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ESPON

Regional airports and regional growth in Europe: which way does the causality run?

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This paper as a part of a larger ESPON project

- Part of an on-going ESPON project ”ADES - Airports as drivers of economic success in peripheral regions”
  - Belongs to ”Targeted Analyses”, conducted under Priority 2 of the ESPON 2013 Programme

- Four partners
  - Department of Sciences for Architecture – University of Genoa, Italy (Lead Partner)
  - BAK Basel Economics AG, Switzerland
  - Knowledge and Innovation Intermediaries Consulting LTD (KINNO), Greece
  - Jyväskylä University School of Business and Economics, Finland

- Stakeholders
  - Province of Savona, Italy (Lead Stakeholder)
  - Region of Western Greece, Greece
  - City of Jyvaskyla, Finland

ESPON ADES - Questions

Policy:

How important are airports as drivers of economic success in peripheral regions?

Research:

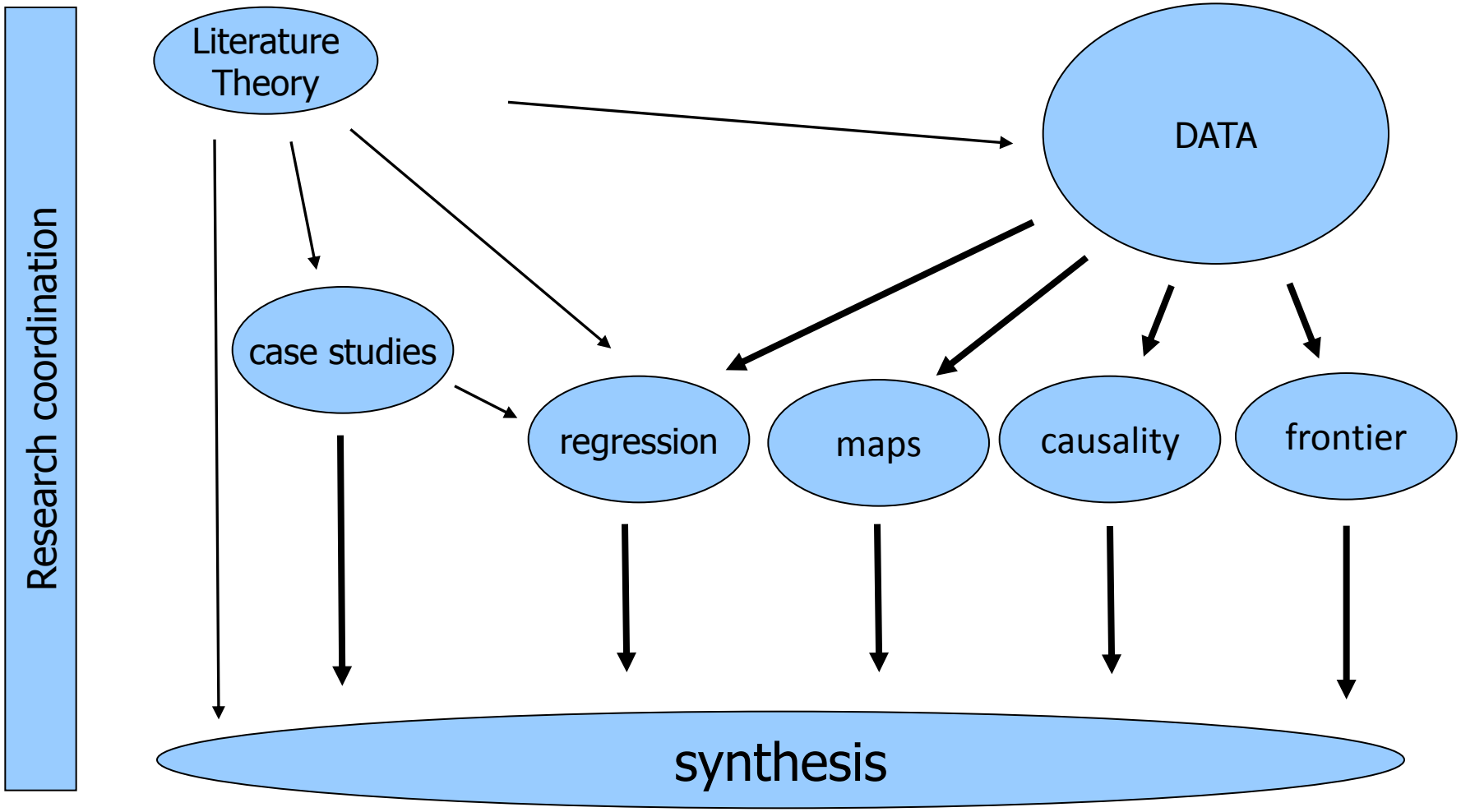
What is the optimal amount and optimal mix of traffic infrastructure for different types of peripheral regions?

What is the quantitative influence of regional airports to the regional economy?

ESPON ADES - Overview of the project

	Research activities	Uni Genoa	BAKBASEL	KiNNO	Uni Jyväskylä
WP2.1	Theoretical underpinning: literature review and formulation of hypotheses		X		
WP2.2	case studies (in the three stakeholder regions) questionnaire, survey with relevant stakeholders SWOT analysis	X			
WP2.3	international database (for common use) descriptive statistics, benchmarking various indicators		X		
WP2.4	maps (showing different types of regions) maps (as a vision - support for strategic process)	X			
WP2.5	statistical analysis (panel causality tests)				X
WP2.6	regression analysis quantification of welfare gains through better accessibility		X		
WP2.7	frontier analysis (looking for limiting factors)			X	
WP2.8	coordination of the research process, synthesis		X		

ESPON ADES – Relation between the work packages



Background of the study – which way does the causality run?

- **" So the question remains why airports have not been the subject of much careful study with respect to their impact on economic development. The answer lies with a difficult econometric issue: simultaneity. While there is a strong correlation between air traffic and economic growth, the direction of causation is not entirely clear."** *(Green 2002)*

- Air transportation as well as transportation in general can be seen as a facilitator that allows the economic potential of a region to be realized
  - The provision of transportation does not, however, automatically lead to economic development
  - It may also be the other way round: economic development leads to the provision of transportation

- The causality issue is of utmost significance for regional policy makers
  - "air traffic => economic development"

    the results stress supply side –elements and the significance of transport policies
  - "economic development => air traffic"

    the results stress demand side-elements and the significance of other policies

Objective

- To know and understand the relationship between regional airports and economic performance
  - Is accessibility a key factor to economic success, or rather a consequence of it?

    (”chicken - egg” - issue)
- Especially, to understand the role of air traffic in peripheral regions
  - In these regions, air traffic may decrease the negative effects of long distances
  - Improved accessibility may cause firms to be more productive and more competitive than the firms in regions with inferior accessibility

- First step to the econometric analysis of the ADES project (WP2.6)
  - Also links to frontier (DEA) analysis (WP2.7)

Earlier studies

- Earlier literature is mainly focused on the role of airports from the view point of metropolitan development, whereas the relationship between airports and peripheral regions is a much less studied field
  - However, the competitive and locational advantage of peripheral regions may be strongly influenced by airline networks

- Many earlier studies and surveys indicate that access to air transportation has an extremely important effect on location decisions of many businesses
  - High-tech industries, in particular, benefit from the proximity of airport due to the importance of face-to-face interaction in their operation

- There have been a limited number of studies that have looked at the impact of airports on regional growth (Brueckner 2003; Green 2007; and Button et al. 2009 being exceptions)
  - These studies mainly have used the instrumental variables technique to overcome the endogeneity problem

Method

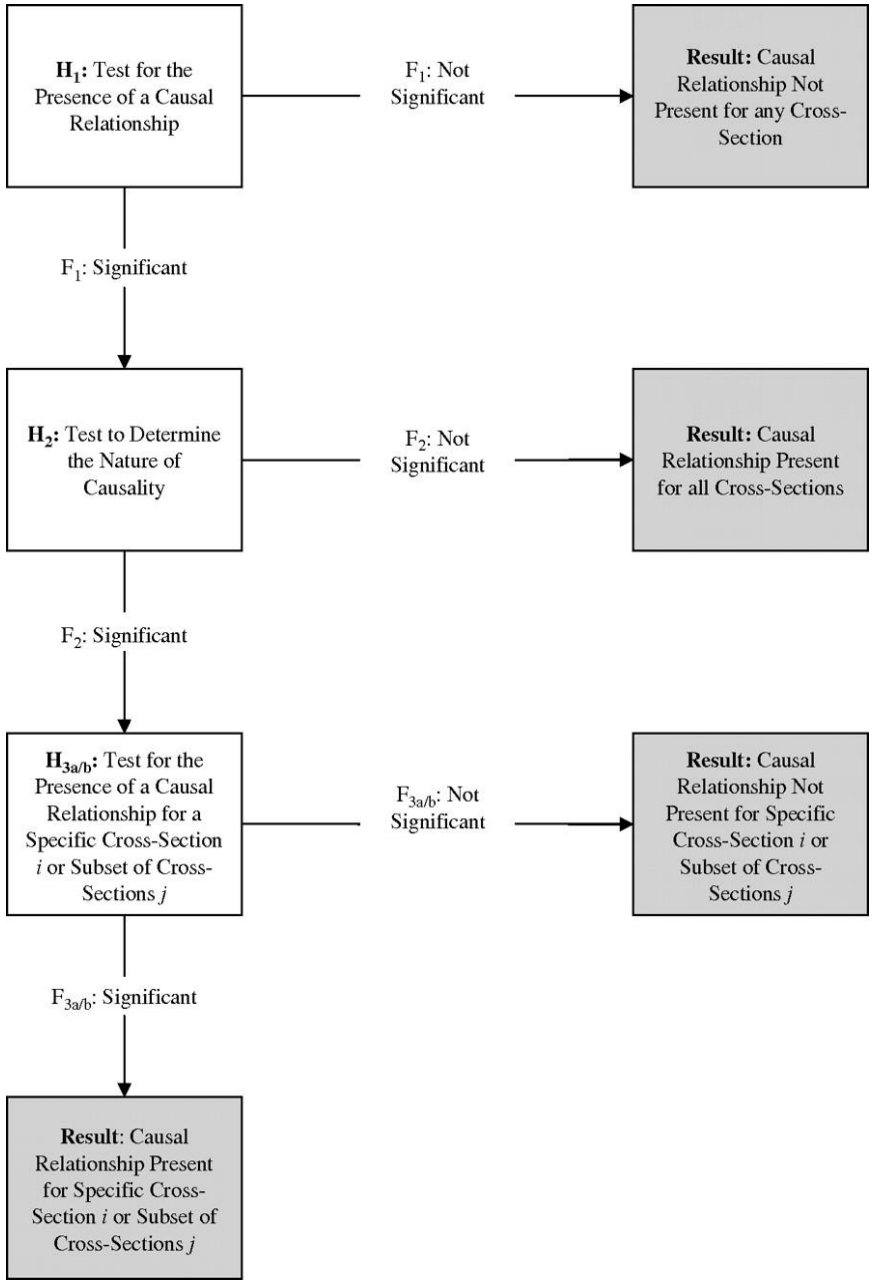
- Our analysis is based on the notion of Granger causality
  - In the case of two variables, say *x* and *y*, the first variable, *x,* is said to cause the second variable, *y,* in the *Granger* sense if the forecast for *y* improves when lagged values for *x* are taken into account
  - This exploits the fact that in time series there is temporal ordering, and the belief that effects cannot occur before causes.

- Here we utilize the Granger method in a novel way
  - The introduction of a **panel data dimension** permits the use of both cross-sectional (regional) and time series information to test causality relationships, which apparently improves the efficiency of Granger causality tests
  - For each region *i*, the variable $x_{i,t}$ causes $y_{i,t}$ if we are better able to predict $y_{i,t}$ when using all the available information than when using only some of it

Employing Granger causality tests in a panel framework

- The Granger technique is a standard tool used in econometrics to evaluate causal processes
- To improve the efficiency of Granger causality tests, Granger tests are increasingly being used to evaluate causal relationships in panel data
- But: a potential flaw shared by many analyses is an inappropriate assumption of causal homogeneity
  - A causal relationship may be present only in a subset of cross-sections (regions) and not in others
  - In our case, causality between regional performance and air traffic may vary according to peripherality, since especially remote regions need to be accessible via air connections
- In our testing procedure, a possibility of heterogeneity between regions is allowed and we test whether peripherality explains differences in causal processes

Hurlin and Venet (2001) outline a testing procedure for evaluating the character of the causal processes within a panel framework



Three main steps

1. Testing homogenous non-causality HNC
2. Testing homogenous causality HC
3. Testing heterogeneous causality HENC

Panel data model with fixed coefficients

- If we consider a time-stationary VAR representation, adapted to a panel context, then for each cross-section unit *i* and time period *t* we have

$$(*) \qquad y_{i,t} = \sum_{k=1}^{p} \gamma^{(k)} y_{i,t-k} + \sum_{k=0}^{p} \beta_i^{(k)} x_{i,t-k} + v_{i,t}$$

where $v_{i,t} = \alpha_i + \varepsilon_{i,t}$

- The autoregressive coefficients $\gamma^{(k)}$ and the regression coefficients slopes $\beta_i^{(k)}$ are assumed constant for all lag orders $k \in [0, p]$
- It is also assumed that $\gamma^{(k)}$ are identical for all units, whereas $\beta_i^{(k)}$ are allowed to vary across individual cross-sections
- This is a panel data model with fixed coefficients.

Implementation

- For both side variables in the analysis, we first take natural logarithms and then difference them in order to eliminate possible unit roots and to reach time stationarity
  - Consequently, we are in fact analysing growth rates

- The general definitions of causality imply testing for linear restrictions on the regression coefficients β_i in the three main steps
  - To perform the estimations required, we used the constrained regression technique

- We follow the nested procedure described above to test different causality relationships
  - The tests are based on Wald statistics
  - In order to test the various hypotheses, we calculated the statistics using the sum of squared residuals from the unrestricted model and the sum of squares from the requisite restricted models.
  - The sums of squared residuals are obtained from the MLE, which in this case corresponds to the fixed-effects estimator

Data

- The empirical analysis is based on regional level data from Europe from the period 1991-2010 (Source: Bak Basel Economics)

- Airport Council International produces data on the use of airports but this data is limited by the number of reporting airports
  - A complete airport data is available in the period 1991-2010 for 86 NUTS Level 2 or NUTS Level 3 regions from 13 countries in Europe
  - The countries include Austria, Switzerland, Germany, Demark, Spain, France, Ireland, Italy, Luxembourg, Holland, Norway, Portugal and the UK

Data - variables

- We need two types of variables to measure:
  - *Air traffic*
  - *Regional economic development*

- *Air traffic*
  - number of passengers
  - accessibility as measured in travel time
  - (cargo)

- *Regional economic development*
  - gdp growth
  - employment development

Step 1. Homogenous non causality (HNC) hypothesis

- implies the non-existence of any individual causality relationships

$$H_o;\ \beta_i^{(k)} = 0\ \forall i \in [1, N],\ \forall k \in [1, p]$$

$$H_1;\ \exists (i,k) / \beta_i^{(k)} \neq 0$$

[H_0; For all regions; air traffic (regional growth) does not cause regional growth (air traffic)]

$$F_{HNC} = \frac{(RSS_2 - RSS_1)/Np}{RSS_1/(NT - N(1+p) - p)}$$

Step 1. Test results for homogeneous non-causality (HNC hypothesis)

Direction of causality and lags	*F-statistic and its significance* Air passengers - GDP	Air passengers - employment	Accessibility - GDP
Causality from air traffic to regional growth			
Lag 1	1.602***	1.591**	1.947***
Lag 2	0.576	0.716	0.991
Causality from regional growth to air traffic			
Lag 1	0.956	1.206^{o}	0.694
Lag 2	0.420	0.604	0.470

Step 1 (HNC): interpretation of the results

- Direction of causality: from air traffic to regional development
  - All the test statistics related to the homogenous non-causality hypothesis are statistically significant with one lag
  - With two lags, they are not significant
  - These results allow us to reject the homogeneous non-causality hypothesis: ***for at least some regions (and possible all), there is statistical evidence of Granger causality from air traffic to regional growth***

- Direction of causality: from regional development to air traffic
  - ***Evidence is only partial***
  - The test statistic cannot be rejected even at lag one when using the combination of variables "air passengers – GDP" and "accessibility – GDP"
  - The test statistic is rejected at the 10% significance level when employment is used instead of GDP which result calls for the next step in the testing procedure.

Step 2. Homogenous causality (HC) hypothesis

-implies uniformity of causality in all regions

$$H_o;\ \beta_i^{(k)} = \beta^{(k)}\ \forall i \in [1, N],\ \forall k \in [1, p]$$

$$H_1;\ \exists k \in [1, p],\ \exists (i, j) \in [1, N] / \beta_i^{(k)} \neq \beta_j^{(k)}$$

[H_o; For all regions, air traffic (regional growth) causes regional growth (air traffic)]

$$F_{HC} = \frac{(RSS_3 - RSS_1) / p(N-1)}{RSS_1 / (NT - N(1+p) - p)}$$

Step 2. Test results for homogenous causality (HC hypothesis)

Direction of causality	*F-statistic and its significance*		
	Air passengers - GDP	Air passengers - employment	Accessibility - GDP
Causality from air traffic to regional growth			
Lag 1	1.646***	1.521**	2.018**
Causality from regional growth to air traffic			
Lag 1	-	0.925	-

Step 2 (HC): interpretation of the results

- Direction of causality: from air traffic to regional development
  - The results indicate significant test statistics for all pairs of variables
  - Accordingly, ***there are causal processes from air traffic to regional growth, but these processes are not uniform***

- Direction of causality: from regional development to air traffic
  - The test statistic is not rejected which implies ***a homogenous causal process***
  - An alternative interpretation is that there are no causal processes at all: this is the result we obtain if we use GDP growth to measure regional performance and air passengers or accessibility to measure transport

Towards the next step

The results so far indicate that:

1. Air traffic, or accessibility in general, Granger –causes regional growth in some regions , but not in all
2. Regional growth Granger-causes air traffic in all regions uniformly (or alternatively, there are no causal processes at all)

- In the first case there is need for further analysis, i.e. for testing the heterogeneous non-causality hypothesis, but not in the second case (testing stops here)
- As the number of regions is high, 86, we do not test individually the contribution of each region to the existence of causality, but categorize the regions into three groups of equal size according to their peripherality
  - In this categorization, we utilize the accessibility variable

Step 3. Heterogeneous non causality (HENC) hypothesis

H_o; For a subset of regions, air traffic does not cause regional growth

$$F_{HENC} = \frac{(RSS_4 - RSS_1)/(n_{nc}p)}{RSS_1/(NT - N(1+p) + n_{c}p)}$$

Step 3. Test results for heterogeneous causality (HENC hypothesis)

Direction of causality and region type	*F-statistic and its significance*		
	Air passengers - GDP	Air passengers - employment	Accessibility - GDP
Causality from air traffic to regional growth			
Peripheral regions	2.527***	3.533***	2.952***
Intermediate regions	1.374^{o}	0.760	1.152
Core regions	0.873	0.393	1.607*

Step 3 (HENC): interpretation of the results

- The more peripheral the region is the more important for it is to have efficient air connections
  - This result is evident when using the pair of variables “air passengers – GDP”
  - With the other two pair of variables, the result is not perfectly consistent, but in all cases a significant result is obtained for peripheral regions

- Overall, the results suggest that remoteness matters in the causality process

Conclusions

- Earlier studies and surveys indicate clearly that access to air transportation has an extremely important effect on location decisions of many businesses
  - A well-developed transport infrastructure can be seen as a facilitator that allows the economic potential of a region to be realized

- In peripheral regions, air traffic may decrease the negative effects of long distances
  - Easy accessibility attracts firms and other economic activity to the region and stimulates employment and production at established firms

- Our results suggest that
  - In remote regions, air transportation is even more than a facilitator; in addition that regional growth causes airport activity, air transportation may also give a boost to regional development
  - In core regions, the reverse is only true: airport activity does not cause growth, but regional growth causes airport activity

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