ABSTRACT

The airport network for scheduled air transport in Norway consists of 26 short take-off and landing airports, and 15 full length runway airports. The number of passengers arrived-/departed on domestic routes amounted to approximately 19 millions in 2005. Given a population of 4.5 millions, Norwegians are among the most frequent flyers in Europe. The airport system has been used as a policy means for maintaining regional balance and to ensure viable conditions for the exporting industry, which is mainly located in remoter areas.

This paper sets out to discuss the methods and the findings from a study of the employment effects of the Norwegian air transport system, which was finished in January 2006. To shed light on the link between air transport and employment, the paper is organised as follows: First, the definitions and conceptions of employment measures are presented. Second, the methods and results of the analyses of direct, indirect, induced and catalytic employment from Norwegian air services are presented and discussed in the light of international experiences. Third, a pilot study of catalytic effects will be presented, which clearly indicates the need for further research on this matter.

The results from Norway give a slightly different picture as compared to several international studies. The indication is that the direct, indirect and induced employment effects may be smaller. On the other hand, the catalytic effects may be larger than what are indicated from other studies.
1. INTRODUCTION

In recent years, there has been a growing attention towards the link between airports and economic development. Air transport may be regarded as an economic activity in itself, where the resulting employment effects can be measured as direct, indirect, induced and catalytic impacts derived from airport activities. These effects have been the concern of numerous studies, where the employment multipliers show a quite diversified picture of the link between airport activities and regional employment. Some of these variations may be due to differences in economic linkages in the airport regions, while others may be due to the use of methods and data. The catalytic effects are of particular interest because they indicate air transport and airports as catalytic agents stimulating economic activity in industries that are not directly derived from or connected to the air transport activities. In other words, catalytic effects indicate how access to air transport may act as a prerequisite for economic activities. There are reasons to believe that these effects are significant, and that they may be even more important that the impacts derived from the air transport activities by means of the more 'classical' multiplier effects.

This paper presents a study on direct, indirect and induced employment effects from air transport in Norway. The findings are contrasted against international findings. In addition, an explorative case study on catalytic effects is presented.

2. CATEGORIES OF EMPLOYMENT EFFECTS

Intuitively, air transport is important for both industry and residents of a country. That is especially true if the alternatives are weak, due to long distances or lack of alternative modes of transport. This is often the case in Norway. The importance of air transport becomes particularly evident when the air transport system fails for instance due to union strikes. However, it is not straightforward to measure the importance for the society of a well functioning air transport system, and it is almost impossible to imagine a contra-factual situation without air transport. The rapid growth in air transport in many economies may be seen as an indicator of the importance of air transport to economic growth but conversely, rapid growth may reflect increasing travel opportunities as economic prosperity take place.

If we focus on air transport as a contributor to economic activity more in general, the contribution can be characterised by four main categories:
Table 1  Main employment categories

<table>
<thead>
<tr>
<th>Type of impact</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Direct</td>
<td>Operation of airlines and airports (technical support and handling, catering, fuel, security, cleaning), commercial activities (shopping, restaurants, car rental, parking), land transport and air cargo.</td>
</tr>
<tr>
<td>2 Indirect</td>
<td>Sub supplies (goods and services) to direct activities (covered in the region)</td>
</tr>
<tr>
<td>3 Induced</td>
<td>Spending by employees in activity 1 and 2</td>
</tr>
</tbody>
</table>
| 4 Catalytic    | a- Location impacts (firms and labour)  
b- Tourism and trade (demand side)  
c- Productivity and investment (supply side)                                                      |

2.1 Direct effects

Directs effects are defined as the activities required for producing air transport services. The distinction between direct activities and indirect activities may be difficult. Usually, airport activities are described as direct activities even if they are non-airside activities like shops, car rental etc.

This principle has its flaws, especially if indirect activity is calculated by use of multipliers. At some airports services are located at the airport while at other airports the same services can well be located outside the airport area, thus providing a smaller base for multiplier calculations. In our case the “at site principle” has been used, with a few exceptions. Airline office functions and Air Traffic Control services that are not located directly at the airports are assigned as direct effects.

The next question is what to measure and how to measure the extent of activity. Turnover figures are difficult to acquire and the firm structure and the quality and comparability of the accounting figures may vary. Our experience is that employment figures are much easier to acquire. Estimates on turnover and wages may later be acquired from structural business statistics from Central Bureau of Statistics. Employment data were collected from each airport that used their registers over tenants and service providers in order to get estimates on employment.

2.2 Indirect effects

Indirect effects are defined as sub supplies (goods and services) to direct activities provided from the surrounding region. A relevant airport region must therefore be defined. Direct measurements of indirect effects by asking respondents is usually too demanding.

2.3 Induced effects

Induced effects are defined as impacts of income generated by activity 1 and 2 in particular via private consumption (spending by employees in direct and

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indirect activities). Estimation of indirect and induced impacts is explained below.

2.4 Catalytic effects

When we initially state that air transport is vital for industry and consumers, we are really talking about catalytic effects. These are a kind of spill-over effects that capture how the growth in air transport boosts the performance of other industries (through tourism, trade, investments and productivity). Such effects may also include consumer welfare impacts as individuals benefit from increased availability of travel. Thus, we distinguish between three kinds of catalytic effects (see below). They are not fully commensurable, as some of them may be regarded as measures (like location and trade) to achieve increased productivity.

a- Location impacts (firms and labour)
b- Tourism and trade (demand side)
c- Productivity and investment (supply side)

Further, when it comes to tourism and trade there is a question whether air transport entails positive and negative effects. The trade and tourism balance may very well turn out to be negatively affected on a regional level. E.g. if air transport activities increase, the net outbound flow of tourists may increase. Besides, location effects may occur to the benefit of some regions but at the expense of other regions. Correspondingly, positive cumulative growth effects in some regions may lead to negative backwash effects in others. Thus, one should avoid adding regional location impacts to a national aggregate. However, positive airport impacts in remote regions may contribute to national goals of developing such regions.

Eurocontrol (2005) have estimated that EU residents travelling by air spend more as tourist outside EU than visitors arriving into EU do (around 0.3 % of GDP in 2003). However, the net impact was positive for the 10 new members of the EU with spending by inbound tourism and business travels that were higher than spending by own residents abroad (net GDP effect of 0.4 %). They have also estimated effects on investments and overall productivity by controlling for other drivers of economic growth. The analysis reveals a clear relation between air transport and investment development and the underlying productivity. The combined long-run effect of growth in air transport is estimated to increase the level of GDP by 4 % each year. Effects are greater in less developed countries than in developed economies. The main objection against such econometric analysis is the direction of causation.

ATAG (2005) has done similar calculations for world regions. Total employment (including catalytic employment) is seen in relation to the sum of direct, indirect and induced employment. The “catalytic multiplier” varies from 1.15 in North America, via 1.8 in Europe to 3.90 in Latin-America. The less developed regions seem to benefit most from air transport. Transferred to a national perspective one could argue that remote regions, many of whom are export oriented, would experience the largest catalytic effects.
3. MEASURING EMPLOYMENT EFFECTS

The main product provided by the air transport industry is of course air transport, and air transport is a part of the transport network. Air transport is very important for long distance travels, but also in connection remote areas to the rest of the world. In order to provide air transport, the air transport industry utilises primary resources, like labour and capital, as well as intermediate products. Air transport itself is a product, which is delivered partly as intermediate products for other industries, partly as final demand like private consumption.

This brief introduction illustrates at least two major points. First, air transport is a part of the transport network. Second, the air transport industry is an ordinary production sector. Both these points imply that the activities in the sector have economic impacts. The following section is focused on discussing impacts connected to the air transport industry being an ordinary production activity.

The air transport industry, as well as other production activities, has impacts for resource allocation as well as for value added and income. All production activities also have impacts for production of intermediates in other industries. These impacts are normally called direct (the use of resources and generation of income and value added in the air transport sector), indirect (the production of intermediates, and the generation of value added and income (and production of intermediates) in other sectors), and induced (the impacts of income generation, especially via private consumption). In addition, air transport industry activities, as well as air transport as a product, contribute as a catalyst in industrial development outside the direct, indirect and induced impact. These catalytic impacts are very important and will be discussed in some detail below.

3.1 Direct, indirect and induced impacts of airport activities

For now, we will concentrate on discussing how to measure the direct, indirect and induced impacts of airport activities. We can distinguish between measuring the direct impacts on the one hand, and the indirect and induced impacts on the other. The direct impacts have to be counted, in one way or the other. Given the direct impacts, we can use economic models to measure the indirect and induced impacts.

Above we have defined direct impacts as the different activities required for providing the product air transport in itself. There is an array of such activities, ranging from flying via different ground handling activities to activities in the public sector. One might also include a range of private services as production activities. For simplicity, these activities together can be called air transport production. We present the employment figures for these activities below for different airport categories. This means that we have measured the direct employment within air transport production.
The next step is to measure production and value added. This is somewhat more difficult, but it is possible to measure these variables directly. Direct measurement means asking all the different producers included in air transport production activities what the values are. Since there are a variety of private and public producers at each airport, the direct method might be relatively costly. We have therefore applied an indirect method of measurement. Rates\(^1\), collected from production sectors in the Regional National Account by county (the RNA), were applied in order to reduce data collecting costs. We were then able to use the employment figures for calculating figures on value added, production values and wage payments for the air transport sector as a whole. Since the sector is divided into many sub-activities (called “different producers”), we have been able to calculate these figures on a relatively disaggregated level. Altogether, we have calculated production values, value added and wage payments\(^2\) for five functional sub-activities. Together, these make up the air transport production sector:

- Government Activities (customs, police, airport security)
- Land and Air Transport (air lines, fuel, transport to and from the airport)
- Private Services (parking, car rental, travel agencies, cleaning)
- Hotels and Restaurants (hotels, cafes, trade, catering)
- Post and Telecom (cargo handling and air freight)

As mentioned previously, these five sub-activities add up to the air transport sector as a whole. We have now calculated the amount of direct air transport activities, measured in several ways and disaggregated into five sub-activities. In this sense, we now know the amount of resources the air transport sector uses, and we know its value of production and value added, and we know the wage payments. This information can be used for calculating the activities’ indirect and induced impacts.

In our case, we have used the regional economic model Panda (Lian et al 2006) to calculate what indirect and induced impacts the air transport sector activities have in the hinterland of four airports. These airports includes one of Norway’s larger regional airports for short take-off and landing aircraft (Leknes, 75 000 pax), one medium-sized airport for mainly domestic traffic (Molde, 350 000 pax) and two larger international airports (Bergen, 3.5 mill pax) and Oslo (16 mill pax).

Panda is a single-region input-output model of a Keynesian type, which means that it is demand driven and that there, by assumption, is excess capacity in the regional economy. The model’s main source of data is the RNA. Since the model is a relatively simple, Keynesian input-output model with excess capacity, the (indirect and induced) impacts have to be interpreted as gross, rather than net, impacts. We have not addressed the question whether the resources allocated to air transport activities could be used more efficiently for other purposes, or the crowding out effects of air transport. We merely calculate the gross impacts of air transport activities.

We have run the model in two alternatives for each of the four airports. The base, or zero, alternative includes all activities in the economy including the
air transport activities. The impacts alternative is similar to the base alternative, but we have excluded the air transport activities. Information on direct impacts (production value, value added and wage payments) on sub-activity level are fed into the model. In addition, we have used information from the RNA on intermediate deliveries from regional production sectors to each sub-activity. The difference between the two alternatives represents the impacts of air transport activities in the region, which can be split into primary (direct) and secondary (indirect and induced) impacts, and can be reported in some detail (i.e. by production sector). We can use this information to calculate regional production and/or employment multipliers. Table 2 shows the multipliers for each of the four airports.

<table>
<thead>
<tr>
<th>Multiplier employment (no of employees)</th>
<th>Leknes</th>
<th>Molde</th>
<th>Bergen</th>
<th>Oslo main airport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiplier man-years</td>
<td>1,37</td>
<td>1,26</td>
<td>1,61</td>
<td>1,91</td>
</tr>
<tr>
<td>Multiplier regional production</td>
<td>1,54</td>
<td>1,49</td>
<td>1,71</td>
<td>1,99</td>
</tr>
<tr>
<td>Multiplier regional income</td>
<td>1,39</td>
<td>1,36</td>
<td>1,77</td>
<td>1,95</td>
</tr>
</tbody>
</table>

The table illustrates that the impacts of air transport activities are more significant in “large” than in “small” regions. This can be explained partly by the fact that these regions are larger and therefore can absorb more of the impacts within the regions, partly that the industrial structure is “more modern” (contains more services production) in larger regions. Since the secondary impacts, especially the induced impacts are larger in the sectors producing services than in those producing physical products, the services producing regions can absorb more of them than the regions with more traditional industry. Generally, the industrial structure is more varied in Oslo/Akershus and Hordaland than in the other two regions. At the same time, the air transport activities are relatively more important in Oslo/Akershus and Hordaland than in the two other regions. This can partly be explained by the fact that these airports are larger, and provide services for larger regions and are hubs in the national air transport network with international connections. Larger airport at the same time have a more varied production structure, since they provide more diversified non-airside services that the smaller ones.

The Norwegian multipliers given in Table 2 are much smaller than can be found in most of international studies. The international multipliers vary from around 1.3 to 8.5, with an average of around 2.6 (Bråthen et al 2006). There are no evident correlation between annual traffic and the size of the multiplier. If we study air ports at the size of Oslo main airport, the multiplier spans from 1.5 (Brussels) to 4.1 (Milano). Evidently, some of the variations have to do with how the direct employment effects are defined, as pointed out above.
3.2 Results

A thorough survey of employment at all Norwegian airports gave the following results:

Table 3  Employment* by type of activity and size of airport.

<table>
<thead>
<tr>
<th>Airport</th>
<th>Air transport</th>
<th>Other</th>
<th>Totalt</th>
<th>1000 pax</th>
<th>Man-years/ mill pax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oslo airport</td>
<td>465</td>
<td>6500</td>
<td>3181</td>
<td>10146</td>
<td>14865</td>
</tr>
<tr>
<td>Large airports</td>
<td>804</td>
<td>3666</td>
<td>1867</td>
<td>6337</td>
<td>12318</td>
</tr>
<tr>
<td>Medium airports</td>
<td>476</td>
<td>483</td>
<td>574</td>
<td>1533</td>
<td>3767</td>
</tr>
<tr>
<td>Regional airports</td>
<td>352</td>
<td>306</td>
<td>204</td>
<td>862</td>
<td>1440</td>
</tr>
<tr>
<td>Other</td>
<td>306</td>
<td>300</td>
<td>265</td>
<td>871</td>
<td>1131</td>
</tr>
<tr>
<td>Total</td>
<td>2403</td>
<td>11655</td>
<td>6091</td>
<td>19749</td>
<td>33520</td>
</tr>
</tbody>
</table>

* HQ employees for the airport operator (AVINOR AS) and the airlines are not included.

Other activity includes land transport (1420), security (1040), police, customs etc (560), catering (530), hotel, restaurant (980), parking, car rental, travel agency, banking (720) shopping (380) and cleaning (280).

There is on average around 600 man-years per million passengers (pax). In a European context this is relatively low. Oslo airport and some of the larger airports has airline operational and technical bases and thus relative high employment per passenger. For medium and regional airports there is a clear tendency to reduced employment per passenger as traffic volume increase.

The main results from the I-O model are summarized below. We have assumed a “catalytic multiplier” of 1.8 (like the European average). Total employment connected to air transport in Norway is 50 - 70 000 man-years.

As an indication of the social value of air transport we have calculated the costs of 10 % diversion of air traffic to other transport modes (for example due to limited capacity). Under reasonable assumptions on value of time and saved travel time, the costs amount to NOK 2.1 billion per year. Some of these saved costs due to air travel are expressed through higher productivity and a more effective geographical division of labour. Some of the cost savings devolve on private travellers.

Table 4  Employment and value of air transport

<table>
<thead>
<tr>
<th>Employment (1000 man-years)</th>
<th>2005 (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct employment</td>
<td>20</td>
</tr>
<tr>
<td>Indirect and induced employment</td>
<td>12-16</td>
</tr>
<tr>
<td>Catalytic employment</td>
<td>18-34</td>
</tr>
<tr>
<td>Total employment (1000 man-years)</td>
<td>50-70</td>
</tr>
<tr>
<td>Value added (billion NOK)*</td>
<td>35-50</td>
</tr>
<tr>
<td>Annual economic cost of 10 % diversion of air traffic to other transport modes (billion NOK)</td>
<td>2.1</td>
</tr>
</tbody>
</table>

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Local estimates for Oslo main airport shows that visiting air travellers spends about NOK 14 billions per year in the region, of which 6 billions were from foreign travellers.

4. AN EXPLORATIVE STUDY OF CATALYTIC IMPACTS: MOLDE AIRPORT

4.1 The region and the airport

Molde is a city of around 25 000 inhabitants which is located on the north-western coast of Norway. The catchment area of the airport includes some 70 000 inhabitants. The employment is around 33 000 in the same geographic area. The industrial structure is characterised by exports of fish and advanced electro-mechanical product and engineering services. In addition, the city has a significant share of its employment (35 %) within the public sector, including a University College. The region has currently the largest investment project in Europe within its borders, the Ormen Lange sub sea natural gas project, with investments amounting to around € 7.5 billion, including a pipeline to Easington in the UK.

Molde airport serves at maximum Boeing 737/700 and the like, and there are plans for extending the runway to be able to serve the largest 737’s with maximum payload. The traffic growth has been substantial during the recent years, from around 250 000 pax in 1995 to 350 000 pax in 2005 which gives an annual average growth of 3.5 %. As for air transport in general, Molde airport faced a downturn in the years 2000-2002. The share of business travels is a bit above 50 %, in line with the national average for air travels. Molde airport employed 107 man-years in 2005, and the employment multiplier is 1.34 (Table 2), implying that the indirect and induced employment is around 35 man-years in the region.

4.2 An explorative survey on catalytic impacts

Catalytic impacts are defined above, and in brief, they comprise effects from air transport that is not included in the direct, indirect and induced effects. What may be of particular concern is how air transport affects industrial and residential location, and also how the level of economic activity is affected. The underlying question is to what extent a given airport is a premise for economic activity in its catchment area. In that sense the catalytic impacts may be important for the traffic level in general.

A structured questionnaire was sent to all members of the trade associations in the catchment area. The response rate was fairly low (15 %, 78 respondents), but we decided to investigate how these respondents adapted to the air transport system. Only indicative generalisations to the whole population could be made. The main purpose was to look into the share of the firms’ activity level that was dependent upon the present air transport system.
As compared to the actual industrial structure in the area, the general service industry and financial services are clearly overrepresented in the data set while the construction industry is somewhat overrepresented. Retail, the energy industry and other industries are at the representative level while the public sector and fisheries/agriculture are clearly underrepresented.

4.3 Employment, sales and catalytic sales

The responding firms had an average employment of 82 man-years and average sales of 123 MNOK (1.5 MNOK per man-year, 1 € = NOK 8.3). The firms were asked how much of their sales, apart from delivery to the air transport sector, that were dependent of the transport services at Molde airport. This share is what we denote catalytic sales. 14 firms did not have any such sales, and 16 firms did not answer the question. Among the remaining 48 firms, the catalytic sales constituted 24 % of total sales. The average share for all respondents was 14 %, which corresponds to 0.36 MNOK of catalytic sales per man-year. The largest catalytic sales for one firm were 2.6 MNOK per man-year, which was a firm in the tourist charter industry. In total, the catalytic sales among the respondents amounted to BNOK 1.2. It is worth noting that three larger firms were responsible for ¾ of this amount.

The electro-mechanical industry appeared to have a higher share of catalytic sales than other sectors (see Table 5). This was due to the fact that two firms with around 175 man-years each and sales of between MNOK 300 and 400 reported a share of 100 % of catalytic sales. These firms operated in markets where products and services were subjected to just-in-time demand.

Table 5  Man-years, sales (MNOK) and catalytic sales

<table>
<thead>
<tr>
<th></th>
<th>Services</th>
<th>Mech. industry and energy</th>
<th>Other sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Average</td>
</tr>
<tr>
<td>Man-years</td>
<td>1</td>
<td>1000</td>
<td>60</td>
</tr>
<tr>
<td>Sales</td>
<td>2,5</td>
<td>2000</td>
<td>115</td>
</tr>
<tr>
<td>Sales per man-year</td>
<td>0,5</td>
<td>7</td>
<td>1,92</td>
</tr>
<tr>
<td>Catalytic sales (CS)</td>
<td>0</td>
<td>24,6</td>
<td>3,59</td>
</tr>
<tr>
<td>CS per man-year</td>
<td>0</td>
<td>2,1</td>
<td>0,34</td>
</tr>
<tr>
<td>% CS</td>
<td>0</td>
<td>16 %</td>
<td></td>
</tr>
</tbody>
</table>

Molde and the surrounding area have around 33 000 employees which corresponds to around 29 000 man-years. A large share of the employment is related to production of goods and services for the region itself. Our data set of 78 firms had 6400 man-years, which was 22 % of the total employment in the catchment area. The sales for the firms in the data set amounted to BNOK 9.6. The firms who did answer the question of catalytic sales employed around 3500 man-years. Of these, 850 man-years were reported as catalytic employment.

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As stated earlier, the data set do not allow for any statistical generalisation. But considered only from the respondents alone, 850 catalytic man-years is extremely high as compared to the direct employment of 107 man-years and the average multiplier of 1.8 for catalytic employment in Europe (see above). As stated, the data set counts for 22% of the employment in the area, and one might think that the total catalytic sales may well be two or three times higher in total, amounting to around 3.5 BNOK and around 9% of the region’s employment.

Of course, these numbers are encumbered with substantial uncertainty. In addition to the generalisation problem, we may also face a reliability problem because we have not examined in detail what the adaptation to the counterfactual situation without Molde airport would have looked like. There are however reasons to believe that the airport affects the economic activity level in general, and also the industrial structure. This is due to the fact that multinational companies and network industries have located themselves in the area, and they are clearly dependent on reliable air services. Another issue is related to the fact that some important parts of the electro-mechanical industry within shipbuilding and off shore constructions are less footloose because they are dependent on local skills and local industrial networks. If this kind of resource base becomes less productive without an airport in the vicinity, then there are productive catalytic effects present, and not only relocation effects that are often zero-sum games. A third issue is related to how economic players in remoter areas interact with their markets in buyer-supplier relationships. A priori, the probability of finding markets and collaborators are significantly higher for businesses in central areas. Hence, the air transport system may play an important role in exploiting the scale effects in both human capital and natural resources in remoter areas. However, there will certainly be large variations among regions depending on their existing resource base. This pilot study gives only a hint on that catalytic effects may be quite significant in certain areas, and that this issue should be pursued in future research.

5. CONCLUSIONS

There has been a lot of concern about the economic impacts of air transport, in terms of employment. This paper has examined the direct, indirect and induced employment effects of Norwegian air transport, calculated by means of an input-output model. The results suggest that the employment effects are smaller than what can be seen from an average of international studies. The average number of employees at Norwegian airports amounts to around 590 per million pax. The European average given by York Aviation/ACI (2004) suggests 1000 employees per million pax. The multiplier effects do also turn out to be lower in this study than in most international studies, even if there may be differences in data and methods that may explain some of these differences.

Catalytic impacts comprise effects from air transport that is not included in the direct, indirect and induced effects. What may be of particular concern is how air transport affects industrial and residential location, and also how the level
of economic activity is affected. The underlying question is to what extent a
given airport is a premise for economic activity in its catchment area. In that
sense the catalytic impacts may be important for the traffic level in general. An
explorative case study of one Norwegian airport suggests that given certain
regional characteristics, the catalytic impacts of air transport may be of great
significance to the local economy, and the importance may be much larger
than suggested from international studies.

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NOTES

1 Average value added per employee, average production value per employee and average wage rates
2 Since we have used rates from the RNA, we are not able to distinguish between the producers included in the air transport activities and those producing similar products outside air transport. Typically, productivity rates as well as wage rates might vary between air transport and non-air transport companies.