Analysis of **SPATIAL AGGLOMERATION** of KIS and HT-manufacturing in the Metropolitan Region of Barcelona (MRB)

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This presentation

• Economical development and ‘performance’ of the Barcelona city region. It shows results of the CAEE study (The Case for Agglomeration Economies in Europe) of the ESPON program.

  Main purpose of CAEE was to examine the relationship between agglomeration economies and city-regional/metropolitan governance.

• Progress in defining functional economic areas of KIS and HTI sectors in MRB.

  With the assistance of a spatial interaction model, we constructed functional economic areas in which MRB is structured from the perspective of the complementarity of economic activity.
Study area and overview
In 2001 the population was 4.805 million of inhabitants (Census), distributed throughout a total of 311 municipalities and 11 counties, in an area of 7,728 km².

Over 50% of the population of the city-region lies within 7 municipalities with populations in excess of 100,000 inhabitants. It is concentrated within 3.5% of the total area of the city region.

By contrast just over 20% of the population resides in 161 municipalities of less than 20,000 inhabitants, distributed over more than 87% of the city region.

The remaining 29% of the population of the city region lies within 37 towns and cities in the 20,000 - 100,000 range, spread over just 9.5% of the total area.
The MRB comprises 164 municipalities, being considered as the commuting area of Barcelona. Territory corresponds to the Metropolitan Territorial Plan, which was approved by the Regional Government on 2010.

**Figures from 2001 Census (MRB)**

- 4.390 million inhabitants
- 1.963 million locally based jobs (LBJ)
- 1.951 million resident workers
- 75% of Catalan GDP and 13% of Spanish GDP
Spatial distribution of locally-based jobs within the Barcelona city region (2001)
Employment and change during the period of 1991-2001

- 8.5% increase in the economically active resident population (RP)
- 16.9% increase in the locally-based jobs (LBJ)
- Manufacturing sectors decrease 17% in the LBJ to 551,689 in 2001,
- Service sector increase 29% in the LBJ to 1.292 million LBJ in 2001.

Change in LBJ (1991-2001) in the industrial and service sectors

<table>
<thead>
<tr>
<th></th>
<th>Agriculture</th>
<th>Industry</th>
<th>Construction</th>
<th>Services</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economically active</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>resident population</td>
<td>30.400</td>
<td>775.680</td>
<td>177.463</td>
<td>990.486</td>
<td>1.974029</td>
</tr>
<tr>
<td>population 1991</td>
<td>1.54</td>
<td>39.29</td>
<td>8.99</td>
<td>50.18</td>
<td>100</td>
</tr>
<tr>
<td>(% of total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Economically active</td>
<td>21.403</td>
<td>569.300</td>
<td>198.368</td>
<td>1350.834</td>
<td>2.139905</td>
</tr>
<tr>
<td>resident population</td>
<td>1.00</td>
<td>26.80</td>
<td>9.27</td>
<td>63.13</td>
<td>100</td>
</tr>
<tr>
<td>2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locally-based jobs</td>
<td>22.614</td>
<td>663.590</td>
<td>126.342</td>
<td>919.547</td>
<td>1.732093</td>
</tr>
<tr>
<td>1991</td>
<td>1.31</td>
<td>38.31</td>
<td>7.29</td>
<td>53.09</td>
<td>100</td>
</tr>
<tr>
<td>(% of total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Locally-based jobs</td>
<td>19.868</td>
<td>551.689</td>
<td>161.444</td>
<td>1291.641</td>
<td>2.024642</td>
</tr>
<tr>
<td>2001</td>
<td>0.98</td>
<td>27.75</td>
<td>7.97</td>
<td>63.80</td>
<td>100</td>
</tr>
<tr>
<td>(% of total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>
Employment density and commuting flows (2001)

Consolidated subcentres of employment

- 50% of the locally-based jobs were contained within 5 municipalities (Barcelona, Sabadell, Terrassa, L’Hospitalet de Llobregat and Badalona).

- 28% of the locally-based jobs of the city region were contained in some 28 municipalities.

Travel to work flows between municipalities of Catalonia

Employment subcentres in the city region
Density analysis 2001
What role key sectors have?
The city region is changing into a service-based economy, where knowledge is set to have a central role. This structural change is clearly visible in the city of Barcelona, where knowledge-based industries are replacing the old industrial sites, which in turn, are moving to the wider metropolitan region.
In order to reach an understanding of the effects agglomeration economies exert over the territory, economic sectors linked to "knowledge economies" (areas defined by the OECD as high-tech industries, medium and high technology industries, high knowledge activities) have been selected. Textile and clothing industries were also selected on the basis of the strong historic tradition within Catalonia and their importance within the economic base of the city region.

The analysis was carried out in 2001, based in 2001 Census data, and in a complementary form for 1991. The objective was, in the first place, through a dynamic analysis to identify the details of the process of evolution of the localization of the selected economic activities; and in the second place, to gather criteria for the selection of a number of municipalities of the study area which represent processes of growth in these economic sectors.

This enabled a qualitative analysis (through interviews) to be carried out, to determine the degree to which governance processes had facilitated, or not, this process.
Sector selection

OECD (1999)

Manufacturing

Services

Primary

Low technology

Medium-low technology

Medium-high technology

High technology

Knowledge intensive

Knowledge non intensive

Rectification of sector pertinence through factorial and cluster analysis using educational and occupational level
Selected Key Sectors (5 groups)

1) Creative industries (e.g. media, culture, sportive)

2) Financial and business related services (e.g. bank, insurance, finance, professional services)

3) Medium-high technological industries (e.g. hardware, precision machinery and medical instruments, advanced electronics)

4) Education and Research and Development; and

5) Textile related activities (because of their importance in the city region (CAEE-ESPON))
Share of the key sectors on provincial labor market, 2001

- 5 key sectors: 1.633 million of LBJ (77%)
- Remaining sectors: 0.499 million of LBJ (23%)

Source: 2001 National Census
Share of the key sectors on provincial labor market, 2001 (II)

Source: 2001 National Census
Structural change 1991-2001

5 sector’s share 1991-2001

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage Points</th>
<th>1991-2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial + Business</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Creative</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Education + R&amp;D</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>High-tech manufacturing</td>
<td>-0.5</td>
<td>-0.5</td>
</tr>
<tr>
<td>Textile</td>
<td>-3.1</td>
<td>-3.1</td>
</tr>
</tbody>
</table>

(\%LTL 2001)-(\%LTL 1991)
What is the role of the Key sectors in the structural hierarchy of economical relationship?
Multidimensional scalling analysis of economical relationship

Proxcal analysis from Matrix input-output Catalonia, 2001

Financial and business
45 Insurance and pension plans
47 Real estate
44 Financial services
46 Auxiliary services to financial services
49 Computer services
51 Other business Services
64 Postal and Telecommunications

HT-manufacturing
24 Office machinery and computers manufacturing
26 Manufacture of electronic materials, radio, tv and communications
27 Manufacture of surgical instruments, precision optics and watches

Education
50 Research and Development
53 Education services

Creative
57 Recreational, cultural and sport

Textile
11 Industries clothing and fur
12 Textile
### Proxcal space of economical dependency matrix

**Average distance to the Key sectors from other economic sectors**

<table>
<thead>
<tr>
<th>sector code</th>
<th>sector name</th>
<th>distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>s30</td>
<td>Furniture and other manufacturing</td>
<td>0.52</td>
</tr>
<tr>
<td>s42</td>
<td>Services related to transport and services of travel</td>
<td>0.53</td>
</tr>
<tr>
<td>s48</td>
<td>Rental services of machinery</td>
<td>0.53</td>
</tr>
<tr>
<td>s33</td>
<td>Distribution of water and other services related</td>
<td>0.54</td>
</tr>
<tr>
<td>s36</td>
<td>Services and wholesale trade intermediaries</td>
<td>0.56</td>
</tr>
<tr>
<td>s25</td>
<td>Machinery and electrical materials</td>
<td>0.57</td>
</tr>
<tr>
<td>s40</td>
<td>Maritime transport services and by roads</td>
<td>0.61</td>
</tr>
<tr>
<td>s41</td>
<td>Air and space transport services</td>
<td>0.61</td>
</tr>
<tr>
<td>s16</td>
<td>Products of the edition, printed and recorded media</td>
<td>0.62</td>
</tr>
<tr>
<td>s37</td>
<td>Retail services (except motor vehicles) and repair</td>
<td>0.62</td>
</tr>
<tr>
<td>s35</td>
<td>Services trade and repair of motor vehicles</td>
<td>0.66</td>
</tr>
<tr>
<td>s34</td>
<td>Construction</td>
<td>0.69</td>
</tr>
</tbody>
</table>

- **Quartile (Q) 1:** 0.60
- **Q 2:** 0.75
- **Q 3:** 0.95
- **Q 4:** 1.18

### Diagram

- **KIS-HTI sectors with the rest:**
  - Manufacturing: 0.85
  - Services: 0.95
  - Primary-energy: 0.85

- **KIS-HTI sectors with primary sectors:**
  - Manufacturing: 0.76
So...What role the key sectors have in the planning of territory?
Identification of Key sectors’ subcentres

Cut-off criteria used by García-López (2007) in the MRB (*based on density cut-offs (density and mass) developed by Giuliano & Small in Los Angeles 1991*)

A municipality is proposed as a subcentre if it:

1. Has a density of metropolitan Locally based jobs
   LBJ/Km² > Metropolitan density average

1. Concentrates >1% of LBJ of whole metropolitan region
### Subcentres of concentrated employment by sector (2001)

<table>
<thead>
<tr>
<th>Employment sub-centres</th>
<th>Textile industries</th>
<th>Creative industries</th>
<th>Financial and business related services</th>
<th>Medium-high technological industries and medical machinery</th>
<th>Education, research and development</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of municipalities</td>
<td>13</td>
<td>11</td>
<td>11</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Total locally-based jobs per sector</td>
<td>49,885</td>
<td>25,651</td>
<td>181,907</td>
<td>9,011</td>
<td>89,937</td>
</tr>
<tr>
<td>Locally-based jobs per sector/ Locally-based jobs per sector in the city-region</td>
<td>57.1%</td>
<td>76.0%</td>
<td>76.1%</td>
<td>67.9%</td>
<td>71.4%</td>
</tr>
</tbody>
</table>

Table 16: Locally-based employment sub-centres of the key sectors (2001)
Source: INE. Census of Population, 2001
Subcentres for the 5 key sectors, 2001

Size of the mark denotes average size, in employment terms, of Key sectors.
Subcentre for the 5 key sectors 2001: Financial

11 subcentres
Subcentre for the 5 key sectors 2001: Creative

11 subcentres
Subcentre for the 5 key sectors 2001: Education + R&D

15 subcentres
Subcentre for the 5 key sectors 2001: High-tech Manufacturing

18 subcentres
Subcentre for the 5 key sectors 2001: Textile

15 subcentres
Subcentre for the 5 key sectors 2001: comparison

Barcelona Province

E = Education + R&D
F = Financial + Business
C = Creative
T = Textile (conventional)
HT = HT Manufacturing
Subcentre for the 5 key sectors 2001: comparison (II)

MRB (only KIS-HTI sectors) - without textile

EIT: education, software, services, telecommunications
SE: Related business services
SS: Healty services
SF: Financial services
ICC: cultural industries
MHTI: Medium-high technology industries
### Location patterns Key sectors

*MRB (only KIS-HTI sectors) - without textile*

<table>
<thead>
<tr>
<th>Area</th>
<th>numbers of municipalities by area</th>
<th>% of LBJ of KIS and HTI sectors</th>
<th>ratio of LBJ of KIS and HTI sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD and central conurbation</td>
<td>9</td>
<td>64.1%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Employment subcentres</td>
<td>14</td>
<td>14.2%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Cities connected by highways with employment subcentres</td>
<td>36</td>
<td>7.5%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Rest of territory of MRB</td>
<td>105</td>
<td>14.3%</td>
<td>0.1%</td>
</tr>
<tr>
<td>All MRB</td>
<td>164</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
Subcentres are consequences of a hierarchical employment organization... so What happen to their areas of influence?
Definition of the functional economic areas of KIS and HTI sectors in the MRB
They have a high level of diversity of the production structure,

They have a relationship of interdependence between different economic sectors found in them,

They comply with maximum self-restraint of production, higher than average self-contained city municipalities and,

They are structured around a center of header (subcentre) to where the main economic flows are.
1- From input-output matrix (which accounts for complementarity among economic sectors) and matrix of commuting flows (which accounts for the location of workplaces by economic sector), we estimate the monetary flows among the different municipalities of Catalonia with the assistance of a spatial interaction model.

2- From these flows are constructed functional areas in which territories are structured from the perspective of the complementarity of economic activity. In order to do this, with the maximum interaction value of economical flows, we estimate the functional economic areas, which correspond to areas with high values of self-contention of economical activity.
Step One: Spatial interaction model

Spatial interaction model of economical relationship constrained in origin
This estimate is obtained by multiplying the number of LBJ in a particular sector for their respective productivity expressed in EUR / LBJ

Apparent productivity of LBJ by economic sector (from the input-output table of Catalonia, 2001)
Step One: Spatial interaction model

Origin constrained model of economical relationship:

\[
F_{ij \ x-y} = O_{i \ x-y} \frac{D_{j \ x-y}}{dij^{\beta}} \sum_{j=1}^{946} \frac{D_{j \ x-y}}{dij^{\beta}}
\]

Where:

\(F_{ij \ x-y}\) is the flow that relates the production sector in the municipality \(i\) to the demand of the sector \(y\) located in municipality \(j\).

\(O_{i \ x-y}\) is the part of the sector’s output \(x\) located in the municipality \(i\) that would sell the sector \(y\) located in the 946 municipalities \(j\) of Catalonia. To estimate this value, the sector’s total output \(x\) located in the city \(i\) has been increased by the technical coefficient of the input-output matrix that relates the sector \(x\) to \(y\).

\(D_{j \ x-y}\) is the part that will buy the sector \(x\) to \(y\).

\(D_{ij}\) is the distance by road between the origin municipality \(i\) and destination municipality \(j\).

Beta is a parameter representing the friction that internalizes the cost of overcoming the space separating municipalities \(i\) from \(j\). It corresponds to a value resulting from the analysis of the mobility matrix work-work for the MRB.
From the matrix resulting from the implementation of step 1 of the methodology (spatial interaction model of production in each municipality) the maximum interaction value of economical flow between different municipalities is searched. The results are formation of proto-systems (the previous joining-up process culminates when a closed system is achieved). The proto-systems are only consolidated if they are physically continuous. Likewise, the consolidation requires a minimum level of 50% self-containment. If a proto-system does not reach this degree of autonomy, it is aggregated with the proto-system which has a maximum level of interaction and this continues in an iterative form.

*Methodology developed by Roca and Moix (2005) Interaction of the maximum value (VI) in the functional relationship residence / employment*
Step Two: Delimitation of Functional economic areas from the methodology of the maximum value of interaction (VI)*

\[ V_{ij} = \frac{F_{ij}^2}{fts_i \cdot ftr_j} + \frac{F_{ji}^2}{fts_j \cdot ftr_i} \]

Where:

- \( V_{ij} \) is the interaction value of economical flows of KIS-HTI sectors with other sectors between the municipalities \( i \) and \( j \);
- \( F_{ij} \) and \( F_{ji} \) are the reciprocal economical flows of KIS-HTI sectors with other sectors between municipalities \( i \) and \( j \);
- \( fts_i \) and \( fts_j \) are the total flows of KIS-HTI sectors with other sectors from \( i \) to the rest;
- \( ftr_i \) is the total flows of KIS-HTI sectors with other sectors received in \( i \) from the rest municipalities.

Functional economic areas of KIS and HTI sectors in MRB

Diversity index of economical activity
Functional economic areas of KIS and HTI sectors in MRB

Specialization index of economical activity

HTI

KIS

Other manufacturing

Other services
Final remarks
1. The principal characteristic of the Barcelona city region is concentration of economic activity in and around the capital, within the metropolitan region, and the low representation of such activity within the hinterland or remainder of the city region, with the exception of important centres of employment of medium size.

2. The deindustrialization marking the decrease in industrial economic activity and the increase in economic activity in the service sector was very much reflected in the Barcelona city region.

3. From the definition of economic proto-systems, which were a prelude to defining functional economic areas, the results have reflected a metropolitan structure clearly determined by the characteristics of the underlying economic structure, in which is observed around urban centers with larger and diversified labor markets, the most extended and consolidated functional economic areas are found. Barcelona certainly has the largest and most extended functional economic area, but across the metropolitan territory there are other areas, which are genuine areas of economic and territorial functionality, alternatives to the area of Barcelona, forming in that sense a real equipotential territorial system of functionality in the MRB.
According to the interviews of the public authorities in four case studies... What territorial factors have conditioned the phenomena of consolidation of KIS-HTI sectors? (in 4 employment subcentres)

Common features of each of the four case studies:

1. Good accessibility and communication,
2. Less congestion,
3. Industrial land prices being lower than in the core of the city region (i.e. in and immediately around Barcelona),
4. Access to a wide and skilled labour market,
5. Availability of industrial land.

In the particular case of Sant Cugat del Vallès:

- High quality residential areas and low residential density,
- High proportion of employed population in the business sector.
Thank you

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