# Importance of aviation in higher education

by

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**Abstract**

Air transport is particularly important for countries with geographically scattered settlements, where ground transport can be time consuming. Norway is one such country, and Norwegian authorities regard aviation as a regional policy instrument; therefore, they procure unprofitable air services in rural areas. To increase human capital in rural areas, Norway has a decentralised system of Higher Education Institutions (HEIs). This paper evaluates the importance of aviation to this HEI system and estimates the welfare effects from aviation on their students and employees. We found that the number of job-related air trips completed by HEI employees is significantly higher than the average number of business trips in Norwegian enterprises. The number of air trips per HEI employee are highest in the regions furthest from the capital; as such, the welfare effects of aviation are greatest for HEIs in the most peripheral regions. To maintain the positive effect of aviation on HEIs, effective flight connections and the establishment of meeting venues where the HEIs management, airline representatives, airport management, and politicians can discuss measures to increase the benefits for HEIs and society are crucial.

Keywords: Air transport; aviation; consumer surplus; higher education; regional development; rural areas

# 1. INTRODUCTION

Globally, people tend to move from rural areas to settle in more densely populated areas. In Norway, many young people leave the countryside after graduating from high school to continue their studies at Higher Education Institutions (HEIs). When that stage of life is complete, their decision about whether to return to their home districts depends on many factors (Rérat, 2014). Notably, empirical evidence has suggested that graduates tend to settle in the counties where they were registered as HEI students (Røberg, 2014, Eđvarđsson, 2001). Hence, by implementing measures that make HEIs in rural areas more attractive, the outflow of young talent will decrease, and the human capital base in rural areas will increase.

In Norway, the effort to slow down the centralisation of jobs and settlements by making it attractive to settle in rural areas has, for the most, political consensus. To achieve this objective, a broad spectre of regional policy instruments has been established, including a lower employers' contribution in rural, compared with urban, areas (Hervik et al., 2001) and lower tax rates in Norway’s rural north. The overall objectives of the regional development policies are to facilitate equal living conditions in the entire country and broadly maintain the current settlement patterns (NOU, 2004). Because graduates from HEIs tend to settle in the county where they graduate (Røberg, 2014), developing and sustaining a decentralised HEI structure would be a regional policy tool. The same objective applies to the public procurement of unprofitable air services in rural areas through public service obligations (PSOs) (Williams and Pagliari, 2004, Merkert and O'Fee, 2013). The PSO routes reduce the disadvantages of living and doing business in the remote areas of Norway (Bråthen and Halpern, 2012).

The attractiveness of an HEI is mostly related to its reputation, study programmes, and facilities (Elliott and Healy, 2001, Price et al., 2003, Athiyaman, 1997, Douglas et al., 2006, Hanssen and Solvoll, 2015, Hanssen and Mathisen, 2016). Creating a decentralised HEI sector generates special challenges with respect to transport and travel (Frenette, 2006, Griffith and Rothstein, 2009, Gibbons and Vignoles, 2012, Suhonen, 2014). In Norway, the HEI sector generates a significant number of air trips related to students, employees, and guest lecturers. Without satisfactory air services, recruiting students and professionals would be difficult for some HEIs and create challenges when attempting to implement their degree programmes (Hanssen et al., 2014).

Norway has scattered settlements and a topography that makes road and rail transport time consuming (Kjærland and Mathisen, 2012, Mathisen and Solvoll, 2012); therefore, air transport is essential. Norway has the highest domestic air trip rate per capita in Europe (Williams et al., 2007). This scenario, in connection with the crucial role of local HEIs in increasing human capital in rural areas and maintaining rural settlements, makes it interesting to analyse the significance of aviation for HEIs in rural areas.

The aim of this article is to evaluate the importance of aviation on a decentralised HEI system in Norway and estimate the welfare effects of aviation for HEIs in different regions of the country.

According to our review of the literature, no similar study has been conducted. Most of the research on the attractiveness of HEIs has focused on the characteristics of the institutions and their reputations (see e.g. DesJardins and Toutkoushian, 2005, Hanssen and Mathisen, 2016, Price et al., 2003, Obermeit, 2012). Research has also focused on the role the distance between a potential student's home and the HEI's location plays in attracting students (Frenette, 2006, Griffith and Rothstein, 2009, Gibbons and Vignoles, 2012, Suhonen, 2014). We contribute to the literature on distance by focusing on the importance of efficient transport services for HEIs.

The article proceeds as follows. Section 2 presents a literature review. Section 3 provides an overview over the HEI sector in Norway. Section 4 explains the methodology and model used to analyse the problem and presents the data. Section 5 is a presentation and discussion of the results. In Section 6, we conclude and suggest implications based on our findings.

# 2. LITERATURE REVIEW

## 2.1 AIR TRANSPORT SERVICES AND REGIONAL DEVELOPMENT

The quality of a region's air transport services is important for the settlement, location, and expansion of firms (Blonigen and Cristea, 2015, Bråthen and Halpern, 2012, Brueckner, 2003, Halpern and Bråthen, 2011, Smyth et al., 2012, Baker et al., 2015); however, the direction of the causal relationship between economic growth and air traffic is complex. Although airports and air transport services affect economic growth, the bidirectional relationship is also generally accepted (Baker et al., 2015).

The air transport sector has four types of effects on society (Halpern and Bråthen, 2011, Lian et al., 2005, York Aviation, 2004): direct effects (related to airport operations), indirect effects (related to the operations of suppliers in the area), induced effects (related to the activity generated by the direct and indirect operations), and catalytic effects (related to the broader role of the airport on regional development). When focusing on airports as facilitators for value adding and economic growth, the catalytic effects are the most important—but difficult to measure. These factors have, nevertheless, been investigated in Europe (e.g. Robertson, 1995, Lian et al., 2005, York Aviation, 2004, Oxford Economic Forecasting, 2006, Bandstein et al., 2009, Cooper and Smith, 2005, ACI-Europe, 1998), and it was suggested that the catalytic impacts from aviation on productivity and investments can produce a mark-up of 80% of the sum of direct, indirect, and induced employment (Lian et al., 2005).

## 2.2 HEIS AND REGIONAL DEVELOPMENT

The link between HEIs and regional development has been investigated. A meta-analysis by Peer and Penker (2016) showed that the role of HEIs on regional development evolved from an education infrastructure to a regional actor that actively interacts with regional stakeholders and shapes regional development paths. Hence, HEIs do not inevitably spur regional development; instead, their effect on regional development depends on the regional absorptive capacity, the regional actors' willingness to cooperate, and other regional characteristics. Goldstein and Drucker (2006) found that teaching and basic research conducted at HEIs had substantial positive effects on regional earnings. They also found that an HEI affects neighbouring regions. Drucker (2016) estimated that the spillover was substantial, that is, up to approximately 100 km from an HEI.

The establishment of HEIs affects the creation of new firms and jobs. An analysis of the establishment of HEIs in Portugal's municipalities from 1992–2002 showed that a new university has a positive effect on subsequent levels of knowledge-based firm entry and a negative effect on the levels of entry in other sectors (e.g. low-tech manufacturing) in those municipalities (Baptista et al., 2011). Armstrong et al. (1997) found that Lancaster University demonstrated major environmental and social effects as well as the more widely documented employment and income multiplier effects. The positive local effects were related to direct employment, increased local GDP, the local construction sector, and social and recreational aspects. The negative local effects were higher local rent, excessive traffic flow, and critical negative environmental externalities caused by providing the necessary parking spaces for employees and students. Baptista and Mendonça (2010) found that having local access to knowledge and human capital significantly influenced entry of knowledge-based firms. However, Hughes and Kitson (2012) indicated that when discussing the effects of HEIs, widening the conversation about the impact pathways and the strategic role of universities beyond the commercialisation of science and technology transfer is essential.

## 2.3 HEIS AND TRANSPORT SERVICES

The proximity of a student's hometown to an HEI has been identified as a principal factor that influences their choice of HEI. Frenette (2006) assessed the role of distance to school in the probability of attending university shortly after high school and found that Canadian students living 'out of commuting distance' are far less likely to attend university than students living 'within commuting distance'. Griffith and Rothstein (2009) investigated factors influencing the choice of 4-year colleges in the United States (USA) and found that a 120 km increase in distance to a college decreases the likelihood of applying to an HEI by approximately 2 percentage points. Gibbons and Vignoles (2012) found that geographical distance had little or no effect on the decision to participate in higher education in England but had a strong influence on institutional choice. Suhonen (2014) examined field-of-study decisions in Finland's university system with a special focus on distance. He found that a 100 km increase in the shortest distance to enrol in a field was on average associated with an approximately 15% reduction in the likelihood of selecting that field.

Jepsen and Montgomery (2009) found that if mature individuals must travel an additional 1.6 km from home to the nearest community college, enrolment would reduce by 3% to 5%. Likewise, Long (2004) found that, all else equal, a 1972 high school graduate had an 83% less likelihood to choose a 4-year college that was 160 km farther away, whereas a 1992 graduate had only a 73% less likelihood, indicating that distance became less important during the period. Alm and Winters (2009) found that intrastate college students in Georgia, USA, were strongly discouraged by a greater distance, but the effects differed across the types of HEIs.

Five factors explain the negative association between distance from home and the likelihood of applying to and enrolling in an HEI (Leppel, 1993). First, information about a school decreases with distance; although information is widely available on the internet, high school guidance advisers are probably still more likely to provide information about nearby institutions. Second, transport cost is likely to increase with distance, making attending an HEI far from home less desirable. Third, as the distance from home to an HEI increases, the number of competing institutions also increases. Fourth, the negative psychological effects for students may be higher in unfamiliar areas far from home. Finally, friends and family of a high school graduate are more likely to have attended a proximal HEI, increasing the attractiveness of that institution.

The generalised costs (i.e. the sum of the monetary and nonmonetary costs of a trip) of reaching an HEI's host city by air is one of the factors that makes one HEI more attractive than another for employees and students (Cattaneo et al., 2016, Hanssen and Mathisen, 2016). In an examination of the flow of Italian university students at the provincial level from 2003–2012, Cattaneo et al. (2016) found that the air transport service affects university attractiveness for long-distance students living at least 300 km from their university. Specifically, accessibility increased with the proximity of universities to airports, when low-cost carriers serve university routes, and when a greater number of alternative airports existed proximal to the origin.

## 3. NORWEGIAN HEI SECTOR

Norway, with approximately 5 million inhabitants, has 52 accredited HEIs: eight universities and the remainder are university colleges. Notably, these numbers do not include the police academy and military colleges. The HEI sector is highly decentralised and has campuses in all regions of the country. Our study examined 34 publicly owned HEIs in Norway. The locations of these institutions and the main airport for each are shown in Figure 1.

Table 1 presents an overview of the number of institutions, employees, students, and air trips. In 2012, approximately 30,000 were employed in this sector, namely, 20,400 at the universities and 9,700 at university colleges; additionally, approximately 204,000 students were associated with these institutions, namely, 104,000 at the universities and 101,000 at the university colleges.

Employees conducted approximately 137,000 job-related trips by plane in 2012, representing approximately 4.6 trips per person—approximately twice as much as the average number of flight trips by all the employees in Norway (Denstadli and Rideng, 2012). The location of three of the four HEIs with highest air travel activity per employee was in the northern part of Norway. The total costs for flight trips in 2012 was €33 million, with the average expense of flight tickets at approximately €1,000 per employee and €760 per student. All the HEIs in northern Norway are among the ten institutions with the highest flight ticket expenses per employee.

*Table 1: Number of institutions, employees, students, air trips, and ticket expenses for air trips at Norwegian HEIs in 2012**

| *Region* | *Number of HEIs* | *Number of* | | *Number of air trips for* | | *Number of air trips per* | | *Ticket expenses (€) per* | |
|---|---|---|---|---|---|---|---|---|---|
| | | Employees | Students | Employees | Students | Employee | Student | Employee | Student |
| North | 7 | 3,813 | 21,542 | 25,303 | 148,620 | 6.6 | 6.9 | 1,580 | 1,106 |
| Mid | 3 | 6,274 | 34,435 | 40,359 | 202,338 | 6.4 | 5.9 | 1,339 | 937 |
| West | 9 | 6,720 | 50,075 | 35,663 | 249,472 | 5.3 | 5.0 | 1,623 | 1,136 |
| East | 14 | 12,398 | 87,775 | 30,528 | 208,805 | 2.5 | 2.4 | 500 | 350 |
| South | 1 | 935 | 9,795 | 5,382 | 54,690 | 5.8 | 5.6 | 1,295 | 907 |
| Total/ average | 34 | 30,140 | 203,622 | 137,235 | 863,925 | 4.6 | 4.2 | 1,086 | 760 |

* 1€ = 9 Norwegian kroner (NOK).

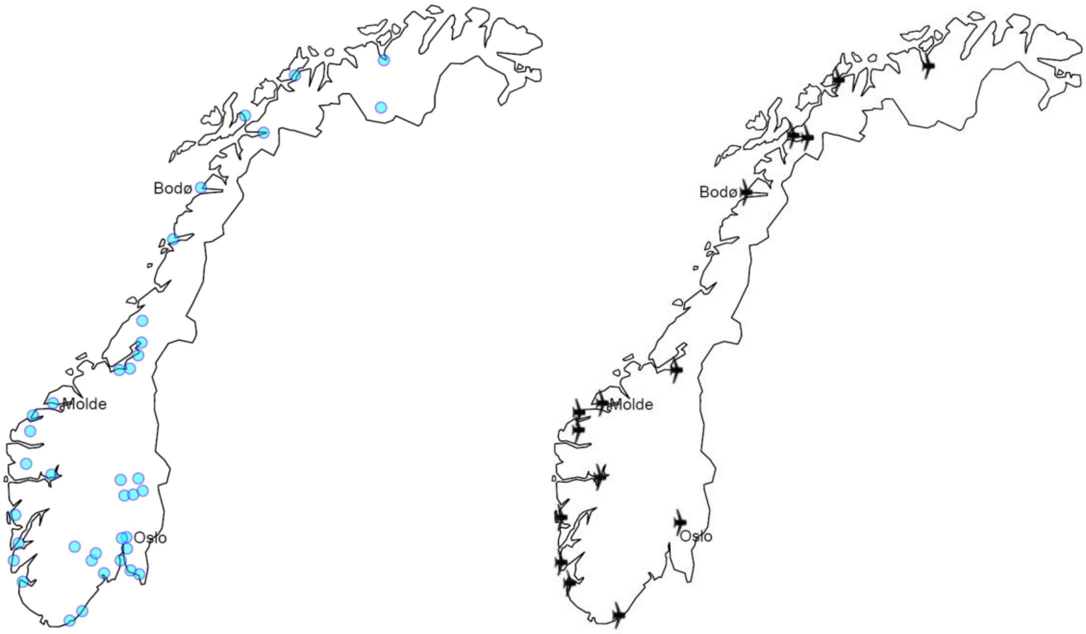


*Figure 1: Locations of the HEIs (left) and airports 'serving' them (right). Some HEIs have more than one campus.*

# 4. MODEL SPESIFICATION AND DATA

## 4.1 THE MODEL

Assume the travel data show that employees and students at each HEI conduct $X_0$ trips and that the average fare paid by the same groups is $P_0$. As such, we know that the demand curve for flights completed by those groups passes through point ($X_0$,$P_0$) (Figure 2). The airlines' revenue from the trips made by the employees and students is $X_0 \cdot P_0$.

When the expenditure of a service constitutes a small proportion of the total budget for a business or household, the shaded area in Figure 2 provides a satisfactory approximation of the consumer surplus ($CS$) (Varian, 2003). Therefore, we interpret $CS$ as the welfare effect aviation has on employees and students at HEIs. In addition to $X_0$ and $P_0$, $CS$ depends on the slope of the demand curve: the steeper the curve, the greater the area of $CS$. A steep demand curve (price inelastic demand) indicates that users are highly dependent on air transport services. The services have, as such, a great impact on the welfare of the users.

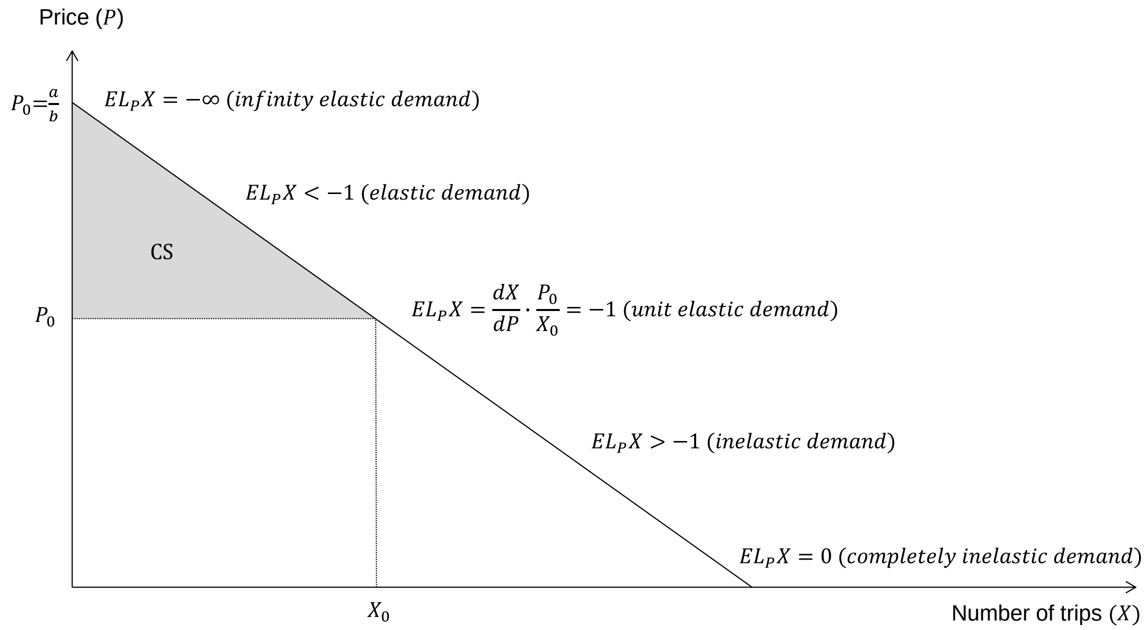


*Figure 2: Welfare effects of aviation ($CS$).*

As in Jørgensen et al. (2011b)[1], we use the following linear demand function:

$$(1) \qquad X = a - bP, \quad a, b > 0 \Rightarrow \frac{\partial X}{\partial P} = -b \quad and \quad EL_pX = -\frac{bP}{X}$$

We normalise (1) such that price elasticity of demand $EL_pX = -e_0$ and $X = X_0$ when $P = P_0$. It then follows from (1) that $b = e_0X_0/P_0$ and $a = (1 + e_0)X_0$. This implies that the demand function can be written as follows:

$$(2) \qquad X = (1 + e_0)X_0 - \frac{e_0X_0}{P_0}P$$

From (2), Jørgensen et al. (2011b) deduce that $X$= 0 when $P = [(1 + e_0)/e_0]P_0$. The $CS$ then becomes the following:

$$(3) \qquad CS = (P_0X_0)\frac{1}{2e_0}$$

From (3) we can see that $CS$ increases proportionally with the revenue and decreases convexly with $EL_pX$. If, for example, $EL_pX$ = -0.5 and -1.0, $CS$ is equal and half the revenue, respectively. With a linear demand curve, $EL_pX$ depends not only on the slope of the curve but also on the

[1] In Jørgensen et al. (2011b), the social surplus of Norwegian ferry services is estimated by using a linear, power, and exponential demand function.

value of $P$ and $X$. Therefore $EL_pX$ varies along the curve as $P$ and $X$ change. Near the top, where $P$ is high and $X$ is small, $EL_pX$ is large in magnitude (elastic demand) and at the intersection with the price axis $X$=0, so $EL_pX = -\infty$ (infinity elastic demand). Near the bottom, where $P$ is small and $X$ is high, $EL_pX$ is small in magnitude (inelastic demand) and at the intersection with the quantity axis $P$=0, so $EL_pX = 0$ (completely inelastic demand). At a particular point of the demand curve $EL_pX = -1$ (unity elastic demand). For illustrative purposes, this point on the demand curve is ($X_0$,$P_0$).

A linear demand curve is chosen for three reasons. Firstly, with a linear demand curve, $EL_pX$ increases in numerical value when $P$ increases, which is reasonable (see Button, 2010). Secondly, the calculation of $CS$ becomes simple (Equation 3). Thirdly, a linear demand function results in a lower $CS$ compared with a power or exponential demand function with the same values on $EL_pX$. Given the uncertainty regarding $EL_pX$, we assert that using a 'cautious' approach is appropriate.

The choice of demand function is based on a traditional utility theory approach where a person selects the travel alternative that minimises the traveller's generalised transport costs (i.e. the sum of monetary and time costs). This is reasonable for rarely taken trips; however, for regularly made trips, habits and routines are more important in mode choice (Banister, 1978). According to Goodwin (1977), habit may dominate even in cases where the more 'rational' choice based on generalised costs favours another mode. In that case, major price or service changes regarding the transport service normally used or on an alternative transport service will be the only factors that make the traveller change modes. Demand is then completely elastic below the point where the demand curve intersects the y-axis ($P = \frac{a}{b}$). This price is the reservation price in the market, implying that air travel is always chosen if $P \leq \frac{a}{b}$. $CS$ could then be interpreted as the value of mobility rather than the importance of aviation. However, because the employees at Norwegian HEIs must choose the cheapest travel option, we find it natural to assume that transport mode is chosen based on generalised transport costs; thus, $CS$ becomes the welfare effect of aviation.

As observed in Equation (3), choice of $EL_pX$ is critical for the size of $CS$. Several factors determine the price sensitivity of the demand for a transport service (Button, 2010). Trip purpose is one factor that makes leisure trips more price sensitive than business trips. The time period under consideration is also important. The demand for a transport service can be price elastic in the short run and price inelastic in the long run, that is, in the long term, people can change transport modes, employment, and residential locations, and industry can modify their entire supply chain. Elasticities are generally found to increase with the length of the journey under consideration. This phenomenon is due to the magnitude of the price change (long trips normally have higher fares than short trips) and that people gather more information about long trips because they are made less frequently. There is ample evidence that transport is a normal good in the sense that more is demanded at higher level of personal income and economic activity. In both cases, as prosperity increases, people tend to be less sensitive to price (Alperovich and Machnes, 1994). The demand for air transport is also likely to be influenced by the price of other transport services. This cross-price elasticity of demand is positive for substitutes in the sense that an increase in the price of one stimulates the demand for the other. For complements, the cross-price elasticity of demand negative because a price increase in one service causes the demand for the other service to decline. Finally, consumer preferences or 'taste' is one variable that can be considered. Although the economic meaning of 'taste' is seldom made clear, this variable is meant to embrace all influences on demand not covered by the previous influences.

Our analysis relates $EL_pX$ to a particular point on the demand curve, and the calculation of $CS$ is based on the point elasticity of demand ($EL_pX = -\frac{bP}{X}$). The relative price and quantity change can be calculated by either using the initial price–quantity ratio or the final price–quantity ratio: notably, which is most correct to use is not obvious. This problem can be resolved by using the arc elasticity of demand ($EL_pX = -\frac{b\bar{P}}{\bar{X}}$), where $\bar{P}$ is the average of the initial and final prices and $\bar{X}$ is the average of the initial and final number of trips. The arc elasticity of demand will always lie somewhere between the point elasticities calculated at the lower and higher prices (Pindyck and Rubinfeld, 2013). Price elasticities of demand at the various airports (Table 3) is based on empirical surveys of price elasticities for air travel, where point and arc elasticity approaches are used.

## 4.2 DATA

***Travel activity***

The air travel activity by employees at HEIs was gathered from the Agency for Public Management and eGovernment (Difi) in 2012. All HEIs in Norway are required to report their air travel activity to Difi. Hence, the agency has a database that provides an overview of how much the employees at each Norwegian HEI travel by air. From this database, we obtained the number of trips conducted by the employees at each HEI in Norway.

The students' travel activity is estimated based on data from a web survey conducted at two Norwegian HEIs in 2013: Molde University College (MUC) and the University of Nordland (UON)[2]. Their location in Bodø (UON) and Molde (MUC) are shown in Figure 1. The survey included the following question: *How many flights do you expect to complete in autumn 2013?* Only Norwegian students at the two institutions received the questionnaire. The UON and MUC students' travel activity is used to estimate the travel activity of the students at all the HEIs in Norway, based on the assumption that the ratio between the average number of air trips conducted by students and employees is equal to the ratio at UON and MUC.

***Destinations, ticket prices, and expenses for flights***

The average ticket prices ($P_0$) paid by the employees and students at each HEI are estimated by using data from a national air travel survey (Denstadli and Rideng, 2012), which asks about the price the respondents have paid for the trip they are conducting. The calculations of the ticket prices for the trips completed by the employees was estimated in five steps:

1. The nearest airport to each HEI was identified.
2. The five most common destinations to and from that airport were determined.

[2] 1 January 2016, two university colleges merged with UON. The new institution is called Nord University.

3. The average ticket price paid by business travellers to and from each of the destinations was calculated.
4. The number of trips from each 'HEI airport' to each of the five destinations was estimated.
5. The average ticket price for business trips for each 'HEI airport' was estimated by weighting the ticket price with the share of trips made to each of the five most common destinations.

In our calculations, we assumed that average ticket price paid by employees at the HEIs was the same as the price we found for business travellers (step 5). The average price paid by the students at each HEI was found by using the same procedure as for the employees. Notably, instead of using the ticket price for business trips, we used the ticket price for leisure trips (step 3).

***Price elasticities of demand***

Median price elasticities of demand in air transport drawn from a number of studies were summarised by Gillen et al. (2003). They identified six market segments based on trip length (short-haul and long-haul) and trip purpose (leisure or business), each with different median price elasticities of demand. An extract of their findings is shown in Table 2, where the deviation in percent of the price elasticity for business travellers and leisure travellers from the average price elasticity of all travellers is calculated.

*Table 2: Price elasticities of demand for air travellers by trip purpose (Gillen et al., 2003).*

| *Type of operation* | *Price elasticity of demand* | | | *Deviation from 'all'* | |
|---|---|---|---|---|---|
| | All studies | Business | Leisure | Business | Leisure |
| Long-haul international | -0.790 | -0.265 | -0.993 | -66.5% | 25.7% |
| Short-/medium-haul | -1.150 | -0.730 | -1.520 | -36.5% | 32.2% |
| Average | - | - | - | -51.5% | 29.0% |

Table 2 shows that the price elasticity for business travellers is 51.5% lower (in absolute values) than the average price elasticity. Moreover, the price elasticity for leisure travellers is 29.0% higher (in absolute values) than the average price elasticity. Notably, for this study, it is reasonable to apply different price elasticities for trips completed by the HEI's employees (i.e. business trips) and students (i.e. leisure trips). Therefore, we use the estimated difference between the average price and actual price elasticities for business and leisure trips, respectively, when we set the price elasticities for the employees and students at each HEI in Norway (Table 3).

However, it is important to note that more recent studies have generated somewhat different price elasticities of demand than those reported in Table 2. From a time series analysis of leisure trips from UK, Njegovan (2006) estimated price elasticities in the range -0.7 to -1.3. Bhadra and Kee (2008) analysed US domestic air travel on routes at different markets and found the demand at thick markets to be relatively price elastic ($e$ = -1.3 to -1.8) while the demand at thin markets were price inelastic ($e$ < -0.3). Kopsch (2012) used a time series analyses on domestic air travel in Sweden and found short run price elasticities of demand for business and leisure trips of -0,58 and -0,79. Long run price elasticities were estimated to -1.0

and -1.2, respectively. Department for transport (2017) used price elasticities of demand of -0.2 and -0.7 for business trips and leisure trips when preparing forecasts for air passengers at UK airports. The variation in estimated price elasticities of demand illustrate the importance of conducting sensitivity analysis when calculating $CS$.

Jørgensen et al. (2011a) have estimated the price elasticities from all the airports in Norway. The assumptions regarding elasticities are based on a literature review of price elasticities in aviation and adapted to Norwegian conditions where the differences in alternative transport options to air transport for the inhabitants in the airports' catchment area is taken into account. The larger cities are well connected by coach bus and railway (and fast-craft services for coastal areas) and have well-developed road infrastructure for private vehicles. Hence, alternatives are plentiful, and the average price elasticity is set to -1.2, indicating a high sensitivity to price. As a special case, alternatives are even more abundant at the main airport located proximal to Oslo, the capital of Norway, and the elasticity was set to -1.4. Regional airports located far away from the main airport, and where travel alternatives are fewer, are assigned an elasticity of -1.0. For the many local airports, fares are higher, and people have no alternatives to air transport for long trips. The price elasticities are relatively inelastic at these airports and set to -0.8.

*Table 3: Price elasticities for employees and students at the nearest airport for each publicly owned HEI in Norway.*

| *Region* | *Airport** | *Name of HEI*** | *Price elasticities of demand* | | |
|---|---|---|---|---|---|
| | | | All | Employees | Students |
| North | Alta Airport (ALF) | Finnmark University College, Sámi University College | -0.8 | -0.4 | -1.0 |
| | Bodø Airport (BOO) | University of Nordland | -0.8 | -0.4 | -1.0 |
| | Narvik/Harstad Airport (EVE) | Harstad University College | -0.8 | -0.4 | -1.0 |
| | Bodø Airport (BOO) | Nesna University College | -0.8 | -0.4 | -1.0 |
| | Narvik Airport (NVK)*** | Narvik University College | -1.2 | -0.6 | -1.5 |
| | Tromsø Airport (TOS) | The Arctic University of Norway | -0.8 | -0.4 | -1.0 |
| Mid | Trondheim Airport (TRD) | Nord-Trøndelag University College, Norwegian University of Science and Technology (NTNU), Sør-Trøndelag University College | -1.2 | -0.6 | -1.5 |
| West | Bergen Airport (BGO) | Bergen University College, University of Bergen, Norwegian School of Economics (NHH) | -1.2 | -0.6 | -1.5 |
| | Haugesund Airport (HAU) | Stord/Haugesund University College | -1.2 | -0.6 | -1.5 |
| | Molde Airport (MOL) | Molde University College | -1.0 | -0.5 | -1.3 |
| | Sogndal Airport (SOG) | Sogn og Fjordane University College | -0.8 | -0.4 | -1.0 |
| | Stavanger Airport (SVG) | University of Stavanger | -1.2 | -0.6 | -1.5 |
| | Volda Airport (HOV) | Volda University College | -0.8 | -0.4 | -1.0 |
| | Ålesund Airport (AES) | Ålesund University College | -1.0 | -0.5 | -1.3 |
| East | Oslo Airport (OSL) | Buskerud University College, Gjøvik University College, Hedmark University College, Lillehammer University College, Norwegian Academy of Music, Norwegian School of Sport Science, Norwegian School of Veterinary Science, Norwegian University of Life Science (NMBU), Oslo and Akershus University College, Oslo School of Architecture and Design, Telemark University College, University of Oslo, Vestfold University College, Østfold University College | -1.4 | -0.7 | -1.8 |
| South | Kristiansand Airport (KRS) | University of Agder | -1.0 | -0.5 | -1.3 |

* Airport identifier codes according to International Air Transport Association; IATA in parenthesis.
** A structural reform among Norwegian HEIs in 2016 resulted in mergers and changed names for some of the institutions. The names in the table are their names before the reform.
*** Narvik Airport was closed down in March 2017, but was in operation when the analysis was carried out.

According to Table 3, students are more price sensitive than employees are. Whereas a 1% increase in ticket price from Oslo Airport reduces the number of student trips by 1.8%, a similar price increase reduces the number of employee trips by 0.7%. The table also illustrates that price sensitivity is greatest in the most urban areas, such as Oslo, Bergen, and Trondheim. This result is reasonable because students and employees in these cities have a greater number of alternative means of transport than students and employees in rural areas.

# 5. RESULTS AND DISCUSSION

## 5.1 EMPIRICAL RESULTS

Based on the described methodology, Equation (3) and the price elasticities of demand in Table 3, we find that annual consumer surplus from the employees' work-related flights and student flights is approximately €77 million, of which €47 million is related to students and €30 million to employees (Table 4).[3]

*Table 4: Welfare effects for employees and student studying at HEIs in different regions in Norway in 2012.*

| *Region* | *Welfare effects (CS) in 1,000 €* | | | *Welfare effects (CS) in €* | | |
|---|---|---|---|---|---|---|
| | Employees | Students | Total | Per employee | Per student | Average |
| North | 7,366 | 11,844 | 19,210 | 1,932 | 550 | 758 |
| Mid | 7,000 | 9,826 | 16,825 | 1,116 | 285 | 413 |
| West | 9,521 | 14,010 | 23,531 | 1,417 | 280 | 414 |
| East | 4,429 | 8,238 | 12,667 | 357 | 94 | 126 |
| South | 1,211 | 3,313 | 4,524 | 1,295 | 338 | 422 |
| Total/average | 29,527 | 47,231 | 76,757 | 980 | 232 | 328 |

The welfare effect of aviation is approximately €1,000 annually per employee. For the students, we demonstrated an average value of just over €200 per student. We also found that the total annual welfare effect is highest in the west and north of Norway. Regional differences are even larger when comparing the $CS$ per employee or per student, which is especially high in the northern part of Norway.

Using 20% higher / 20% lower price elasticities of demand (in absolute values) the $CS$ becomes 17% lower and 25% higher, respectively. This shows that the choice of price elasticity is critical for the size of $CS$. However, the relative difference in $CS$ between the regions does not change.

To measure the relative concentration of $CS$ in Norway's HEI sector, we apply the Lorentz curve and Gini coefficient (see e.g. Hubbard and O´Brien, 2013). The Lorentz diagram (Figure 3) presents the cumulative size of $CS$ per HEI and average $CS$ per person per HEI on the vertical

[3] By comparison, total $CS$ for users of all ferry connections in Norway in 1997 is €640 million (Jørgensen et al., 2011).

axis—ranked from largest to smallest on the horizontal axis. The 45° line indicates the situation where all HEIs have an equal $CS$.

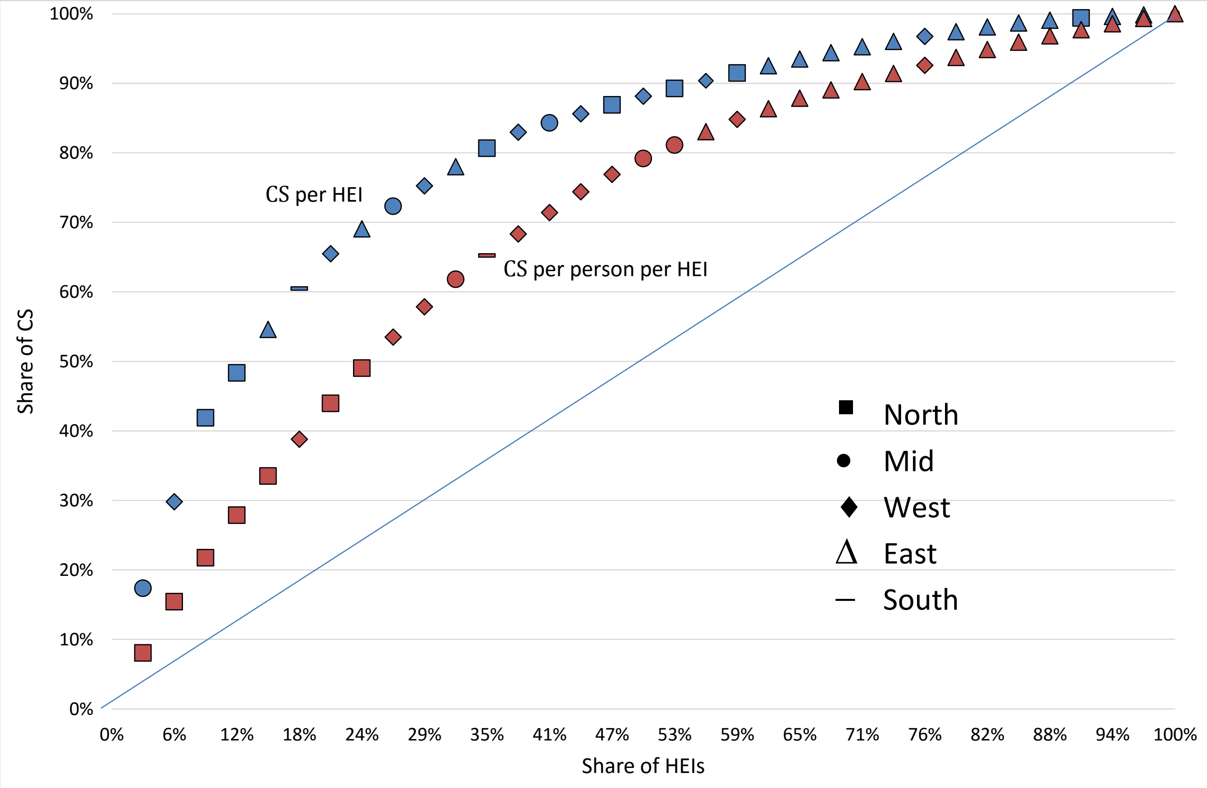


*Figure 3: Lorentz diagram for the distribution of consumer surplus (CS) from air transport services among HEIs in Norway.*

The inequality in the size of the $CS$ illustrated in Figure 3 can be more precisely defined by the Gini coefficient ($G$). $G$ = 0 corresponds to a situation with n HEIs with equal $CS$, whereas $G$ = 1 corresponds to a case with one dominant HEI and n-1 negligible HEIs. From the data, we calculate $G$ = 0.79 for the $CS$ per HEI and $G$ = 0.69 for the $CS$ per person per HEI. These results confirm a larger concentration of $CS$ on the institution level than the individual level. A closer examination of the distribution of institutions shows that the seven largest HEIs, that is, 21% of the HEIs in our sample, generate 65% and 44% of the total $CS$ and $CS$ per person per HEI, respectively. We also found that all the northern HEIs are in the southwest corner of the figure and, as such, among the institutions with highest $CS$ per person.

After adding the welfare effects of aviation for employees and students and illustrating the effect aviation has on welfare for the HEI sector in different regions in Norway, we observe a situation presented in the maps in Figure 4. The area of the circles corresponds to the size of the $CS$.

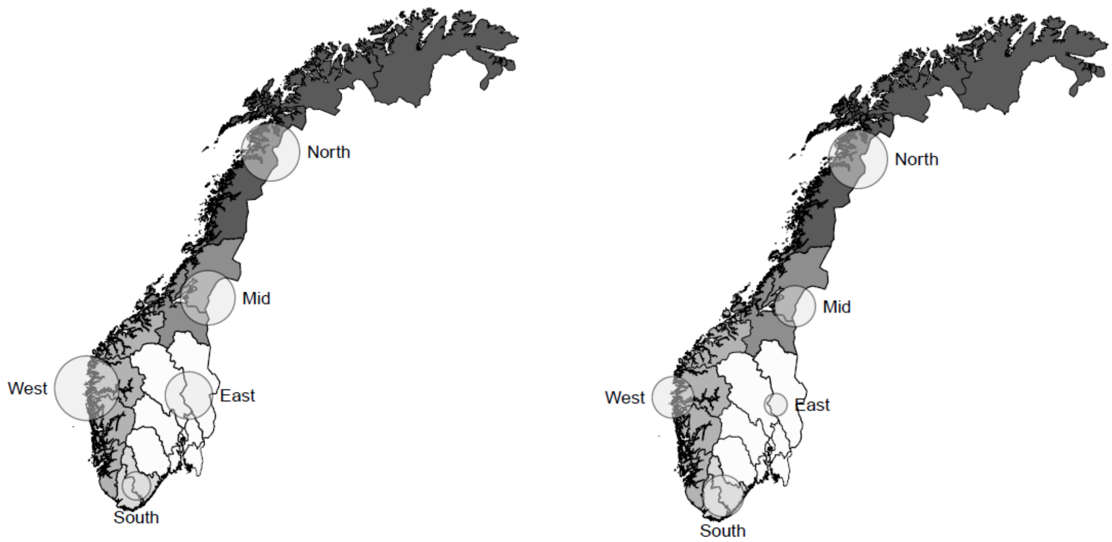


*Figure 4: Geographic distribution and size of welfare effects (CS) of aviation for employees and students at HEIs in regions in Norway. CS per employee and student (right) and total CS (left).*

## 5.2 DISCUSSION

The results presented in Section 5.1 warrant several comments. First, HEIs generate substantial air travel activity from employees and students; therefore, efficient passenger transportation services are a critical condition for successful HEIs. In the rural regions of Norway, this result implies easy access to airports and satisfactory services to and from the airports, as confirmed by the calculations of the welfare effects of aviation on this sector. Second, a region's industry and public institutions have easier access to well-educated young people when an HEI is nearby. This scenario presents, all else being equal, favourable conditions for regional growth. The HEIs, airports, and airlines have a symbiotic relationship (Figure 5), implying that cooperation will benefit all three parties.

Successful HEIs must attract students, and their tools are developing programmes of study, recruiting skilled professionals, and investing in infrastructure (Hanssen and Solvoll, 2015). Airlines want as many passengers as possible, preferably with a high willingness to pay, and their tools are networks and revenue management (Doganis, 2010). The airports obtain revenues from air traffic movement and terminal passengers, and the instruments are the prices of airport services and investments in terminal facilities and runway systems (Halpern and Graham, 2013, Solvoll and Mathisen, 2017). In addition, the government has an overall responsibility to formulate framework conditions, for example, by providing efficient air transport services through the PSO system (see e.g. Merket and O'Fee, 2013). The management at the local airport and university and the political management in the host municipality, therefore, have a common interest in collaborating on a package of measures that reward all stakeholders. Output will be the measures' effect on regional development and contributions to the authorities' regional policy goals.

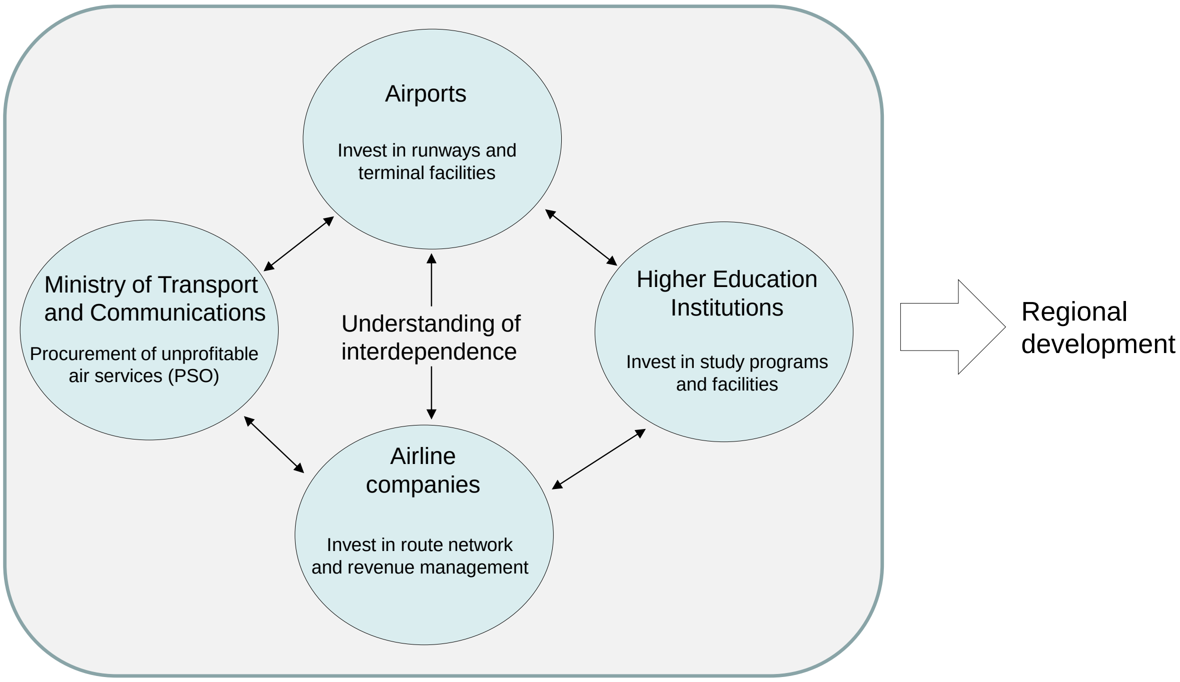


*Figure 5: Interdependence among transport authorities, airports, airline companies and HEIs, and their effect on regional development.*

Efficient air services and their benefits are also critical for HEI's recruitment of academic staff, especially for part-time positions and key foreign personnel. HEIs typically have several part-time staff members that reside elsewhere in Norway or abroad. These specialised positions often require employees who possess a specialised competence available neither locally nor nationally. Academic staff residing abroad come to the institution for shorter periods of time than the regular staff, and without effective flight services in the host cities, retaining such personnel would be very difficult (Hanssen et al., 2014).

Several HEIs have session-based courses with participants from Norway and abroad; thus, the implementation of these degree programmes relies on the availability of the appropriate air services. Without satisfactory flight connections, recruiting the minimum number of participants required would be very difficult. At HEIs offering session-based follow-up studies and PhD courses with participants from Norway and abroad, foreign professors administer many courses that could hardly be feasible, especially at the graduate level, without sufficient air services. Organising national and international conferences at rural HEIs would also be unthinkable without satisfactory flight connections to host cities (Hanssen et al., 2014).

## 5.3 LIMITATIONS OF THE STUDY

The calculation of the welfare effects of aviation on regional HEIs relies on several assumptions open to debate. First, the calculation is based on a linear demand function. Another demand function would have given other results. For example, if we had chosen an exponential demand function, the estimated $CS$ and welfare significance of flight services would have been larger. However, uncertainty in the data and method used for estimation makes it reasonable to make a 'cautious' estimation. The estimated $CS$ also heavily depends on the price elasticities of demand. Using a linear demand function $CS$ is overestimated (under-estimated), when the chosen price elasticities of demand are more inelastic (elastic) than the 'correct' price elasticities of demand.

Second, the price elasticities of demand used for trips completed by employees and students at different HEIs are based on assumptions regarding the average price elasticities of demand at the closest airport to the institution in question. Additionally, these average elasticities are differentiated between employees and students based on the literature about elasticities of demand for business and leisure trips, respectively. It can be argued that trips for the HEI employees may be more price sensitive than the average price elasticities for business trips. In Norway, academic staff are commonly allocated a travel allowance to travel to, for example, conferences. That situation implies a high price sensitivity because the travel budget can then allow for more trips. Similarly, employees at Norwegian HEIs must choose the cheapest travel option. Moreover, the travel alternatives to air transport in Norway are limited, which indicates low price sensitivity.

Concerning the students travel activity, their trips are often to and from their hometowns and are, in many cases, paid by their parents. As parents are looking forward to having their children back home, a lower price sensitivity than an average leisure trip can be assumed. Notably, many of these trips are related to holidays (e.g. Christmas and Easter) and planned in advance, leading to high price sensitivity. Since we do not have information about who pays for the trips or when they occur, our assumptions about price elasticities of demand could not consider this information. Ideally, $CS$ estimations should be based on price elasticities calculated from local surveys; however, this would be very resource demanding. Based on this information, we used results from empirical research on median price elasticities for air trips for business and leisure purposes to determine relative differences in price elasticities between air trips conducted by HEI employees and HEI students, respectively.

Third, it is assumed that the ratio of the number of air trips completed by employees and students at each institution equals the ratio at the UON and MUC. The reasonability of this assumption is difficult to determine. However, if a differentiation of this ratio should be used to obtain a more accurate estimate of the number of student air trips, we can think of no other method than conducting distinct surveys at each HEI, which is beyond the scope of this study.

Fourth, the data used in the analysis are from Norwegian HEIs only. Even in countries with a decentralised HEI sector, such as Norway, this is important to consider when generalising the results. In particular, Norway has an extensive network of PSO routes that facilitate air travel for students and employees in rural areas.

Despite these limitations, this paper presents a first attempt to quantify the importance of aviation on a decentralised HEI system, and the welfare effects of aviation for HEIs in different regions of a country. Moreover, the findings are, broadly speaking, in line with accepted theories and common sense.

## 6. CONCLUSIONS AND IMPLICATIONS

This article evaluated the importance of aviation on the decentralised educational system in Norway and estimated the welfare effects of aviation for the HEIs located in different regions of the country.

The literature review strongly suggested that the catalytic effects of aviation (airports and air services) are crucial for regional development. We found evidence that education in general and higher education in particular promote economic growth through the effect on human capital. Notably, the causal relationship between aviation and education and the importance of airports and air services for HEIs is far less obvious. One method to empirically investigate this phenomenon is to calculate the volume of air trips from this sector and, through paid airfares and assumptions about price elasticities, calculate the consumer surplus from the employee and student trips: This was the approach used in this study. Based on the findings, we emphasise three factors that make it reasonable to believe that efficient transport infrastructure and services are important for a decentralised educational system.

- The number of job-related air trips completed by employees at HEIs is significantly higher than the average number of similar trips of employees of Norwegian enterprises.
- The number of air trips per employee at HEIs are highest in the regions located furthest from the capital.
- The welfare effects of aviation are the largest in the most peripheral regions.

Our findings have policymaking implications; in particular, we offer three suggestions:

- A satisfactory provision of routes at Norway's regional airports requires the Norwegian Ministry of Transport and Communications to continue procuring air transport services from these airports through the PSO system.
- Investments in airports concentrated in regions with HEIs and an underlying growth potential will increase the attractiveness of studying in rural locations and spur growth in the airports' catchment area.
- Establish venues for meetings among the HEIs' management, airline representatives, local airport management, and politicians about the actions required to stimulate and perpetuate regional development.

Although these conclusions are based on a literature review and data from one country, Norway, it is reasonable to assume that aviation services are also of great importance for HEIs in other countries with a topography, HEI, and settlement structure comparable to Norway. For countries that differ considerably from Norway, the results must be treated with caution. In conclusion, the method applied is relevant for investigations of the welfare effects of a transport service on a sector in a specific country, regardless of its size and topography.

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