Mechanisms of knowledge flows in bottom-up and top-down cluster initiatives

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ABSTRACT
Knowledge flows are widely believed to be a phenomenon of clusters, and inducing them is one of the chief objectives in establishing and promoting cluster initiatives (CI). However, not many studies discuss how these flows and their effects may differ depending on the mode of CI creation and on the role of public authorities in this process. The main aim of this article is to compare mechanisms of knowledge flows in bottom-up and top-down cluster initiatives. The results of an empirical research involving two case studies in western Poland, obtained through the use of Social Network Analysis (SNA), allowed stating that in bottom-up cluster initiatives firms which were innovation leaders played a prime role in disseminating technological and business knowledge, while in the top-down initiatives the most important were representatives of universities and research centres as well as formal coordinators of cooperation. Policy implications stemming from these results were identified.

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INTRODUCTION
Clusters have recently become a key theoretical and empirical issue in regional economic competitiveness and innovativeness (Cruz & Teixeira, 2010), in particular the way that knowledge flows or spillovers occur between cluster actors: firms, universities, research institutions, agencies for regional development and other cooperating entities. Knowledge flowing between cluster agents can drive a variety of positive knowledge externalities, thereby stimulating regional innovativeness (Karlsson & Gråsjö, 2014). Generating knowledge flows is one aim underlying cluster initiatives – organized efforts to increase growth and competitiveness within a cluster (Lindqvist, Ketels, & Sölvell, 2013).

We know relatively little about how different actors influence the mechanisms of cluster knowledge flows. Spillovers involve third parties tapping into existing innovation networks, changing those networks’ nature and, hence, how knowledge creation, exchange and spillover occurs (Maskell, 2001). Because clusters involve heterogeneous constellations of these actors, knowledge spillover mechanisms may function depending on the way these cooperating of formalize
cooperation. Two extremes are stylized here: a bottom-up cluster initiative is created where relations already existing between the firms, as against a top-down cluster initiative where public authorities or business support units formalize cooperation (Fromhold-Eisebith & Eisebith, 2005). Therefore, three research questions are asked in this paper:

- How do a cluster initiative’s origins (bottom-up or top-down) affect cluster-based knowledge spillover mechanisms?
- How does entrepreneurs’ willingness to share their knowledge in bottom-up and top-down cluster initiatives affect spillover creation?
- What instruments of cluster policies should be employed to achieve the highest knowledge externalities in both investigated types of initiatives?

**KNOWLEDGE FLOWS IN CLUSTERS**

The theoretical foundations of cluster processes were laid by Porter (1990) and Krugman (1991), who posited that geographical proximity of firms from one sector favoured knowledge spillovers. Face-to-face contacts engendered interactive learning processes in clusters facilitating exchange of both explicit and tacit knowledge (Storper & Venables, 2004), also augmented by cluster agents building channels of communication with outsiders (Bathelt & Cohendet, 2014). Among the many kinds of economic knowledge, firms use clusters primarily to obtain technological and business (entrepreneurial) knowledge through a cluster (Karlsson & Gråsjö, 2014). Dahl and Petersen (2004) considered these cluster knowledge flow processes empirically, whilst others measured firms’ patent stocks or patent networks to analyse cluster knowledge creation and knowledge spillovers (e.g. McCann & Folta, 2011). However, such approaches cannot investigate the mechanisms and processes knowledge flows between particular actors (knowledge sources and receivers): Swann’s (2009) ‘Ladder model of cluster richness’ claimed informal knowledge exchange was the highest level of cluster advancement, but also the most difficult to measure. Stough (2015) likewise argued that as clusters mature, the more homogeneous the knowledge that exists and is exchanged (purposefully and spontaneously) internally.

There are several reasons for entrepreneurs to share their knowledge in clusters (e.g. Bessant & Tidd, 2011), including:

- Complementarity of the knowledge possessed (bilateral exchange).
- Willingness to help friends or colleagues (whether positional or philanthropic).
- Building confidence and creating a chance to establish long-lasting cooperation.
- Difficulty in hiding knowledge or unplanned transmission during personal meetings and conversations.
- A desire for self-innovativeness, especially when talks/discussions encourage managers to think how to improve their business.
- Encouragements from public authorities.

Of course, not all of a company’s knowledge can be shared or disseminated. Firm owners will resist giving away secrets of production or promotion, especially if they ensure competitive market advantages. Universities and research institutions also play their roles in cluster knowledge flows: their knowledge may spillover spontaneously, as well as also offering payable knowledge transfers in the form of consultations, training courses or contract research (Runiewicz-Wardyn, 2013). The extent to which firms can exploit valuable knowledge in clusters depends on their ability to
build a relational network position inside a cluster, and their skills to find the best knowledge source inside such networks (van der Valk & Gijsbers, 2010).

Research shows that different methods of initiating cluster initiatives: top-down and bottom-up, significantly affect rules of interaction, routines of collaboration and collective learning (Fromhold-Eisebith & Eisebith, 2005). The present paper investigates how cluster initiative origins can influence knowledge flows between cluster agents (mostly firms, but also universities, research institutions and coordinators of cooperation) and what role they play in disseminating knowledge within those initiatives. Identifying such mechanisms affects regional policies, as it can help in formulating recommendations on optimizing knowledge spillovers in regional contexts.

**SELECTION OF CASE STUDIES AND METHODOLOGY**

Social network analysis (SNA) is widely accepted as a good tool for investigating different actors’ positions and behaviour patterns in innovation networks, systems or processes, including clusters (Giuliani & Petrobelli, 2011; Ter Wal & Boschma, 2009). The present paper explores knowledge flows in two cluster initiatives, in the Wielkopolska region (western Poland): The Swarzędz Cluster of Furniture Producers and The Leszno Flavours Food Cluster. Both represent low-tech industries where the respective branches had been selected in 2014 as smart specializations for Wielkopolska. Firm formal cooperation had been established in 2011, with both initiatives actively operating in 2014 and 2015. The most substantive difference between them was their mode of creation. The furniture cluster initiative had been set up by several local entrepreneurs who had known each other for years and decided to reinforce and formalize their cooperation. The food cluster was initiated by the Leszno Business Centre with the support of Leszno municipality authorities (Table 1).

The author conducted personal interviews with the owners of every firm in both initiatives. Each interview started by giving the interviewee a list of all entities formally constituting the given cluster initiative, including firms (12 and 18 respectively, all small in size), as well as coordinators and cooperating universities and research units (2 and 5 respectively). Managing authorities were asked from whom they had acquired two kinds of knowledge: technological (concerning machines, materials, components, the production process) and business (concerning entrepreneurial matters: financing, organization of production, promotion, marketing). These two types of knowledge were selected because both are important for firm performance and relatively easy for managers to differentiate.

| Differences        | Swarzędz cluster of furniture producers                                                                 | Leszno flavours food cluster                                                                 |
|--------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Firms’ profile    | Furniture and upholstery: on offer both standardized furniture and customized furniture on request       | Food processing: meat products, dairy, fruits and vegetables, a variety of products on offer    |
| Firms’ origins     | Firms with family traditions, some dating back to the 1950s–60s                                           | Firms founded after 1989 (the end of the centrally planned economy), some after 2000          |
| Mode of creation   | Bottom-up: traditions of local guild of carpenters and furniture makers, long-term relationships among entrepreneurs, cluster initiative was several firms’ own idea | Top-down: initiative of Leszno Business Centre with support from the Leszno municipality authorities, no earlier relations among firms (with few exceptions) |
Table 2. Networks of knowledge flows in the bottom-up and the top-down cluster initiative.

| Furniture cluster | Food cluster |
|-------------------|-------------|
| **Technological knowledge flows**<br>![Network diagram](image1.png) | ![Network diagram](image2.png) |
| **Business knowledge flows**<br>![Network diagram](image3.png) | ![Network diagram](image4.png) |
| **Knowledge flows (together)**<br>![Network diagram](image5.png) | ![Network diagram](image6.png) |

Note: (a) Diamonds – coordinators of cluster initiatives; circles – firms; squares – universities/research units; (b) ties indicate bilateral relations; (c) node size is directly proportional to actor’s centrality degree; (d) an arrow pointing from actor A to B means that A acquires knowledge from B (B is the source of knowledge for A); (e) the layout of nodes is random (does not reflect the spatial distribution of firms).

Source: Author’s own work in Ucinet and Netdraw.
The method chosen was ‘roster recall': interview participants recall in their memory relations to other network members on the basis of the presented list. It was assumed that firms had similar absorptive capacities and that answers reflected business contacts rather than personal sympathies. Matrices for the two initiatives for both types of knowledge were constructed (12 × 12 and 18 × 18, recording 1 if a knowledge flow from an agent was clearly declared and 0 if not) as well as one extra matrix covering both network flows (with 2 if both types of knowledge were obtained from the same agent, 1 if only one type, 0 if none). These matrices were then analysed with Ucinet VI software (Borgatti, Everett, & Freeman, 2002) and visualized in Netdraw software (Borgatti, 2002). The networks were analysed in terms of four network characteristics (Wasserman & Faust, 1994):

• Network density: the overall number of ties relative to the number of possible ties.
• In-degree centrality: the number or per cent of all ties oriented toward actors, sometimes termed popularity or attractiveness.
• Out-degree centrality: the number or per cent of all ties emanating from actors, also known as expansiveness.
• An actor’s centrality degree: the number of an actor’s ties relative to the number of the actor’s all possible ties; it reflects the actor’s level of network activity or involvement.

COMPARING KNOWLEDGE FLOWS IN BOTTOM-UP AND TOP-DOWN CLUSTER INITIATIVES

The network analysis conducted yielded substantially different results for the bottom-up and top-down cluster initiatives (Tables 2 and 3).

Network densities in the bottom-up furniture cluster were higher than those in the top-down food cluster, possibly suggesting that well-established relations influence knowledge flows’ intensity. Moreover, in the furniture cluster the network density of technological knowledge flows was higher than that of business knowledge flows, a pattern reversed for the food cluster.

Table 3. Characteristics of knowledge flow networks in the bottom-up and the top-down cluster initiative.

| Networks                | Cluster initiative | Network density | Out-degree centrality | In-degree centrality | Maximum actor’s centrality degree | Mean (SD) actor’s centrality degree |
|-------------------------|--------------------|-----------------|-----------------------|----------------------|-----------------------------------|-----------------------------------|
| Technological knowledge flows | Furniture          | 0.619           | 38.095%               | 55.952%              | $C_{\text{max}} = 92.857$: firms B and C | $C_{\text{av}} = 77.143$ (15.028) |
|                         | Food               | 0.353           | 21.739%,              | 44.423%              | $C_{\text{max}} = 56.522$: University of Life Sciences | $C_{\text{av}} = 24.638$ (15.406) |
| Business knowledge flows | Furniture          | 0.462           | 26.871%               | 39.626%              | $C_{\text{max}} = 100.000$: firm B | $C_{\text{av}} = 62.857$ (19.533) |
|                         | Food               | 0.361           | 20.983%,              | 61.815%              | $C_{\text{max}} = 73.913$: University of Economics | $C_{\text{av}} = 26.087$ (19.726) |

Source: Author’s own calculations in Ucinet.
Because the firms in the furniture cluster were offering similar products, it was inferred that that
the stronger the market competition among firms in a cluster, the weaker their propensity to
share business knowledge. This does not fully apply to technological knowledge, which is usually
explicit, more difficult to hide and easily accessible through magazines, conferences, training
courses, and Internet resources: indeed, firm owners in both cluster initiatives claimed they had
no interest in hiding it.

Figure 1. Mechanisms of knowledge flows in bottom-up and top-down cluster initiatives.
Actors’ roles different in the two networks. In the furniture cluster, the most central actors in both technological and business knowledge flows were two ‘innovation leader’ firms. In the food cluster, the most central actors in both knowledge networks were the Poznań universities: of Life Sciences and of Economics, that functioned as ‘external knowledge brokers’. The cooperation coordinator also played an important role here (especially in disseminating business knowledge and organizing events transferring technological knowledge to firms).

Many relations between actors were bilateral in both cluster initiatives, and the findings (average out-degree centrality was lower than in-degree centrality) suggest that firms tend to seek knowledge suppliers rather than knowledge users. Certainly the presence of important knowledge sources (universities and research centres) on the list affected these results.

These two cases suggest that a cluster initiative’s origins affect the processes of internal knowledge flows. Figure 1 shows the initial models of mechanisms of knowledge flows in bottom-up and top-down cluster initiatives. In bottom-up clusters, strong relations link those firms playing major roles in disseminating knowledge. Other cluster firms link to innovation leaders and their inside knowledge as the main source of their new knowledge, whilst coordinators and external experts play largely insubstantial roles in disseminating knowledge. In top-down type clusters, firms want to access outside knowledge, coming from universities and research institutions. Here, representatives of universities and research centres are considered trustworthy, becoming important sources of sector-specific technological and business knowledges, whilst inter-firm knowledge exchange is more restricted.

CONCLUSIONS AND POLICY RECOMMENDATIONS

In countries of Central and Eastern Europe (CEE), cluster initiatives recently became a popular innovation policy instrument (Ketels, Lindqvist, & Sölvell, 2006), particularly driven by European Union funding (Churski & Stryjakiewicz, 2006; Kowalski, 2013). In CEE countries, market rules and network cooperation are often new to some firms, with cluster alliances facing many problems, including meeting legal requirements or overcoming lack of trust in relations between entrepreneurs, scientists and public authorities (Stryjakiewicz, 2005). Regional innovation strategies should emphasize more strongly the significance of supporting knowledge flows between cluster agents to reinforce ‘regional advantages’ and foster regional smart specializations (Asheim, Boschma, & Cooke, 2011).

This paper demonstrates that mechanisms of cluster initiative knowledge flows appear to depend on those initiatives’ origins. Cluster agents positions differed in knowledge flow between bottom-up and the top-down cluster initiative. In the bottom-up cluster, innovation-leading firms played the prime role in disseminating technological and business knowledge, while in the top-down clusters, universities and research centres, playing a ‘knowledge broker’ role, were most important. Firms in the bottom-up initiative used mainly other cluster firms’ knowledge, while those in the top-down one exploited external knowledge. Entrepreneurs’ willingness to share knowledge also differed: in the bottom-up initiative, entrepreneurs were generally more active than in the top-down initiative, which suggests that long-lasting relations impact upon knowledge flows.

This analysis gives two examples of low-tech Polish industries, leaving open the question whether similar patterns might be visible in medium or high-tech clusters outside CEE countries. Certainly further studies of this issue are needed, concerning also qualitative research on network orchestration as well as relations between knowledge flows and the level of trust or cooperation/competition inside a cluster initiative. These results suggest that further studying knowledge spillovers in clusters as well as regional policy tools concerning knowledge creation and dissemination in cluster initiatives (especially in CEE countries) should account for differences resulting from their bottom-up or top-down character.
There are also consequences here for regional policy-makers supporting cluster initiatives. Bottom-up cluster initiatives should firstly provide financial and organizational support for research and innovation work in the most active and innovative firms. Thereafter, events should be organized, (e.g. meetings, conferences, trade fairs) – so create long-lasting trust relationships with other firms who then benefit from innovation leaders’ knowledge. In top-down cluster initiatives, superficial relationships and lack of confidence between firms hinder immediate knowledge spillovers, encouraging innovation leaders to behave protectively to their knowledge, and raising distrust in other cluster companies. Therefore supporting direct knowledge transfer from universities or research institutes to firms is a useful first step, via various types of training courses, conferences and open meetings.

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**REFERENCES**

Asheim, B., Boschma, R., & Cooke, P. (2011). Constructing regional advantage: Platform policies based on related variety and differentiated knowledge bases. *Regional Studies, 45*, 893–904.

Batheil, H., & Cohendet, P. (2014). The creation of knowledge: Local building, global accessing and economic development—toward an agenda. *Journal of Economic Geography, 14*, 869–882.

Bessant, J., & Tidd, J. (2011). *Innovation and entrepreneurship* (2nd ed.). Oxford: John Wiley & Sons Ltd.

Borgatti, S. P. (2002). *Netdraw: Network visualization*. Harvard, MA: Analytic Technologies.

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *Ucinet for windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.

Churski, P., & Stryjakiewicz, T. (2006). New experiences of Polish regional policy in the first years of membership in the European Union. *Quaestiones Geographicae, 25*, 17–28.

Cruz, S. C. S., & Teixeira, A. A. C. (2010). The evolution of the cluster literature: Shedding light on the regional studies – regional science debate. *Regional Studies, 44*, 1263–1288.

Dahl, M. S., & Petersen, C. R. (2004). *Knowledge flows through informal contacts in industrial clusters: Myths or realities?* DRUID Working Paper No 1263-01. Aalborg: Aalborg University.

Fromhold-Eisebith, M., & Eisebith, G. (2005). How to institutionalize innovative clusters? Comparing explicit top-down and implicit bottom-up approaches. *Research Policy, 34*, 1260–1268.

Giuliani, E., & Petrobelli, C. (2011). *Social network analysis methodologies for the evaluation of cluster development programs*. Washington, DC: Inter-American Development Bank, IDB Publications.

Karlsson, C., & Gräsjo, U. (2014). Knowledge flows, knowledge externalities, and regional economic development. In M. M. Fischer, & P. Nijkamp (Eds.), *Handbook of regional science* (pp. 413–437). Berlin Heidelberg: Springer-Verlag.
Ketels, C., Lindqvist, G., & Sölvell, Ö. (2006). Cluster initiatives in developing and transition economies. Stockholm: Center for Strategy and Competitiveness.

Kowalski, A. M. (2013). The impact of industrial clusters on the innovativeness of business firms in Poland. *World Journal of Social Sciences, 3*, 73–84.

Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy, 99*, 483–499.

Lindqvist, G., Ketels, C., & Sölvell, Ö. (2013). The cluster initiative greenbook 2.0. Stockholm: Ivory Tower Publishers.

Maskell, P. (2001). Towards a knowledge-based theory of the geographical cluster. *Industrial and Corporate Change, 10*, 921–943.

McCann, B. T., & Folta, T. B. (2011). Performance differentials within geographic clusters. *Journal of Business Venturing, 26*, 104–123.

Porter, M. E. (1990). *The competitive advantage of nations*. New York, NY: Macmillan.

Runiewicz-Wardyn, M. (2013). Knowledge flows, technological change and regional growth in the European union. Cham, Heidelberg: Springer.

Storper, M., & Venables, A. J. (2004). Buzz: Face-to-face contact and the urban economy. *Journal of Economic Geography, 4*, 351–370.

Stough, R. R. (2015). Cluster life-cycles, entrepreneurship and regional economic development with a case study of the Korean shipbuilding cluster. In P. Nijkamp, et al. (Eds.), *Regional science matters* (pp. 223–254). Switzerland: Springer International Publishing.

Swann, G. M. P. (2009). Clusters and networks. In G. M. P. Swann (Ed.), *The Economics of Innovation* (pp. 147–172). Cheltenham: Edward Elgar Publishing.

Ter Wal, A. L. J., & Boschma, R. (2009). Applying social network analysis in economic geography: Framing some key analytic issues. *The Annals of Regional Science, 43*, 739–756.

van der Valk, T., & Gijsbers, G. (2010). The use of social network analysis in innovation studies: Mapping actors and technologies. *Innovation: Management, Policy & Practice, 12*, 5–17.

Wasserman, S., & Faust, K. (1994). *Social network analysis*. Cambridge: Cambridge University Press.