

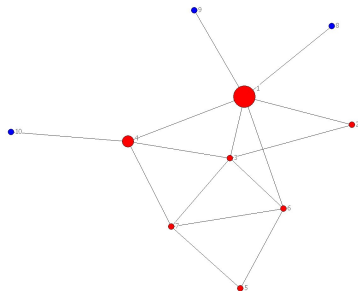
Innovative Performance of Gatekeepers in Regional Networks

Holger Graf Jens J. Krüger

Jahrestagung des Vereins für Socialpolitik
Magdeburg, 8. - 11. September 2009

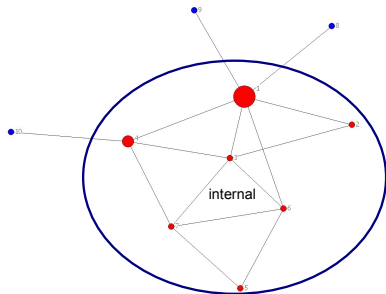
Regional innovation system (RIS) and gatekeepers

- Innovation is not pursued in isolation
 - ➔ spillovers, collective invention, network view
- RIS: density of a local network increases specific knowledge-stock
 - ➔ BUT: risk of lock-in
- Local 'buzz' is linked to global 'pipelines'
(Storper & Venables 2004; Bathelt, Malmberg & Maskell 2004)
 - ➔ Successful actors generate novelty by combining local with external knowledge
- Gatekeeper: actors at the interface between local and global knowledge systems



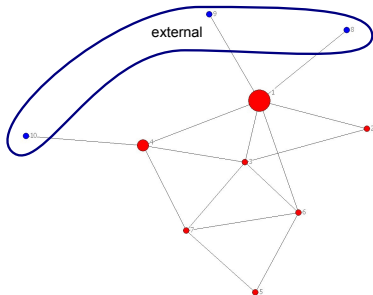
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Structure of the talk

- 1 Introduction
- 2 Literature review
- 3 Methodological approach
- 4 Results
- 5 Conclusions

Linkages in innovation

- Knowledge spillovers: international, national, intra- and intersectoral
- Knowledge spillovers as major drivers of economic growth (Romer 1990, Aghion and Howitt 1992)
- Here: localized knowledge spillovers (LKS) (Jaffe et al. 1993)
- Social proximity as an explanation for LKS (Breschi and Lissoni 2009)
- People exchange knowledge if they know each other from previous collaboration through...
 - Cooperation in R&D
 - Job mobility
- Resulting connections represent the social network of knowledge production
- Application of network analysis to clusters (e.g. Giuliani and Bell 2005) or regional networks (e.g. Cantner and Graf 2006)

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Network position and innovative success

Theory

- More relations \Rightarrow acquisition of external knowledge
- Central actors in the network should be more successful
- Reverse could be true: successful actors are more attractive partners

Empirical evidence

- Scarce and mixed
- Ahuja (2000) finds direct and indirect linkages to influence subsequent innovation
- Powell et al. (1996) find degree centrality (no. of linkages) to spur employment growth, but no evidence for closeness centrality

Research questions

- Influence of central network position on innovation output?
- To which extent is this dependent on the centrality concept?

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Gatekeepers

- Interface between local and global knowledge systems
- External knowledge sourcing and diffusion into the local system
- Large and technologically advanced firms (Giuliani and Bell 2005)
- Universities and public research institutes (Graf 2007)
- Positive effect of gatekeepers in local systems is rather clear
- Knowledge *diffusion* might diminish profits as knowledge becomes non-exclusive

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- Are gatekeepers more successful in innovation?
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Methodology

Social network analysis to reconstruct innovator networks

- German patent data between 1995 and 2001
- Four regions: Dresden, Jena, Aachen and Karlsruhe (Raumordnungsregionen)
- Boundaries of the networks: patents with at least one inventor located in the respective region
- Linkages between two innovators (patent applicants) if they
 - ... jointly apply for a patent ('co-operation') or if
 - ... the same inventor worked for both innovators on distinct patents ('scientist mobility')
- Innovators are external if they are themselves not located in the region (neither headquarters nor subsidiary ↔ web search)

Regression analysis

- Actor position in the network in period 1 to explain innovative performance (no. of patents) in period 2
- Count data regression models

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Social network analysis to reconstruct innovator networks

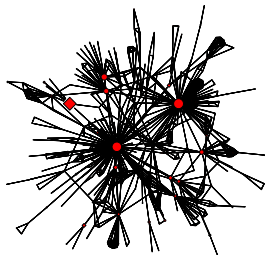
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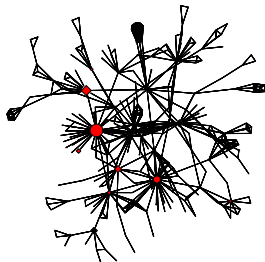
Main components of networks

Dresden



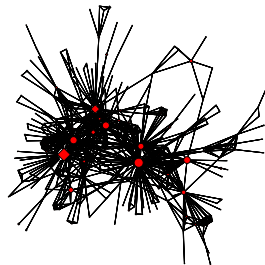
Internal - red, External - black

Aachen



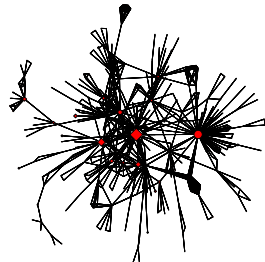
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Jena



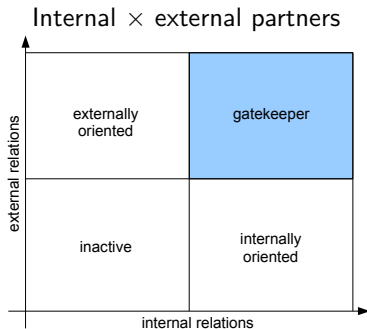
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Karlsruhe

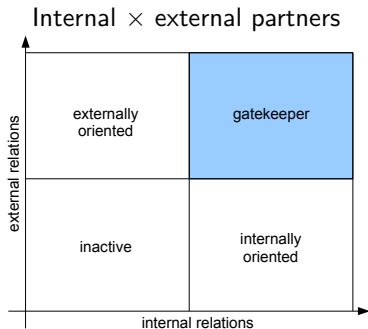


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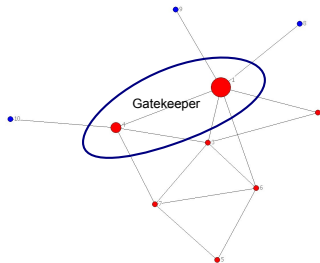
Two definitions of gatekeepers I



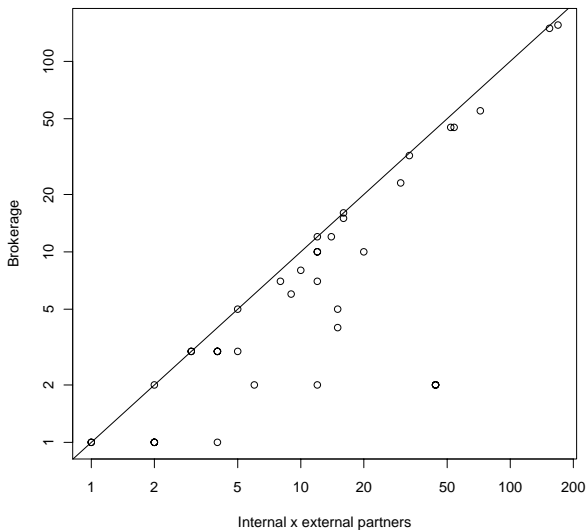
Two definitions of gatekeepers I



Brokerage



Two definitions of gatekeepers II



Variables

| Name | Min | Max | Mean | SD |
|--|-----|------|-------|--------|
| No. of Patents _t – applications 1999–01 | 0 | 448 | 3.046 | 19.692 |
| No. of Patents _{t-1} – applications 1995–97 | 1 | 181 | 3.210 | 11.039 |
| No. of Inventors _t | 0 | 410 | 3.990 | 23.908 |
| Degree _{t-1} – no. of distinct partners | 0 | 29 | 1.026 | 2.157 |
| Betweenness _{t-1} – centrality measure | 0 | 0.25 | 0.001 | 0.011 |
| Main component _{t-1} – member y/n | 0 | 1 | 0.068 | 0.252 |
| Gatekeeper _{t-1} | | | | |
| Index 1: internal × external partners | 0 | 169 | 0.954 | 7.610 |
| Index 2: broker | 0 | 155 | 0.505 | 6.507 |
| East | 0 | 1 | 0.340 | 0.474 |
| Public | 0 | 1 | 0.023 | 0.149 |
| Individual | 0 | 1 | 0.618 | 0.486 |

Econometric model

- Dependent variable: no. of patents \Rightarrow count data model
- Simple version: Poisson regression
- Overdispersion as well as zero-inflation
 \Rightarrow zero-inflated generalised Poisson (ZIGP) regression model
- Density function of the ZIGP model:

$$\Pr(y_i) = \begin{cases} \omega + (1 - \omega) \cdot \exp\left(-\frac{\mu}{\phi}\right) & \text{for } y_i = 0 \\ (1 - \omega) \frac{\mu(\mu + (\phi - 1)y_i)^{y_i - 1}}{y_i!} \cdot \phi^{-y_i} \cdot \exp\left(-\frac{\mu + (\phi - 1)y_i}{\phi}\right) & \text{for } y_i > 0 \end{cases}$$

$$E(y_i) = (1 - \omega)\mu$$

$$Var(y_i) = (1 - \omega)\mu \cdot (\phi^2 + \mu\omega)$$

- Parameters:
 - degree of overdispersion $\phi = 1 + \exp(\alpha) \geq 1$
 - extent of zero-inflation $\omega = \exp(\gamma)/(1 + \exp(\gamma)) \in [0, 1]$
- Parameterization: $\mu(\mathbf{x}_i) = \exp(\mathbf{x}'_i\boldsymbol{\beta})$
- Four specifications: Poisson vs. ZIGP and two gatekeeper indices

Performance of gatekeepers

| Dependent variable: no. of patents (1999–2001) | | | | |
|--|----------|----------|----------|----------|
| | Poisson | | ZIGP | |
| | index 1 | index 2 | index 1 | index 2 |
| No. of patents _{<i>t</i>-1} | 0.0222 | 0.0222 | -0.0078 | 0.0238 |
| No. of inventors _{<i>t</i>} | 0.0042 | 0.0050 | 0.0201 | 0.0087 |
| Degree _{<i>t</i>-1} | 0.1928 | 0.1785 | 0.1109 | 0.1048 |
| Betweenness _{<i>t</i>-1} | -31.3043 | -33.7571 | -39.8423 | -49.3087 |
| Main component _{<i>t</i>-1} | 0.6184 | 0.6167 | 0.2396 | 0.2659 |
| Gatekeeper _{<i>t</i>-1} | -0.0441 | -0.0507 | -0.0241 | -0.0528 |
| Gatekeeper _{<i>t</i>-1} ² | 0.0003 | 0.0004 | 0.0003 | 0.0006 |
| East | 0.0426 | 0.0373 | -0.2480 | -0.2584 |
| Public | 0.4768 | 0.6159 | 1.1752 | 1.5073 |
| Individual | -2.1053 | -2.1374 | -1.0661 | -1.0751 |
| Intercept | 0.8970 | 0.8855 | 0.9236 | 0.8978 |
| Overdispersion (α) | | | 1.3204 | 1.2574 |
| Zero-inflation (γ) | | | -9.4083 | -2.8368 |
| Pseudo R^2 | 0.779 | 0.792 | 0.761 | 0.815 |
| $\ln L$ | -3,058.7 | -3,019.5 | -1,560.0 | -1,559.7 |
| n | 1,322 | 1,322 | 1,322 | 1,322 |

Gray-shaded coefficients are not significant on 5% level

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Discussion of results II

RQ1: Influence of central network position on innovation output?

Degree centrality, i.e. the number of linkages has a positive influence, betweenness is negative

RQ2: To which extent is this dependent on the centrality concept?

Degree positive \Leftrightarrow betweenness negative

RQ3: Are gatekeepers more successful in innovation?

It depends. . .

RQ4: Is this relationship monotonic?

U-shape: only innovators with a gatekeeper index above a threshold benefit from their gatekeeper position

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Conclusions

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- Network position matters
- Gatekeeper position not unequivocally positive
- ➔ Diffusion of external knowledge within a region as a public good
- ➔ Explanation why public research acts as a gatekeeper

Limitations and open topics

- Only four regions, not necessarily typical
- Benefits of gatekeeper position might arise later
- Can local actors benefit from being connected to gatekeepers?
- Awareness of indirect neighbors

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Example: social network analysis

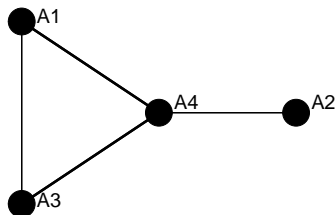
| Patent | Applicant | Inventor |
|--------|-----------|----------|
| P1 | A1 | I1, I4 |
| P2 | A2 | I2 |
| P3 | A3 | I3, I4 |
| P4 | A4 | I1, I4 |
| P5 | A4 | I2, I3 |
| P6 | A4 | I5 |

Incidence matrix I :

| | I1 | I2 | I3 | I4 | I5 |
|----|----|----|----|----|----|
| A1 | 1 | 0 | 0 | 1 | 0 |
| A2 | 0 | 1 | 0 | 0 | 0 |
| A3 | 0 | 0 | 1 | 1 | 0 |
| A4 | 1 | 1 | 1 | 1 | 1 |

Adjacency matrix II' :

| | A1 | A2 | A3 | A4 |
|----|----|----|----|----|
| A1 | — | 0 | 1 | 2 |
| A2 | 0 | — | 0 | 1 |
| A3 | 1 | 0 | — | 2 |
| A4 | 2 | 1 | 2 | — |



Gatekeepers (internal actors only)

