**The social and economic bases of network multiplexity:**

**Exploring the emergence of multiplex ties**

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## Abstract

The goal of this paper is to shed light on the role of tie content in the evolution of multiplex ties – i.e., ties featuring both an economic and a social component – in interorganizational networks. We clarify and extend the theoretical framework on network multiplexity by testing the extent to which two distinct tie content-related logics – *social interaction* and *economic exchange* – and their underlying mechanisms lead to the emergence of multiplex ties. Results from a longitudinal network analysis of firms located in an Italian multimedia cluster support our hypotheses, confirming that both social and economic drivers contribute to the emergence of network multiplexity, and that social ties have a stronger impact than economic ties on this process, thus providing further insight into the microdynamics of network evolution.



**Keywords:** Multiplex ties, network evolution, tie content, microdynamics, geographical clusters.

## Introduction

In social network research multiplexity refers to the extent to which two actors are linked together by more than one relationship in a network. Multiplexity thus occurs when actors share "multiple bases for interaction in a dyad" (Verbruggen, 1979: 1287), such as when actors in a relationship play different roles (Ibarra, 1995), maintain different affiliations (Wheeldonm, 1969) or engage in different types of exchanges (Kapferer, 1969). In the context of interorganizational networks, network multiplexity represents "the breadth of the involvement of participating organizations" (Kim, Oh, and Swaminathan, 2006: 711). Examples of multiplex ties between organizations include overlapping ties across upper echelons (Haunschild and Beckman, 1998), interorganizational ties in which firms compete and cooperate (Lomi and Pattison, 2006; Shipilov and Li, 2012), or vertical ties intertwined with personal relationships (Uzzi, 1996).

Although an increasing number of scholars have investigated the dynamics of network evolution both at the individual (Gibbons and Olk, 2003; Buskens and Van de Rijt, 2008) and organizational (Gulati and Gargiulo, 1999; Baum et al., 2005; Shipilov et al., 2006) levels, we know relatively little about the mechanisms through which interorganizational ties become multiplex. This leads to potentially dangerous simplifications since, as Shipilov and Li recently pointed out, "when examining the determinants of dyadic relationships, many studies make a simplifying assumption that dyads arise from their members playing a single role … and as a result they are embedded in a single type of relationships only" (2012: 474). A possible cause of this shortcoming is that explanations of network dynamics – which delineate mechanisms through which specific relationships are expected to materialize – typically assume away the multiplexity of roles, interest, and relationships between organizations, to focus on how and why the structure of a network in one period affects the likelihood of future ties between specific pairs of actors (Stuart and

Sorenson, 2007; Sorenson and Stuart, 2008). However, this approach does not explain how multiplex ties emerge in the first place, i.e. the process through which multiple bases of interaction come together, thus making the exchange multiplex. As a result the underlying mechanisms of multiplexity remain poorly understood (Kuwabara et al., 2010). What microdynamics turn uniplex relationships into multiplex ones? How do multiplex ties emerge?

We start to address these questions in the network literature by theoretically clarifying and empirically investigating the mechanisms underlying the emergence and evolution of multiplex ties, here defined as ties featuring both an economic and a social component (Uzzi, 1996, 1997) in inter-organizational networks. Such multiplex ties are particularly important as they are at the core of the social embeddedness perspective, which aims to explain why economic transactions often become embedded in multiplex socio-economic relationships imbued with feeling of reciprocity and trust that create expressive value above and beyond the instrumental value of the exchange (Granovetter, 1985; Uzzi, 1996). To fulfill our goal, we build on recent work highlighting the need to study network emergence focusing on the or mechanisms driving the evolution of network structures (Ahuja et al., 2012). We theoretically argue and empirically investigate the role played by *tie content* – what flows through the tie – in the dynamics of multiplex networks. We focus on tie content as it is both *driver* and *locus* of change in multiplex networks that is, we argue that to understand the emergence of multiplex networks (tie content as locus of change) we should start by exploring the role played by single-type or uniplex relationships, such as social and economic ties, in their emergence (tie content as driver of change). This is because one type of ties often entails another (White, 1992) or, as Lomi and Pattison put it, "the tendency of organizations to form relations in one setting can be fully understood only in terms of what relations are present or absent in other settings" (2006: 316). Drawing on these insights, we theorize and empirically

test the role of two alternative logics in the emergence and evolution of multiplex ties among firms (Uzzi, 1996). First, leveraging the *logic of social interaction*, we discuss how social ties serve as antecedents to the formation of multiplex ties. Second, we introduce the *logic of economic exchange*, which focuses on the possibility of economic transactions leading to the emergence of multiplex ties. Finally, we theorize about the relative influence of these two distinct logics in creating multiplex ties, arguing that the logic of social interaction has a stronger impact on the emergence of network multiplexity than the logic of economic exchange.

We explore these predictions in an analysis of the formation and interplay of social ties and economic transactions established within a sample of multimedia companies located in a geographical cluster in Northern Italy. Our findings suggest that while the presence of both social and economic ties increases the likelihood of multiplex ties' formation, the effect of social ties is much stronger than the one of economic ties, indicating the predominance of the social interaction over the economic exchange logic in driving multiplexity. Taken together these findings contribute a better understanding of the microdynamics of multiplex relations, thereby directly addressing recent calls "for greater clarity about the logic underlying how overlapping ties interact with each other" (Kuwabara et al., 2010: 252).

## Theory

### *The evolution of multiplex networks*

Network multiplexity is a structural property of network ties that entails the existence of more than one type of relationship between two actors (Wasserman and Faust, 1994). Although the general notion of multiple overlapping ties has been invoked and ever discussed since Becker's theory of social and economic action (1976), and Granovetter seminal treatise on the strength of ties (1973), we know surprisingly little on the causal processes underlying the

emergence of multiplex ties and extant research remains "largely correlational or descriptive in empirics and typological in theory" (Kuwabara et al., 2010: 247). While focusing on any type of multiplexity is critical as most – if not all – relationships in which individual and firms are involved entail varied forms of exchange that intermix across social and professional arenas (Shipilov and Li, 2012), in this paper we focus on a specific type of multiplex ties, i.e. those that are configured by the simultaneous presence of one social and one economic tie between two actors. What makes these multiplex ties particularly interesting to investigate is their central role within the research tradition on social embeddedness (Granovetter, 1985, 1992; Uzzi, 1996, 1997), defined as the degree to which commercial transactions take place through social relations that use exchange protocols associated with social (i.e., non-commercial) attachments to govern business dealings (Granovetter, 1985).

To understand the genesis and evolution of multiplex networks, we build on recent research on network change and attend to the mechanisms responsible for changes in what flows through the tie, and thus for the emergence of multiplexity (Ahuja et al., 2012). We focus on tie content as we believe it represents both the locus and the driver of change in multiplex networks. First, focusing on tie content as the locus of change in multiplex networks, an analysis of what flows in the ties is likely to be critical for understanding the emergence of these structures. This is confirmed by research on tie interdependence, which suggests that one type of tie often entails another (White, 1992; Lomi and Pattison, 2006; Rank et al., 2010; Shipilov and Li, 2012). The co-occurrence of different types of ties implies that one type of tie might drive the emergence of other important types of ties (Lomi and Pattison, 2006), making it critical not only to investigate the relationship between types of ties and economic outcomes but also to understand the interaction between different types of ties, and their possible morphing into multiplex relationships, as "the relationships between

these different forms of ties and how these ties evolve or morph over time may in itself be useful" (Ahuja et al., 2012: 443). Second, examining the role of tie content allows us to take on a long-standing invitation coming from several scholars in the sociology and organization theory fields to study networks by focusing on "the content of ties, rather than merely the structure formed by those ties" (Powell and Smith-Doerr, 1994: 371).

Focusing on tie content as the driver of change in multiplex networks entails looking at the content of pre-existing uniplex ties – either purely social or purely economic – to understand how – over time – they can transition to a multiplex state. Uzzi's (1996, 1997) ethnographic account of network ties among apparel firms in the Manhattan garment district provides some direction as to this process, suggesting that extant social ties foster the emergence of economic ties between two organizations – thus making the ties multiplex – by equipping them with resources such as trust and common languages, both of which facilitate the emergence of economic exchange. As for the role of economic ties in creating multiplex relationships, while Uzzi (1997) hints at the theoretical possibility of economic exchange leading to the emergence of a multiplex tie, he finds no strong evidence of this mechanism operating in his setting. In our view, two distinct logics related to tie content – the social interaction and the economic exchange logics – are at play in the formation of multiplex ties at the micro level, i.e. at the level of the individual network member. We now turn to describe each one of these logics and their underlying mechanisms responsible for the emergence of network multiplexity.

### *The logic of social interaction and network multiplexity*

The social interaction logic underlies those arguments that, in the extant literature, point to the effect of individual ties on the formation of interorganizational networks (Larson and Starr, 1993; Uzzi, 1996), such as those highlighting the role of a "history of personal relations

[which] shape[s] the context for the new exchange between organizations by reducing the risks" (Larson, 1992: 84) or that prior personal ties of a new venture's founders are strong predictors of that firm's later partnerships (Hallen, 2008).

What is still missing in the literature, though, is a systematic understanding of what mechanisms underlie this effect and a statistically grounded investigation of what makes the emergence of an economic tie – and thus of network multiplexity – more likely (Kuwabara et al., 2010). We argue that the social exchange logic entails two distinct mechanisms – information accrual and better monitoring – both of which contribute to increase the reliability of a potential business partner, thus enabling the emergence of tie multiplexity.

Information accrual leads to multiplexity because social ties provide additional information about potential partners' competencies and reliability (Gulati and Gargiulo, 1999), which facilitate the creation of an economic tie. This argument rests primarily on the idea that personal social relationships channel private information (Coleman et al., 1966) about the characteristics of potential partners, including direct experience and fine-grained knowledge that can be used to verify their reputations,. Access to such information works as a micro-level mechanism behind the emergence of tie multiplexity by providing signals about both the capabilities and trustworthiness of potential partners that facilitate their selection for new business ties. The same logic inheres in Geertz's (1978) explanation of why, in a peasant bazaar, people keep purchasing goods from the same vendor.

As for the link between better monitoring and multiplexity, an extant social relationship between two organizations allow them to develop stronger expectations about each other's behavior, reducing the likelihood of defections and/or opportunistic behaviors: as Uzzi commented in his ethnographic analysis, "previous ties enable resources and open handed expectations from an existing relationship … to elaborate the multiplexity of the relationship" (1996: 680). As the possibility of being exploited is greatly reduced, this

increases the likelihood that the two organizations will develop a business tie. Social ties and the reciprocal monitoring they afford via expectation setting allow a focal actor not only to forearm itself against hidden agendas potential partners might harbor but, to an extent, also against changes in their attitude toward the partnership occasioned by environmental shifts (Gulati and Gargiulo, 1999), as the existence of a social tie might make it less likely that partners will radically change how they behave towards the focal organization in such circumstances. Of course, not all social bonds will configure opportunities to start joint economic endeavors (Das and Teng, 2001), but it will be more likely that they will emerge where there are previous social ties rather than where no such opportunities exist.

In sum, since personal relationships help actors identify reliable potential partners by transferring information about their quality and/or trustworthiness and by allowing closer reciprocal monitoring over their future behaviors, the social interaction logic suggests that the presence of a social tie between two firms favors the creation of subsequent economic exchange between them, thus leading to the emergence of a multiplex tie. Therefore:

**HYPOTHESIS 1** The presence of a personal social relationship between two firms has a positive effect on the likelihood that they will form a multiplex tie.

***The logic of economic exchange and network multiplexity***

Most research by economic sociologists and organizational scholars has pointed to the importance of personal social relationships as priming mechanisms in promoting the emergence of multiplex ties. However, at least in principle, multiplex ties may also develop from arm's length or purely economic transactions. Uzzi, for instance, explicitly acknowledges this as a theoretical possibility even though he finds only limited empirical evidence to support this process, claiming that "the data suggest that embedded ties may also originate from anonymous market ties, but that this source of embeddedness is uncommon in

this industry" (1996: 680). Polanyi seemed to envision a similar possibility in his seminal account of the rise of the market, when he states that "[i]nstead of economy being embedded in social relations, social relations are embedded in the economic system" (1957: 57). Thus, the possible role of the market in driving network change is envisioned by the literature, yet under-theorized and even less empirically validated, which may be due to an excessive emphasis on the role of the social in the economic sphere - as Krippner and her colleagues put it, "the concept of embeddedness has contributed to the lack of an adequate theorization of the market in economic sociology" (Krippner et al., 2004: 112). We address this challenge by envisioning the mechanisms through which a pure economic tie may lead to the emergence of a social relationship, making the tie multiplex. This possibility is the essence of the economic exchange logic, which entails two distinct mechanisms – relational proximity and redundancy – that, by increasing partners' closeness and the need to overlay new ties over existing ones, favor the emergence of multiplex ties.

Relational proximity points to the idea that parties in a business transaction have incentives to develop reciprocity and behave in a trustworthy manner if they want their economic relations to continue into the future (Axelrod, 1984). As these behaviors are reciprocated over time, the calculative orientation of transaction ties makes way to a decision making process where actors are predisposed to interpret their partners' actions favorably, even in uncertain situations. By rendering the exchange relatively independent from its initial economic goals, relational proximity favors the emergence of a multiplex tie: as Uzzi explains, "just as economic transactions are embedded in social relations, new social relationships are partly reverse-embedded in economic transactions" (1996: 679). For example, once a seller has supplied a product or service to a buyer in careful adherence to the agreed deadline and standards, the latter is more likely to view the seller as one on whom it can rely on for future help or claims (Chua et al., 2008). As such economic interactions are

successfully repeated, a party's confidence in the competence of the other and in the economic value of the exchange also grows. The relational proximity between the two parties also increases and, with it, the likelihood that the original market transaction will become imbued with social components such as trust and altruistic attachment (Hite, 2005), thus turning the economic exchange into a multiplex relationship. The resulting closeness provides the relationship with an expressive value that is separate from purely material stipulations, even if it is built on them (Uzzi, 1999).

The second mechanism underlying the economic exchange logic is redundancy (Laumann and Marsden, 1982), or the tendency to overlay ties over existing relationships to improve their stability and, therefore, secure important connections involved and/or critical resources flowing through them (Lomi and Pattison, 2006). While the relevance and implications of nodal redundancy have been detailed by extant research (Burt, 2005; Reagans and Zuckerman, 2008), tie redundancy has received less attention (Laumann and Marsden, 1982), although it represents a powerful mechanism driving the emergence of network multiplexity. According to resource dependence theory, organizations involved in economic exchanges that are critical for their survival may decide to reduce their level of dependency on critical business partners via a new business tie that partially (equity agreement) or completely (acquisition) internalizes these transactions (Pfeffer and Salancik, 1978; Gulati and Gargiulo, 1999). While the creation of new business ties is a typical strategy to reduce organizations' dependence on their environment, the formation of social ties with their economic exchange partners – by increasing their reliability and their trustworthiness – represents an alternative, network-based mechanism for reducing firms' dependency on such parties (Pfeffer and Salancik, 1978; Lomi and Pattison, 2006), thus configuring the embeddedness of a social tie into economic exchanges as an alternative mechanism of dependency reduction in inter-organizational networks (Casciaro and Piskorski, 2005).

Recent research on network evolution echoes this possibility, remarking that "from a resource dependence perspective, affective and hierarchical ties may also be critical to organizations, and it is very likely that social relations are used in these arenas to achieve instrumental goals" (Ahuja et al., 2012: 443). To the extent that overlaying a social tie over an economic exchange reduces an organization's uncertainty as to the critical resources flowing through its economic ties, redundancy enables an organization to reduce its dependence on inter-organizational networks. Thus, organizations engaged in business exchanges that are critical for their survival will be driven to build social ties with such partners, making the emergence of multiplexity more likely.

Of course, similarly to what happens for the social interaction logic we do not expect that the economic exchange logic entails that all economic ties will lead to social relationships. There may be factors that interfere with the manifestations of the effects described above – e.g., a problematic business relationship; the resource flowing through a specific exchange may not be critical or status differential between partners may impede the creation of a social relationship; etc. However, the mechanisms discussed above lead us to expect a stochastic prevalence of economic ties between two firms morphing into multiplex ones (i.e. economic and social).

The organizational literature has documented instances of the emergence of social relationships out of economic exchanges. For example, Ingram and Roberts' (2000) study of friendship ties among Sidney hotel managers makes it clear that multiplex relationships are not completely foreordained by preexisting social relationships, but that shared economic interests also play a significant role in their emergence. In a similar vein recent evidence by Kuwabara (2011) shows that "certain forms of economic exchange can reinforce bonds of cohesion" (p. 578). In sum, both our theoretical argument and sparse empirical evidence suggest that an economic tie may be recast into a multiplex tie, we can therefore posit that:

**HYPOTHESIS 2** The presence of a business transaction tie between two firms has a positive effect on the likelihood that they will form a multiplex tie.

***The relative importance of social and economic logics for network multiplexity***

Our previous arguments point to a higher likelihood that firms' extant interactions will become multiplex, whether they originate as instrumental (economic exchange) or expressive (social interaction) ties. Taking a finer-grained look at these processes allows us to theorize about their relative magnitude: in particular, we argue that the social interaction logic plays a more important role than the economic exchange logic in the emergence of multiplex networks due to the different nature of the extant ties involved.

Social ties are expressive ties, thus are affect based, while economic ties are instrumental ties, which are instead cognition based (Ibarra and Andrews, 1993; Umphress et al., 2003). Affection plays a critical role in explaining why social ties exert a stronger influence than economic ties in shaping the emergence of multiplex networks, as the latter lack the degree of intimacy and mutual commitment inherent in social relationships. As Krackhardt notes, while "interaction creates opportunity for exchange of information … affection creates motivation to treat the other in positive ways … and time creates the experience necessary to predict how the other will use any shared information" (1992: 219). Thus, while both types of ties offer the *opportunity* and experience necessary to generate multiplex ties, only social ties provide the *motivation* that comes with affect. The motivation to treat others positively is a particularly powerful driver when it comes to promoting initial offers of trust and reciprocity, which lead to the emergence of multiplex exchanges by allowing actors to initiate new exchanges without (or with a reduced) fear of being exploited by the other party. As affection-based trust is emotionally imbued, it is especially likely to be enhanced by the presence of expressive ties, as they typically convey social support (Chua et

al., 2008). In fact, to the extent that economic transactions often involve the maximization of self-gain, economic transactions may reflect what Sahlins (1972) called 'negative reciprocity', characterized by actors' limited concern for each other. Furthermore, since economic interests – unlike affection – are easily quantifiable (Chua et al., 2008), they are more naturally the subject of the specific exchanges which are the basis of instrumental relations, rather than of the generalized exchanges on which expressive relations are built (Sahlins, 1972).

The nature of the extant tie also affects the quality of the information exchanged via that tie: since the affective component of social ties makes them comparably stronger than economic ones, they are more conducive to richer information exchange. This additional strength may also derive from the sense of identity that expressive ties afford - as Umphress and her colleagues put it, "expressive ties are sources of social support, provide a sense of identity and personal belonging, and serve to transmit normative expectations" (Umphress et al., 2003: 74). As channels of identity, social ties not only carry information about the parties' identity which is both hard to access in the case of economic ties and critical in establishing a new relationship, but they are also comparatively stronger than ties that do not have these identity implications and lack an affective component. Organizations that benefit from the richer information afforded by stronger ties are more likely to initiate valuable relationships with other parties, while firms that cannot rely on information of such quality need to be more careful in assessing potential partnerships, making the former - ceteris paribus - more likely to create new ties.

Finally, the type of trust inherent in the two types of extant ties is also different. Trust can be characterized as being about "a partner's ability to perform according to agreements (competence trust), or his intentions to do so (goodwill trust)" (Nooteboom, 1996: 990). Therefore, while expressive ties allow the development of goodwill trust, instrumental ties

foster the accrual of competence trust. Although competence trust – built via a successful economic exchange – is clearly important for firms, it is not as effective as goodwill trust in driving multiplexity, since the development of a social tie is only partly linked to the demonstrated abilities of the firms involved in an economic exchange. On the other hand, goodwill trust is critical in making a social tie multiplex, as the conviction that firms intend to eschew opportunistic behavior and do their best to perform according to their agreements is essential to the decision to start an economic exchange. Another related reason why goodwill trust could be more critical in developing tie multiplexity is that it is relatively more valuable than competence trust, as it is less imitable - it takes time and idiosyncrasy to develop within the social interaction - and it cannot be acquired on the market - as instead can be in part done with competence trust, with reputation and status acting as partial substitutes in signaling firms' ability to perform. This difference might also contribute to the social logic having a greater effect on the emergence of multiplex networks.

These observations suggest that uniplex relationships are more likely to develop into multiplex ties if they begin with initial stocks of affect and trust deriving from pre-existing social relationships rather than with the 'assets' provided by purely economic transactions, which lead us to posit that:

**HYPOTHESIS 3** Social ties have a stronger impact than business transaction ties on the emergence of multiplex ties.

Figure 1 provides a graphical summary of our hypotheses.

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Figure 1 about here
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## Methodology

### *Research setting*

We study the emergence of network multiplexity in the context of a geographical cluster of multimedia firms located near the city of Bologna in Northern Italy. Geographical clusters – also called 'industrial districts' (Beccattini, 1979) or 'neo-Marshallian nodes' (Amin and Thrift, 1992) – are spatially concentrated groups of small entrepreneurial firms competing in the same or related industries that are linked through vertical (buyer-supplier) or horizontal (alliance, resource sharing) relationships (Porter, 1998). Several academic disciplines have recently shown renewed attention for such contexts, in the attempt to further explore the link between spatially concentrated industries and the economic prosperity of regions (Maskell, 2001). We believe that geographical clusters provide a fruitful context to address the gaps of the existing literature on multiplex networks and their evolution, since such settings are typically fertile grounds for the emergence of networks in general and, more specifically, of structures featuring multiplex ties. In fact, geographical clusters are commonly envisaged as embedded economies where social relationships – such as friendship and kinship – are entangled with business ones (Breschi and Malerba, 2005), thus resulting in an environment rich in multiplex connectedness where, as Powell and his colleagues suggest, "increasing returns are present in the form of overlapping networks, recombinant projects, personal and professional relationships, and interpersonal trust and reputation, all of which are thickened over time" (Powell et al., 2002). Thus, business ties created in such context are more likely either to be or to become imbued with social meaning that instills expectations of trust and reciprocity into future exchanges. As contexts characterized by a mixture of competition and cooperation, where geographical and cultural proximity facilitates knowledge diffusion and mutual learning among buyers, suppliers, and even competitors (Dei Ottati, 1994; Pyke et al., 1990), geographical clusters are uniquely fit to examine the emergence of multiplex ties. In

fact, the presence of geographical and cultural proximity facilitate opportunities for regular meetings, the emergence of trust among partners, and the use of common practices, which eventually lead to the emergence and strengthening of multiplex ties between organizations.

The higher likelihood that multiplex ties will be present in such *locales* makes them a unique context for studying the emergence and the evolution of network multiplexity. Thus, it is not surprising that some of the insights informing the work on the origin and consequences of multiplex ties – including our own – are grounded in empirical research focusing on locally concentrated industries (Uzzi, 1996, 1997; Grabher, 1993; Lazerson, 1995). For these reasons, we choose this context to test our hypotheses on alternative logics of network multiplexity.

***Data***

All the companies in the cluster we examined are classified by the local Chamber of Commerce, which operates a comprehensive database providing basic demographic information and classification criteria on all firms operating in the area. At the time of the study, it listed 205 multimedia companies in the cluster, grouped into six segments: publishing, audiovisual, computer graphics, communication & advertising, film, and music (see Table 1 for the distribution of firms by segment).

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Table 1 about here
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After contacting all 205 firms, we secured interviews with 89 owners. We piloted our study with seven companies and used information from these initial interviews to inform the final version of our questionnaire. Since we obtained only partial data from nine companies, they were dropped from the study, leaving us with 80 firms in our final sample, which were almost proportionally distributed across the six segments. Companies that refused to be involved in

the study appeared randomly mixed between those not interested in the research and those without time to devote to the interview. Possible non response bias was analyzed by comparing respondents and non respondents in terms of industry segments, founding year, and employees. We collected data on industry segment and founding years for all non responding firms from the InfoImprese database and employee data for only a sub-sample of non respondents for which data were publicly available from the Chambers of Commerce. T-tests revealed no significant differences between respondents and non respondents across these variables, hence suggesting the representativeness of our sample (for a similar approach see what Zaheer et al. 1998).

We conducted two structured face-to-face interviews ranging from 40 to 200 minutes with each of the companies in our sample at two different time points (one in 2001, and the other in 2002). In each case, the respondent was either the firm's founder or co-founder. During the interviews, we asked each informant to provide both relational and attribute data. Our goal in crafting our network questions was twofold. First, we wanted to gather multi-relational data on firms' position in both formal, transaction-type networks and informal, social-type structures. Second, we wanted to track changes in the firms' positions in such networks over time, in order to identify causal relationships between these two types of ties and the emergence of multiplex ties. Thus, we focused on two types of networks: one featuring economic transaction ties (buyer-supplier relationships) and the other social ties (guidance and personal advice). Interviewees were presented with a roster of the cluster's entire population of multimedia firms (i.e., 205 companies) and asked to indicate both their transaction partners (suppliers) and the firms that provided them with guidance and personal advice. The specific questions used to measure the different types of ties can be found in Appendix A.

Given the complexity of sociometric instruments when compared to more traditional

surveys (van Tilburg, 1995) the questionnaires were administered in person so that interviewers could help respondents who needed clarification or assistance in completing the survey. Interviews were carried out early in 2001 (when respondents were asked to report on their networks for 2000 and 1999) and in 2002 (when they were asked about their relational activity in 2001). These network data were then converted into two non-symmetric (i.e., directed) adjacency matrices representing the two types of inter-firm relationships for each one of the three years, resulting in a total of six socio-matrices for our entire analysis period.

***Measures***

***Dependent variable.*** To build the multiplex network we proceeded as follows. First, we assessed the presence of economic ties by asking each firm to indicate which firms were its suppliers over the last year: an economic transaction tie existed from firm A to firm B if the latter indicated the former as one of its suppliers. Then, we assessed the presence of social ties by asking each firm to tell us about the firms to whose members they turned to for guidance and personal advice: a social tie existed from A to firm B if the latter indicated that the former was a source of 'guidance and personal advice'[i]. Finally, we built the multiplex network by joining the two networks resulting out of the economic and the social ties: thus, we considered a tie from firm A to firm B as a *multiplex tie* if A was both a supplier and provided guidance and advice to B.

***Independent variables.*** To test the relevance of the two distinct logics related to tie content – social interaction and economic exchange – on the emergence of multiplex ties, we considered economic and social network ties as potential independent drivers of the emergence and evolution of the multiplex network. Accordingly, we created the two variables *Social* and *Economic*, which reflected the presence of an advice tie and of a supplying tie from firm A to firm B respectively, and allowed us to gauge both the extent to which the

existence of either of these two types of ties at a given time increased the probability of the creation of a multiplex tie from firm A to firm B in the following periods (as predicted in Hypotheses 1 and 2 respectively) as well as the relative magnitude of such effects (as discussed in Hypothesis 3).

***Control variables*.** To rule out possible competing explanations for the emergence of multiplex ties, we included several control variables in our models, which reflect both the influence of endogenous and exogenous variables that may drive their evolution (Lomi and Pattison, 2006; Whitbred et al., 2011).

Endogenous mechanisms are local structures (Whitbred et al., 2011) emerging from the multiplex network itself that drive the emergence and evolution of multiplex ties. *Outdegree* is included to control for actors' general propensities to form multiplex ties to other actors in the network without any specific consideration for any of the dyadic – relational – or triadic – structural – configurations underlying the two different logics (which we specified separately in our models). *Reciprocity* captures the tendency to reciprocate multiplex ties over time. To account for ties' directionality and unpack the mechanisms behind the role of triadic local structures in the dynamics of multiplex networks we control for two distinct network mechanisms, both leading to triadic closure: transitivity and balance (Wasserman and Faust, 1994). In the case of transitivity, a focal firm may create a multiplex tie with a firm to which it is only indirectly connected through a third firm – a possible referrer – with which it has a multiplex connection. Thus, *Transitivity* expresses the extent to which there is a structural tendency towards closed triads in a multiplex network due to an endogenous drive toward transitivity. In the case of balance, the mechanism which may lead a focal firm to create a multiplex tie with a firm it is not yet connected with is their structural equivalence, i.e. the fact that they are both connected with multiplex ties to a third firm, which again may play the referrer role. Thus, *Balance* may be regarded as a measure of

structural equivalence for outgoing ties, or of a focal firm's propensity to establish ties with other firms making its same choices as to multiplex ties. Figure 2 illustrates the difference between these two mechanisms.

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Figure 2 about here
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We also controlled for a series of exogenous variables, i.e. variables driving the evolution of the multiplex network but that do not emerge from the structure of the multiplex network itself. Firms in different sectors may experience different market conditions or competitive intensity; there may also be systematic differences between different segments in terms of the attractiveness of their firms as receivers of multiplex ties. To control for possible differences leading to the evolution of the multiplex network owing to the industry segment in which the firms operated, we included five dummy variables – *Segment (alter)* – capturing sector-specific effects (here, Segment 3 was used as the holdout comparison category). Firm's age appears as a predictor in ecological and life-cycle theories of firm survival, and also serves as a proxy for experience or advantages due to the establishment of internal routines. As past research has also found connections between firm age and network dynamics (Gulati and Gargiulo, 1999), we controlled for age-related differences by including a *Firm Age (ego)* variable in our models, which measures the association between the age of a firm and its propensity to form multiplex ties. Since the endowment of social capital a founding team brings to a venture is likely to increase with the size of the team – a large team might increase the propensity towards reaching out for new partnerships or informal connections due to the sheer number of accrued relational opportunities – we also controlled for team size in our analysis by including *Size of Founding Team (ego)*, a variable that captures the association between the number of individuals in a firm's founding team and its propensity to form multiplex ties. Entrepreneurs may differ in terms of their commitment towards growth and

their propensity to take risks on emerging opportunities. Entrepreneurs who differ on these two dimensions may act differently on the information they come across through their networks and their participation to the life of the cluster. We controlled for this effect by including *Equity Share (ego)*, a variable that measures the differential propensity to form multiplex ties associated with the share of firm's equity owned by the entrepreneur (or the entrepreneurial team) at the founding date: higher equity commitment is consistent with higher risk-taking propensity, resulting in an increased likelihood to be proactive toward the external environment (Miller, 1983). Network evolution may also be influenced by the size of the actors: larger firms may have fewer incentives to reach out for external linkages, while smaller organizations may be much keener to establish ties with them to secure the endorsement and support of more reputed players (Pollock and Gulati, 2007). To account for this possibility, we included the number of employees as a variable in our models, in two different forms: as an ego variable – *Employees (ego*) – which represents the number of employees each firm's had in the previous time period and controls for the association between the size of the firm and the propensity to form multiplex ties, and as a similarity variable – *Employees (similarity*) – which controls for the propensity to form ties to firms of similar size. Inclusion of the previous year's firm size should also help account for the fact that firms may already have had different development trajectories from before the start of our observation period. Finally, *Network Rate 1999-2000* and *Network Rate 2000-2001* are rate parameters which we included to account for the amount of change between two subsequent observations of the network, i.e. the speed at which our dependent variable – the multiplex network – changes. Such rate parameters were calculated separately for each of the two periods, namely 1999-2000 and 2000-2001.

***Estimation procedure***

We modeled the evolution of firms' multiplex network across the three observations – 1999, 2000, and 2001 – as a stochastic process in continuous time, applying the actor-based models of network change introduced by Snijders (2005) and implemented in the statistical software SIENA (Snijders et al., 2008; for recent organizational applications, see Ebbers and Wijnberg, 2010, and Schulte et al., 2012). This modeling approach treats the evolution of the network as driven by the individual changes actors make, one at a time, in their outgoing ties (the ties they 'send' to other actors) – changes such as establishing a new tie or withdrawing (dissolving) an existing one. Actors are assumed to add or remove outgoing ties according to their preferences for alternative local network configurations, formalized as a hypothesized random utility function. Choosing a model of network evolution is equivalent to selecting the components of the utility function that underlies the actors' choices. The parameters associated with the components of the utility function correspond to the hypothesized dynamic tendencies of the network; they are estimated by means of an iterative procedure, which implies many simulations of network evolution between consecutive observations leading to convergence on a set of parameter estimates, based on which a final series of simulations is performed that produces estimates for the standard errors.

These models represent the best choice to model network evolution, as their "parameter estimates provide a model for the rules governing the dynamic change in the network" (Snijders et al., 2010: 57). Based on a discrete choice model of partner selection, they identify which rules the actors in the network follow when deciding whom to connect to, thus offering an opportunity to single out and test the influence of different microfoundations on network emergence. In fact, they owe their name "to the idea of constructing the model as the result of context-dependent choices made by the actors, following up the suggestion by Emirbayer and Goodwin (1994) to combine structure and agency. Actors are thought to

control their outgoing ties." (Snijders, 2011: 146). As they are based on the agency of individual actors (Ebbers and Wijnberg, 2010; Schulte et al., 2012), this makes them the most appropriate models to test for the emergence of multiplex ties[ii].

Now let us review the logic of these models in light of the variables we choose to include in our analyses. The internal logic of SIENA models implies at least the estimation of a number of *Rate* parameters, and the *Outdegree* parameter. A *Rate* parameter is estimated for each period between consecutive observations of the network and measures how frequently actors change their outgoing ties – in other words, the speed of change of the network in each period. Modeling the evolution of a network across *m* discrete observations therefore implies the estimation of *m-1* rate parameters; hence, our models included two rate parameters, for the periods 1999-2000 and 2000-2001. The *Outdegree* parameter is included to account for the observed density of the network (the number of ties) when assessing higher order structural features. This is important because, for instance, the observation of a certain number of transitive triplets (see Figure 2, right side) could be trivial in a network with a very high density, but in a sparse (low density) network could well indicate an important structural mechanism of the network's evolution. Other parameters are almost always included in SIENA models not as much because they are intrinsic to the model's logic, but because they reflect the most classical and widely observed structural tendencies of networks. If ties are 'directed' (i.e., the tie has a sender and a receiver actor), *Reciprocity* is estimated to measure the extent to which a tie sent from actor A to actor B tends to be reciprocated by a tie from B to A. While this parameter refers to pairs, transitive closure involves instead triplets of actors at the micro-level, and holds important macro-structural implications (Granovetter, 1973). We test for the two most widely known and investigated of such mechanisms, by including the *Transitivity* parameter and the *Balance* parameter in our models.

In addition to these structural mechanisms, which are endogenous to the dependent

network whose evolution is modeled (in our case, the multiplex network), exogenous factors also drive network evolution (Whitbred et al., 2011). Such exogenous mechanisms can come from other networks linking the same actors: in our models, these exogenous network influences are captured by the variables *Social* and *Economic.* Exogenous influences can also come from the attributes of individual network actors. Actors' attributes can be included in SIENA models in three different ways. First, when associated with an *ego* effect the parameter of a given attribute measures the tendency of those actors that score highly on that attribute to *send* more ties; this is the case of our *Firm Age*, *Size of Founding Team*, *Equity Share*, and *Employees* variables, which are referred to as *(ego)* in our models. Second, when associated with an *alter* effect the parameter measures the tendency of actors scoring highly high on that attribute to *receive* more ties, as in the case of the *Segment* dummies noted as *(alter)* in our models. Third, when associated with a *similarity* effect the parameter measures the tendency of the network actors to send ties to those who measure similarly – i.e., both high or low – on that attribute; this is the case of our *Employees* variable, which is referred to as *(similarity)* in our models.

## Results

Table 2 presents the distribution of sampled firms by industry segment, and the basic statistics of their attributes that we included in our models: a quick comparison with Table 1 shows that industry segments are represented in the sample more or less proportionately to their weight in the whole population. Firms' age as of 2000 - the central observation year - averages about nine years, the oldest being a photography studio established in 1971. The average size of sample firms is between 13 and 16 employees, and increases across the three observation years. While the three largest firms employ 80 people or more, most sample firms are very small, as 86% of them employ less than 20 people and 70% employ ten or less. The average size of the group of firms' founders is three to four individuals, who typically

still own the majority of the firm's capital; while in only 16% of the firms in the sample their aggregated ownership was less than 50%, in 40% they still owned 100% of the company.

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Table 2 about here
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The correlations of the effects included in Models 1, 2 and 3 are reported in Table 3, while the results from the models we used to test our hypotheses about the evolution of the multiplex network can be found in Table 4[iii]. The convergence of the estimation algorithm was very good for all models, with the t statistics for all parameters well below 0.1, which is the typical convergence threshold in SIENA models.

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Table 3 and Table 4 about here
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In the SIENA models all the parameters are coefficients of the utility function that actors try to maximize by choosing to create new ties, to maintain existing ties, or to terminate them. If a parameter is positive, then there is a higher probability of moving towards a network configuration where that variable has a higher value or, in other words, that the variable associated with such parameter drives network evolution; the opposite is true if the parameter value is negative (Lazega et al., 2011). Model 1 includes all the control variables, some of which are endogenous effects while others are exogenous. Model 2 adds two more endogenous variables, representing the structural effects coming from the multiplex network itself: Transitivity and Balance. Both these variables reflect a firm's tendency to create a multiplex tie with a firm to which it is indirectly connected in the multiplex network via a third firm. Finally, Model 3 adds the Economic and Social variables to Model 2, to estimate the tendency of a multiplex tie to emerge between two firms if either a social or an economic tie is already present between them.

In Model 3 – the full model – most control variables are not significant. The

outdegree parameter remains significant across all models, suggesting that firms are generally reluctant to form random multiplex ties (i.e., of the kind not included in the endogenous parameters present in our models, such as reciprocity or transitivity). This finding is typical in network evolution models, as actors draw no benefit from forming random ties to other network members which are not part of specific local structures. Our models also show that firms have no specific tendency to reciprocate multiplex ties. As for the triadic variables, Model 3 indicates that the transitivity variable is not significant, suggesting that a firm with a multiplex tie to two unconnected firms will not necessarily act as their 'go-between' and trigger the formation of a new multiplex tie between them. On the other hand, the balance variable is significant and negative, thus indicating an aversion of firms to create multiplex ties with firms that are structurally equivalent to them in the multiplex network or, in other words, that have multiplex ties with the same third party firm/s. Taken together, these results provide a more nuanced perspective on how third-party referral networks work, especially with regards to the role played by tie content. By supporting the observation that "triadic closure will not be automatic" (Shipilov and Li, 2012), they further suggest that whether third parties act as a source of multiplex ties between firms depends not only on the structure but also on the nature of the network – tie content and types of nodes – in which the referrer is embedded.

As for the variables underlying our hypotheses, Model 3 shows that the presence of either a social tie or an economic tie between two firms leads to the emergence of multiplex ties between them (both $p < .001$), supporting Hypothesis 1 and Hypothesis 2 respectively. A comparison between the parameters for social and economic ties in our full model (Model 3) shows that the former is 2.14 times – ($\exp(4.95)/\exp(4.19) = \exp(.76) = 2.14$ – larger than the latter ($p < .01$, for the difference between parameters), indicating a stronger impact of social ties on the emergence of multiplex relationships, which provides support for

Hypothesis 3. In short, we find evidence to support all our hypotheses, with both social and economic ties driving the emergence of multiplex ties, and with social ties appearing to have a much stronger influence in this process.

***Robustness checks***

An alternative explanation for the emergence of multiplexity is that ties' duration might be a factor, rather than the sheer presence of a social or economic tie. In other words, if ego and alter have engaged in repeated economic exchanges, they might be more likely to form a social tie; similarly, if they have engaged in repeated social exchanges, they might be more likely to enter into an economic relationship. To test for this possibility, as a robustness check we re-ran our full model using valued social and economic ties as a proxy for their duration. Specifically, after eliciting data on the presence of customer/supplier and advice ties, we asked respondents to indicate which of these relationships they considered to be strong. We opted for a simple dichotomous assessment to mitigate respondents' cognitive burden and reduce the questionnaire's complexity. This is consistent with prior research suggesting that people are remarkably accurate in eliciting their strong relations and distinguishing them from weaker ties (Freeman, Romney, & Freeman, 1987; Marin, 2004) and with previous approaches used to elicit ties' strength (see Granovetter, 1973: 1371). The use of ties' strength as a proxy of tie duration seem reasonable since, ceteris paribus, longer lived ties are likely to be stronger than more recent ones. Results from this model – available from the authors – do not change the support for our three hypotheses. However, while valued social relationships are still more critical for the emergence of multiplex ties than valued economic relationships, the difference in effect shrinks considerably. We take this as a suggestive evidence that ties' strength plays a role in the link between economic ties and multiplexity, with stronger economic ties – perhaps the more successful or the more critical ones – playing a more relevant role in the emergence of multiplex ties. Since we realize that

tie strength as we measured it might capture different features of these ties – such as the extent to which they are repeated ties and successful ties, just to name two of them – future research could disentangle them and test their distinctive effect on the emergence of multiplexity.

An additional concern has to do with the extent to which the likelihood of tie formation might be affected by the nature of the firms involved in a given dyad. More specifically, one could argue that if the actors involved in a dyad are competitors, then this might result in a lower probability they will form an economic or social relationship amongst themselves than with customers and suppliers. Thus, we ran an additional robustness check where we added the control variable *Same segment* to our full model, which captures firms belonging to the same segment and therefore is a proxy for firms competing with each other's. Results from this model – available from the authors – show no significant correlation between *Same segment* and the emergence of multiplex ties and do not change the support for our three hypotheses, thus providing additional robustness to our results.

## Discussion and conclusions

We believe our findings have significant implications for research on network multiplexity and network evolution, as well as more in general for the theory of interorganizational networks. First, our research clarifies and extends the extant literature on network multiplexity (Gimeno and Woo, 1996; Lomi and Pattison, 2006; Rank et al., 2010), providing empirical evidence for the antecedents of multiplex ties. Our results offer large-sample statistical support for the idea that pre-existing personal ties play a critical role in creating multiplex networks (Uzzi, 1997). They also highlight the relevance of ongoing economic transactions in providing a platform for the accrual of benefits that may favor the embedding of economic ties into social relationships, a generative mechanism of multiplex networks

suggested by scholars yet not previously systematically explored, for which we now provide both theoretical clarification and longitudinal statistical validation. This finding is particularly important because it suggests that seeing instrumental economic and affective socio-emotional ties as incompatible with each other (Clark and Mills 1979; Sahlins, 1972) may be debatable: as interactions often change actors' motives, treating them as immutable may be inappropriate. While firms may follow a purely transactional logic in building instrumental ties to gain access to market opportunities, enacting these ties can broaden the narrow aims that may initially have motivated those exchanges because these exchanges can create expectations that are more typically associated with non-economic ties. Our data shows that, even if a relationship emerges from a market-type logic, firms can follow on their initial exchange with expressive bonds that affect their subsequent decisions, and that the trade-off between selfish instrumental interests and an exchange partner's interests can fade as multiplexity kicks in (Uzzi, 1999). Nevertheless, multiplexity seems decidedly more difficult to develop in the absence of a pre-existing social relationship that can help firms interpret mixed signals, transfer values, and monitor each other. Indeed, our findings show that social ties play a much stronger influence – more than twice as strong – than economic ties on the emergence of multiplex relationships, confirming our reasoning on the primacy of the social over the economic logic in shaping the evolution of multiplex networks.

While we found that the presence of social or economic ties makes the emergence of multiplex relationships more likely, this does not equal to say that all social or all economic uniplex ties will develop into multiplex ties. What we point to here is a stochastic tendency for either type of tie to entail another; as Rank and his colleagues eloquently put it, "the idea is that the presence of any particular tie is more likely in the presence of particular configurations of other ties. That this is a statistical tendency is important so that, for instance, the tendency for ties of different types to co-occur does not imply that all or even

the majority of them will do so. It does imply, however, that we expect to see more co-occurrences than would be expected simply on the basis of other features of the network" (Rank et al., 2010: 747). Obviously, social and economic ties are not all intermediary steps in relationships destined for multiplexity: some of these ties will remain purely social (or purely economic) while other will decay, and determining which contingencies will make them stay uniplex or disappear represents a very interesting avenue of research. In addition to the dangers discussed above about overlaying social ties with economic ties, research also provides a more general rationale for not turning uniplex into multiplex ties, by showing the potential downsides of the latter. Padgett and Ansell (1993) discussed how the underlying networks connecting the Florentine oligarch families in Renaissance Florence inhibited them from mobilizing against the ruling Medici family. While the oligarch families were linked to each other mostly by multiplex relations (involving both marriage and economic exchange), the Medicis largely refrained from building multiplex ties, preferring to enact either social (marriage) or economic (business) ties with each family in their network. Multiplex relationships implied increased commitment between the oligarch families (as Padgett and Ansell put it, "the more overlapping ties one has with another, the more closely and holistically bound the other is to you. Obligations from one sphere spill over into another"; 1993: 1280), which restricted the range of strategic response such families could enact in the dangerous and unpredictable political environment of that time. By abstaining from multiplex ties, the Medici instead retained the possibility to enact multivocal behaviors – or "robust action" – which could have been at the root of their ability to retain power for such a long time (Padgett and Ansell, 1993). This is an example of agentic behavior on part of network members which intentionally keeps uniplex ties from becoming multiplex. Such research echoes – and broadens – Ruef's (2002) insights on the limits on actors' behaviors imposed by strong social ties, which underlies the argument against making social relationships

multiplex. While our data do not allow us to test such hypotheses, future research might focus on why we should expect some purely social or economic ties to remain that way. Our speculation is that particularly entrepreneurial individuals, e.g. brokers, may be more skilled at understanding when and where multiplexity may be an asset or a liability, thus being instrumental as to whether or not to push uniplex ties into multiplex ones.

Our findings also highlight the primary role that tie content plays in determining network evolution, opening up an entire set of questions on the relationship between type of ties and network dynamics that might be the object of future research. For example, the type of multiplex ties we examined can be seen as *one* form of multiplexity, where two parties are connected by both a social and an economic tie. However, multiplex ties may not necessarily consists of two different types of relationships – they could be made of several types of either economic or social ties – nor are they limited to the economic and social pattern investigated in our study – other pairs of economic and social ties may configure multiplex ties. While we focused on a very important type of multiplex tie (which represents the backbone of the embeddedness argument) and our research design provides novel directions for exploring network multiplexity, more research is needed to understand the role that tie content plays in the emergence of other types of multiplex ties between organizations, entailing either multiple links of the same type (either social or economic) or different combinations of economic and social ties.

Second, our work contributes to the emerging literature on network evolution. By focusing on the role of tie content in network change, we add to recent developments on the genesis and dynamics of organizational networks (Ahuja et al., 2012) by detailing the role tie content plays as both locus and driver of network change. Although the literature has previously discussed the social interaction logic, we further unpack its role in the emergence of multiplex networks by clarifying the theoretical mechanisms via which it operates, and by

assessing its relative influence as compared to the alternative economic exchange logic. One additional consideration about the two logics we discuss is that they represent two possible drivers of network evolution which we stress are coexisting and not – as the literature might imply – conflicting pathways through which networks might evolve. We suggest that future studies should focus more on their interrelation, for example by examining how they affect each other over time (Rank et al, 2010). Finally, our identification of the specific mechanisms operating within each logic further enriches our understanding of the microdynamics of network evolution. Our focus on mechanisms working at the level of the tie content complements the work of Ahuja and his colleagues, who have theorized the presence of such mechanisms but only focused on those operating at the levels of network node and structure (Ahuja et al., 2012).

Our methodology represents a distinct contribution to the study of both network multiplexity and evolution. The generative mechanisms of multiplexity rest on complex processes operating both at the level of actors' attributes and at the endogenous level of their relationships, and the interplay of these mechanisms makes the disambiguation of causal relationships in the dynamics of tie formation and dissolution particularly hard to pin down (Rivera et al., 2010). Achieving this goal is made more difficult by the methodological challenge of endogenizing network change (Fligstein and Stone Sweet, 2002), due to the composite dependence structure of the tie variables. The statistical modeling approach we followed (i.e., actor-oriented models; Snijders, 2005) offers a distinctive and powerful toolkit for tackling this complexity. It is distinctive because it enables a focus on the evolution of the entire network – while previous research has typically been limited to study the formation of dyadic ties – which can account simultaneously for generative mechanisms across different levels without making unrealistic assumptions of dyadic independence, thus allowing us to model interdependencies and thus assess network evolution properly. It is powerful because

it is based on maximum-likelihood estimation, which has been shown to be superior in estimating network change to the pseudo-likelihood estimators traditionally used for inference from exponential random graph models (van Duijn et al., 2009). While our statistical approach affords several advantages for studying network evolution – and has started to take root in other disciplines (such as sociology and education) – it is still relatively new in the organizational field (for two recent studies using this method in the organizational literature, see Ebbers and Wijnberg, 2010; Schulte et al., 2012). We hope our research will help bring it to the attention of organizational scholars, answering the increasing calls for more dynamic models of social network analysis (Shipilov, 2005; Shipilov et al., 2006).

Our research points to the equifinality of social and economic ties in the emergence of network multiplexity. Katz and Kahn stated that equifinality in organizational settings occurs when "a system can reach the same final state, from different initial conditions and by a variety of different paths" (1978: 30). In line with this definition, we found that both economic and social logics can lead to the emergence of multiplex networks, however, the different origin of multiplex ties may have implications for how resilient they are or for their impact on other organizational outcomes. While social ties play a bigger role in multiplex ties' emergence, they do not necessarily make such ties more permanent nor more consequential for organizations. As our focus was the emergence of multiplexity, we did not evaluate their permanence (i.e. how long such multiplex ties survived before decaying) nor their impact on relevant organizational outcomes such as innovation or financial performance. In fact, there is some indirect evidence suggesting that multiplex relationships emerging out of social ties may be both less stable and less consequential for organizations than those emanating from economic exchanges. The well-known warning "never do business with friends or family" may hint that multiplex relationships developing out of social ties may be less permanent and less beneficial than those arising from economic ties

(Zelizer, 2005). Future studies, especially those with a longer temporal horizon, could specify contingencies affecting resiliency and consequentiality of multiplex ties emerging from the two different types of logics.

We should point out a few limitations to our study. We analyzed a specific phase in the life of an interorganizational network, neither its beginning nor its end; the network we studied had existed for quite a while and was not yet showing signs of decay in its membership or their performance. Thus, our findings apply to an established and consolidated network, which has existed for some years, and whose demise cannot be foreseen in the immediate future. Different dynamics could drive networks evolution in the earliest or final days of their life cycles, and future studies could consider this by purposefully comparing the evolution drivers in networks at different life cycle stages, since as Rivera and his colleagues observed, "it is relatively unknown whether different mechanisms play greater or lesser roles as networks evolve" (Rivera et al., 2010: 108).

Since our first data point (t1) was elicited from our informants at a later point in time (t2), their recollection of relationships could have introduced bias in our data. As reliable and valid measures remove or greatly reduce retrospective bias (Miller et al., 1997), several aspects of our data collections procedure – collecting data on facts (the presence or not of a tie) rather than opinions, using a single item to assess tie presence rather than a scale, asking directly to the individuals involved in the relationships, allowing them not to answer the question if they wanted to, and guaranteeing confidentiality, among other things (see Schilling and Steensma, 2002; Cardinal et al., 2004; Miller et al., 1997; Glick et al., 1990) – give us good reasons to believe that retrospective bias might not have been a problem in our data. This notwithstanding, we ran an additional robustness check where we tested our full model using only data which were elicited from the interviewees in a more traditional manner (t2 and t3). As results from this analysis – available from the authors – did not substantially

differ from those obtained using all our data and still support our hypotheses, in the paper we report analyses using the full dataset.

The choices we made in our data collection process led to a few idiosyncrasies – as it is the case for most empirical studies – that should be noted. First, while using a geographical cluster as an empirical setting provides some clear advantages in investigating the emergence of multiplex networks (as previously discussed), the preponderance of multiplex ties in this type of setting might limit the generalizability of our results to settings where multiplex ties are not so prevalent. Also, while our choice of the type of flows representing economic and social ties is fully justified – for example, using advice flows allows us to capture the information accrual we posited as the mechanism generating multiplexity from social ties – other flows could also capture these ties and provide a slightly different view of the network. For example, mapping cooperation instead of customer/supplier relationships as the economic tie might provide a less hierarchical view of the network, one that privileges both cross- and within-segment (or lateral) collaborations. Finally, while the mechanisms we propose are at work in the two distinct logics, we do not directly measure their relative impact on the emergence of multiplexity and the contingencies that might impact their role. Thus, to strengthen the generalizability of our results beyond the case we analyzed we recommend replicating our analysis using different types of economic and social ties, measuring the impact of the different mechanisms underlying each logic, and investigating settings featuring less drive toward multiplexity than geographical clusters. Among the many markets exhibiting multiplex exchanges, labor markets could be an interesting setting for studying these processes, as research has repeatedly shown the interplay between personal and professional networks in shaping individuals careers: as businesses evolve toward flatter structures, the combined role and interactions of these networks may become even more important (Ingram and Zou, 2008). We hope our initial findings provide new insights on which future micro and macro-level studies of networks and transactions within organizations and markets can build and expand.

## Notes

[i] Although this may be seen as an atypical way to construe a social network, our pilot interviews showed that informants grossly overestimated their advice network when asked which firms they provided advice to, possibly due to the social desirability of being perceived as providing advice. As asking the opposite question - i.e. which firms the focal firm goes to for advice - seemed to yield much better data, we decided to use this question to elicit information on the presence of an advice tie between two firms, which we then used to build the advice network. For consistency reasons, we used the same procedure with the supply network, even though here we had no reasons to expect a difference between the focal firm's assessment of its customers and the customers' assessment of their suppliers.

[ii] Another advantage is that they allow modeling the behavior of individual actors while controlling for network structure (Snijders et al., 2010); this is very important as it allows us "to incorporate a wide variety of actor-driven micro-mechanisms influencing tie formation" (Snijders et al., 2010: 45) and assessing their impact on network formation while at the same time controlling for the emerging structure of the network itself (i.e. its endogenous components). Approaches failing to account for these inherent interdependencies of network data will likely deliver biased results for estimates and standard errors of the tested parameters (Snijders, 2011; Veenstra and Steglich, 2011). Finally, they allow estimating the influence of a given relational effect (e.g., the presence of a social tie) while controlling for other effects (e.g., the presence of an economic tie), since one of their benefits is "the availability of procedures for estimating and testing parameters that also allow to assess the effect of a given mechanism while controlling for the possible simultaneous operation of other mechanisms or tendencies" (Snijders et al., 2010: 45).

[iii] Although included in all our models, we do not report the effects for network rates in our tables in the interest of parsimony, as they have no theoretical significance other than controlling for differences in rate of change between periods.

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**Figure 1** The role of social interaction and economic exchange logics role for the emergence of multiplex ties

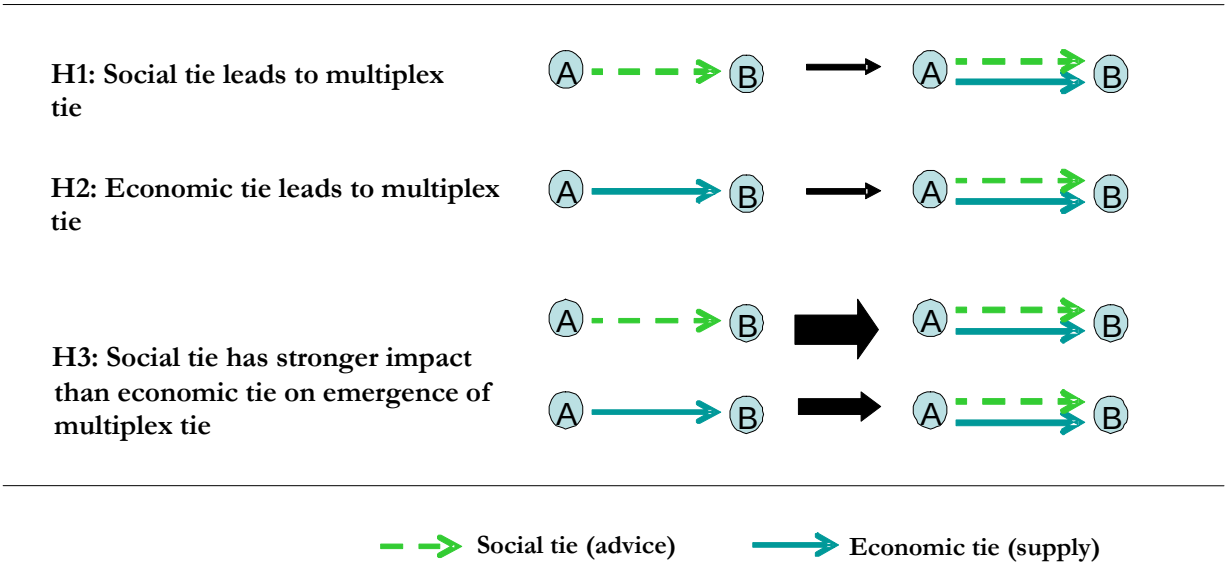

**Figure 2** Transitivity vs. balance as triadic structural mechanisms leading to multiplexity

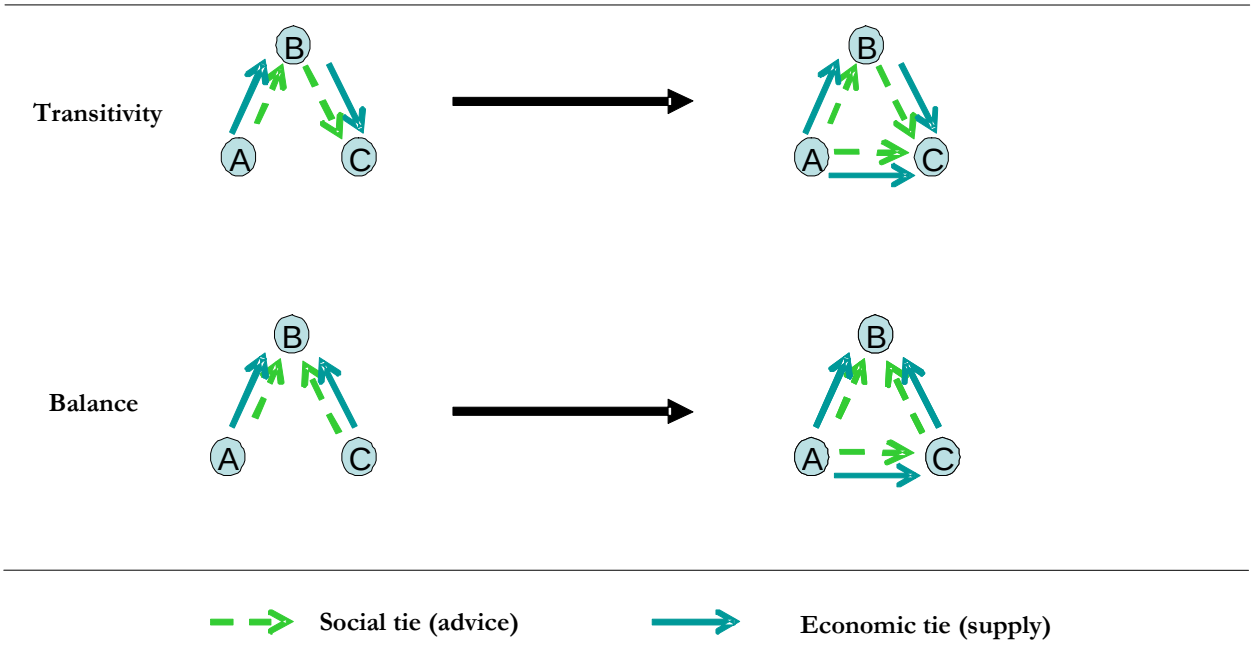

**Table 1** Frequency distribution of cluster-located multimedia firms by industry segment

| Industry segment | No. of firms (%) |
|---|---|
| 1. *Publishing* | 31 (15%) |
| 2. *Music* | 24 (12%) |
| 3. *Film* | 11 (5%) |
| 4. *Audiovisual* | 56 (27%) |
| 5. *Computer graphics and multimedia software* | 57 (28%) |
| 6. *Advertising and communication* | 26 (13%) |
| *Total* | 205 (100%) |

**Table 2** Frequency and mean attributes of sampled firms by segment

| | N (%) | Firm Age (SD) | Size of Founders' Team (SD) | Founder(s) Owned Equity (SD) | Employees in 1999 (SD) | Employees in 2000 (SD) | Employees in 2001 (SD) |
|---|---|---|---|---|---|---|---|
| *Segment 1* | 10 (12.50%) | 11.10 (6.90) | 4.56 (3.00) | 0.76 (0.23) | 14.20 (9.61) | 17.80 (12.75) | 23.60 (18.34) |
| *Segment 2* | 10 (12.50%) | 14.40 (8.24) | 3.10 (2.18) | 0.55 (0.35) | 9.40 (10.30) | 11.30 (9.62) | 10.50 (9.48) |
| *Segment 3* | 5 (6.25%) | 4.80 (4.92) | 2.75 (2.36) | 0.60 (0.31) | 16.80 (19.74) | 16.80 (19.77) | 16.60 (19.92) |
| *Segment 4* | 22 (27.50%) | 12.27 (7.91) | 3.38 (2.69) | 0.66 (0.28) | 12.14 (20.17) | 12.86 (20.00) | 13.27 (19.72) |
| *Segment 5* | 20 (25.00%) | 3.75 (3.11) | 2.80 (1.74) | 0.67 (0.39) | 6.45 (4.02) | 7.35 (4.87) | 8.15 (4.25) |
| *Segment 6* | 13 (16.25%) | 11.77 (8.76) | 4.82 (3.57) | 0.85 (0.28) | 24.92 (38.03) | 27.85 (37.43) | 29.77 (37.46) |
| *Total* | 80 (100.00%) | 9.71 (7.81) | 3.51 (2.61) | 0.69 (0.32) | 13.00 (20.28) | 14.59 (20.48) | 15.83 (21.20) |

**Table 3** Correlation matrix

| Variable | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Outdegree | | | | | | | | | | | | | | | |
| Segment 1 (alter) | 0.03 | | | | | | | | | | | | | | |
| Segment 2 (alter) | -0.04 | 0.40 | | | | | | | | | | | | | |
| Segment 4 (alter) | 0.17 | 0.47 | 0.52 | | | | | | | | | | | | |
| Segment 5 (alter) | 0.19 | 0.42 | 0.44 | 0.56 | | | | | | | | | | | |
| Segment 6 (alter) | 0.04 | 0.41 | 0.40 | 0.43 | 0.42 | | | | | | | | | | |
| Firm Age (ego) | 0.09 | -0.10 | -0.18 | 0.04 | 0.00 | -0.05 | | | | | | | | | |
| Size of Founding Team (ego) | -0.34 | 0.03 | 0.02 | -0.06 | -0.03 | 0.05 | -0.23 | | | | | | | | |
| Equity Share (ego) | -0.04 | -0.08 | -0.01 | -0.03 | -0.05 | -0.07 | 0.16 | 0.06 | | | | | | | |
| Employees (ego) | -0.12 | 0.08 | 0.02 | -0.03 | -0.01 | -0.07 | -0.10 | -0.22 | -0.07 | | | | | | |
| Employees (similarity) | -0.11 | 0.07 | -0.02 | -0.09 | -0.08 | 0.05 | -0.14 | -0.01 | 0.01 | 0.48 | | | | | |
| Reciprocity | 0.04 | -0.09 | -0.02 | -0.08 | -0.09 | -0.15 | 0.05 | -0.05 | 0.01 | -0.04 | -0.13 | | | | |
| Transitivity | -0.25 | -0.13 | -0.14 | -0.24 | -0.19 | -0.05 | -0.07 | 0.03 | 0.23 | 0.01 | 0.02 | -0.06 | | | |
| Balance | 0.51 | -0.03 | -0.14 | 0.15 | 0.02 | -0.12 | 0.02 | -0.17 | -0.19 | -0.09 | 0.05 | 0.07 | 0.04 | | |
| Social | -0.43 | 0.10 | 0.11 | 0.01 | 0.02 | 0.02 | -0.26 | 0.10 | 0.04 | 0.11 | 0.14 | -0.15 | 0.06 | -0.04 | |
| Economic | -0.25 | 0.03 | 0.11 | 0.00 | 0.08 | -0.14 | -0.10 | 0.03 | -0.07 | 0.14 | 0.00 | -0.01 | -0.13 | -0.03 | 0.28 |

**Table 4** SIENA models for evolution of multiplex ties (1999-2001)

| | **Model 1** Controls | | | **Model 2** Controls Structural Mechanisms | | | **Model 3** Controls Structural Mechanisms Social and Economic Ties | | |
|---|---|---|---|---|---|---|---|---|---|
| | Estim. | SE | p-value | Estim. | SE | p-value | Estim. | SE | p-value |
| Outdegree | -3.52 | 0.57 | <0.001*** | -3.98 | 0.49 | <0.001*** | -5.16 | 0.62 | <0.001*** |
| Segment 1 (alter) | -1.19 | 0.80 | 0.138 | -1.16 | 0.85 | 0.173 | -0.58 | 0.98 | 0.555 |
| Segment 2 (alter) | -0.81 | 0.80 | 0.312 | -0.79 | 0.78 | 0.309 | -0.30 | 0.93 | 0.744 |
| Segment 4 (alter) | -0.69 | 0.62 | 0.267 | -1.21 | 0.70 | 0.082 | -1.05 | 0.68 | 0.125 |
| Segment 5 (alter) | -1.43 | 0.73 | 0.050 | -1.73 | 0.79 | 0.029* | -1.14 | 0.85 | 0.183 |
| Segment 6 (alter) | -0.76 | 0.81 | 0.348 | -0.66 | 0.79 | 0.406 | -0.37 | 0.92 | 0.689 |
| Firm Age (ego) | 0.02 | 0.06 | 0.797 | 0.00 | 0.04 | 0.925 | -0.04 | 0.05 | 0.446 |
| Size of Founding Team (ego) | 0.11 | 0.14 | 0.402 | 0.14 | 0.11 | 0.177 | 0.21 | 0.13 | 0.101 |
| Equity Share (ego) | -1.18 | 1.52 | 0.438 | -0.53 | 1.05 | 0.612 | -0.32 | 1.25 | 0.796 |
| Employees (ego) | 0.00 | 0.04 | 0.899 | 0.01 | 0.03 | 0.705 | 0.01 | 0.03 | 0.644 |
| Employees (similarity) | 2.82 | 2.64 | 0.286 | 2.58 | 2.41 | 0.285 | 2.77 | 2.23 | 0.213 |
| Reciprocity | 0.50 | 0.89 | 0.576 | 0.20 | 0.97 | 0.836 | -0.64 | 0.85 | 0.454 |
| Transitivity | | | | 1.43 | 0.54 | 0.008** | 1.24 | 0.77 | 0.108 |
| Balance | | | | -0.20 | 0.07 | 0.002** | -0.22 | 0.07 | 0.002** |
| Social | | | | | | | 4.95 | 0.75 | <0.001*** |
| Economic | | | | | | | 4.19 | 1.17 | <0.001*** |

* $p < .05$, ** $p < .01$, *** $p < .001$

# Appendix A

## Relational questionnaires: Sociometric questions

For each of the following sociometric questions, firms were provided with a complete roster of the multimedia firms located in the geographical cluster under analysis (the 'Bologna Multimedia Cluster').

Economic tie

Thinking of your business transactions with other firms in the cluster community over the past year, could you indicate which firms were among your suppliers, among those indicated in the list? Please check off the cells in correspondence of the firms that you recognize as parties of your supply-network among those in the list we provided. If there are other suppliers in addition to those provided in the list, please include them at the end of the document.

Social tie

Thinking of the informal ties with other members of the cluster community over the past year, could you indicate what are the firms, among those provided in the list, whose members (one or more) you know personally and turn to for guidance and personal advice? Please check off the cells corresponding to these firms in the list we provided. If there are companies to whose members you turned for guidance and advice in addition to those provided in the list, please include them at the end of the document.

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