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Air passenger transport and regional development: Cause and effect in Europe

Abstract
This article scrutinizes the mutual and complex causal relationship between air passenger transport and regional development in European NUTS2-regions with heterogeneous Granger causality analysis between 2002 and 2011. Employment is used as a relatively robust and measurable indicator of a region's development and employment in the services sector and in the manufacturing sector is treated separately to discern basic sectoral variances. The proposed methodology allows investigating (i) if air transport in the European regions causally influences employment, (ii) if employment also leads to higher transport levels, and (iii) regional variations in this causal relationship. Results show that both directions of causality occur among European urban regions, albeit very geographically fragmented. This indicates that air passenger transport is a necessary part of, but not sufficient condition for generating regional development. The more abundant relationships for employment in the services sector confirm the sensitivity of the services industry to air passenger transport.

Keywords
Economic development; air passenger transport, European regional development; Granger causality

1. Introduction

The research presented in this article aims to investigate the causal linkages between air passenger transport and regional development -expressed in employment- in Europe. Much research on this topic has been carried out for the United States of America (US) [1, 2, 3, 4, 5, 6], but research elsewhere has been lacking. According to Dobruszkes et al. [7], the main reason for this is the difficulty of finding homogeneous data in a multinational context. Moreover, in the US, most of the airports serve a distinct city with limited ground transport options, while, for instance, European airports are surrounded by multiple cities, creating overlapping catchment areas. In a European context, this literature has been limited to Mukkala and Tervo's analysis [8] of the causal link between air traffic and economic growth -represented by GDP and employment growth- in 86 regions and Percoco's study [9] on the impact of air passenger transport on the local employment in Italian provinces. The literature

often concludes that air passenger transport has a larger influence on economic development than the other way around, although it is obvious that the socio-economic function of a region (e.g. employment and GDP) can equally influence the demand for air passenger transport services [7, 10, 11].

Despite the limited research on Europe, The European Commission suggests that air passenger transport is ‘a strategically important sector that makes a vital contribution to the EU's overall economy and employment’ [12]. Against this backdrop, efforts have been made to liberalize the internal air transport market in the European Union in order to unleash the alleged economic benefits associated with the associated rise in levels of air passenger transport. During a time span of 10 years and via a three-stage process, the European Union (EU) went from a heavily regulated to a liberalized market, culminating in an opening up of European domestic markets to free competition from all EU-licensed carriers (i.e. cabotage) in 1997 [13, 14, 15]. During this time frame, European countries also signed increasingly liberal air service agreements with countries outside the European Union, with the Netherlands-USA Open Skies Agreement in 1992 as a pioneering event. These open skies agreements eliminate government involvement in airline decision-making about routes, capacity, and pricing, which contrasts heavily with previous restrictive air service agreements [16]. Since 2005, the EU -as a single aviation market- has tried to extend its uniform aviation policy beyond its borders by negotiating comprehensive agreements to integrate the EU aviation market with those of its key international partners. For example, the EU-US Air Transport Agreement, of which the first phase went into effect in 2008, allows any airline of the EU and the United States to fly between any point in the EU and any point in the US. This progressing liberalization of air travel between the EU and its major economic partners has in turn been paralleled by a broader deregulation of the internal air travel market (especially throughout the 1990s), which resulted in increased competition (more airlines, serving more routes), the emergence of low cost carriers (LCC), and lower air fares in the EU. Taken together, these evolutions did not only significantly boost the intra-European air travel, but also the international air travel to and from European airports [13, 15].

The link between air passenger transport and economic development is felt strongly in regional airports, which are the major destinations of the minimal cost seeking low cost carriers (LCC), because of their lower airport fees, higher availability of airport slots, and absence of traffic congestion [13, 17]. In many cases, growth in passenger volumes facilitated economic growth and employment growth and stimulated tourism in the surrounding regions

(e.g Donzelli [18] for Southern Italy), effects that can be labelled as the 'catalytic effects' of air transport [19]. At the same time, LCC-related air transport investments to stimulate regional development is not without risks, as this type of airline tends to exhibit a footloose behaviour. Olipra [20], for instance, gives examples from Poland, where LCC-passengers make up more than 90% of total passengers in some airports (e.g. Katowice, Lodz and Bydgoszcz). Cessation of services from Ryanair or Wizzair on those airports could severely affect the surrounding regions. In a similar vein, in regions that are strongly dependent on tourism, the volatility of air transport connectivity can cause a quick downfall in economic growth and employment levels that are dependent upon tourism.

The major European airports also prospered from the liberalization wave, in that they witnessed larger passenger volumes, thus influencing their surrounding urban and economic landscapes as well [21]. Hakfoort et al. [22], for instance, label the Dutch Amsterdam Schiphol Airport as a 'growth pole' in the regional economy. Multiple case-studies have examined the catalytic impacts of European airports on the regional economy (for instance Heuer and Klophaus [23] for Frankfurt-Hahn Airport, and Abraham et al. [24] for Lübeck Airport). These case-studies generally put forward that European airports are vital for the international competitiveness of their wider surrounding region by providing improved accessibility, attracting inward investment, and facilitating trade and tourism [24, 25, 26], and can as such be seen as regional economic motors [21]. However, air passenger transport is endogenous to economic development, as economic development influences air passenger transport in its own right.

In this light, the complex causal relationship between air transportation and employment in European NUTS2-regions with heterogeneous Granger causality analysis will be examined, similar to the work of Tranos [27] on the Internet infrastructure and economic regional development in European city regions. The proposed methodology allows to (i) investigate if air transport in European NUTS2-regions has a causal influence on employment, (ii) investigate if employment in those regions also leads to higher transport levels, and (iii) discern regional variations in this causal relationship. Employment is used here because it is a relatively robust and measurable indicator of a region's economic success [28], and employment in the services sector and employment in the manufacturing sector is treated separately in the analysis to discern basic sectoral variance.

The remainder of the paper is organized as follows. First, the literature on the link between air passenger transport and economic development is reviewed in more detail, followed by a discussion on how the EU uses air passenger transport as a tool for stimulating regional development. Next, the units of analysis are described, the data collection is presented, and the procedure of the heterogeneous Granger causality-methodology is briefly explained. In the following sections, the results of the Granger causality analysis are shown and discussed. The paper concludes with a summary of the results and an overview of avenues for future research.

2. Some notes on air passenger transport and economic development

2.1 Literature review: The link between air passenger transport and economic development

It is generally assumed that air transport is an enabling factor for wider economic development in a region. Button and Yuan [29: 337], however, state that 'the evidence for this has largely been anecdotal', while Burmeister and Colletis-Wahl [30: 232] warn for the misperceived 'automatic nature' of 'infrastructure effects' which could lead to 'a dangerous vision of infrastructure investment as a universal tool for development strategies'. Vickerman et al. [31: 1] add that 'the precise role of transport infrastructure in the process of regional development, even the direction of causality, is still open to much debate'. Nevertheless, some efforts have been made to shed further light on this complex relationship, mainly within a US context. Table 1 gives an overview of the main analyses within the literature investigating the reciprocal link between air passenger transport and employment as an indicator for economic development.

A close reading of Table 1 confirms the overall understanding that air passenger transport and employment in urban regions are positively linked, but additionally highlights three trends: the dominant focus on US metropolitan areas (MAs), the larger influence of air passenger transport on employment, and the emphasis on employment in the services sectors.

Referring to the second trend, a majority of the authors obtain this result by relying on regression-types analyses, where (changes in) air passenger traffic volumes are used to explain (changes in) employment in urban regions. The rationale behind these analyses is the observation that better air transport services imply better accessibility, which encourages companies to locate in a region, and stimulate existing businesses to expand [19, 32].

Table 1. Literature on the relationship between air passenger transport and employment.

Literature	Region	Results
Goetz [33]	US MAs, 1950-1997	Positive relation between passengers per capita and both previous and subsequent levels of employment
Debbage [34] Debbage and Delk [4]	US MAs, 1973-1995 and 1973-1996	Positive correlation between air services volume and administrative and auxiliary employment
Liu et al. [10]	US MAs, 1999	% workforce in professional, services and technical sector (PST) and management is a predictor for being a major air traffic market
Alkaabi and Debbage [35]	US MAs, 1999	Linear relationship between number of passenger enplanements, and employment and number of companies in the PST- and high-technology sector
Button and Taylor [36]	US MAs, 1996	Link between the quantity and quality of air services to the EU and 'new employment' (electronics, IT, telecom, management and services…)
Brueckner [1]	US MAs, 1996	Increase in passenger enplanements leads to increase in employment in services sector, not in the manufacturing sector
Green [37]	US MAs, 1990-2000	Boardings per capita and origin passengers per capita increase employment growth
Percoco [9]	Italian provinces, 2002	Significant influence of air passenger transport on employment in the services sector
Blonigen and Cristea	US MAs, 1969 -	Annual growth in passenger traffic leads to increase in annual growth in employment

[38]	1991	(especially in wholesale and retail-sector)
Irwin and Kasarda [5]	US MAs, 1950-1980	Changes in the structure of the US airline network are a cause rather than a consequence of employment in manufacturing and producer services growth
Ivy et al. [6]	US MAs, 1978-1988	Changes in air service connectivity of US metropolitan areas influence employment levels in administrative and auxiliary sectors (more than the other direction)
Neal [39]	US MAs, 2001-2008	Number of passengers 'causes' employment in creative sector and vice versa
Button and Lall [2] Button et al. [3]	US MAs, 1994	Increases in traffic at hub airports have a positive effect on high-tech employment. Granger causality in two case study areas indicate causality from air traffic to employment
Mukkala and Tervo [8]	European urban regions, 1991-2010	Homogenous Granger causality from employment growth to number of passengers. Granger causality from air traffic to employment growth in peripheral regions, but not in core regions

MA: Metropolitan Area

This improved accessibility and connectivity contributes to the economic performance of the wider economy by enhancing its overall level of productivity through increased access to other markets, freer movement of investment capital and workers between regions [25]. Only a number of studies rely on the concept of causality by using regression analyses with lagged variables or Granger causality analyses (e.g. [3, 5, 8, 39]). These analyses perceive causality as a chronological precedence of air transport to employment, and some of these studies indicate that employment can also precede air transport services [8, 39].

Referring to the third trend, the focus on employment in the services sector stems from the assumption that the services industry is more sensitive to air passenger transport than other

sectors in the economy, because they rely heavily on direct face-to-face contact [9, 34]. Even with recent technological innovations minimizing the need for interpersonal contact, this direct contact with colleagues, suppliers, customers, and other key employees remains important (e.g. [40, 41, 42, 43]). This point came explicitly to the fore in Brueckner [1], who distinguished between employment in the manufacturing and services sector, and found only evidence for a link between air transport and employment in the services sector. Particularly the professional, services and technical (PST), management and high technology sectors seem related to air passenger services [3, 10, 35]. Also the creative sector, wholesale and retail, and administrative and auxiliary employment have been subject to research [6, 38, 39].

In this article, previous research is extended by focusing on European urban areas and using the methodology of Granger causality to discern causality in the relationship between air transport and employment. Additionally, it is acknowledged that employment in the services sector may be particularly influenced by air traffic, by comparing causality patterns with total employment and employment in the manufacturing sector.

Given that most of the discussion in this article (and indeed the literature as a whole) focuses on economic development, it is recognized that the used employment indicator has a tangible, yet complex association with economic development more broadly defined. Rather than a construct validity issue per se, in the context of our research, the major potential issue would be the uneven temporal responses of employment and air transport volumes to changing macroeconomic conditions. Air transport is a very cyclical industry, i.e. an industry that follows the business cycle so that revenues are higher during economic prosperity and lower during economic contraction. Per capita income, disposable income, and consumer confidence are immediate key drivers of demand for air transport. This is not a crucial problem as it is clear that macro-economic trends have a broadly similar impact on (un)employment, while our methodological approach controls for time trends (see 3.3). However, given its very cyclical nature, air transport demand may well respond more quickly to economic changes than visible in the creation or destruction of jobs, and this may impact our analysis which centers on the suggestion of causality as seen in the timing of change. Given the onset of the economic crisis following the 2007-8 financial crisis (cf. [44]), this may impact the findings reported in this paper.

2.2 Air transportation as a tool for regional economic development in the European Union

The EU is, of course, in many different aspects heterogeneous, which is inter alia expressed in large regional economic disparities between, but also within countries. One of the prime concerns of regional economic policies is to lower these inequalities, with the particular aim of socio-economic convergence, which involves an equalization of basic incomes promoted by higher GDP growth, competitiveness and employment [45]. Improving accessibility – particularly to remote and less developed regions- is viewed as one possible avenue for facilitating this convergence. In a report for the European Parliament, Dubois et al. [46] acknowledge that access to large markets, extensive and diversified labour markets and advanced services is becoming increasingly important for economic development, but they question the power of improved accessibility for stimulating this development, due to 'the lack of scientific evidence on the correlation between transport endowment and the level of economic development' [46: vi].

The assumption of better accessibility improving regional development was used as a starting point for the European Commission to set up the Trans-European Transport Networks (TEN-T) in 1996, a programme to support the construction and upgrade of transport infrastructure across –often peripheral- European regions to reduce the abovementioned large regional socio-economic disparities and to enhance European competitiveness, job creation and cohesion [47]. This is part of the wider system of Trans-European Networks (TENs), including a telecommunications network (eTEN) and a proposed energy network (TEN-E or Ten-Energy). TEN-T envisages coordinated improvements to primary roads, railways, inland waterways, airports, seaports, inland ports and traffic management systems, providing integrated and intermodal long-distance, high-speed routes. Two rounds of funding schemes (2000-2006 and 2007-2013) have already been accomplished, in which also some airports (such as Faro airport, Portugal in 2009) have received funding (http://inea.ec.europa.eu/en/ten-t/ten-t.htm).

In the framework of its Regional Policy, the EU has also established development plans, where part of the focus is on improving accessibility through air traffic, for example in Greece1, Lithuania2 and Poland3. Reflecting the statement of Dubois et al. [46], it is explored to what degree these sorts of programmes and incentives significantly contribute to economic development in European regions by focusing on employment, which is of course only one, but an important dimension of development.

3. Delineation of the study areas, data collection and methodology

3.1 Delineation of the study areas

Data are collected at the level of European NUTS2-regions, and only those regions for which all the necessary data were available are considered. As is well known, NUTS (Nomenclature of territorial units for statistics) is developed by the statistical agency of the European Union 'Eurostat' to provide a single uniform breakdown of territorial units for the production of regional statistics [48]. Although it has no legal value per se, it is a powerful tool for comparing European countries and regions. The classification comprises three levels, ranging from countries (level 1) to metropolitan regions (level 3). NUTS level 2-regions are defined as the basic regions for the application of EU regional policies concerning job creation, competitiveness, economic growth, improved quality of life and sustainable development [48]. Their absolute sizes (in terms of population) differ: they constitute provinces, regions or counties, depending on the country to which they belong to. In this study, NUTS2-regions are assumed to be the prime catchment areas of airports. Defining catchment areas of airports and linking this to functional catchment areas of airports is, of course, very difficult. The size and shape of catchment areas differ [49, 50], and are influenced by various parameters such as the availability of direct connections, the frequency of flights, but also the accessibility of the airport on land side [7]. The overlap between catchment areas and NUTS2-regions is complex, and may include the following possibilities:

1. Some catchment areas are larger than the proposed NUTS2-regions. For example, the actual catchment area of Vienna International Airport in Austria also covers parts of Western Slovakia and Hungary, and Southern Czech Republic [51].
2. NUTS2-regions without an airport are not included in our analysis, although they might be influenced by airports located in adjacent NUTS2-regions. For example, all NUTS2-regions in Belgium are in the sphere of influence of Brussels International Airport, but most of them are not included in our analysis because they do not have an airport in their territory.
3. Overlap may also occur, as nearly two-thirds of European citizens are within two hours' drive of at least two airports [52]. For instance, for residents in the southern parts of The Netherlands, Amsterdam Schiphol Airport and Brussels International Airport are two viable options.

Taken together, it is clear that NUTS2-regions should above all be seen as best-available proxies for the actual catchment areas of airports, and this may have repercussions for the results of our analysis. Nevertheless, they remain the most convenient divisions, being important units for European statistical data collection. The selected 112 NUTS2-regions are located in 18 different countries, and for each of them the employment-statistics and the number of passengers are collected for the period 2002-2011. The data are freely available on the Eurostat website (http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/).

3.2 Data collection

The employment-statistics were retrieved from the Eurostat-database on Labour Statistics. The information in this database is based on the EU Labour Force Survey (EU-LFS), a quarterly household sample survey conducted in all Member States of the EU and in the European Free Trade Association (EFTA) and Candidate countries.

The database follows the NACE-classification, which is a statistical classification of economic activities in the European Community [53], and represents the employment in the different economic sectors across the European NUTS-regions. Until 2008, the NACE Rev. 1 version was used, after which there was a shift to an improved and more detailed Rev.2 version. Although small differences in the classification system exist between these two versions of NACE, this poses no major problems, as the changes are similar for all the 112 regions and are rather small. Information is collected on:

1. Total employment (all persons aged 15 and over);
2. Employment in manufacturing (NACE section C for statistics from 2008 onwards, respectively D for statistics until 2008);
3. Employment in services (NACE sections G-Q4). These sections comprise much of the subsectors mentioned in Table 1, such as wholesale and retail trade, information and communication, professional, scientific and technical activities, administrative and auxiliary activities, but also tourism-related services (accommodation and food service activities).

The passenger data were extracted from the database ‘Air transport of passengers by NUTS 2 regions’. These data express the total passengers embarked and disembarked in each region and have been calculated by aggregating data collected at the airport level on the regional level, excluding double counting within each region.

3.3 Granger causality

Granger causality tests are widely used methods for empirically examining causal relationships between variables. Causality in this sense refers to a chronological precedence of one variable to another. A variable X (e.g. air passenger transport) is said to 'Granger cause' a variable Y (e.g employment), if taking into account past values of X enables better predictions of Y than based exclusively on past values of Y The variable X does not literally 'cause' Y, but rather helps to forecast it which is then taken to be a sign of explanatory power [26].

In this research, the variant of heterogeneous time series cross-section (TSCS) Granger causality testing is used. This method allows for scrutinizing the 112 NUTS2-regions simultaneously over a given time period (2002-2011), permitting dissimilar causation among the different regions [54], a feature that has often been neglected in other research (e.g. [29]).

The heterogeneous TSCS-Granger model can be expressed as:

$$y_{i,t} = a_i + \sum_{k=1}^{p} \gamma_k y_{i,t-k} + \sum_{k=1}^{p} \beta_{i,k} x_{i,t-k} + u_{i,\,t} \qquad (1)$$

In which a_i are the fixed effects, γ_k and $\beta_{i,k}$ represent the autoregressive and regression coefficients respectively, $y_{i,t-k}$ and $x_{i,t-k}$ the lagged values of the dependent and independent variables respectively, $u_{i,t}$ the error term, and p the number of time lags. The latter refers to the time difference which offers the maximum level of 'causality' [54]. The assumption underlying this extension is that the autoregressive coefficient is constant for all cross-sections, while the regression coefficient is constant for all time periods but can vary across the cross-sections, which enables the causal heterogeneity [26].

The heterogeneous TSCS-causality testing procedure consists of three consecutive steps, which have been extensively described in Hurlin and Venet [54], Hood III et al. [56], Tranos [27] and Van De Vijver et al. [26]. The procedure is tested separately for the three relationships (i) passenger volume versus total employment, (ii) passenger volume versus employment in the services sector, and (iii) passenger volume versus employment in the manufacturing sector. The three procedures are performed in two directions, once running from passenger volume to the employment indicator and once running from the employment indicator to the passenger volume. In this way, the two-way influence between employment and air transport is simultaneously measured.

In a first step, the homogeneous non-causality test, the null hypothesis of absence of causality from X (e.g. passenger volume) to Y (e.g. total employment) across all regions is put against the alternative hypothesis of presence of causality for at least one region, and verified with an F-test. If the null hypothesis is rejected, a heterogeneous causality test is performed in a second step. Here, the null hypothesis assumes that the perceived causality is similar for all regions, against an alternative hypothesis of similar causality for only some of the regions. In case of rejection of this null hypothesis, individual causality tests for all the regions are executed in a third and optional step.

This methodology is equally used in Mukkala and Tervo [8], who examine the causal relationship between air transport and economic development (translated in GDP and employment) in 86 regions across Europe. They were able to discern regional variability in this relationship (see Table 1): causality from employment growth to passenger volume is homogeneous, but causality from passenger volume to employment growth is heterogeneous and mainly occurs in peripheral regions. The current paper adds to this study, in that it takes into account total employment, but also distinguishes between employment in the manufacturing and services sector.

4. Results and discussion

Prior to the Granger analysis, the data series needed to be checked for the possible presence of a time trend, which can cause the Granger tests to produce unreliable results5. Additionally, a time lag of one year is set, due to the short time period under study (2002-2011)6.

First, the causal relationships between the passenger volumes and total employment are analysed, and then those between passenger volumes and employment in the manufacturing and services sector, in order to test whether Breuckner's [1] statement of air transport only influencing employment in the services sector and not the manufacturing sector holds true in our study.

4.1 Air passenger transport versus total employment

The results of the homogeneous non-causality test (step 1) and the heterogeneous causality test (step 2) are shown in Table 2 and indicate that for only a subset of the 112 NUTS2-regions, causality relationships between total employment and the passenger volume can be detected.

Table 2. Results of the homogeneous non-causality (F1) and the heterogeneous causality test (F2).

Direction	F1-test	F2-test
Passengers -> total employment	1.302**	1.223*
Total employment -> passengers	2.390***	2.382***

*** p<0.01, **p<0.05, *p<0.10

The individual causality tests7 reveal that causality is present for about half of the regions (Figure 1). For the majority (43) of the regions, causality runs from the passenger volume in year t to total employment in year t+1. This confirms Irwin and Kasarda's [5: 533] finding that 'changes in air transportation have altered the competitive advantages of metropolitan areas, and not the reverse'. However, this statement can be challenged as well, as 10 regions show this 'reverse' effect, and four show bidirectional causality. This illustrates the ability of our analysis to reveal the regional nuances that lie in the relationship between air transport and employment.

These regional nuances do not show a clear pattern (Figure 1), but some clusters with causality from air transport to employment can be perceived. One cluster comprises the central, well developed German and Austrian regions, which are part of the 'European polygon' (cfr. [7]). There is also a Spanish cluster, where Aragon and Cantabria show bidirectional causality. At the same time, causality is missing in other well-connected areas such as the French and Dutch capital regions, while it is present in peripheral regions –both in terms of geographical location and GDP- such as Malta, Estonia and Vest (Romania).

This shows that accessibility is necessary, but not sufficient, for regional growth [57]. The absence of a link in well-developed and accessible regions could point to the fact that additional gains in accessibility may only bring marginal gains in employment [47]. Another explanation lies in the definition of the catchment areas, the areas in the sphere of influence of particular airports: NUTS2-regions are designated as a proxy, but these do not always coincide with the actual size. In Île de France, for instance, causality is lacking, which may be ascribed to the fact that the catchment area of the Parisian airports actually cover a large part of France, instead of only the NUTS2-region.

This can equally explain the lack of any relationship in other regions with 'national' airports - that are labeled as the gateway airport for a country and possesses the majority of international connections- such as Schiphol Airport in Zuid-Holland, whose catchment area actually spans the whole of the Netherlands and parts of Belgium. The large size of these catchment areas is enhanced by the availability of the dense ground transport, such as high-speed railways [7].

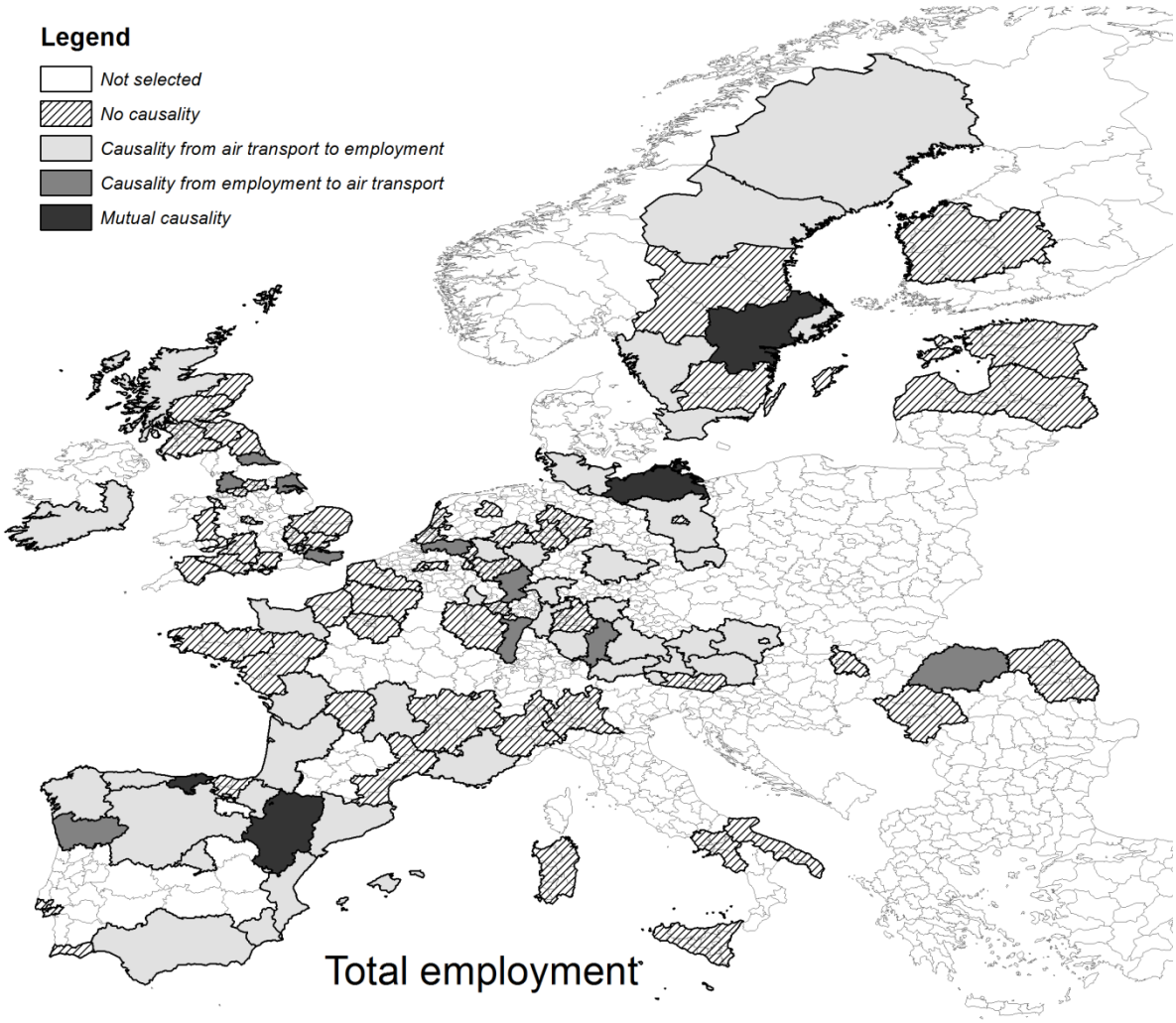

Figure 1. The different causality relationships between passenger volume and total employment among the 112 NUTS2 European-regions.

4.2 Air passenger transport versus employment in manufacturing and services sectors

The results of the homogeneous non-causality tests and the heterogeneous causality tests for both services and manufacturing in Table 3 show that bidirectional causality between air

passenger transport and employment is present for the services sector, but that causality only runs from air transport to employment in the manufacturing sector.

Table 3. Results of the homogeneous non-causality (F1) and the heterogeneous causality test (F2).

Direction	F1-test	F2-test
Passengers -> services	2.078***	1.895***
services -> passengers	1.775***	1.726***
Passengers -> manufacturing	1.203*	1.194*
manufacturing -> passengers	0.960	/

*** p<0.01, **p<0.05, *p<0.10

In other words, the link between air passenger transport and employment in the services sector seems indeed stronger and more abundant: separate analyses for the 112 regions show signs of causality for more than 60% of the cross-sections (68 NUTS2-regions, Figure 2). The observed trend runs mainly from the number of passengers to employment (52 cross-sections), while causality in the opposite direction holds for only six regions and bidirectional causality occurs for 10 regions. In contradiction with Brueckner [1], Granger causality for the manufacturing sector occurs for a subset of 39 NUTS2-regions (Figure 3), mainly in regions with high levels of manufacturing employment, such as Piemonte and Lombardia in Northern Italy [58]. Other clusters are Scotland and Northern France.

For the link between air passenger transport and employment in the services sector, there is a clear geographical divide. Except for the presence of causality running from air passenger transport to employment in the central European polygon, the abundance of such links frequently holds for the NUTS2-regions in Spain and Southern France. Tourism – which is comprised in our services indicator- possibly plays an important role here. A major part of passengers arriving in South-European regions are tourists, stimulating employment in the tourism industry. This is obviously related with the emergence of low cost carriers (LCCs) after intra-European air transport liberalization [59]. A large part of their networks are clearly

designed to carry travellers to the tourist destinations of Mediterranean Europe8, such as the Spanish ‘costas’ [13, 60].

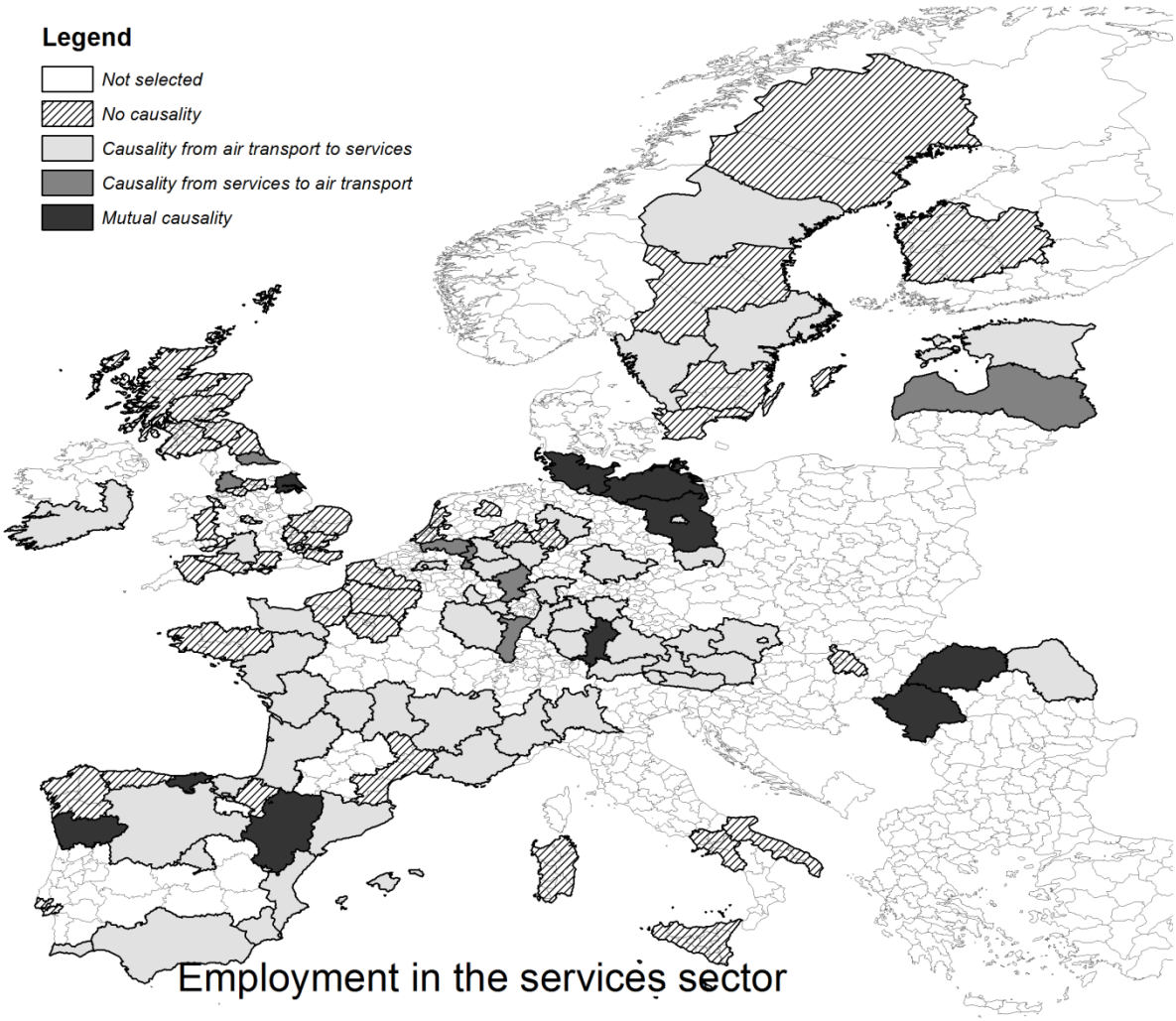

Figure 2. The different causality relationships between passenger volume and services employment among the 112 European NUTS2-regions.

Additionally, LCCs commonly launch new routes on destinations that were previously unavailable or unpopular due to high fares, and the arrival of LCCs in such a region gives a strong initial impulse to tourism. In Barcelona, for instance, there was a considerable increase in passenger arrivals after the entrance of LCCs (Ryanair, Easyjet) into the market in 1996, which was accompanied by a strong increase in hotel room supply [61].The differences in results for total employment, and employment in the services and manufacturing sector call for caution when interpreting and comparing the results of research that investigates the link between air passenger transport and total employment only [8, 33, 37]. Although this literature offers interesting insight, it says little about how these links are translated for the

different sectors of the economy. Employment in the manufacturing and services sector seem to respond differently to air passenger transport, and certainly do not show the same need for generating traffic. This, in addition to the lack of a geographical homogeneity in causality, implies that policy-makers should be cautious when interpreting results with the purpose of formulating policies for the investment in air traffic infrastructure and services for regional (re)development: not all sectors of the economy will be affected in a similar way, just as not all regions are equally affected.

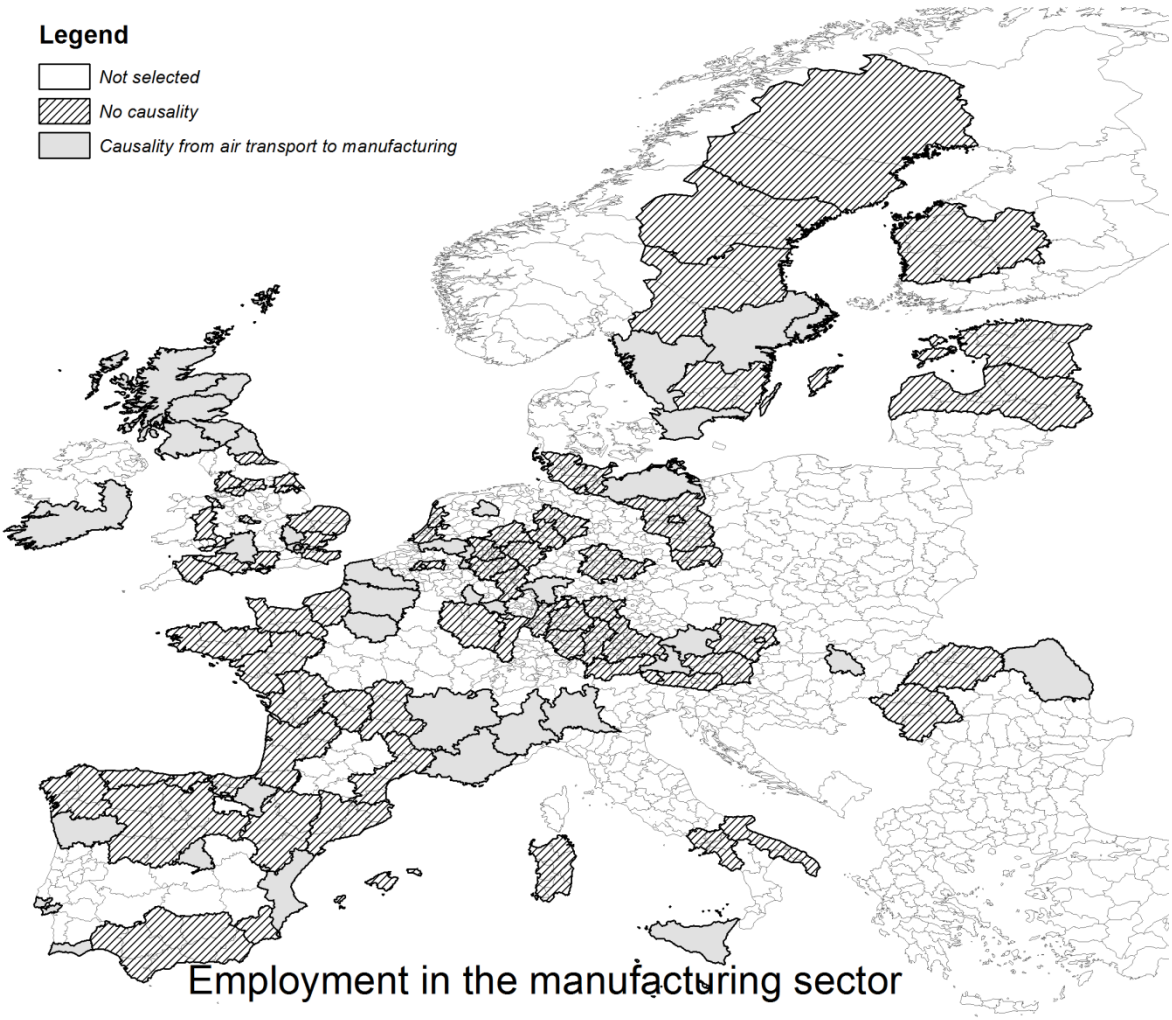

Figure 3. The different causality relationships between passenger volume and manufacturing employment among the 112 NUTS2-regions.

Referring to the European investment programmes, such as TEN-T, the presence of causal links in several peripheral sectors suggest the possible effectiveness of these development and investment programmes. Increased accessibility and connectivity (often through LCCs [62]) in regions that are characterized by relatively lower labour and facilities costs, can encourage

companies to invest in those regions and existing business to expand their market [14]. This can in turn stimulate the economic growth potential these regions still possess [45, 47]. However, our results indicate that the causal relationship is not omnipresent in those peripheral regions, and the EU (and national governments alike) should be cautious to set up infrastructure investment programmes with the goal of regional development.

At the same time, it must be noted that air accessibility constitutes only one small part of the total accessibility of European regions [63] Other transport modes, mainly road and rail transport [47], are also important, as are the internet infrastructures (e.g. [27, 64]), and these are not taken into account in our study. Hence, in agreement with Graham [45], who states that air transport should be viewed as an enabling factor in regional development, overlapping with other transport infrastructures and networks to support European regional development. In this sense, the causality that is proved here does not imply that air transport unconditionally leads to regional development, or that higher employment in regions unequivocally leads to additional generation of air travel. Other factors intervene in the relationship, such as the mentioned presence of other infrastructure, but just as well the population in these regions, or the level of GDP.

5. Conclusion

This paper has tried to disentangle some of the net causes and effects between air passenger transport and economic development, expressed through passenger volume and employment, in European NUTS2-regions. To this end, heterogeneous Granger causality analyses is used, which allows for statistically assessing causal relationships. In short, our results suggest that (i) the causality patterns between air transport and employment are geographically heterogeneous and sometimes absent, (ii) the influence of air transport on employment is more marked than the influence of employment on air transport, although this direction can also be detected for several regions, and (iii) causality from air transport to employment is stronger for the services sector, but also occurs in the manufacturing sector.

These findings suggest that policy-makers should be careful when advocating infrastructure investment (e.g. by expanding air transport services at airports) as a way of stimulating economic development in a region, as these investments are not always translated into comparable increases in employment. Although there are no clear patterns, it seems that air passenger transport can stimulate growth in employment in some of the peripheral countries,

which makes that investment programmes such as those implemented by the EU could bring some benefits.

Our analysis obviously has some limitations. The main limitation of the Granger causality test lies in its bivariate nature, while air passenger transport and economic development are interrelated though a complex web of associations with intervening factors. Future analyses could take these additional factors into account by expanding the analysis to a multivariate framework.

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[5] The logarithm of the initial data did not contain any trend.

[6] Alternatively, the Granger tests are also performed with a 2-year time lag, but no causality in step 1 could be detected.

[7] The results of the separate Granger tests of the third step are available from the authors upon request

[8] Currently, LCCs increasingly target the business segment [13].