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The evolution of a strategic
alliance network – Exploring
German stock photography



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Issue 2008-01 | Volume 6
www.spaces-online.com

Please quote as Glückler, J. (2008): The evolution of a strategic alliance network – Exploring German stock photography. SPACES online, Vol. 6, Issue 2008-01. Toronto and Heidelberg: www.spaces-online.com

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Keywords creative industries, photography, network evolution, social network analysis, strategic alliances, Germany

JEL codes C45, O52, R10, Z13

Abstract

This paper explores network evolution in the context of economic geography and focuses on two mechanisms: the existence of endogenous network dynamics, and the geography of network growth patterns. The analysis is based on the strategic alliance network in a cultural industry sector, namely stock photography. Stock photography is particularly suitable for the study of network dynamics since it has been undergoing major technological, institutional and organizational change in very short time. A survey on the German stock photo agencies provided relational alliance data for the period between 1989 and 2005. The paper finds that organizational homophily and popularity bias in prior network stages are relatively weak conditions for estimating the locus of new alliances. Instead, multiconnectivity explains on average half of the variance in the distribution of alliances across the network over a consecutive ten-year period. It measures the extent to which two nodes build a linkage because of multiple indirect prior linkages through third parties. Finally, the analysis creates preliminary evidence for an emerging proximity bias in the formation of new linkages. Given the exploratory character of the study, more research is needed to understand network evolution in a geographical perspective.

Editors: Harald Bathelt, Johannes Glückler

Managing Editor: Heiner Depner

ISSN: 1612-8974

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The evolution of a strategic alliance network – Exploring German stock photography

1 Introduction

Over the recent years, increasing effort has been taken to conceptualize an evolutionary perspective within economic geography (Boschma und Lambooy 1999; Boschma und Frenken 2006). Evolutionary approaches have theorized a variety of conceptions, among others, the notion of path dependence in regional development (Martin und Sunley 2006), the role of technological and sectoral variety in regional innovation (Rigby und Essletzbichler 2006; Boschma und Iammarino 2007) and the idea of co-evolution in regional development. Explicitly or implicitly, many geographical accounts of the economy rely on the notion of networks to represent and analyze economic processes and modes of organization. A dynamic perspective of network evolution, however, has experienced only little attention until recently (McPherson et al. 2001; Baum et al. 2003; Kilduff und Tsai 2003). The common research strategies to focus on the temporal dimension of networks have been twofold. On the one hand, contingency models of networks have analyzed the appropriateness of certain network forms for different environmental conditions. Empirical research demonstrates, for example, that when firms operate under conditions of exploration, i.e. high uncertainty and high innovation rates, weak ties and loose coupling are more beneficial than strong ties. In turn, when firms operate under conditions of exploitation, i.e. stable market conditions and mature products, strong ties are more advantageous (Rowley et al. 2000). On the other hand, sequential models of non-linear cyclical change have been applied to the evolution of firms (Hite und Hesterly 2001; Lavie 2004) and regional clusters (Staber 1997). Within the framework of organizational ecology, Staber (1997) found that in the beginning of a textile cluster, dense networks with strong ties between firms were beneficial in order to circulate knowledge and to ally for joint lobbying. In later stages of cluster development, however, when an increasing number of firms competed for the same resources, i.e. labour, expertise, capital etc., weak ties became more important (Staber 2001). Though these models recognize the ephemeral nature of network structure, they are relatively silent on the endogenous mechanisms that drive network evolution because they always use external environmental changes to explain responses in network development.

This paper aims at exploring and connecting network evolution with the wider project of an evolutionary economic geography (Glückler 2007). Concretely, this paper pursues two questions. First, are there endogenous network dynamics, i.e. mechanisms within network structure that drive the dynamics of inter-firm networks and help to explain future network structure? Second, is geographical proximity associated with growth patterns of these inter-firm networks? The empirical challenge in evolutionary network research is to find appropriate longitudinal structural data on sectoral or regional economic activity. This paper focuses on the inter-firm sales partnerships in the organizational field of stock photography and uses a survey on German stock photo agencies for the period between 1989 and 2005. Stock photography is an interesting sectoral case since it has been undergoing major technological, institutional and organizational change in very short time (this shift is discussed in more detail below). The empirical analysis looks at the recent emergence of sales alliances between picture agencies as the unit of analysis. Strategic alliances are an organizational strategy to access and share resources, costs and profits with partner organizations. Especially under conditions of increased competition and unstable market conditions, they render different advantages to individual organizations, such as firm survival, performance, imitation and innovation (Knoke 2001; Brass et al. 2004). A sales partnership, in particular, is a contractual licence agreement, where one firm grants the usage right either for an intellectual property-right protected content to another firm for a specified time and use in return for a royal-

ty payment (Knoke 2001). Though stock photography has a long tradition in international sales cooperation (Wilkinson 1997), the alliance behaviour has changed dramatically over the last ten years. It has changed in quantitative terms because more and more picture agencies seek sales partners; and it has experienced a qualitative change because picture agencies no longer ally only internationally but they have also started partnering with agencies in their domestic market. Section 2 discusses some elements of an emerging theory of network evolution and develops research hypotheses. Section 3 introduces the business context and the fundamental technological and organizational changes occurring in the market for still images in recent history. Section 4 documents the methodology and section 5 presents the findings of the empirical analysis before the paper closes with some concluding remarks with respect to the emerging project of an evolutionary economic geography.

2 Network evolution and geography

The essential starting point for any theory about network evolution is the question of “how do structural dimensions of an interorganizational communication network at Time 1 affect the interactions among member organizations – specifically, their formation of ties to other organizations – at Time 2?” (Kenis und Knoke 2002, 277-278). This question pays attention to inherent conditions of a network rather than external conditions that drive network change. The network trajectory (Kilduff und Tsai 2003) is an appropriate concept in the analysis of network evolution which combines the notions of evolution, network and geography: It describes a geographically and historically specific development path of a network in which the formation and dissolution of ties in earlier stages generates cumulative propensities for the formation and dissolution of ties in the future and in which the mechanisms of path-disruption and variation are endogenous (Glückler 2007). This perspective explicitly moves beyond the dyadic analysis of single relations to the analysis of entire networks of relations. A theory of network evolution, thus, looks at the changes that new ties produce in the existing structure and, conversely, at the impact that the structure imposes on the formation of these next ties. In a recent, sophisticated study Powell et al. (2005) explicitly tested a set of alternative hypotheses on the emergence of new relationships in an expanding network. Recurring on the network literature, they focused on a set of hypotheses that they assessed as potential mechanisms for network evolution: homophily, preferential attachment and multiconnectivity. The following sections briefly review these concepts before geography will be explored as a fourth potential condition of network evolution.

2.1 Homophily vs. diversity between firms

According to homophily theory, firms with similar attributes have a greater ease in developing characteristic-based trust (Zucker 1986) and are therefore more likely to engage in trust-demanding activities. The similarity between firms implies a stronger overlap of interests, strategies and interpretative frameworks to deal with information on markets and products. Hence, networks are expected to expand by a process in which new partners are chosen for similarity or homophily (McPherson et al. 2001; Sorenson 2003; Rowley et al. 2005). The homophily between firms may be measured as the similarity in firm size, age and form as well as similarities in terms of strategy and products. Alternatively, however, alliances may also be hypothesized to follow a pattern of diversity. Firms may choose to collaborate exactly because of different, complimentary resources and competencies (Rowley et al. 2005) in order to yield synergies from collaboration. Therefore, the dissimilarity with respect to strategy, resource endowment etc. may be also be a driving element in the formation of strategic alliances.

2.2 Preferential attachment and multiconnectivity

Apart from firm specific characteristics that may be compared and assessed for pair-wise homophily, Powell et al. (2005) also propose structural effects on future tie formation which would produce endogenous dynamics. The preferential attachment-hypothesis expects firms with many ties at one point in time to be more likely to receive new ties in the future than those with fewer ties. There is obviously accumulative advantage for well positioned actors on the one side and a liability of dis-connectedness for peripheral actors on the other, as the authors found in earlier research (Powell et al. 1996). Alternatively, the multiconnectivity-hypothesis expects networks to expand through a process in which firms seek diversity of relations and form multiple independent paths. By moving in different communities and connecting to heterogeneous groups the firm enhances the multiple reachability of partners. Empirically, however, Powell et al. largely disprove homophily and popularity by analyzing extensively the evolution of the strategic alliance network in US biotechnology over a 12-year period between 1988 and 1999. Instead, they found strong support for the multiconnectivity-hypothesis because new alliances were more likely to form between those firms that were more multiply or more diversely linked to each other at a previous stage of network growth. This finding suggests that networks entail a logic of multiconnectivity, where new linkages reinforce diversity and multiple cohesion (Powell et al. 2005). Another strand of network research supports these conclusions from a different perspective. While the former approach stresses the mechanisms of change through the appearance of new ties in an incumbent network, Walker et al. (1997) emphasize path-dependence and persistence in network structure through its evolution over time. In their empirical analysis of the alliance network in biotechnology they found that early partner choice at the beginning had a significant impact on future cooperation. A year-to-year comparison of structural equivalence for each pair of actors showed that if two firms were connected to the same other companies, i.e. they were structurally equivalent, they most likely remained so throughout the subsequent expansion of the network. This finding leads Walker et al. (1997) to argue for path dependence in the network trajectory.

2.3 Geographical proximity

Interestingly, a lot of the economic evidence on path dependence and lock-in has actually been produced and exemplified in the context of geographic clusters (Martin und Sunley 2006). Geographical propinquity seems to be an important constraint on network formation. Sometimes this effect is abbreviated in unfortunate terms of 'spatial causation'. Space, however, is not a necessary cause of economic interaction. Instead, its role is mediated through at least two underlying social technologies: communication technology (Storper und Venables 2004) and transport technology (Marquis 2003). Breschi and Lissoni (2006) demonstrate nicely, that the effect of geographical proximity on innovation is often mediated through inert mobility of inventors. They tend to stay in a region over long periods of time but move between companies in the same region to produce a pattern of locally interrelated innovation networks. Only with respect to the actors' communication preferences and mobility opportunities may the contingent relation between physical space and economic interaction be established (Glückler 2007). In other words: the constraints of proximity only rule if face-to-face is the only mode of communication and if travel is prohibitive. In any other case, especially in a world of high mobility of people, commodities and information, proximity is contingent on the underlying social technologies. Owen-Smith and Powell (2004) distinguish two such communication technologies to explain why knowledge intensive businesses such as biotechnology tend to favour co-located patterns of inter-firms alliances: One is the *conduit* as the distribution of private information from a sender to a number of limited receivers, and the other is the *channel* as the potential spill-over of information into the entire set of connected actors in a network under conditions of spatial proximity (Owen-Smith und Powell 2004). In fact, the more complex the knowledge in a particular industry, the more do industries agglomerate. This is mainly because the distri-

bution of complex knowledge entails more problems of accurate transmission and interpretation such that spatial proximity eases transfer and locks-out remote actors from the knowledge flow (Fleming und Sorenson 2001; Sorenson 2005). Furthermore, Powell et al. (2005) found unequivocal evidence for a strong geographical bias on strategic alliances in the organizational field of biotechnology. New ties as well as repeat ties were more likely when two firms were co-located. These studies univocally suggest the importance of geography to the organization and dynamics of networks.

Geographical proximity is not only mediated through communication technologies at a given moment in time but may also be a result of its historical legacy. Marquis' (2003) work illustrates just how geographical proximity may sustain to affect the formation of network relations even though communication and travel technologies have changed dramatically. He demonstrates that those networks of interlocking directorships in U.S. cities that had established prior to the advent of air travel technology continued to be significantly more locally bound than networks in younger cities. Despite the availability of modern travel technologies in all cities today, even new corporate board positions were filled with local directors. This persistence of geographical network structure in older communities supports imprinting theory (Stinchcombe 1965): organizations adopt organizational characteristics in response to the environmental conditions during their period of foundation. Marquis' study legitimizes the possibility that geographical proximity endures in network practice even though the communication and travel technologies have changed and now allow for different patterns of spatial interaction. These arguments are challenging with respect to sales alliances in the case of stock photography because digital technology has enabled picture agencies to operate nearly independent of physical constraints and to exchange pictures with other agencies at any place. Will geography still matter for the creation of new alliances in the network, although the business processes are almost fully digitized and virtualized?

3 A case from the cultural economy: the evolution of stock photography

Photography is an essential element of visual information and communication at all levels of society. We encounter still images in press, television, the internet, books, exhibitions, corporate communication, and advertisement campaigns. Wherever we find a photograph, there is a supply chain behind the placement and there are basically two ways for a photo to reach the market. One is to assign a photographer and have photos produced in photo-shootings, the other is to buy a licence for the use of an existing photograph from a stock picture agency. Licensing a stock photo has a number of advantages. In contrast to a photo production, the customer avoids the production risk, i.e. she sees what she gets, and saves the production cost which might sum up to considerable sums for location, equipment, models, stylists and the photographer crew. The customer only pays a royalty to the agency for using a photo which might be just a small percentage of the production cost. Typically, it is the picture editor in a publishing house or the art buyer in an advertising agency who takes the decision whether to assign a photographer for production or to buy a photo "from the shelves". In the USA, picture editors and art buyers spend about double the amount of money on stock photography than on photo-shootings (Sachs 2003) and use about four times more stock photos than own productions (Kjemtrup 1997). Today, there are around 1,000 picture agencies in Europe offering photographs and illustrations from about 21,000 photographers and generating revenues of roughly 1 billion euros (CEPIC 2001).

The historical evolution of stock photography might well be interpreted as a continuous response to technological innovation. Ever since its invention by Louis Daguerre in Paris and W. H. Fox Talbot in London, photography has been shaped and developed through the ongoing advance in production and transmission technologies: Talbot was the first to develop the principle of the negative pattern, an invention that laid ground for

repeated duplication in 1840 (Frizot 1998); and Arthur Korn's invention of the *Telefotokopie* in 1902, for instance, built the technological fundament for large-distance circulation and distribution of photographs within short time and thus made photography available as a visual medium in the established news press at the beginning of the 20th century (Albert und Feyel 1998). The emergence of picture agencies as intermediaries between photographers and publishing houses was a consequence of the rapid growth of photography in the 1920s. Toward the end of the 1930s a significant number of firms specialised on archiving and marketing photography on commission of photographers. After this historical departure, the organizational field of stock photography has experienced some fundamental changes. Three major organizational and technological shifts are apparent in this context (see Glückler 2005 for an extended elaboration).

3.1 From press to publicity: expansion into commercial photography

Stock photography had long been editorial, i.e. pictures for reportage, documentation, and news, whereas advertising agencies would usually produce their visual content through assignment photography with commercial photographers. The 1970 brought about a major change. Given the economic downturn and the oil crisis in 1973, the advertising industry suffered serious budget constraints and sought for new image sources at lower cost. At the same time, the 1978 US Copyright Law, which asserted that an image was the photographer's rather than the client's property, provided institutional guarantee for photographers to use stock photography as an additional business opportunity (Frosh 2001). *The Image Bank* pioneered modern stock photography by venturing from the editorial into the commercial market in 1974. In order to compete with assignment photography, they managed to improve picture quality, attract commercial photographers, and raise the attention of advertising agencies to buy stock at lower cost than to assign photo productions. The company pursued an aggressive marketing strategy, introduced picture catalogues as an instrument to gain visibility and create visual style (Frosh 2001). Today, picture catalogues are an established marketing tool. In Europe, half of all agencies publish catalogues on an annual basis (CEPIC 2001). In addition, the British pioneer Tony Stone developed a sophisticated licensing system to maximise the profit per picture such that the agency succeeded in selling the same picture over 300 times in just one year generating revenues of £30,000 with just one photograph (Rich 1994).

3.2 From light-box to screen: digitization and online archives

In the early 1990s the market experienced enormous growth rates of up to 25% per year and enthusiastic expectations accompanied the advance of digital technology. However, still in 1995 no single company had launched an online archive and a survey in Britain at the time revealed that many of the big agencies had not yet taken clear decisions when to go online. Some business experts were even quite averse to the notion of selling pictures via the internet and saw more threat than opportunity: "I can't understand why any picture library can consider going on-line" (Sal Shuel, BAPLA, quoted in Goddard 1995). While the incumbent business was somehow reluctant to the advent of digital technology, very powerful and resourceful investors entered the market with high expectations. The strategic opportunity of digitization was based on the fact that more images could be offered and distributed to more customers at essentially less cost. British oil magnate Mark Getty and Microsoft founder Bill Gates recognized this opportunity and made large investments to buy up basically all established and significant players in the market. Today, Getty Images (founded 1995) and Corbis (founded 1989) are by far the largest firms in the global market place for still images. In contrast to their incumbent competitors, both firms drove technological change with intensive commitment. Getty was the first big agency to launch an e-commerce platform on their online archive in 1998. While they gained 14% of their revenues in the first year, they increased online sales to over 90% in only five years.

3.3 From licence to property: royalty-free images

Online-archives and e-commerce platforms have not been the last innovation, though. Decreasing distribution cost through digital technology has made another source of friction more obvious: the legal constraints of intellectual property right. When customers buy a reproduction license, the royalty is tailored to the intended use and depends on the size and placement of the photography, the medium (commercial or editorial), the print run, and eventually on exclusivity. If the customer wanted to extend the use of a photograph to e.g. brochures, homepage, flyers, posters etc. she would have to buy a new reproduction licence and pay an additional royalty. Managing the property and reproduction rights implies transaction cost and limits the flexibility of the customer. As a consequence, a new licence model called 'royalty-free' successfully established in stock photography. When customers buy a royalty-free (RF) photo they pay a fixed price and acquire unlimited usage right. The royalty-free licence model thus converts photography into a full commodity. *Mark Torrence* had known this licence model in the music industry, when he founded *PhotoDisc* in 1991 to pioneer stock photography with RF-visual content. Servicing graphic and web designers in the beginning, *PhotoDisc* launched an e-commerce platform in 1995 and drove the company among the top ten of Americas 500 fastest growing companies in 1997. Like many successful agencies, *Getty Images* acquired *PhotoDisc* in order to incorporate their technology and know-how and to go online just a year later in 1998. In 2000, the market share of RF-images was already assumed to reach 15% in the US and 7% in Europe. Today, *Getty* gains about one third of their revenues from royalty-free images and at higher margins per image than traditional rights-managed photography (Glückler 2005).

In conclusion, the market for stock photography has experienced major changes which have only been highlighted very briefly. Nonetheless, digital technology and royalty-free photos have dramatically reverberated the market environment, and redefined fundamental business parameters. As a consequence, the market now looks very different from what it looked like fifteen years ago. It has shifted from a market of medium-sized companies to an oligopolistic market dominated by three players that easily take a 35% share of the global revenues in this sector; it has moved from localised enduring personal relationships to a virtual business transaction; and it is transforming photography from a licensable content to a private commodity (Glückler 2005). This shift has deep cutting implications for competitive strategy. The availability of e-commerce and internet search in online picture archives disrupts existing networks of personal relationships between agents and customers and turns a seller market into a buyer market. The global dominance of *Getty Images*, *Corbis* and *Jupiter Images* forces picture agencies into niche strategies, specialization and inter-firm alliances. Since market visibility and scale of photo collections have become so center stage, many agencies have begun to seek sales partnerships in order to forge alternative distribution channels or to collect additional material and reach scale.

The aim of the empirical analysis is to analyse the growth pattern of the stock photography field-net of inter-agency licence agreements in Germany. An organisational field-net is "a particular pattern of both present and absent links among the entire set of organizational dyads occurring in a specified organizational field" (Kenis und Knoke 2002). The term is used to explicitly focus on the dyadic relations and the overall structure of relations between every pair of players in a field.

4 Methodology

The empirical approach to test the hypotheses of homophily, geography, popularity bias, and multiconnectivity on the alliance behaviour of picture agencies made necessary a network survey because there are no secondary data available on alliance behaviour in the stock photography market. The survey method, however, limits the study of evolutionary processes in at least three ways: it cannot deliver long-term historical data; it

will normally produce incomplete response; and it produces a survival bias by missing out those firms and earlier alliances that were abandoned in the past. The network thus represents a growth path of surviving firms rather than the entire network evolution.

Variables. The questionnaire consisted of two parts. The first part collected attribute information on the individual picture agencies such as firm age, product specialization, firm size by number of employees, by image stock and by number of represented photographers as well as international sales and membership in the national business association. These attribute items were used to develop relational values of firm-to-firm similarity (homophily) and geographical propinquity between all pairs of agencies (see Table 1 for variable definitions). The calculation of relational similarities is based on measures of pair-wise differences or coincidence in the individual scores on an item. For each variable, the similarity values are then represented in a similarity matrix for all pairs of $n \times n$ firms, where each cell value indicates the coincidence (e.g. association membership) or (dis)similarity (e.g. difference in firm age) of two firms on an item.

The second part asked firms to identify all sales partnerships with other agencies. The variable is represented in a binary adjacency matrix, where for each pair of agencies the value one indicates the existence of an alliance and where zero indicates its absence. Thus, the *dependent variable* is the network of sales alliances trading rights managed picture licenses between picture agencies in Germany. Each relationship was further specified for three characteristics: First, two types of licence models – rights-managed vs. royalty-free – were distinguished. Since the alliance behaviour in royalty-free imagery is quite different from cooperation in rights managed photography, the study focused purely on the dominant business of rights-managed sales alliances. Second, the year of establishment of each licence agreement was assessed in order to produce network stages on a year-to-year basis. This temporal dimension of network formation builds the basis for the analysis of network dynamics over time and allows for testing the effects of homophily, geographical propinquity, popularity bias and multiconnectivity on later stages of network structure. Third, the direction of picture supply distinguishes between senders and receivers and thus identifies reciprocal and unidirectional linkages.

Finally, four other variables were generated from the alliance data. The dyadic differences between individual firms' indegree and outdegree centralities were used to measure the concept of popularity bias. The greater the differences in indegree (receiving relations) or outdegree (sending relations) centrality between a pair of agencies, the more likely should they be to have a relationship in the future. The concept of multiconnectivity was measured by two variables. The point connectivity of two unconnected (non-allying) firms is the number of firms that need to be deleted so that no indirect connection exists between them any more (Borgatti et al. 2002). Geodesic count produces a measure that counts the number of shortest network paths between each pair of agencies (Borgatti et al. 2002).

Survey population. There are three organizational types of picture agencies. In the dominant case the agency is a commercial representative of the images provided by independent photographers. The photographer holds the intellectual property rights and commissions the agency to sell reproduction licenses for a royalty. Apart from this dominant form, there are photographer cooperatives and archives. In contrast to agencies, the former maintain the intellectual property rights within the cooperative and the latter can market historical public domain images, where intellectual property right has expired. Therefore cooperatives and archives may offer pictures at more competitive prices since they do not have to share their revenues with the legal originator. The population of picture agencies is defined as the number of commercial firms that licence usage rights of still images under commission of independent photographers. This explicitly excludes non-commercial archives, small-scale sideline businesses and direct-marketing activities of photographers. Photographer cooperatives, however, are included into the analysis since they often licence material also from independent photographers. For the year 2005, 201 agencies were identified through the industry association's member directory, own research and through snow-ball sampling in the course of data collection. Altogether, 75 agencies com-

pleted the questionnaire where 70 had at least one sales alliance in rights managed photography. The adjacency matrix of this alliance network between the set of 70 agencies represents the independent variable. Though the response rate of 37% is not very high, the respondents represent the majority of the actual business in the market. Many medium and large players took part in the study and most non-respondents were micro businesses with often just one self-employed owner, and most of them unknown to the national business association. Therefore it seems justified to assume that the complete network would look quite similar to the one surveyed. The only alliances missing out in the survey are peripheral alliances between non-responding microfirms.

Network regressions. Network data violate the assumption of independence between observations and thus require alternative methods to generate test statistics. Hence, regression analysis uses the QAP technique to test for associations with the dependent variable. The quadratic assignment procedure (QAP) calculates the Pearson correlation coefficient for two observed matrices and compares it with a self-generated distribution of correlations based on random permutations of the reference matrix (Krackhardt 1987; Kilduff und Krackhardt 1994). All regression analyses were computed with the software package Ucinet (Borgatti et al. 2002).

Tabelle 1: *Variable labels and definitions, dyad level*

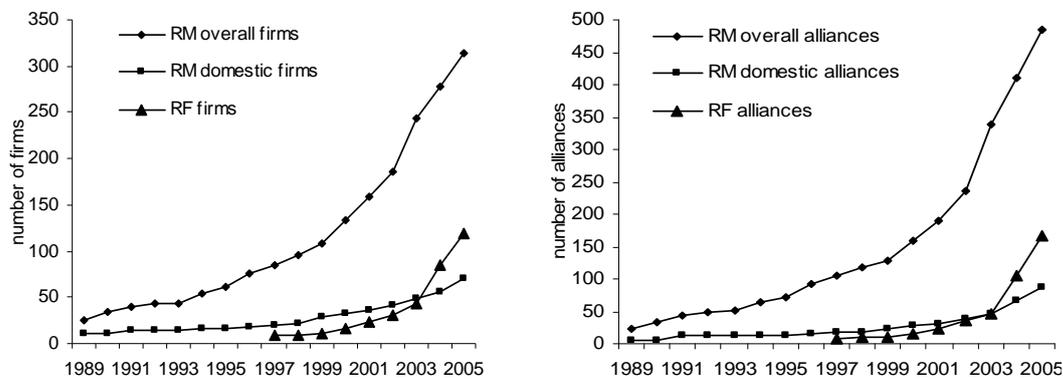
| Label | description |
|------------------------------|--|
| Dependent variable | |
| sales alliances | Sales alliances between all pairs of agencies for each year, 1989-2005 |
| Independent variables | |
| A. Homophily | |
| firm age | Difference in years of foundation in Germany |
| digital entry | Difference in years of launching an online picture archive |
| size employment | Difference in number of employees |
| size images | Difference in size of picture archive |
| size photographers | Difference in number of photographers (suppliers) |
| Universality | Dummy, 1 = two firms are both universal agencies |
| Specialization | Dummy, 1 = two firms are specialized in the same picture portfolio |
| international sales | Difference in percentage of foreign annual sales |
| lobby association | Dummy, 1 = two firms are members in the same business association (BVPA) |
| B. Geography | |
| Location | Dummy, 1 = two firms are located in the same metropolitan region |
| C. Popularity bias | |
| indegree centrality | Difference in indegree |
| outdegree cenrality | Difference in outdegree |
| D. Multiconnectivity | |
| Point connectivity | Number of different firms through which a pair of firms is connected |
| Geodesic count | Number of shortest paths between two agencies |

5 Results

5.1 Visualizing network growth in German stock photography

The study of network evolution is promising especially in early stages of network growth, since network structure has not yet become fully institutionalized (Kenis und Knoke 2002). In the case of stock photo alliances this seems to be the case since it is a more recent reaction to digitization and competitive shift. New agencies and new ties in the alliance network had remained quite limited throughout the 1990s with a clear and disproportional increase since 1999. This increase is reflected in rights-managed as well as royalty-free photography and also in the domestic rights-managed alliance network in Germany (Figure 1). 46 agencies were founded in the considered period between 1989 and 2005, while 29 had already been established before 1989.

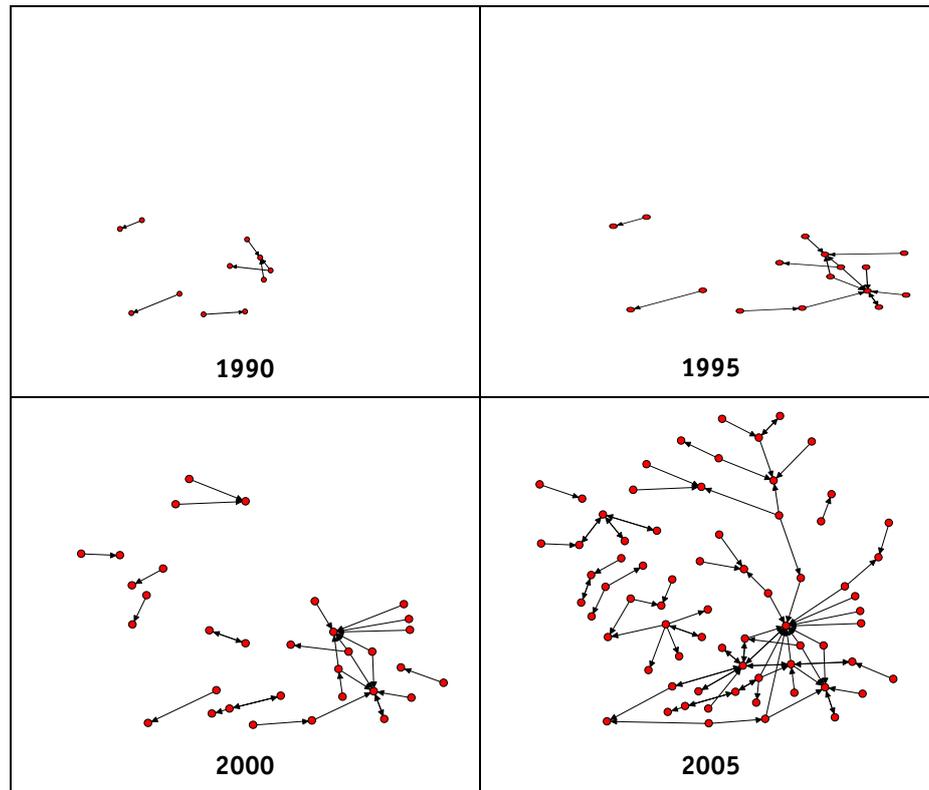
Abbildung 1: *Growth of alliance network by members and by licence agreements, 1989-2005*



Correlation analysis of firm attribute data supports the argument that digitization and royalty-free photography reduce transactional friction and ease inter-agency cooperation. First, companies with RF-photos receive a higher percentage of pictures from partner agencies and they tend to generate a higher proportion of revenues internationally. At the same time, RF-agencies do not differ in terms of firm age or employment size. Second, there is a more general trend that the higher the proportion of digital images, the higher the share of photo supply through sales partners. Technological and institutional change thus fosters the emergence of a new division of labour and a growth in inter-agency sales partnerships.

Figure 2 displays four stages of the domestic RM alliance network in five-year intervals between 1990 and 2005. The visualization of this network illustrates the rapid, exponential expansion of alliances since 2000 only. The network started off from a few disconnected cores in 1990 that remained rather stable and small throughout the 1990s. Toward the end of the decade, as the number of new ties increased, one large component emerged in which two thirds of all alliances are connected either directly or indirectly. One third of alliances however forms a rather peripheral landscape of various unconnected and isolated alliances. In the next analytic section, social network analysis will be used to search for an explanation of this emerging network structure.

Abbildung 2: Stages of the domestic RM sales alliance network, 1990-2005



5.2 Explaining tie formation in the rights-managed sales alliance network

This section applies the hypotheses on network growth to the domestic RM alliance network in Germany. Two sets of analyses are carried out. First, in a static perspective the independent variables are tested against the network of sales alliances all in the same year 2005. The results for bivariate QAP regressions are summarized in Table 2. This produces a number of significant explanatory variables for further analysis. Second and in a dynamic perspective, significant variables from the first set of regressions in the year 2005 are used for a year-to-year longitudinal analysis between 1995 and 2005. Each independent variable from one year t_n is compared to the alliance network structure of the subsequent year t_{n+1} thus providing a year-to-year estimation of the hypothesized effect on the new network structure in the subsequent year. The regression effects for the four hypotheses are found to be quite different.

Homophily. Arguments about preferential partner selection based on homophily suggest that the more similar two partners are to each other, the more likely will they engage in a relationship. However, this proposition receives hardly any support in the context of the alliance network between picture agencies. Most of the similarity variables are insignificant except for employment size, specialization and business association membership. According to this finding, collecting image material in the same topic specialty and being a member of the business association increases the odds of having a licence agreement. In contrast, however, dissimilarity also drives alliance formation. The higher the difference in employment size, the more likely are two agencies to initiate a licence agreement. This result would argue more in favour of diversity than for similarity. It might reflect an emerging division of labour between big agencies that source their image material increasingly from

small supplying agencies (cf. Glückler 2005). It has to be emphasized that none of the significant effects explains more than one percent of overall variance in the distribution. Hence, the impact of firm similarity may be summarized as being negligible.

Tabelle 2: *Bivariate QAP regression analysis: all sales alliances in 2005*

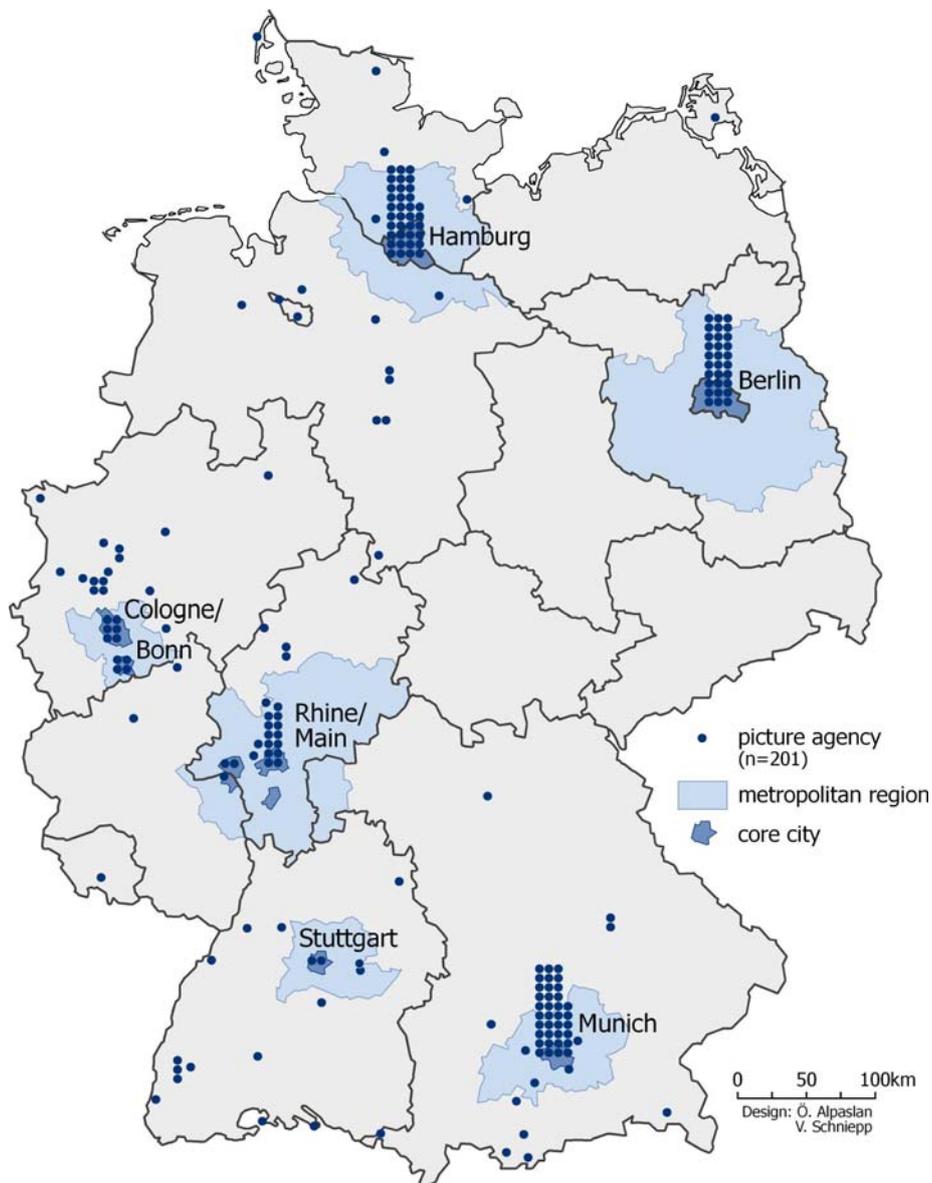
| Independent variables | Regression coefficient | R^2 (adjusted) | observations |
|-----------------------------|------------------------|------------------|--------------|
| A. Homophily | | | |
| Firm age | .000 | .000 | 2,070 |
| digital entry | .002* | .003 | 1,560 |
| size employment | .001* | .009* | 1,332 |
| size images | .000 | .000 | 2,450 |
| size photographers | .001 | .000 | 1,806 |
| Universality | .002 | .000 | 2,756 |
| Specialization | .016* | .002* | 2,756 |
| International sales | .000 | .000 | 1,190 |
| Lobby association | .012** | .002** | 4,830 |
| B. Geography | | | |
| Colocation | .023** | .004** | 2,652 |
| C. Popularity bias | | | |
| Indegree centrality | .002** | .006** | 4,830 |
| Outdegree centrality | .001* | .004* | 4,830 |
| D. Multiconnectivity | | | |
| Point connectivity | .229** | .220** | 4,830 |
| Geodesic count | .207** | .195** | 4,830 |

* $p < 0.05$; ** $p < 0.01$; 2,000 random permutations

Geography. A second argument about preferential partner choice holds that geographical proximity between partners increases the likelihood for an alliance. Three quarters of all agencies in the 2005 alliance network are located in one of the top five metropolitan regions, Hamburg, Munich, Berlin, Frankfurt and Cologne (Figure 3). Regression analysis shows that if two firms are located in the same metropolitan region, they are more likely to have a licence agreement. Though the association is highly significant, again, location does not explain more than 0.4% of overall variation and thus can only be an auxiliary condition for alliance formation. The analysis of a series of year-to-year regressions offers an additional and quite remarkable finding. Over the ten-year period since 1995, co-location has become increasingly important in the structuration of alliances. While until 1999, the pattern of domestic sales partnerships was independent from geography, the new ties in the network have been increasingly constrained by geographical propinquity within the dominant metropolitan regions. The positive effect of co-location in the same metropolitan region has grown steadily over the last five years, yet remaining a highly contingent condition for tie formation.

Popularity bias. The argument about accumulative advantage predicts that a partner with many previous contacts is more likely to have new ties than a partner with only few prior relations. Evidence from the regression analysis suggests that the higher the difference in the number of licence agreements between a pair of agencies, the more likely are they to have a relationship. This result applies to both, licence-giving and licence-taking, and reflects the overall centralization of alliances on a smaller number of highly connected agencies. In line with the former hypotheses, however, popularity bias accounts for less than 1% of the variance in the distribution of network ties.

Abbildung 3: Metropolitan clustering of stock picture agencies in Germany, 2005



Multiconnectivity. Finally, the argument of multiconnectivity theorizes that multiple indirect linkages between partners enhance the formation of direct ties between these organizations. In comparison with the other hypotheses, this argument seems best to represent the pattern of licence agreements in the German stock photography market. Point connectivity as well as geodesic count are highly significant and explain around 20% of the variance in the distribution of sales alliances. Both measures particularly focus on unconnected firms in the network and develop notions of the quality of their indirect interconnection through third parties. If there are many different intermediate contacts between any two firms, and if there are many alternative shortest connections between the two, they can be considered as being multiply connected (multiconnectivity) – although there is no direct link between them. The analysis of a series of year-to-year regressions reinforces this association. Point connectivity and geodesic count for each pair of agencies in year t_n explain roughly between 40% and 60% of the network structure in each subsequent year t_{n+1} . In addition, the ten-year time series since 1995 conveys that although both measures are continuously significant, their explanatory value has suffered

in the last couple of years because more and more new ties enter the alliance network and challenge the existing structure (Table 3). One conclusion might be that when networks face major expansion and high rates of new tie formation, the incumbent network structure imposes less constraint on new ties and may experience a period of path-destruction.

Table 3: *R*²s for year-to-year QAP regressions of the alliance network, 1995-2005

| | New ties | All ties | Location [†] | Pt. connectivity | Geodesic count |
|--------------|----------|----------|-----------------------|------------------|----------------|
| 1995 to 1996 | 2 | 16 | .000 | .519** | .638** |
| 1996 to 1997 | 1 | 17 | .000 | .536** | .654** |
| 1997 to 1998 | 1 | 18 | .000 | .552** | .668** |
| 1998 to 1999 | 4 | 22 | .000 | .489** | .587** |
| 1999 to 2000 | 7 | 29 | .002* | .461** | .519** |
| 2000 to 2001 | 3 | 32 | .003* | .609** | .655** |
| 2001 to 2002 | 7 | 39 | .003* | .544** | .608** |
| 2002 to 2003 | 8 | 47 | .004** | .526** | .607** |
| 2003 to 2004 | 19 | 66 | .002* | .428** | .459** |
| 2004 to 2005 | 21 | 87 | .004** | .158** | .123** |

* $p < 0.05$, ** $p < 0.01$, 2,000 random permutations; *R*²s are adjusted. Between 1989 and 1995 there were only eight new entries and a total of 14 alliances. Year-to-year regression would not convey interpretable results before 1995.

[†] The information on the location of an agency is only available for 2005 and thus used consecutively for regressions in each year of alliance network.

6 Discussion and conclusion

This paper has sought to combine research on network evolution with an evolutionary approach to economic geography. A number of different theoretical arguments about the nature of network expansion were discussed and empirically applied to the context of inter-organizational alliances in stock photography. Although stock photography is a small market in financial terms and has been largely ignored in academic research, it is a particularly interesting organizational field for the study of network dynamics. The market has experienced fundamental changes with respect to various dimensions: digitization in technological terms, new licence models in institutional terms, and new organizational practices as well as major new entrants to the incumbent field. It has been argued that these environmental changes have given rise to new forms of sales alliances between picture agencies. Despite the fact that agencies renounce a significant share of revenue with a distribution partner, they increasingly now engage in domestic partnerships. Moreover, the sheer number and rate of new alliance formation has grown exponentially over the last couple of years. Since this phenomenon is relatively recent and still in an early phase, the evolving alliance network represents an ideal case for the study of network evolution.

The analysis revealed that organizational homophily and popularity bias are relatively weak conditions for estimating the locus of new alliances. Only organizational diversity, i.e. difference in firm size, and geographical co-location were highly significant, yet relatively weak predictors for network growth. The multiconnectivity-hypothesis (Powell et al. 2005) received stronger support. It was measured as the extent to which two agencies were multiply and indirectly connected via alternative third parties. Multiconnectivity explained on average half of the variance in the distribution of alliances across the network over a consecutive ten-year period. In sum, two agencies were more likely to form a sales partnership if they were located in the same metropolitan region, had different firm size, and if they were indirectly connected through other organizations

in the field. On the other hand, while over time the tendency to cooperate locally has increased, the impact of multiple linkage on the alliance network has decreased. This is mainly because in recent years, many new agencies were established and formed many new alliances in the network. Given the limit of this study on stylized survey data it is difficult to interpret the emerging effect of geographical propinquity on new tie formation appropriately. Although the picture trading business has become mostly virtual, the new uncertainties emerging from the dynamic market environment seem to facilitate strategic partnerships in spatial proximity. The local milieu or creative fields (Scott 2000) might be argued to represent both, an imprinted institutional mode of communication among the creative professionals in a city or city region (Marquis 2003), and a territorialized form of culture (Maillat et al. 1995) that conveys positive communication externalities and reduces uncertainty through more monitorable interaction. Though the association between geography and alliance behaviour corresponds well with other empirical evidence (Powell et al. 2005), more detailed research on the nature of sales alliances is necessary to support the findings in the context of stock photography.

It is an open question for further research whether and under what conditions rapid network expansion reproduces an imprinted structure over long times to lock-in as a path of network evolution or whether it disrupts established patterns and creates a new path to network growth (Martin und Sunley 2006). The study presented here is only a first and exploratory analysis toward a currently emerging field of evolutionary theory on networks. For economic geography, this is a promising line of reasoning not only because geography learns from their input but also because it may essentially contribute to the development of solutions. If geography is a continuous constraint (or enabling condition) for networks to form, how then do networks travel over space in the course of their development and how do regions anchor these networks to retain their dynamics locally?

The focus of this paper has been on the mutual effects that network structure imposes on future tie formation and, vice versa, the effect of new ties on the existing network structure. For this purpose, the research strategy has focused on a more standardized, quantitative approach to these patterns of variation over time. The specific regional context that reflects in a set of interrelated institutions, the particular set of actors and a given resource endowment will also play an important role for the understanding of network formation in a geographical perspective. Future research should dedicate more enquiry also to institutional aspects of geographical network evolution.

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