Regional labour markets in Germany. And a Three-Step-Approach.

Developing European Labour Market Areas
Workshop and training on TTWA method

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1. Problem: Delimit Regional Labor Markets (RLM)
2. Data: German commuting data
   ▪ modified graph theory approach:
   ▪ using Newman-Girvan´s Modularity measure $Q$
4. Results:
   ▪ a robust and „rough“ delineation
5. Comparison with other delimitations
6. Discussion
1. Problem: Delimit Labor Markets Regions

- **Relevance:**
  - RLMs are better than administrative regions (like districts) for:
    - reliable regional statistics
    - labor market policy
    - regional planning
  
- **What is a good delineation?**
  - Capture as many commuters as possible in RLM.
    - How many RLM?
    - Sizes of RLM?
2. Data: German commuting data

- Data of all employees covered by the social security system in Germany (~ 70% of all 40 Mill. employees)
  - cross sections, June 30th each year (here: pooled data 2006-2008)
  - information about **place of work and place of living on municipality level**
  - 12,000 municipalities with various sizes across German states (Bundesländer)

>> **2,000 municipal regions** of similar sizes across German states
  - 3,998,000 possible commuting links
2. Data: German commuting data

2,000 municipal regions merging procedure

- distances between all municipality pairs $M_{ij}$
- calculated the fusion coefficient:
  $$F_{ij} = \text{distance}_{ij}^2 \cdot (\text{inhabitants}_i + \text{inhabitants}_j)$$
  where $i=1,\ldots,n$ and $j=1,\ldots,n$
- The two municipalities with the lowest $F_{ij}$ merged to form a single municipal region (with the sum of the inhabitants and the coordinates of the municipality with the greatest population).
- repeated until a solution with 2,000 municipal regions that were quite homogenous in size was achieved.

A significantly greater number of merging steps would lead to larger municipalities and would affect small towns.
2. Data: German commuting data
3. Methods: Overview

- **Threshold methods:** Coombes’ Travel-to-Work-Areas
  - + simple
  - - arbitrary thresholds

- **Graph theory approach**
  - concept of dominant flows (Nystuen/Dacey 1961; Rabion/Occelli 1997)
  - + simple; efficient
  - - not well known

- **Cluster analysis** (Cörvers et al. 2009 / Baumann et al. 1983)
  - - re-allocation problem of hierarchical clustering

- **Adaptive clustering** (Kropp/Schwengler 2008)
  - + good result, adjustable
  - - not well known

- **Factor analysis**
  - 150 regional labor markets, Eckey u.a. (2006)
  - + theoretically best method, German standard
  - - no top results

- **Network analysis** (applicable since 2014 for large valued graphs)
  - + best methods for structural analysis
  - - no top results
3. Methods: Overview

Usual restrictions for practical application:

- follow district or „Länder“-borders (NUTS 1 & 3)
- spatial contingency & complete coverage
- max. interaction within RLM
  - most employees live within RLM
  - most inhabitants work within RLM
- low interaction with other RLM
  - thresholds for **Self-Containment** between 65% & 75% (Binder/Schwengler 2006; Hensen/Cörvers 2003; Casado-Díaz 2000)
- min. size (inhabitants or employees)
  - 30.000 inh. (Klemmer/Kraemer 1975), 50.000 (Eckey/Klemmer 1991, Eckey/Kosfeld/Türck 2006); 100.000 (Eckey 2001, Binder/Schwengler 2006); 200.000 (van der Laan/Schalke 2001: 205)
- max. size (spatial extention within daily commuting range)
  - 45, max. 60 minutes (Eckey, Kosfeld & Türck 2006)

„closed“ RLM = high **Self-Containment**
3. Methods: Applied

The Three-step-method


3.1 Cluster-Generator: Graph theoretical methods
concepts of dominant flows (Nystuen/Dacey 1961)
+ simple; efficient
- not well known
+ combination with thresholds (Rabino/Occelli 1997, Binder et al. 2003)
+ application for more than one region:
  Iteration of the basic method (Kropp/Schwengler 2008)
>> generates a wide range of delineations

3.2 Select the analytically best delineation
using the Modularity approach (Newman/Girvan 2004)

3.3 Optimize the result
3.1 Methods: Graph Theory

start with a (symmetric) **commuting matrix**

1. compute the **relative strength** of all links between regions
   
   
   < sum in-/out-commuters / employees living in a region

2. find **dominant flows**…
   
   < the strongest commuter link of a region

   < from smaller to larger regions

3. select dominant flows above a **threshold**

4. **merge** all regions connected by such flows

5. **re-calculate commuting matrix**

   >> continue with **step 1** until no changes occur
3.2 Methods: Evaluate results & select

- **Cluster-Generator**: Graph theory approach produces a wide range of results depending on threshold and iteration
  - small thresholds create a few large regions after a few iterations
  - larger thresholds create many small regions

- Which delineation captures interaction (commuting) best?
3.2 Methods: Evaluate results & select

- **Modularity** $Q$ (Newman/Girvan 2004)
  - Start: symmetric matrix $e$ (RLM x RLM)
  - cells $e_{ij}$: commuters $i > j$ (commuters) as share of all units
  - diagonal $e_{ii}$: units within clusters (not-commuters) as share of all units
  - comparison with a random clustering (null model) with same row totals and column totals as matrix $e$:

$$Q = \sum_i (e_{ii} - a_i^2)$$

with $a_i = \sum_j e_{ij}$

- $0 < Q < 1$, $Q=0$ … random, often: $0.3 < Q < 0.7$
3.2 Methods: Evaluate results & select

threshold 7, 4th iteration -> $Q_{\text{max}} = 0.8447$, with $N=51$
3.3 Methods: Optimize

- assign each municipal region to the RLM with which it has the **strongest commuting link**
- changes might affect assignments of **neighbouring regions**

>>changes of 57 municipal regions with only 321,000 employed persons concerned

Q = 0.8447  >>  Q = 0.8458

- Optimisation procedure can be used to adapt the recent delimitation to other aggregation levels or changing boundaries
3.3 Methods: Modify

Identification of local labour markets:

- using results of previous iterations
- 70 regions with 50 „cores“
4. Results: a „rough“ delineation

- 50 RLM (established German delineations have 100-150 RLM)
- very heterogeneous sizes

<table>
<thead>
<tr>
<th></th>
<th>GDP 2007 (10⁹)</th>
<th>...per capita (10³)</th>
<th>Employees 2008 (10⁶)</th>
<th>Unemployed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duesseldorf-Ruhr</td>
<td>301.5</td>
<td>30.4</td>
<td>3087.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Munich</td>
<td>245.5</td>
<td>39.6</td>
<td>2302.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Frankfurt a.M.</td>
<td>223.3</td>
<td>36.3</td>
<td>2198.7</td>
<td>6.0</td>
</tr>
<tr>
<td>Hamburg</td>
<td>191.6</td>
<td>32.0</td>
<td>1972.6</td>
<td>7.8</td>
</tr>
<tr>
<td>Stuttgart</td>
<td>189.3</td>
<td>34.0</td>
<td>2004.3</td>
<td>3.8</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Konstanz</td>
<td>8.1</td>
<td>29.4</td>
<td>83.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Harz</td>
<td>4.8</td>
<td>19.9</td>
<td>67.4</td>
<td>13.0</td>
</tr>
<tr>
<td>Hof</td>
<td>4.5</td>
<td>29.1</td>
<td>54.7</td>
<td>6.7</td>
</tr>
<tr>
<td>Weiden i.d.OPf.</td>
<td>4.1</td>
<td>31.0</td>
<td>45.5</td>
<td>4.9</td>
</tr>
<tr>
<td>Wunsiedel i.F.</td>
<td>3.3</td>
<td>25.5</td>
<td>38.7</td>
<td>5.6</td>
</tr>
</tbody>
</table>

- state and district borders ignored
### 4. Results: Robustness

<table>
<thead>
<tr>
<th>Category</th>
<th>% of municipalities</th>
<th>% of labour force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>70.6</td>
<td>81.3</td>
</tr>
<tr>
<td>Part</td>
<td>20.4</td>
<td>15.1</td>
</tr>
<tr>
<td>Overlapping</td>
<td>9.0</td>
<td>3.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
5. Comparison with established delineations

Measures for comparison

- Commuting ratio: Ratio commuters / no-commuters
- Modularity Q (Newman/Girvan 2004)
- Relation between labour demand and supply (van der Laan/Schalke 2001):
  - Home-Work-Ratio (HWR)
  - Housing Self-Containment Ratio (HSC)
  - Employment Self-Containment Ratio (ESC)
- Usefulness for practical application?
5. Comparison with established delineations

Relation between ESC, HSC & HWR

Home-Work-Relation
Difference in- & out-commuter in relation to all employees in a region
< 0: more out-commuting (region with living function)
> more in-commuting (region with living function)

ESC/HSC-optimum
5. Comparison with established delineations

50 RLM (Kropp/Schwengler 2011)
(72% RLM in ESC/HSC-optimum)
5. Comparison with established delineations

- **Eckey/Kosfeld/Türck 2006**
  - **Data:** employees covered by the social security system 2004, commuting between districts
  - **Method:** Factor analysis
  - **Restrictions:**
    - Min.size: 50,000 inhabitants
    - Max.commuting distance: 45 to 60 minutes
  - **Result:**
    - 150 homogenous RLM (2006)
    - $35\%$ RLM in ESC/HSC-optimum
Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)

Data: employees covered by the social security system, district level

Method: accessibility and commuting

Restrictions: „Planing regions“, Länder borders

Result:
- Compromise between planing traditions and functional regions
- 96 „Raumordnungsregionen“ (2008) → 31% RLM in ESC/HSC-optimum
5. Comparison with established delineations

- Joint Task of the Federal Government and the federal states dedicated to the "Improvement of Regional Economic Structure"

**Data:** employees covered by the social security system, district level

**Method:**
- accessibility and commuting + factor analysis

**Restrictions:**
- Min. size 100,000 inh.
- Max. commuting distance: 45 minutes

**Result:**
- 270 Joint Task Regions (2007)
- \(\rightarrow\) 17% RLM in ESC/HSC-optimum
5. Comparison with established delineations

Administrative delineations:

176 Employment Agencies (2008) → 20 % RLM in ESC/HSC-optimum

413 Districts (2008) → 5 % RLM in ESC/HSC-optimum

[Graph showing comparison with established delineations]
## 5. Comparison with established delineations

<table>
<thead>
<tr>
<th>delineation</th>
<th>N</th>
<th>Q</th>
<th>Commuter</th>
<th>ESC*</th>
<th>HSC*</th>
<th>HWR*</th>
<th>ESC/HSC optimum</th>
<th>Employees 1,000* (2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLM (Kropp &amp; Schwengler)</td>
<td>50</td>
<td>0,846</td>
<td>10,5 %</td>
<td>85,6</td>
<td>87,4</td>
<td>-2,0</td>
<td>72 %</td>
<td>546,9</td>
</tr>
<tr>
<td>RLM (Eckey e.a.)</td>
<td>150</td>
<td>0,797</td>
<td>18,8 %</td>
<td>76,8</td>
<td>80,8</td>
<td>-4,8</td>
<td>35 %</td>
<td>182,3</td>
</tr>
<tr>
<td>Planing Regions</td>
<td>96</td>
<td>0,789</td>
<td>19,5 %</td>
<td>78,4</td>
<td>82,1</td>
<td>-4,2</td>
<td>31 %</td>
<td>284,8</td>
</tr>
<tr>
<td>Joint Task Regions</td>
<td>270</td>
<td>0,734</td>
<td>25,7 %</td>
<td>69,1</td>
<td>75,0</td>
<td>-7,5</td>
<td>14 %</td>
<td>101,3</td>
</tr>
<tr>
<td>Employment (2008) Agencies</td>
<td>174</td>
<td>0,730</td>
<td>26,2 %</td>
<td>72,0</td>
<td>76,4</td>
<td>-4,8</td>
<td>20 %</td>
<td>157,1</td>
</tr>
<tr>
<td>413 Administrative Districts</td>
<td>413</td>
<td>0,614</td>
<td>38,2 %</td>
<td>59,1</td>
<td>63,8</td>
<td>-1,8</td>
<td>5 %</td>
<td>66,2</td>
</tr>
</tbody>
</table>

* Mittelwerte der abgegrenzten Regionen
5. Conclusions

- **Methods:**
  - Graph theory approach is a useful delineation generator
  - Newman-Girvan’s modularity Q is an appropriate measure to identify good delineations
  - Simple optimization algorithms can further improve the results and adjust delineations to different aggregation levels

- **Results for the German labor market:**
  - Fewer RLM than in other delineations
  - Strong heterogeneity of sizes
  - Stable structures over time, despite increasing mobility rates

- **Further research:**
  - Homogeneous price levels for labor, housing & goods within RLM?
  - Application of the 50-RLM-delineation to regional research.
Thanks for your attention!

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References


