2003) study the impact of airport development in the Japanese economy and show how this sector is very important for the Japanese economy. As competition between air and rail is included in their analysis, they find that an improvement in air transport productivity reduces the price of rail transport but also output due to substitution effects. Yamaguchi et al. (2001) show that the expansion of the Haneda airport in Japan generates huge benefits including spillover effects. Ueda et al. (2005) show that the expansion of the Haneda airport benefits not only Kanto but also peripheral regions such as Hokkaido, Kyushu and Okinawa due to an increase in tourism which benefits households in these regions. Ishikura and Tsuchiya (2007) show that there is a price decrease in the air transport industry as well as other related industries due to the expansion of the Haneda airport.

Njoya and Nikitas (2020) delve into distributional aspects of air transport expansion in South Africa and show that growth generated by air transport may lead to a widening of income inequality and a reduction in inclusive growth because the sector employs skilled workers and generates benefits only to households at the top end of income distribution. Njoya and Ragab (2022) study air transport investment in Egypt and show how it has stronger backward linkages in comparison to forward linkages. Such inter-sectoral linkages have also been studied by

Ishikura et al. (2003) in the case of Japan, Ishikura and Tsuchiya (2007) in the case of the expansion of the Haneda airport and Njoya and Nikitas (2020) in the case of South Africa.

3.3.3. Air Transport System Disruptions

Aviation system disruptions such as terrorist attacks have also been studied in the literature. This model can incorporate disruptions in a straightforward manner because the economy can be shocked with this model. Rose et al. (2009) show that the 9/11 terrorist attack in the United States negatively impacted the air transport sector because of the induced fear factor. Chen et al. (2017) also study this topic and show that behavioural aspects have a significant negative impact on air transport. However, they show that these problems can be mitigated by building a resilient air transport system.

3.3.4. Computable General Equilibrium, Air Transport and Other Themes

Some other themes explored in the literature are impacts of price-reducing reforms, the impact of the NextGen project and urban air mobility. Njoya (2020) studies price-reducing reforms in air transport services in the Egyptian economy. His results show that there is a reduction in the price of air transport which leads to a rise in tourism, gross domestic product, trade and household income. Unemployment is shown to be reduced due to price-reducing reforms in the air transport sector in Egypt. Harback et al. (2015) study the impact of the NextGen project on the economy of the United States. They show that the direct effects are a price reduction by 2% and an output increase of the air transport industry by $10 billion. They also show that consumer welfare increases up to a maximum of $28.8 billion. Straubinger et al. (2022) study urban air mobility in Germany. They show that high-skilled workers benefit at the expense of low-skilled workers because of the introduction of urban air mobility. From a welfare and emissions perspective, urban air mobility is shown to be better than gasoline cars but worse than electric cars.

3.4. Econometric Estimation of the Economic Impact of Air Transport

3.4.1. Air Transport and Total Factor Productivity

Air transport capacity expansion entails significant capital costs and the benefits of these investments need to be analyzed before expanding capacity. Allroggen and Malina (2014) study the contribution of air transport to regional economic development in Germany. Their key insight is that the expansion of capacity-constrained airports might promote economic growth if the positive output effects from additional air services outweigh the negative effects of capital appropriation. One justification for expanding airport capacity is that it enhances productivity and the literature shows that this is indeed the case with air transport capacity expansions increasing total factor productivity in the case of the United States, South Africa, Japan and China (Cohen and Paul, 2003; Fedderke and Bogetic, 2009; IATA, 2007; Yamaguchi, 2007; Gibbons and Wu, 2020). IATA (2007) further show that investments in air transport capacity in developing or transition countries, where connectivity is relatively low, will have a much larger impact on their productivity and economic success than a similar level of investment in a relatively developed country. Another result is that better accessibility lowers manufacturing costs through both labor- and materials-savings (Cohen and Paul, 2003; Gibbons and Wu, 2020).

3.4.2. Causality Between Air Transport and Economic Development

The direction of causality between air transport and regional development has been analyzed in the literature. Literature has shown that there is a bi-directional causality between air transport and regional development with the two series being co-integrated in the case of Australia, Europe, the Asia-Pacific and Brazil (Baker et al., 2015; Van De Vijver et al., 2016; Van De Vijver et al., 2014; Marazzo et al., 2010). Van De Vijver et al. (2016) show that there are cases where causality runs from air passenger volume to total employment as well as the reverse effect in the case of Europe. Van De Vijver et al. (2014) show that trade and air passenger travel can develop independently, trade can facilitate air passenger traffic and air passenger traffic can facilitate trade in the case of the Asia-Pacific. One pattern that they observe in their analysis is that there is a lack of causality for linkages between more economically developed countries versus the more abundant presence of causality for linkages between economically developed and economically less developed countries. The second pattern is that in the cases of Malaysia and Singapore, causality runs mostly from trade to seats.

3.4.3. The Impact of Air Transport on Gross Domestic Product and Gross Value Added

There are studies which show that a uni-directional relationship exists between air transport and regional development. The studies show that air transport has a significant positive impact on gross domestic product and gross value added in the case of Turkey, the United States, the EU-28 countries, China and Austria (Baltaci et al., 2015; Florida et al., 2015; Sheard, 2019; Tittle et al., 2013; Gherghina et al., 2018; Hu et al., 2015; Sellner and Nagl, 2010). Sellner and Nagl (2010) use the elasticities and passenger forecasts to analyze how an expansion at the Vienna International Airport will impact the gross domestic product of Austria. They show that additional gross domestic product growth in Austria would be 0.81% in 2040 based on the values of the official forecast scenario with a third runway. In a more conservative forecast with a third runway, they show that gross domestic product is projected to increase by 0.2%. Tittle et al. (2013) show that average flight delay has a negative impact on economic development in the United States. Hong et al. (2011) is the only study that shows that the economic contribution of airway transport infrastructure in China is weak. This is a study that analyzes the entire transport sector in China and arrives at the conclusion that as air transport has a minor market share in comparison to other transport modes, it has an insignificant contribution to the Chinese economy.

3.4.4. The Impact of Air Transport on Population

The impact of air transport on population has been studied in the literature. These studies show that indicators such as air passengers per capita, boardings per capita, hub status, a city's air connectivity and airport size have a positive impact on population growth in the United States (Goetz, 1992; Green, 2007; Blonigen and Cristea, 2015; Cristea, 2023; Sheard, 2019). Chi (2012) studies the role of air transport accessibility in Wisconsin and finds that there is a positive impact on population growth in rural and suburban areas while there is no significant impact on population change in urban areas. Green (2007) shows that air cargo has an insignificant effect on population growth in the United States. Tveter (2017) studies the effects of airports on regional development in Norway from 1970 to 1980 and his results demonstrate a positive but insignificant effect on population.

3.4.5. The Impact of Air Transport on Employment

The literature has extensively analyzed the impact of air transport on employment. Studies have found that air transport has a positive effect on employment change, high-technology employment, new economy employment, service-related employment, average weekly wage, annual income growth rate, creative jobs and construction related employment in the United States (Goetz, 1992; Button et al., 1999; Button and Taylor, 2000; Brueckner, 2003; Green, 2007; Bilotkach, 2015; Blonigen and Cristea, 2015; Cristea, 2023; Neal, 2012; Sheard, 2014; Sheard, 2019). Button and Yuan (2013) study airfreight in the United States showing that changes in airfreight volume do Granger cause changes in per capita income and employment. While studies on the United States show that air transport has no significant effect on manufacturing related employment (Brueckner, 2003; Sheard, 2014), a study for Italy has shown that airport activity has a positive impact on total employment, employment in the manufacturing sector as well as employment in the service industry (Percoco, 2010). Neal (2012) studies air transport and creative employment in the United States finding that air passengers follow creative jobs during periods of national economic decline and creative jobs follow air passengers during periods of national economic growth.

Lakew and Bilotkach (2018) show that air transport delays negatively impact total employment, service-sector employment, leisure and hospitality employment as well as goods-producing employment in the United States. One study for the United States shows that it is not the airport that is generating jobs but rather other features in its vicinity (Cidell, 2015). She shows that airports have been fitted into existing metropolitan areas with established patterns and directions of growth. She concludes that considering the airport as a job generator without taking into account other locations at a similar distance can lead to overly optimistic findings about the airport's importance. Fageda and Gonzalez-Aregall (2017) in fact find that cargo movement via air transport has no relevant impact on industrial employment in Spain because passengers have a priority over goods in air transportation policies in Spain. Tveter (2017) studies the effects of airports on regional development in Norway from 1970 to 1980 and his results demonstrate a positive but insignificant effect on employment.

3.4.6. Air Transport and the Number of Business Establishments

Air transport might also attract firms to locate their offices in the vicinity due to access to a wide range of destinations through the air transport network. This strand of literature shows that air transport leads to an increase in the number of business establishments in the United States (Bilotkach, 2015; Blonigen and Cristea, 2015; Cristea, 2023; Sheard, 2019). Perhaps interestingly, Cristea (2023) shows that small and especially medium-size firms benefit the most from better air connectivity in the United States. Cantos et al. (2005) perform a case study of Spain showing that airports have a positive impact on agriculture and industry but they don’t find evidence for a spillover effect.

3.4.7. Air Transport, Trade and Foreign Direct Investment

Research has also studied the role of air transport in trade and foreign direct investment. Alderighi and Gaggero (2017) show that non-stop air connections positively impact the exports of Italian manufacturers and full-service carriers are mainly responsible for this result. Brugnoli et al. (2018) focus on Lombardy in Italy showing that civil aviation has a positive impact on international trade. The strongest positive effects are found in high-tech and medium-tech manufacturing sectors. In the case of Italy, Banno and Redondi (2014) show that the development of international airports and new routes from Italy to EU-25 countries has a positive impact on foreign direct investment. In the case of Spain, Fageda (2017) shows that reduction in travel time due to the availability of nonstop flights scheduled with sufficient frequency increases the amount of foreign direct investment in Barcelona due to the enhanced transmission of information.

3.5. A Synthesis of the Literature Survey

While the time, countries, limitations, context and progress of the studies have been highlighted in Appendix A, Appendix B, Appendix C, Section 2.2 and Section 4, this section will instead focus on synthesizing the results obtained from the literature survey. In the input-output literature, airports are shown to generate employment, income, output and value added. We find that these effects are observed not only with respect to the airport but also in the entire supply chain and also the overall economy because of the spending of employees working at the airport or in another node within its supply chain. We obtain the same results not just for airports but for the entire air transport sector. Catalytic effects of air transport are also found to be significant with the tourism sector being one of the main beneficiaries of air transport. Studies that analyze the whole transport sector find that air transport is relatively crucial for the economy with only one exception of Latvia that does not depend much on air transport. Air transport is shown to be crucial for logistics and freight transport and its sustainable efficiency is of utmost importance. This is because even though air transport carries a relatively minor share of freight in comparison to maritime transport with respect to mass, its contribution with respect to value is very high in comparison to maritime transport with time sensitive cargo such as perishables and electronics being majorly transported via air transport. With all this being said, air transport’s decarbonization is shown to be vital and both technology and policy will play a major role in the future for the greening of this sector.

Our set of literature on CBA shows: CBA is used for singular projects with limited impact on other markets. While a positive NPV is the typical goal, qualitative factors can override a purely quantitative recommendation. Important factors are time preference (for discounting), monetization and the selection of costs and benefits that are considered in the calculation. The limitations of traditional CBA are also repeatedly highlighted. The partial equilibrium nature of the method, the difficulty in monetizing certain benefits like consumer surplus in a standard CBA approach, and the challenge of accounting for economy-wide effects are recurring themes. In case of the analyzed airport expansion projects a general increase in social welfare can be measured. Purely financial CBA typically show positive results in the existing literature, with few outliers.

Computable general equilibrium models have analyzed a wide range of topics. Air transport subsidies and taxes are shown to have a positive impact on the economy. With respect to subsidies, analysis has shown that poor regions benefit due to an increase in output and the ensuing multiplier effects. The air passenger movement charge which acts as a tax is shown to be beneficial to the economy mainly because of inter-sectoral linkages with transfers from the tourism sector to the rest of the economy. Carbon taxes are shown to be beneficial because they reduce output of air transport which in turn reduces emissions. Air transport capacity expansion is shown to almost always benefit the economy with two exceptions. What is of relevance here is that spillover effects may also exist and not just core but also peripheral regions may benefit because of expansion. One exception is that rail transport may be negatively impacted on routes where the two modes of transport compete. Another exception is that developing countries may experience a widening of income inequality because of air transport capacity expansion. This problem can be solved by policies that encourage inclusive development and training of unskilled labour may play a vital role. Disruptions such as terrorist attacks are shown to have a significant negative impact and building system resilience is key to mitigate these negative impacts. Some other themes such as price-reducing reforms and the NextGen project are shown to be beneficial to the economy. One interesting study on urban air mobility also highlights how income inequality may be widened due to the introduction of this mode of transport.

The econometric literature shows that air transport expansion leads to a rise in total factor productivity. But the interesting result is that regions with poor air transport connectivity experience a higher rise in productivity in comparison to those that already have a mature air transport system with respect to connectivity. This might be because of the law of diminishing returns to connectivity. The causality literature shows that all possibilities exist. This means that air transport and economic development may develop independently, a bi-directional relationship might exist between economic development and air transport, air transport may lead to economic development and economic development may lead to increased air transport. These results highlight the need to use strong instruments when the assumption is that air transport leads to economic development due to the presence of endogeneity. Most studies do indeed follow this instrumental variable regression approach showing that air transport has a positive impact on gross domestic product, gross value added, population, employment, the number of business establishments, trade and foreign direct investment.

4. Methodological Recommendations

4.1. Input-Output Analysis

While standard input-output analysis is quite useful, methodological advances have been applied to overcome some of the model’s shortcomings. One methodological advance is multi-period input-output analysis which has been applied by Kronenberg et al. (2018) in order to study the tourism sector and the role of air transport in the tourism sector in Jämtland, Sweden. Multi-period analyses are useful because the input-output coefficients get outdated in static analyses. As a result, a multi-period input-output analysis should be applied in cases where a dynamic analysis is more suitable. Another advance is multi-region input-output analysis. This has been applied by Abbood et al. (2025) to analyse the role of air transport in freight transport in major European economies. They highlight that such an approach is useful because it can be used to study various activities within entire supply chains which often span across multiple industries and countries. Scenario analysis applied with input-output analysis is another methodological advance which can be used when the focus of the study is to consider different possibilities that can arise in an economy. This has been applied by Logar and van den Bergh (2013) in order to study the impact of peak oil on tourism in Spain. Their scenarios simulate increase in oil, natural gas, coal and electricity prices. They further simulate an increase in the price of primary inputs that could occur as a result of inflationary effects due to the increase of energy prices. Data envelopment analysis has been applied along with input-output analysis when the focus of the study is to look at how efficient an economy is with respect to various aspects. This has been applied by Abbood et al. (2025) to study the sustainable efficiency of freight transport in the major European economies. They first quantify the carbon footprint of the freight transport sector using a multi-region input-output model. The results of the input-output analysis are used in a second stage data envelopment analysis model in order to analyze the sustainable efficiency of each freight transport mode in the major European economies.

4.2. Cost-Benefit Analysis

Regarding applicability, CBA is typically used to evaluate projects that show the following characteristics:

- Clear cost/benefit structure
- Defined project length

- Effects that are easy to monetize
- Marginal impact in markets beyond the analyzed market

The outcome and policy recommendation resulting from a CBA are the more significant the better the policy analyst is informed about the relevant cost and benefit factors and how they evolve over the course of the project lifetime. Relevant effects have to be measurable and quantifiable into monetary values. Furthermore, having a defined project length is key to properly discount benefits as well as costs, especially if capital costs exist. The factor that sets CBA apart from IO or CGE models the most is the fact that it is ideally used when there are no or only marginal economic impacts in markets that exceed the analyzed market since it is hardly able to capture these effects. Literature showed several methodological advances like hyperbolic or exponential discounting (depending on assumptions and time preference) to address some of the weaknesses of standard CBA. Apart from limited applicability, its biggest flaw remains the lack of standardized monetization schemes on a lot of factors like land use or emissions which often can lead to biased results. CBA is a good tool to evaluate generally smaller projects with a diverse range of costs and benefits, provided these remain within the analyzed market.

4.3. Computable General Equilibrium Models

The conventional computable general equilibrium model has been extended in various directions which further enhances its utility. Norman-Lopez et al. (2024) apply a multi-region multi-sector recursive dynamic computable general equilibrium model to study how a carbon tax on aviation impacts the global economy. Such a model is very useful to analyze how regions and industrial sectors interact dynamically to a shock in the global economy. Njoya and Nikitas (2020) apply a social accounting matrix model along with a computable general equilibrium model to study how air transport expansion impacts the South African economy. Such a model can be used to study the strengths of backward and forward linkages between the air transport sector and the local economy as well as to estimate the economy-wide impact of air transport expansion. Yamaguchi et al. (2001) combine a partial equilibrium model along with a computable general equilibrium model to study the effect of deregulation and airport capacity expansion in the Japanese domestic aviation market. Such a model is useful because the demand and supply curves for aviation can be estimated using a two-stage least squares approach to measure the effect of deregulation and airport capacity expansion. The results of the two-stage least squares partial equilibrium model can thereafter be used as an input to the computable general equilibrium model in order to estimate social welfare. Ueda et al. (2005) extend the computable general equilibrium model in various directions. They combine a discrete choice model, a spatial computable general equilibrium model, an aviation network model and game theory in order to analyze the benefits of the expansion of the Haneda airport in Japan. The benefit of the spatial computable general equilibrium model is that it is capable of analyzing spillover effects. Their aviation network model is capable of estimating the level of transportation service by price of service and travel time. The discrete choice model is within the aviation network model wherein the consumer behaviour is modelled as a multi-stage discrete choice model. Game theory is also incorporated in their aviation network model where the equilibrium of the aviation network model is a Nash-type non-cooperative game. Total factor productivity models have also been used along with computable general equilibrium models. Ishikura and Tsuchiya (2007) do exactly this by combining a Solow residual estimation approach and computable general equilibrium. Such a model can be used to study how an improvement in total factor productivity in the air transport industry impacts the entire economy including inter-industry effects.

4.4. Econometric Estimation of the Economic Impact of Air Transport

In the total factor productivity literature, Allroggen and Malina (2014) apply the limited information maximum likelihood estimator because it is more robust to weak instruments. Yamaguchi (2007) applies a three-stage least squares approach to estimate a production function in order to analyze the impact of deregulation and infrastructure development in air transport on inter-regional accessibility and per-capita gross domestic product growth for core and peripheral areas in Japan. In the causality literature, Baker et al. (2015) apply a vector error correction model which is better than a standard Granger causality test because it is dynamic in nature and is able to estimate the long-run cointegrating relationship. Van De Vijver et al. (2014) contribute to the methodological advances in causality analysis by using a heterogeneous time series cross section Granger causality analysis which is capable of simultaneously detecting if there is no co-evolution, there is co-evolution, air traffic facilitates trade and trade is facilitated by air traffic. They apply this methodology to the case of the Asia-Pacific region. Along with standard instrumental variable regression techniques, one methodological advance has been to use the two-step efficient generalized method of moments estimator that is robust to heteroskedasticity and autocorrelation as has been applied by Alderighi and Gaggero (2017) to study the effect of air transport on the export of Italian manufacturers. In their analysis of the impact of air transport on trade flows in Italy, Brugnoli et al. (2018) estimate a difference-in-difference model in order to control for endogeneity between trade and air transportation. Tveter (2017) also uses a difference-in-difference design in order to measure the effect of airports on regional development in Norway. Another similar approach is to use propensity score matching of regions with and without airports to compare which regions perform better economically (Florida et al., 2015). As air transport could have spillover effects, spatial econometric models are gaining prominence in the literature. For example, Chi (2012) applies spatial regime models in order to examine the variations of the impact of air transport across rural, suburban and urban areas. Fageda and Gonzalez-Aregall (2017) apply a spatial Durbin regression model to estimate the determinants of industrial employment in Spain. The total factor productivity literature has also modelled spatial inter-relationships through external shift factors that control for own- and connected-state airport infrastructure investment (Cohen and Paul, 2003). When there are multiple dependent variables of interest, the literature has applied a seemingly unrelated regression framework to study the economic impact of air transport (Sellner and Nagl, 2010).

5. Conclusion

To conclude, we will highlight the most important and common results that have been obtained by the application of the four methodologies discussed previously on the economic impact of air transport. We will also summarize applicability and methodological advances in this section. Regarding applicability, input-output analysis can be used to study economy-wide relationships with air transport being the key sector of interest. This methodology is also useful to study inter-sectoral linkages. We find that CBA works well for smaller projects which don’t have a significant impact on markets other than the analyzed market. Computable general equilibrium models are best suited to study economy-wide welfare effects of a project or policy shift. Econometrics can mainly be used when the topic of interest is to evaluate how air transport impacts a single variable such as employment. If more variables are to be analyzed, multiple regression equations have to be estimated to analyze the impact of air transport on the variables of interest.

The input-output literature shows that air transport generates jobs and value added in the whole economy in the present as well as in the future. However, some sectors such as rail transport may be negatively affected on routes where there is competition with air transport. The literature has shown that air transport has stronger backward linkages in comparison to the forward linkage. The studies further show that air transport is key for tourism, logistics and freight transport. Finally, studies have shown that air transport emits a significant amount of CO_2 and NO_x and in order to have sustainable growth in this sector, sustainable aviation fuels, liquid hydrogen and electrification may play a vital role.

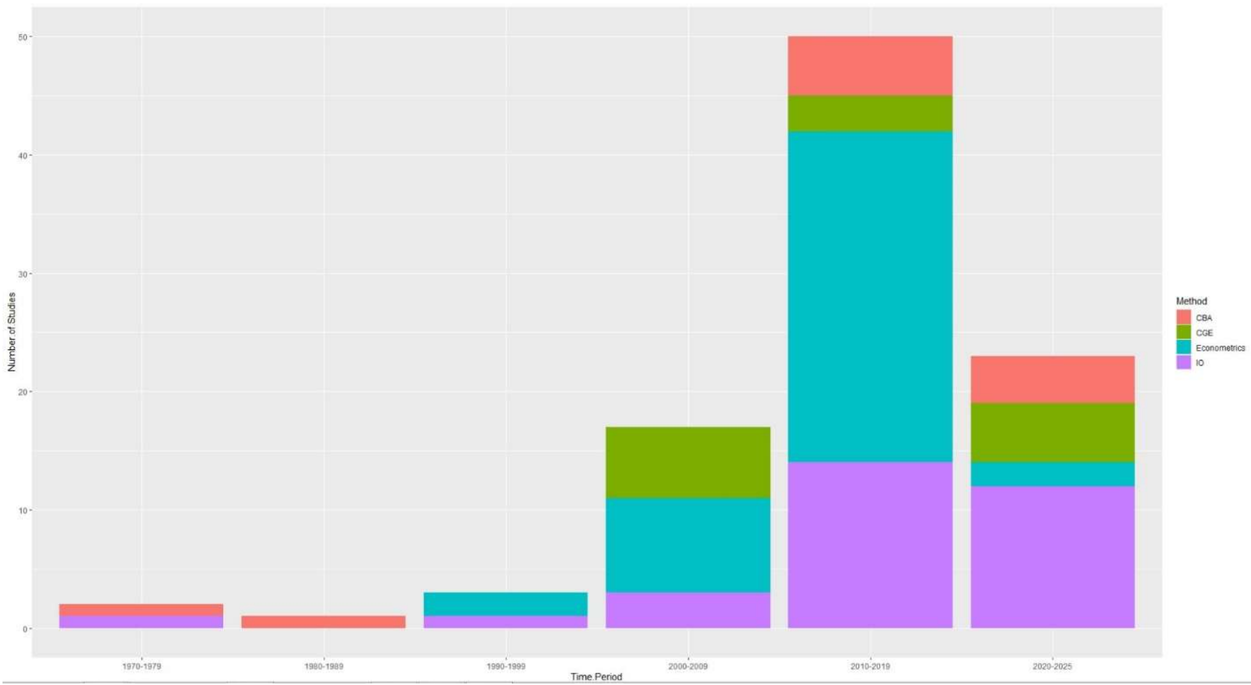
With respect to cost-benefit analysis, we find that having a clear set of cost and benefit factors helps. It has to be stated however that analysts rarely include all relevant cost and benefit factors due to difficulties in monetization or the unavailability of necessary data throughout the full project lifetime. That leads to CBAs often becoming inaccurate and biased due to the arbitrary selection of costs/benefits. This can be seen in multiple studies where effects on emissions/local air quality and opportunity costs where completely left out. CBA results indicate that airport expansion projects typically yield an increase in social welfare throughout our set of literature. Subsidized projects generally aim to increase social welfare but still require a thorough analysis due to existing opportunity costs. NPVs of the available set of projects have to be assessed and compared in order to maximize welfare.

The computable general equilibrium results show that subsidies and taxes in the air transport sector may benefit the economy as a whole. Capacity expansion in air transport is shown to be beneficial to the region where the airport is located as well as to peripheral regions due to increased tourism. However, air transport might widen income inequality in developing countries. The literature on air transport disruptions shows that they can have a detrimental impact on the whole economy and resilience is key to mitigate these negative impacts. Price-reducing reforms are shown to increase tourism, GDP, trade, household income, consumer welfare as well as reduce unemployment.

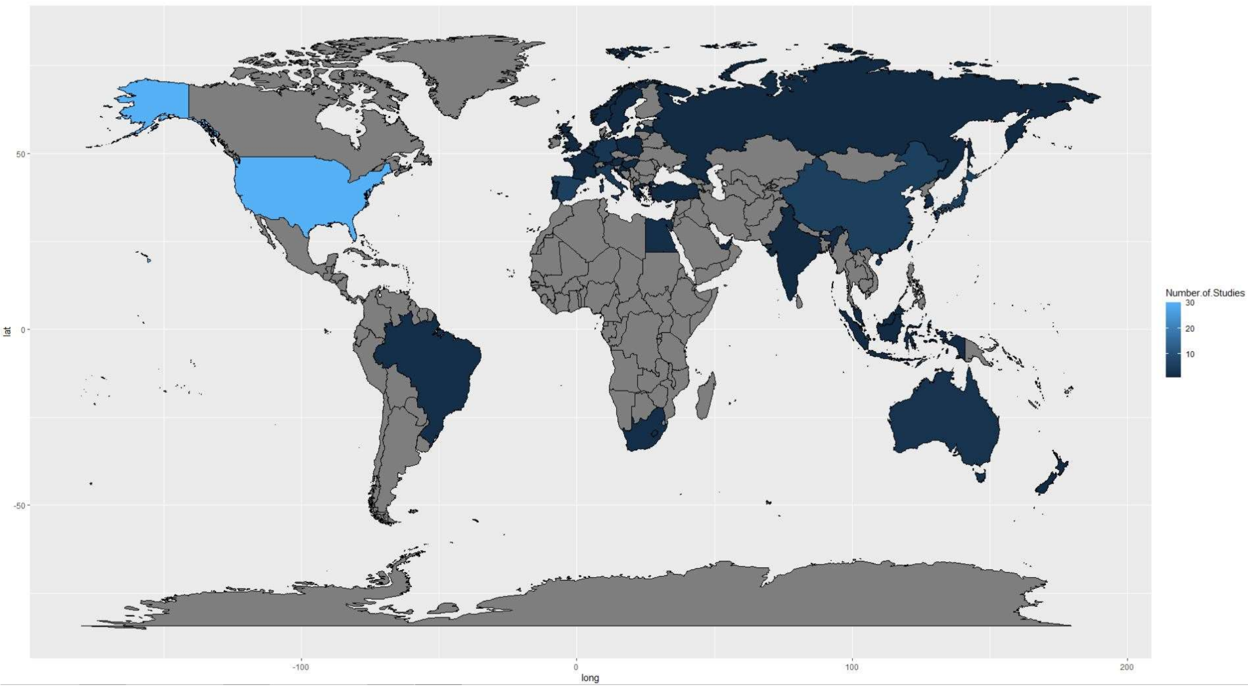
Through the estimation of production and cost functions, the econometric literature has shown that air transport capacity expansions improve total factor productivity. Granger causality analyses have shown that air transport and regional development may be co-integrated, air transport might lead to regional development and regional development might lead to increased air transport. As a result, studies that have hypothesized that air transport leads to regional development have made use of various instruments to address endogeneity. This strand of literature has shown that air transport has a positive impact on gross domestic product, gross value added, population, employment, the number of business establishments as well as trade and foreign direct investment.

There have been numerous methodological advances in the literature which could be applied in further research. Multi-period and multi-region input-output analyses have made this methodology more dynamic and disaggregated. Scenario analysis has shown how price effects can be included in the methodology. Data envelopment analysis along with input-output analysis has been applied to evaluate the sustainable efficiency of regions. Cost-benefit analysis has been extended with alternative discounting methodologies such as hyperbolic and exponential discounting. The most notable methodological extensions within computable general equilibrium have been spatial and dynamic models. The incorporation of an aviation network model and the application of game theory to study oligopolistic aviation markets are also other valuable methodological extensions. Within the econometric literature, heterogeneous time series cross section Granger causality analysis makes it possible to simultaneously study all possibilities with respect to causality. Studies that assume that air transport leads to economic development have used more advanced models such as difference-in-difference, propensity score matching, seemingly unrelated regression and spatial econometrics to better tackle endogeneity. These advances offer a methodologically more robust approach in order to study the role of air transport in regional and economic development.

Appendix A. Distribution of Studies by Methodology and Time Period



Appendix B. Map of the Countries Studied in the Literature



Appendix C. Summary table of the topics, regions and indicators analyzed in the literature by methodology

Methodology	Topic	Region	Indicator
Input-output analysis	Airports, air transport services, air traffic forecasting, tourism, transportation, logistics, emissions, aviation biofuel production	United Kingdom, Greece, Hungary, the Netherlands, Poland, Germany, the United States of America, China, Sweden, Spain, Japan, Indonesia, New Zealand, Taiwan, Croatia, South Korea, Latvia, France, Italy, Malaysia, Russia, Belgium, the United Arab Emirates, Brazil	Employment, income, direct impacts, indirect impacts, induced impacts, catalytic impacts, output, value added, gross domestic product, inter-industry linkages, investment, the industry ripple effect, the production-inducing effect, the supply shortage effect, intermediate demand, trade, price effects
Cost-benefit analysis	Airport operation, airport expansion, infrastructure investments, airline operations, tourism, commercial drone use, public air service	Belgium, India, Portugal, the United States of America	Revenue, producer surplus, consumer surplus, government surplus, emissions, time gains, capacity, capital cost, maintenance cost,

			land requirements, fuel costs, energy availability, transport alternatives
Computable general equilibrium	Subsidies, taxes, air transport capacity expansion, price-reducing reforms, congestion, terrorist attacks, environmental impacts	Australia, Japan, South Africa, Egypt, the United States of America, Germany	Net benefits, welfare, employment, gross domestic product, gross national income, inter-sectoral linkages, distributional impacts, trade, exchange rates, interest rates, household consumption, investment
Econometric estimation	Total factor productivity, causality analysis, instrumental variable regression	Italy, Germany, Australia, Turkey, the United States of America, Spain, South Africa, China, Brazil, Austria, Norway, Japan	Trade, gross value added, gross domestic product, employment, number of firms, wage, population, foreign direct investment, house prices

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