The impact of interdependencies on management accounting information in manufacturing networks: a Social Network Analysis approach

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I. INTRODUCTION

In recent years, a considerable number of authors have focused their research efforts on management accounting information exchanges in inter-firm relationships. Some of them have specifically attempted to investigate the use of management accounting *techniques* in boundary-spanning contexts (e.g. Ellram and Siferd, 1998; Degraeve et al., 2000; Anderson et al., 2000; Dekker, 2003; Cooper and Slagmulder, 2004; Wouters et al., 2005). Some others have explored the *roles* that management accounting may play in the control of inter-organizational settings (e.g. Ittner et al., 1999; Tomkins, 2001; Baiman and Rajan, 2002; Kulp, 2002; Coletti et al., 2005). Specific issues addressed by the accounting literature have been the make-or-buy decision and outsourcing of activities (Anderson et al., 2000; Gietzman, 1996; Mouritsen et al., 2001; Van der Meer-Kooistra and Vosselman, 2000;Widener and Selto, 1999), inter-organizational cost management (Carr and Ng, 1995; Cooper and Slagmulder, 1999), open book accounting and total cost of ownership in supply chain relationships (Frances and Garnsey, 1996; Ittner et al., 1999; Seal et al., 1999), information exchanges in alliances and business networks (Dekker, 2003; Tomkins, 2001) and value chain analysis (VCA) (Shank, 1989; Shank and Govindarajan, 1992, 1993).

These contributions generally share a common interest in understanding the benefits deriving from the exchange of management accounting information between entities that, at an inter-organizational level, share resources and make investments to pursue common specific goals

and undertake joint transactions, and that are therefore linked by significant and durable mutual interdependencies. For example, Dekker (2004) suggests that an increasing sophistication of joint information processing requirements is the result of higher levels of inter-firm interdependence and leads to an extensive use of more complex formal control mechanisms, to successfully manage the relationship with the partners. Cooper and Slagmulder (2004) maintain that arm's-length contracts work well when the interactions between the parties are straightforward, but not when they are highly interdependent. In the former case, only the quantity, price, quality, and delivery times need to be specified, whereas in the latter it is necessary to exchange cost management information at an inter-organizational level during the development of the relationship. Mouritsen (2001) shows how the sharing of accounting information between collaborating firms makes it possible to control and manage the interdependence emerging from the pursuing of production flexibility through outsourcing initiatives.

However, the scope and depth of extant findings have been highly constrained by the conceptualization of interdependence and the unit of analysis as well as the methodological choices adopted by previous contributors: not only empirical investigation has been usually carried out with reference to dyads and/or from just one company perspective[1] but also the observations and explanations have been mainly provided uniquely at the firm level of analysis[2]. These orientations have prevented researchers to grasp the complete picture and account for the heterogeneity of management accounting information exchanges taking place between different actors at an inter-firm level for two reasons. Firstly, because the inter-organizational relationships that have been investigated are not on a dual basis but embedded in a network of partners. Secondly, because information exchanges do not occur between "organizations" but between "individuals" who, despite being part of the same organization, may entertain relationships with very different characteristics.

Our paper aims to overcome these limitations by proposing a multidimensional conceptualization of interdependence, and by using a method that is novel to the accounting discipline. The definition of interdependence adopted will take into consideration different aspects of mutual dependence in inter-firm relationships, i.e. workflow interdependence, interaction interdependence, asset interdependence and contractual interdependence. The

[1] For instance, Cooper and Slagmulder (2004) focused primarily on the Komatsu-Toyo dyadic pair while Mouritsen (1999) and Dekker (2004) analyze open book accounting mainly from the viewpoint of a firm's internal and dyadic partnership.

[2] Wouters et al. (2005) assume the point of view of purchasing decision-makers in examining the reasons for successful adoption of a total cost of ownership; similarly, Ittner et al. (1999) assume the purchasers' perspective for understanding the effects of non-price selection criteria, supplier certification, and supplier interactions on the buying firm's performance.

method used for our empirical study is social network analysis. This latter provides analytic concepts and a set of tools that are distinct from those of traditional statistics as they have been conceived in order to study interdependent observations, being in this way particularly suitable to investigate networked contexts characterized by the interrelatedness of actors. To our ends, this approach is particularly powerful because it allows us to regard all the network relationships as a whole, at the same time and with all their reciprocal influences. In this way, we do not describe each pair or different pairs of relationships at a time, as done in previous contributions and as enabled by conventional statistical analysis[3], but we analyze *simultaneously* the *entire set* of actors involved in networked management accounting information exchanges, thus integrating and extending the findings of previous literature.

Consistent with the ideas discussed above, our contribution applies social network analysis to answer the following research question: what, if any, is the relationship between interdependence and the configuration of management accounting information[4] exchanges at the network level? With this aim, we develop a model that incorporates the link between different dimensions of interdependence and the detail and frequency with which the actors of the network reciprocally communicate management accounting information. The model suggests that the higher the level of interdependencies, the higher the detail and frequency of management accounting information exchanges. We test our predictions using survey data from 1,596 relationships representing a whole manufacturing network of firms operating in the fashion industry. The research is based on this setting because fashion firms are at the forefront experimentation with networked organizational solutions as they have traditionally been 'outsourcing' non-core production activities and been entering into shared, cooperative agreements with "suppliers" to carry out their operations. These firms are also particularly interesting because they have been recently revising their supply chain partnerships/alliances due the need to reduce their delivery times and costs, while at the same time maintaining high product quality and variety (Leung and Yeung, 1995; Forza and Vinelli, 1996; Ko et al., 2000; Lin et al., 2002).

[3] In this way it is possible to include in our investigation the impact that other actors and/or relationships in the network have on the relationship under analysis and their differential influence on the overall management accounting information exchanges. In fact, the management accounting information exchanges taking place between two firms cannot be simply represented and understood with reference to only some of the actors of the two firms, because these exchanges can be affected – either replaced or integrated – by other exchanges occurring between different actors belonging to the same organizations.

[4] When we refer to management accounting information exchanges we mean the provision of periodic financial information that is either used by accountants or other decision-makers to set direction, make decisions and achieve desired goals (Banker et al., 1993).

Our findings support the hypotheses that management accounting information exchanges increase both in detail and frequency with the rise of interdependencies between the actors in the manufacturing network. From our study, we therefore offer some insights for theory and research on the design of management accounting information exchanges in integrated and coordinated manufacturing networks of organizations.

The paper is organized as follows: in the second section we review the relevant literature on interdependence and management accounting information exchanges and we develop the hypotheses of our model. In section three we define and operationalize the variables under study, while in section four we describe our research setting and the research procedure we adopted. The following section is devoted to the description of the method employed to test our hypotheses, i.e. social network analysis. Finally, sections six and seven deal respectively with the presentation and the discussion of our results.

II. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

II.1) INTERDEPENDENCE AND MANAGEMENT ACCOUNTING INFORMATION EXCHANGES

A core idea of management accounting, derived from organization theory (March and Simon, 1958; Thompson, 1967), is that interdependence is a key determinant of control choices in a context of interacting units. Thompson (1967) was the first author to define this variable and his framework has been taken as a reference point by several accounting researchers that have identified interdependence as a relevant dimension for explaining management accounting systems configuration. According to this author there are three types of interdependence - pooled, sequential and reciprocal – that are referred to the patterns of *work flow* that can exist between units. Pooled interdependence is defined as a relation in which 'each part renders a discrete contribution to the whole and each is supported by the whole'. It is the lowest form of interdependence because the units are relatively autonomous, and their work flows are either absent or limited. Sequential interdependence involves linkages between organizational units in a serial fashion. It refers to a unidirectional exchange pattern where each unit's inputs are the outputs from another unit and similarly, each unit's outputs are another unit's inputs. Therefore, each unit completes its work by depending on work from preceding units. Finally, the highest form of interdependence is the reciprocal one. It represents a contingent pattern characterized by the movement of work back and forth among units in a reciprocal fashion. In this case, organizational units typically work jointly on the same project or customer.

At an intra-organizational level, Chenhall and Morris (1986) are among those who more closely studied the relationship between interdependence and the design of management accounting systems (MAS)[5]. To analyze such link, the configuration of MAS was defined in terms of the perceived usefulness of some management accounting information characteristics. These include, first of all, the *scope*, referred to the dimensions of focus, quantification, and time horizon (Larcker, 1981; Chenhall and Morris, 1986).[6] Secondly, the *timeliness*, intended as the frequency and the speed of reporting systematically collected information. Thirdly, the *levels of aggregation,* ranging from basic and unprocessed data to different aggregations around time periods or areas of interest, such as functions or responsibility centers.[7] Finally, the *integration*, related to the presence of information assisting coordination, i.e. the specification of precise targets for activities and their interrelationship within sub-unit, or the definition of measures for reporting intra-sub-unit interactions. The authors showed that high levels of organizational interdependence between sub-units are to be assisted by broad scope, aggregated and integrated information.

At an inter-firm level, the issue of interdependence and management accounting information exchanges has only recently received attention. For example, Tomkins (2001) theoretically argued that the stages of the inter-organizational relationships are characterized by different degrees of interdependence which, in turn, require different volumes of information. The information received in one stage determines whether there will be progression to a higher state of interdependence and trust intensity as the relationship matures. Dekker (2004) empirically showed that the tasks characterised by a limited degree of interdependence (sequential) require timely information to coordinate joint action, while those with higher levels of interdependence (reciprocal) need a more intensive and broader set of information to manage cross-boundary activities. Both authors seem to agree that up to a certain point the higher the level of interdependence between associated parties, the higher the intensity of information exchanges.

Yet, these contributions have some pending limitations and leave some problems open. None of the conceptualizations of interdependence proposed by the authors are completely satisfactory as they both focus only on specific dimensions of the concept and do not allow an assessment of differing amounts of interdependence. In fact, Tomkins (2001) does not provide any specific definition of interdependence and also he does not offer any indication of the items or

[5] On the design of management accounting systems see also: Gordon and Miller, 1976; Otley, 1980; Merchant 1981; Gordon and Narayanan, 1984.

[6] Broad scope management accounting information exchanges incorporate information related to the external environment, non-monetary measurements and probabilistic estimation of the likelihood of future events occurrence. Conversely, narrow scope management accounting information exchanges focus on events within the organizations, are quantified in monetary terms and relate to historical data.

[7] Aggregated information may also refer to data that are elaborated in formats consistent with specific decision models, such as DCF analysis, CVP analysis and so on.

dimensions that may contribute to quantifying the level of interdependence, nor he suggests any explicit measure, simply assuming that there is an increasing amount of interdependence as the relationship between parties develops. Also the definition proposed by Chenhall and Morris (1986) and Dekker (2004) – despite less ambiguous – is not completely satisfactory. Consistent with Thompson (1967), they focus only on one aspect of interdependence – namely work flows – and suggest an operationalization of interdependence that is at best ordinal. The amount of interdependence in a pooled process is considered lower than the amount of interdependence in a serial process, and both pooled and serial processes signify less interdependence than a reciprocal process, but how much more or less characterizes these differences is not specified.[8] These limitations have made the operationalization difficult and the interpretation of results confusing, hence, preventing our full understanding of the role that interdependence plays in explaining management accounting configurations both in intra and inter-organizational settings.

Our paper provides an alternative and more comprehensive framework for conceptualizing interdependence and considers this concept rather broadly, in an attempt to determine which aspects, if any, are related to management accounting information exchanges at an inter-firm level. With this aim, we choose to conceptualize interdependence in a way that allows us to investigate its different aspects and to operationalize it coherently with the need to differentiate explicitly between its varying degrees of intensity. We thus conceive interdependence as including the following dimensions: (1) workflow interdependence; (2) interaction interdependence; (3) asset interdependence; (4) contractual interdependence.

Workflow interdependence is the extent to which actors are dependent upon one another as they need to acquire inputs from other actors to start, to further or to complete their working activities (Thompson, 1967; Daft and Macintosh, 1987; Gresov e Stephens, 1993; Bensaou and Venkatraman, 1995; Abernethy et al, 2004,). *Interaction interdependence* is the degree in which parties need to jointly spend time in interacting with each other in order to manage the relationship or to accomplish their work. *Asset interdependence* refers to the extent to which parties have made major investments specifically for sustaining their relationship (Bensaou and Venkatraman, 1995). [9] *Contractual interdependence* refers to the extent to which parties have committed themselves to specific terms of the relationship that have been explicitly formalized in a contract. In this case, interdependence is not rooted in the characteristics of the workflows,

[8] Also McCann and Galbraith (1981) challenged the utility of Thompson's construct by asking, "are three pooled interdependencies greater or less than one reciprocal interdependency?" (p. 64).

[9] While traditionally, the two latter types of interdependence were assumed to be absent in markets and intensive in hierarchies, with the emergence of inter-organizational arrangements, we believe that they should be distinguished from workflow interdependence and measured specifically.

the time spent or the investments made for the relationship, but is the result of a formal engagement.

II.2) HYPOTHESES DEVELOPMENT

Drawing on these premises, we investigate the impact of interdependencies on management accounting information exchanges configuration at the inter-firm level. We predict that the amount of management accounting information exchanged (*multiplicity*) and the occurrence with which it is systematically transferred between parties (*frequency*) are dependent on the type and intensity of inter-organizational interdependencies. These relationships are expected to be positive except for contractual interdependence. More specifically, in a context of relevant workflow interdependence, the amount and frequency of management accounting information at an inter-organizational level are expected to be high to deal with coordination problems, related to the need to maintain the flexibility to adjust and at the same time reduce discrepancies in the quality and use of the resources transferred between the actors (Chapman, 1998; Dekker, 2003; 2004). In a context of relevant interaction interdependence, the amount and frequency of management accounting information exchanges are expected to be high to verify the exact causes of potential failures and to identify responsibilities, which are particularly difficult to detect in a context of joint working activities (Seal et al., 1999). When facing high asset interdependence, the mutual dependence deriving from joint investments creates lock-in relationships which represent a fertile ground for opportunistic behaviour that can be prevented or detected by using broad and frequent management accounting information exchanges (Baiman and Rajan, 2002). Finally, the more the terms of the relationship are formalized in a contract, the less the need of multiple and frequent management accounting information exchanges to safeguard against false or empty threats and promises concerning future conducts (Tomkins, 2001).

The following two equations summarize our conceptual model:

> Multiplicity = f (workflow interdependence, interaction interdependence, asset interdependence, contractual interdependence)

> Frequency = f (workflow interdependence, interaction interdependence, asset interdependence, contractual interdependence)

Other variables that prior literature has considered as potentially relevant in explaining the relationship between our dependent and independent variables (i.e. size, value of exchanges,

industry, performance and information technology) have been evaluated but not included in the model because they are homogeneous across our sample.[10]

III. EMPIRICAL VARIABLES

The issues of operationalization and measurement were dealt with in two ways: (1) for those variables that were previously employed in research settings, we adopted the measures as long as they fitted in our theoretical framework and we slightly modified them for use in an inter-organizational context; and (2) for those variables that were unique to the conceptual model developed here, we introduced operational measures that were assessed for content validity through interviews and discussions with managers in the field (Venkatraman and Grant, 1986). Where possible, we used "harder" data (i.e. more objective, quantitative data rather than perceptions and opinions) to support the validity of our measures (Ittner and Larcker, 2001). In addition, the constructs of the model were operationalized along multiple dimensions most of which were measured using different items.

III.1) THE INDEPENDENT VARIABLES

We measured four primary types of inter-firm interdependence: (1) workflow interdependence; (2) interaction interdependence; (3) asset interdependence; and (4) contractual interdependence. The measurement of the constructs is discussed in turn.

Workflow interdependence: we measure the workflow interdependence using an adapted version of the Gresov and Stephens (1993) instrument. We attempted to capture the construct through five items. We asked individuals to indicate, along a Likert-type scale of 0 to 5, where 1 = not at all and 5 = very much, how much they rely on other individuals, firstly, to obtain the material inputs needed to start their work, secondly, to further it, and, finally, to complete it.

Interaction interdependence: this concept was operationalised drawing on Bensaou and Venkatraman (1995)[11] as follows: individuals were asked to assess the amount of time (in percentage of total annual work time) they spend to manage the relationship with the partner,

[10] Information about these variables have been collected both with specific items in the questionnaire and through the interviews part of our pilot study.
[11] In contrast to the proposal of Bensaou and Venkatraman (1995), we asked the amount of time spent for/with the partner to perform their individual jobs instead of using a Likert-type scale.

and the amount of time (in percentage of total annual work time) spent working jointly with the partner.

Asset interdependence: we captured this concept drawing on Bensaou and Venkatraman (1995). The construct was measured by asking respondents, firstly, to indicate the amount of time (as a percentage of the total work time in the year the relationship started) spent in learning competencies, procedures, and work practices to interact with the partner. Secondly, we also asked the amount of investments in infrastructures, machineries and equipment expressed as a percentage of the total investments of the company.

Contractual interdependence: in line with Gresov and Stephens (1993), we operationalised this construct by asking individuals to indicate, on a Likert-type scale of 0 to 5, where 0 = not at all and 5 = very much, the extent to which the terms of the relationship have been explicitly formalized in a contract.

The operationalization scheme for each variable is summarized in Table 2.

III.2) THE DEPENDENT VARIABLES

To assess the configuration of inter-organizational management accounting information exchanges, a set of questions suited to our study was constructed. Our aim was to overcome the limitations of previous contributions on the topic, by proposing more refined and accurate measures to empirically capture the properties of inter-organizational management accounting information exchanges. In fact, by reviewing related extant studies, we noticed that contributors mainly used arbitrary response scales and ordinal levels of measurement. Chenhall and Morris (1986: 24) operationalised the managers' perceptions of the information characteristics of MAS – scope, timeliness, aggregation and integration – using a five-point scale self-scoring instrument comprising 24 items. Kulp (2002) measured two accounting information properties, i.e. precision and reliability, respectively, through 4 items detailing the extent to which retailers share accounting information with manufacturers, each measured on a six-point scale, and through seven yes/no responses.[12]

[12] With reference to manufacturer-retailer relationships, Kulp (2002) pointed to two important characteristics of inter-organizational accounting information sharing: *information precision*, which is the level of detail with which the retailer chooses to disclose internal accounting information to the

In order to minimize subjectivity and arbitrariness inherent in previous studies and collect more objective, "harder" data, we decided to define two indexes to objectively quantify, at a ratio level of measurement, management accounting information exchanges properties. These latter are referred to:

Multiplicity, which reflects the numerousness of the different pieces of management accounting information shared between actors at the inter-organizational level. The index comprises twenty items detailing the possible pieces of management accounting information that actors may exchange during their interactions. The higher the number of pieces of information that flow between actors, the higher the multiplicity of management accounting information exchanges. It should be noted that the items included to measure the multiplicity variable are those typical of the empirical setting under analysis. These items were defined through a pilot study[13]: the repeated interviews with the key actors of the research setting were used not only to identify the spectrum of management accounting information at its broadest, but also to identify the level of aggregation of the pieces of information exchanged within the network. [14] More specifically, the index is calculated as follows:

$$Multiplicity = \sum_{i=1}^{20} (i \times d)$$

Where d is equal to: 0 when i is not exchanged
1 when i is exchanged

This index goes from 0, when no piece of information is exchanged, to 20, when all the pieces of information are exchanged.

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manufacturer, and *information reliability*, i.e. the ability of the manufacturer to correctly capture the retailer's internal accounting information and thus incorporate it into his decision making.

[13] In order to define these indexes, we used a pilot test. A set of questions was firstly developed for the two properties of inter-organizational management accounting information exchanges from discussions with numerous management accountants and academics in the early stages of the research. After this considerable testing, during which the questionnaire items were redefined and reduced in number, our pilot study was carried on through semi-structured interviews with the Managing Director, the CFO and the COO as well as with other operations and commercial managers of the firm. Such repeated discussions were undertaken to guarantee that our variables were relevant to the specific setting we wanted to investigate and to prevent any ambiguity in the wording of the measures.

[14] The setting under investigation is a manufacturing network, therefore the management accounting information considered to measure "multiplicity" was that of a manufacturing environment. The specific issue of which pieces of management accounting information and which level of aggregation to include in the measurement of multiplicity was not solved at a theoretical level, but empirically through the pilot study.

Frequency relates to the rate of recurrence with which each piece of management accounting information is exchanged between actors at the network level, and includes six possible categories, ranging from daily frequency to yearly frequency. We constructed a "weighted" frequency index where the numerator is represented by the sum of the different pieces of information actually exchanged multiplied by the number of times a year each of them is exchanged (i.e. a yearly frequency equals 1, a daily frequency equals 365). The denominator is calculated by multiplying the maximum number of the different pieces of management accounting information that may be exchanged (i.e. 20) by the highest frequency (i.e. 365). More specifically, the index is calculated as follows:

$$Frequency = \sum_{i=1}^{20} (i \times f) / (20 \times 365)$$

Where *f* is equal to: 0 when *i* is not exchanged
1 when *i* is exchanged yearly
2 when *i* is exchanged biyearly
4 when *i* is exchanged quarterly
12 when *i* is exchanged monthly
52 when *i* is exchanged weekly
365 when *i* is exchanged daily

This index goes from 0, when no piece of information is exchanged, to 1, when all the pieces of information are exchanged daily.

IV. RESEARCH SETTING AND RESEARCH PROCEDURE

IV.1) RESEARCH SETTING

The required data for our analysis were collected from the fashion industry in Italy. The suitability of this setting to study inter-organizational relationships is due to the following considerations: Italian fashion houses have introduced innovative organizational solutions, able to reconcile flexibility with almost limitless production capacity and class products. Being tightly embedded in a set of local or regional industrial districts, they develop regular partnerships and subcontract a large portion of their manufacturing operations, maintaining in-house only a few functional activities and product lines. With their partners they form manufacturing networks, in which they share resources, make common investments and undertake joint transactions. Therefore they are linked by mutual interdependencies and need to keep strict monitoring over the entire set of activities along the value chain. These

manufacturing networks are considered as an "ideal type" both in the literature and in practice (Duelic and Ainamo, 1999; Ko et al., 2000; Lin et al., 2002), which makes their analysis particularly appealing to our ends.

Our study was conducted in the manufacturing network of a fashion firm. This firm operates in the luxury goods industry and is one of the largest cashmere manufacturers and of the biggest purchasers of the world's finest wools. It counts more than 1,700 employees worldwide and is structured into two specific business sectors, textile and luxury goods. This latter is in charge of the design and production of exclusive sportswear collections for men and women, knitwear, accessories, home, bags, small leather goods, and made-to-measure services, distributed through directly-operated and specialty stores. The collection of data for our analysis was carried out in the knitting division of this business sector and its whole set of subcontractors. These manufacturing partners, operating as outsourcees of specific stages of the knitting process, are small businesses, both in terms of revenues and employees, and present similar financial performance results.

IV.2) RESEARCH PROCEDURE

Methods of data collection

Our field work was carried out in the following way. First, we conducted a pilot study through a set of interviews with the senior managers in the fashion firm responsible for the relationships with subcontractors. These interviews were focused at two functions that were considered to be most critical for the interaction with the partners, operations and commercial, as well as at some key managers, i.e. the Managing Director, the CFO and the COO. They were exploratory in nature and aimed at achieving several objectives: (a) mapping the entire set of actors in the manufacturing network - within both the fashion firm and the subcontractors - interacting with each other in the process of executing and completing manufacturing activities. This map was produced by asking operations and commercial managers to report on their internal and external ties, and the ties that exist among the individuals they chose or nominated (Wasserman and Faust, 1999). These ties were then checked in a succeeding step with a questionnaire; (b) understanding the organizational context and the practices used in the network to reciprocally monitor actors' activities; (c) identifying the types of accounting information exchanges taking place between the individuals in the network and assessing the role and importance of information technology and other communication mechanisms in their reciprocal interactions.

Subsequently, we developed a structured questionnaire to collect data on the dependent and independent variables. The questionnaire was organized in three different sections: in the first

section, a set of questions were directed at collecting information on the respondents' characteristics (name and organizational position) and on the features of their firms (revenues, personnel, financial performance). The second section was focused on the management accounting information exchanges (multiplicity and frequency) taking place between actors. Finally, the last section included questions on the characteristics of the relationships between actors in the network, and was aimed to grasp the level of interdependencies between them. Pre-tests of the instrument were conducted with the operations manager. A focus group was also organized with presentations and interviews with potential respondents (those of the knitting division of the fashion firm). This was meant to review questionnaire items to ensure that the target informants in the fashion firm were interpreting them as intended. Since the people of this focus group would then submit the questionnaire to the actors of the subcontractors, the correct interpretation of wording and questions was also, in this way, guaranteed with reference to these latter. In addition, the interviews allowed to collect much qualitative information on respondents' views of management accounting practices. We took extensive notes during the interviews, which we discussed and compared and compiled into a final set of field notes. At this stage, we made no attempt to structure the interviews except that we made every effort to pursue aspects of the relationships in the network that respondents frequently mentioned as important.

Nearly one year after data collection, as a final step in the process, we visited the company once again, after all data were analyzed, to present and discuss results with the managers.

Sample

The sample includes the managers of the knitting division of the fashion firm and those of its 18 subcontractors. The questionnaire was administered to 14 managers of the fashion firm and 43 managers of the subcontractors. The response rate was 95%. The total data set represents a sample of n = 1,596 relationships between actors of the network across different functions: operations, marketing, commercial and accounting. It is important to notice here that since the flows of management accounting information are directional, i.e. the information is directed from one actor in the pair to the other actor in a pair, the number of observations is double, i.e. n = 3,192.

V. METHOD

The method used for our empirical investigation is social network analysis (SNA). This technique is novel to the accounting literature[15], but has already been applied in a large variety of settings, ranging from sociology, anthropology, social psychology, strategy and organizational studies.[16] Much of the interest from social and behavioral sciences can be ascribed to the appealing focus of SNA on *relationships* and on the *patterns and implications of such relationships*. The typical unit of analysis in SNA is not the single actor, but an entity consisting of a collection of actors and the linkages among them. In fact, the SNA - rather than concentrating on attributes of autonomous individual actors, the associations between these attributes or the usefulness of one or more attributes for predicting the level of another attribute - views the characteristics of the actors as arising out of relational structure and processes, and focuses on the properties of relational systems (Wasserman and Faust, 1994).[17] In other words, on the one hand, traditional data collection and analysis would be concerned with properties, qualities or characteristics which belong to individual actors or single relationships, i.e. with *attribute data*. SNA, on the other hand, focuses on *relational data*, which are referred to the system of relationships that connect actors to each other and represent properties of the whole network.

Starting from these premises, SNA supports model development, specification and testing by: providing formal definitions, measures and descriptions to express relationally defined theoretical concepts; expressing key constructs and propositions as relational processes and outcomes; offering analytic procedures and tools that are different from traditional statistics and data analysis, and are used to statistically analyse multirelational systems.

For our purposes, the strength of this approach is that it concentrates on the overall system of relations and management accounting information exchanges rather than on the single relationships between the actors composing the network and their underlying management accounting information flows.

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[15] To our knowledge, in the management accounting literature, social network analysis has been applied only as a descriptive technique by Chapman (1998) with the aim of studying how accounting may be used, as a tool for organisational control, in the co-ordination of networks facing different degrees of uncertainty.

[16] The concepts of SNA developed out of a fruitful meeting of social theory and application with formal mathematical, statistical, and computing methodology (Freeman, 1984; Marsden and Laumann, 1984). Much network methodology arose as social scientists in a range of disciplines struggled to make sense of some empirical phenomena that could not be adequately explained through existing theoretical frameworks. In so doing, researchers looked for new mathematical models. The three major mathematical foundations of SNA are graph theory, statistical and probability theory and algebraic models (Wasserman and Faust, 1994).

[17] In the traditional data analytic framework, it is assumed that the set of measurements is taken on a set of independent units or cases. On the contrary, SNA is explicitly interested in the interrelatedness of actors. Such dependencies are measured through structural variables and, as will be clarified in the following, demand a set of methods and analytic concepts that are distinct from the methods of traditional statistics (Wasserman and Faust, 1994).

In our study, we employed both descriptive methods and methods based on probabilistic assumptions., i.e. we used graphs to represent and analyse our data as well as some descriptive measures to describe the structure of our network, and we employed the *Quadratic Assignment Procedure Correlation* (QAP-correlation) and the *Multiple Regression Quadratic Assignment Procedure* (MRQAP) to test our hypotheses on the impact of interdependencies on the configuration of management accounting information exchanges.

In order to apply both methods, we expressed our data numerically in a matrix form. Each matrix is composed by *x* rows and *x* columns, corresponding to the number of actors in the manufacturing network, derived from summing the actors interviewed within the fashion firm and the actors interviewed at the subcontractors'. Each actor has a row and a column, which are labeled 1, 2, …*x*. Each cell in the matrix reports the existence of a certain relationship (expressed in terms of the exchange of accounting information, of inputs received, of time spent working together, , etc.) between actor *i* in the row and actor *j* in the column. Thus in the matrix, there is a certain value – corresponding to the measure of the linkage – in the (*i, j*) cell if there is a linkage between actor *i* and actor *j*, and a 0 other wise.

Regarding the descriptive part of our analysis, we employed *valued graphs*[18] to formally represent the relations in our network and to quantify a key important structural property of the network itself[19], i.e. the density[20].

The core of our analysis is based on the *Quadratic Assignment Procedure* (Krackhardt, 1987) and we performed both the *Quadratic Assignment Procedure Correlation* (QAP-correlation) and the *Multiple Regression Quadratic Assignment Procedure* (MRQAP)[21].

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[18] A valued graph is a graph in which each line, carries a value. It consists of three sets of information: a set of nodes, $\mathcal{N} = \{n_1, n_2, \ldots, n_g\}$, a set of lines, $\mathcal{L} = \{l_1, l_2, \ldots, l_L\}$, and a set of values, $\mathcal{V} = \{v_1, v_2, \ldots, v_L\}$ attached to the lines. Associated with each line is a value from the set of real numbers. A valued graph is denoted as $\mathcal{G}_V(\mathcal{N}, \mathcal{L}, \mathcal{V})$, or simply as $\mathcal{G}_V$ (Flament, 1963; Wasserman and Faust, 1994).

[19] Graph theory has been widely used in SNA, firstly because it provides a vocabulary which can be used to label and denote many social structural properties; secondly, because it provides some mathematical operations and ideas with which such properties can be quantified and measured; lastly, because the visual representation of data allows researchers to uncover patterns that might otherwise go undetected (Moreno, 1934; Tukey, 1977; Velleman and Hoaglin, 1981; Freeman, 1984).

[20] In a graph, density, Δ, is defined as the ratio of the number of lines present to the maximum possible that could arise. The density of a binary network is the total number of ties divided by the total number of possible ties. For a valued network it is the total of all values divided by the number of possible ties. In this case the density gives the average value. Thus, the density is $\Delta = \Sigma\, v_k / g(g-1)$ where the sum is taken over all *k* (Wasserman and Faust, 1994: 143).

[21] Within the domain of social network analysis, one of the most serious problems related to the testing of hypotheses, in both simple and multiple regression models, is that the unit of analysis is the dyad, and dyads cannot be assumed to be independent of one another. In fact, network data are assumed not to consist of independent observations, but rather to have varying amounts of dependence on one another according to which row or column they "belong" to. In other words, the error terms can be assumed to be autocorrelated to at least some (unknown) degree within rows and columns. A nonparametric answer to this problem of testing the null hypothesis that two network variables are uncorrelated has been proposed (Mantel, 1967) and developed at length (Hubert and Schultz, 1976; Hubert, 1983; Hubert, 1985; Hubert and Golledge, 1981). By generating all correlations that result from permuting the rows and columns of one of the matrices, it is possible to determine the distribution of all possible correlations given the structures of the other matrices. Thus, it builds into the test statistic the kind of row/column interdependence that is

We used QAP-correlation procedure to test the association between independent variables expressed as matrices employing a two-step algorithm, which, first, computes the correlation between the corresponding cells of two data matrices, and, secondly, randomly permutes the rows and the columns (synchronously) of one matrix and re-computes the correlation. The second step is carried out 2,500 times[22] in order to compute the proportion of times that a random measure is larger or equal to the measure calculated in the first place. A proportion lower than 0.05 suggests that the relationship between the matrices is unlikely to have occurred by chance (Borgatti et al., 2002). Two types of correlation indicators were used for the present analysis: the Pearson coefficient, and the Jaccard coefficient. The former is the conventional Pearson coefficient but applied to network data; the latter is a measure of the proportion of matches when at least one of the observations has a value, which means that it measures the co-occurrence of linkages for two different matrices considering only the existing linkages.

With the MRQAP-procedure we regressed the dependent matrices on the independent matrices. Also this procedure is based on a two-step algorithm, which, in the first step, performs a standard multiple regression across corresponding cells of the dependent and independent matrices, and, in the second step, randomly permutes rows and columns (together) of the dependent matrix and re-computes the regression, storing resultant values of r-square and all coefficients. This step is repeated 2,500 times[23] in order to estimate standard errors for the statistics of interest. For each coefficient, the program counts the proportion of random permutations that yielded a coefficient as extreme as the one computed in step one (Borgatti et al., 2002).

In our analysis, we used two MRQAP permutation methods (Krackhardt, 1988; Dekker et al., 2004):

- the *Y permutation method*, which results in unbiased estimates of the significance of the regression coefficients under conditions of network autocorrelation and is heavily conservative under conditions of spuriousness;
- the *double semi-partialling method*, which has the distinctive advantage that the significance test results in the least bias of all the possible permutation methods.

All the analyses were carried out with the support of a specific software for SNA, UCINET 6 (Borgatti et al., 2002).

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assumed in network data. This permutation procedure is refereed to as the quadratic assignment procedure (QAP). For further details on this point see Krackhardt (1988) who solved the issue of performing inferential tests on data that are (potentially) highly interdependent, by framing it as an autocorrelation problem and demonstrating that QAP can provide unbiased tests of significance of both simple and multiple regression coefficients.

[22] The number of random permutations set by default by the software adopted for the analysis is 500. However, the larger the number of permutations, the better the estimates of standard error and "significance", but the longer the computation time (Borgatti et al., 2002).

[23] See footnote 22.

VI. RESULTS

VI.1) DESCRIPTIVE ANALYSIS

Table 2 reports the Pearson correlations among the independent variables. The items pointing to the same variable are highly correlated as expected. In fact, Time_Work_Dir is positively related to Time_Mngt_Rel ($r = 0.897$; $p<0.01$); Inv_Comp is positively related to Inv_Infr ($r = 0.542$; $p<0.01$); and, finally, Dep_Input is positively correlated with Dep_Dur_Work ($r = 0.97$; $p<0.01$) and Dep_Compl_Work ($r = 0.862$; $p<0.01$), and Dep_Compl_Work is positively related with Dep_Dur_Work ($r = 0.878$; $p<0.01$). With reference to the correlation between items of different variables, the only exception to our expectations is represented by the fact that variables of workflow interdependence and those of interaction interdependence show slightly higher correlation factors (between 0.437 and 0.52) but, in any case, lower than the correlations between the items within the same variable.

In order to limit the multicollinearity problem, we then decided to select for each variable, the item that was less correlated with those independent items selected for the other variables. To this end, we chose those items with dyadic Pearson correlation coefficients lower than 0.4, with the only exception of one item (Dep_Input) whose Pearson coefficient with another item (Time_Work_Dir) was slightly higher than that cap, i.e. 0.437, but not sufficiently high to warrant concerns with multicollinearity. According to this criterion, we thus picked the following items, each one representative of one dimension of interdependence: Time_Work_Dir, Inv_Comp, Dep_Input, Terms_Contr.

The structure of the networks of management accounting information exchanges (multiplicity and frequency) and of those of interdependencies between actors (Time_Work_Dir, Inv_Comp, Dep_Input, Terms_Contr) are represented in Figure 1 – 6. These figures depict the pattern of relationships between actors in the network. The central group of nodes in the centre (in white) is related to the actors of the fashion firm, while the groups of nodes at the periphery (in black) represents the actors of the various suppliers. The ties between the actors show, respectively in the different figures, the pieces of management accounting information exchanged, the frequency with which these pieces are exchanged, the amount of time recurrently spent directly working together, the time invested to learn competences, procedures and working practices for the relationship, the extent that the actors have to rely on other actors to obtain the inputs to do their work and the extent to which the terms of the relationship between the actors have been explicitly formalized in a contract. As it is evident from the graphs the overlap of these networks is substantially high, except for the networks representing the time invested in

learning competences and procedures to support the relationship and the degree of formalization of the relationship in a contract. In fact, the densities of these latter variables (Inv_Comp, matrix average = 0.0182; Terms_Contr, matrix average = 0.0341) are sensibly lower than the other ones, ranging from 0.1062 (matrix average of the multiplicity network) to 0.1677 (matrix average of the dependence on the inputs provided by the actor).[24] This is also confirmed by the results reported in Table 1 presenting the Jaccard coefficients between all the variables. In this respect, the coefficients of the network representing the time invested in learning competences and procedures to support the relationship show that only a percentage ranging from about 11% to almost 14% of the linkages are co-occurring, while for the network of the degree of formalization of the relationships in a contract the co-occurring links range from 15% to almost 27%. As a whole this evidence suggests that where workflow and interaction interdependence occur it is more likely that management accounting information exchanges are multiple and frequent.

	1	2	3	4	5	6
1 Multiplicity	1.000					
2 Frequency	0.977***	1.000				
3 Time_Work_Dir	0.431***	0.427***	1.000			
4 Inv_Comp	0.138***	0.137***	0.109***	1.000		
5 Dep_Input	0.44***	0.436***	0.802***	0.106***	1.000	
6 Terms_Contr	0.266***	0.264***	0.198***	0.152***	0.197***	1.000

Note: *** p< 0.01; ** p<0.05; * p<0.1 Source: Authors' elaboration using UCINET 6 (Borgatti et al., 2002)

Tab 1 – Jaccard Correlation between dependent and selected independent variables

[24] The density has been calculated after having dichotomized the matrices of the variables. The dichotomization has consisted in transforming the valued matrices into binary matrices. Given a cut-off value of zero, the valued matrices have been made binary by comparing each element with the cut-off value (Borgatti et al., 2002).

		1	2	3	4	5	6	7	8
1	**Time_Mngt_Rel**	1.00							
2	**Time_Work_Dir**	0.897***	1.00						
3	**Inv_Comp**	0.267***	0.236***	1.00					
4	**Inv_Infr**	0.25***	0.202***	0.542***	1.00				
5	**Dep_Input**	0.497***	0.437***	0.248***	0.168***	1.00			
6	**Dep_Dur_Work**	0.497***	0.441***	0.253***	0.168***	0.97***	1.00		
7	**Dep_Compl_Work**	0.520***	0.464***	0.263***	0.17***	0.862***	0.878***	1.00	
8	**Terms_Contr**	0.024	0.050	0.046*	0.055**	0.369***	0.349***	0.302***	1.00

Note: *** p< 0.01; ** p<0.05; * p<0.1 Source: Authors' elaboration using UCINET 6 (Borgatti et al., 2002)

Tab 2 – Pearson Correlation between all independent variables

Item definitions:

1. Time_Mngt_Rel — measure for the time recurrently spent to manage the relationship expressed as a percentage of the total annual working time.
2. Time_Work_Dir — measure for the time recurrently spent directly working together expressed as a percentage of the total annual working time.
3. Inv_Comp — measure for the time invested to learn and define competences, procedures and working practices for the relationship expressed as a percentage of the total working time in the year the relationship started.
4. Inv_Infr — measure for the investments in infrastructures, machineries and equipments expressed as a percentage of the total investments of the company.
5. Dep_Input — the extent that the actors have to rely on other actors to obtain the inputs to do their work on a six-point scale, where 0 = not at all, and 5 = very much.
6. Dep_Dur_Work — the extent that the actors have to depend on other actors while doing their respective jobs on a six-point scale, where 0 = not at all, and 5 = very much.
7. Dep_Compl_Work — the extent that the actors, after having finished their part of the task, have to depend on other actors to perform the next steps in the process before the total task is completed on a six-point scale, where 0 = not at all, and 5 = very much.
8. Terms_Contr — the extent to which the terms of the relationship between the actors have been explicitly formalized in a contract on a six-point scale, where 0 = not at all, and 5 = very much.

VI.2) MAIN FINDINGS

Table 3 presents the MRQAP estimation results of the two regression equations in which we regressed, in turn, the multiplicity and frequency of management accounting information exchanges (the dependent matrices) on the four independent matrices referred to: the amount of time recurrently spent directly working together (Time_Work_Dir), the time invested to learn competences, procedures and working practices for the relationship (Inv_Comp), the extent to which actors rely on others for inputs (Dep_Input), the extent to which the terms of the relationship between the actors have been formalized in a contract (Terms_Contr).

Tab 3 – MRQAP regressions

$$\text{Multiplicity} = \alpha_0 + \alpha_1 \text{Time\_Work\_Dir} + \alpha_2 \text{Inv\_Comp} + \alpha_3 \text{ Dep\_Input} + \alpha_4 \text{ Terms\_Contr} + \varepsilon \quad (1)$$

$$\text{Frequency} = \beta_0 + \beta_1 \text{Time\_Work\_Dir} + \beta_2 \text{Inv\_Comp} + \beta_3 \text{ Dep\_Input} + \beta_4 \text{ Terms\_Contr} + \varepsilon \quad (2)$$

Part A - Dependent Variable: Multiplicity (n = 3191)

	Predicted sign	Un-standardized Coefficient	Standardized Coefficient	Significance
Intercept		0.050142	0.000	1.000
Time_Work_Dir	+	0.045755	0.165783	0.000
Inv_Comp	+	0.231150	0.182573	0.000
Dep_Input	+	0.491383	0.339887	0.000
Terms_Contr	-	0.691338	0.188691	0.000

R-square 0.357
Adjusted R-square 0.356
Number of permutation performed = 2500
Permutation methods: Y permutation method; Double semi-partialling method

Part B - Dependent Variable: Frequency (n = 3191)

	Predicted sign	Un-standardized Coefficient	Standardized Coefficient	Significance
Intercept		-0.000669	0.000	0.000
Time_Work_Dir	+	0.002649	0.308967	0.000
Inv_Comp	+	0.006493	0.165097	0.002
Dep_Input	+	0.007918	0.176307	0.000
Terms_Contr	-	-0.004501	-0.039551	0.016

R-square 0.236
Adjusted R-square 0.235
Number of permutation performed = 2500
Permutation methods: Y permutation method; Double semi-partialling method

The results of Equation (1) (Table 3, Part A) provide strong evidence that the numerousness of the different pieces of management accounting information shared at the inter-organizational level depend on the amount of time recurrently spent directly working together (α_1 = 0.045755 sig = 0.000), the time invested to learn competences, procedures and working practices for the relationship (α_2 = 0.231150, sig = 0.000), the extent to which the actors have to rely on others for inputs (α_4 = 0.491383, sig = 0.000) and the extent to which the terms of the relationship between the actors have been explicitly formalized in a contract (α_3 = 0.691338, sig = 0.000). In line with our expectations, the first three relationships are positive, whereas contrary to what was assumed the relationship between multiplicity and contractual interdependence is positive. The variable that has the highest standardized coefficient is the dependence on other actors for input (Dep_Input, standardized coefficient = 0.339887). The adjusted R-square of Equation (1) indicates that the model has a quite good explanatory power (i.e., 35.7 percent).

The results in Table 3, Part B - Equation (2) – are consistent with our expectations concerning the frequency of management accounting information exchanges and the four variables linked to the different dimensions of interdependence. All the relationships are positive, except for the contractual interdependence, and significant. Yet, by analyzing the coefficients it appears that the variable that presents the highest one is the time spent by the actors working directly together (i.e., 0.308967) as compared to the other variables that show sensibly lower values (Inv_Comp = 0.165097; Dep_Input = 0.176307; Terms_Contr = -0.039551).

VII. DISCUSSION AND CONCLUDING COMMENTS

Interdependence has been identified as one of the important variables to explain management accounting at both the intra-organizational and inter-organizational levels. Yet, contributors have mainly referred to the interdependence deriving from workflows as was originally conceptualized by Thompson (1967). While this conceptualization was quite suitable to study the relationship between units within organizations, it has several limitations when applied in inter-organizational contexts. These latter, in fact, present some peculiarities which generate new and complementary sources of interdependence which are not based on transfer of goods and services, but rather on combining similar resources or the joint application of complementary assets. In fact, entities that activate inter-organizational agreements commit to share resources and make investments to pursue common specific goals that create significant and durable mutual dependence: either each partner develops specific assets, the resulting

network being based on their complementarities; or partners decide to pool resources and to create joint investments for part of their activities. This dependence becomes more and more severe, the more weakly redeployable and the more customized resources and investments are to the partners' mutual needs (Ménard, 2004). In addition, these entities often apply differentiated professional know-how to transformation processes, thus originating joint action and consequently the need for real time coordination and common problem solving (Grandori, 1997). To this end, they constantly negotiate to set and follow certain policies or procedures, and discuss to make or approve certain key decisions (Caglio and Ditillo, 2005).

Starting from these premises, our paper provided an alternative framework for conceptualizing and incorporating all these forms of interdependence and that is new in two respects. From a theoretical point of view, a more comprehensive and multifaceted construct of interdependence was adopted in the analysis of boundary-spanning relationships in order to grasp the peculiarities of inter-organizational dependencies. To this end interdependence was evaluated as originating from workflows between actors, joint interaction, mutual investments and inter-organizational contracts. From a methodological point of view, interdependence was studied taking into consideration the interrelatedness of actors, that is to say the fact that the relationships between each pair of actors is dependent upon the other relationships of the network as a whole. Through social network analysis we were able to incorporate in our work the combined effect of these two issues - i.e. the interdependencies of interdependent relationships – because not only we could map and measure the different types of interdependence, but also because we used a statistical approach that is suitable for the analysis of interdependent observations.

The recognition of this multidimentional nature of interdependence allowed us also to go beyond the traditional coordination role assigned, by the existing literature, to the management accounting information in a context of workflow dependence (confirmed here by our empirical evidence) and to capture the multiplicity of its roles. The positive relationship between interaction interdependence and management accounting information unveiled that this information may be used to deal with value appropriation concerns (Jarillo 1988). In fact, the existence of close on-going relationships and joint action between separate entities requires that each party understands the involvement entailed during the relationship, defines the modalities to carry out inter-organizational activities and monitors the level of mutual satisfaction achieved while the progress emerges. Therefore, interaction needs to be supported by continuous exchange of information and revised calculations of costs and benefits to each party to guarantee a fair and clear distribution of value.

The positive association between asset interdependence and management accounting information shows the use of this information to solve opportunistic behaviour problems. Combined resources and investments into and for the relationship may originate incentives to cheat, free riding to attain individual goals, not the collective objectives of the initiatives (Park and Russo, 1996). Multiple and frequent management accounting information exchanges may provide safeguards against these opportunistic actions.

Finally, the unexpected positive relationship between contractual interdependence and management accounting information seems to contradict the conclusions achieved by some previous contributors. In fact, some authors have identified a substitutive relationship between management accounting information and ex-ante control mechanisms, i.e. contracts, due to the incompleteness of these latter (Ring & Van de Ven, 1994; Yan and Gray, 1994; Das and Teng, 1998). The explanation provided is that formal legal contracts represent limited tools for circumventing inter-organizational control problems and therefore may be supplemented by the use of ex-post information-based mechanisms to manage the relationship. Our findings seem to indicate that there is a complementary and reinforcing relationship between contract and management accounting based control mechanisms: an increase in both the level of contractual formalization of the terms of the relationship and the exchange of management accounting information result in a higher level of control of the relationship. This suggests that contracts and management accounting are instrumental in achieving a high level of confidence and that they are used jointly to contribute to the total level of reliance one partner has in partner cooperation.

In addition, the descriptive analysis conducted on our data suggests some implications for the design of inter-organizational management accounting information flows. The investigation of the co-occurrence of the ties between the actors of the network, as expressed by the Jaccard coefficient, allows to extend the conclusions on the relationship between interdependencies and management accounting. Not only the intensity of interdependence influences the multiplicity and frequency of management accounting information exchanges, but also the configuration of interdependence among actors (i.e. high interdependencies concentrated on a few individuals of the network vs high interdependencies diffused among the entire network) affects the patterns of such exchanges. In fact, the focus on individuals as a level of analysis, instead of firms, has unveiled that despite the same level of interdependence between firms, the interdependencies may be concentrated on a single/few individuals of each firm or be shared between more individuals. As a consequence, the exchange of management accounting information may assume different forms even in the case of the same level of interdependence between firms, that is to say centralized on a few individuals in the first case and diffused and more

participative in the other. This has practical implications on the decisions on whether and how to activate specific communication channels between actors and processes and procedures to make them function.

Finally, the Jaccard coefficient seems to highlight that among the different sources of interdependence arising in the relationships between actors, it is the workflow and interaction interdependence that mainly activate the exchange of management accounting information between actors. On the contrary, the asset and contractual interdependence networks overlap to a lesser extent with the network of management accounting information flows. Therefore, among the various roles that management accounting may play in inter-organizational settings those of coordination and of appropriation concerns solver seem to be crucial. Together taken these results contribute to our understanding of the determinants and roles of management accounting information in inter-organizational settings.

Nevertheless, some limitations should be recognized when considering our analysis. On the theoretical side, we concede the simplicity of the model. No empirical study can analyse all the variables potentially impacting on the configuration of management accounting information exchanges at the same time. Therefore, our model concentrated on interdependence, being informed by what was suggested – but not empirically tested – by previous literature on inter-firm settings. On the methodological side, although social network analysis provides powerful responses for the investigation of networks, addressing some of the limitations of conventional statistics when studying interdependent observations, it should be mentioned that some SNA tools have only been recently developed and various issues concerning their use are still in the process of being fully debated. For example, different MRQAP procedures have been developed, but no final consensus has been achieved on which best addresses the problems of autocorrelation and multicollinearity. In order to reduce the drawbacks of this limitation we have used different procedures and compared the corresponding results, which remain consistent across methods. In addition, we would like also to underline that ideally we would have applied factor analysis to deal with the multi-dimensional nature of interdependence variables, nevertheless a suitable procedure has not been developed for social network analysis purposes. On the data side, to conclude, though we do not see any specific reason why our findings cannot be extended to other industries, countries or network typologies, we suggest the replication of this study in other contextual settings before generalizing our conclusions.

APPENDIX

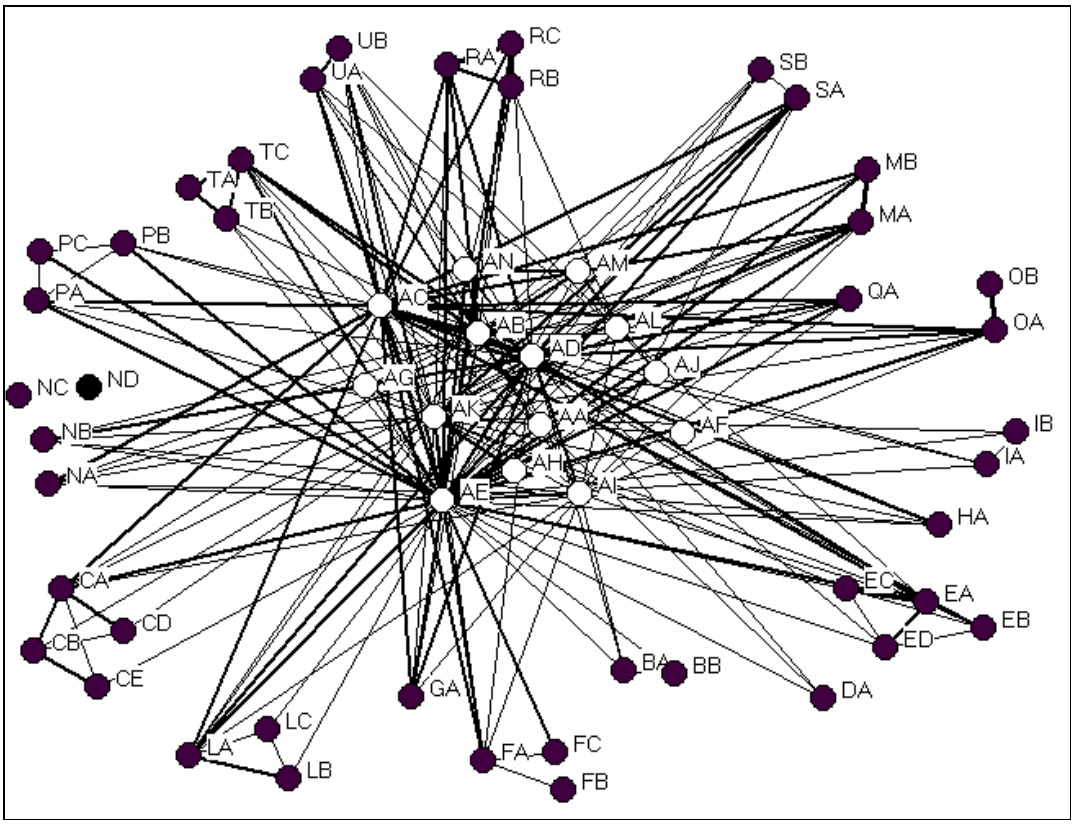

Fig. 1 – The multiplicity of management accounting information exchanges (Density (matrix average) = 0.1062)

Note: each tie indicates that there is an exchange of accounting information between the individuals that are part of the manufacturing network. Those represented as white nodes and coded as AA, AB etc. are individuals of the fashion firm while those represented as black nodes are the individuals of the suppliers. These latter have been coded with the same initial letter if they belong to the same supplier. The strength of the ties specifies the multiplicity of accounting information exchanges. The higher the size of the tie, the higher the number of pieces of accounting information exchanged.

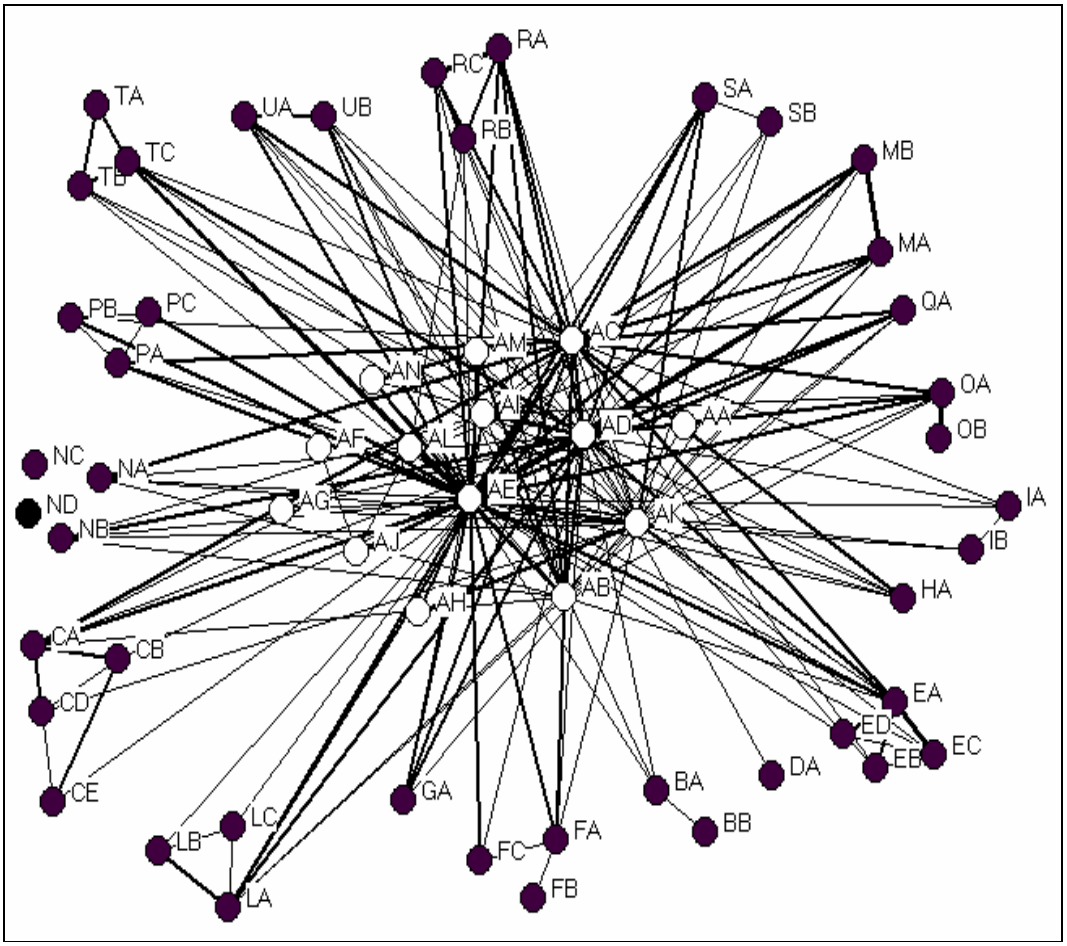

Fig. 2 – The frequency of management accounting information exchanges (Density (matrix average) = 0.1068)

Note: each tie indicates that there is an exchange of accounting information between the individuals that are part of the manufacturing network. Those represented as white nodes and coded as AA, AB etc. are individuals of the fashion firm while those represented as black nodes are the individuals of the suppliers. These latter have been coded with the same initial letter if they belong to the same supplier. The strength of the ties specifies the frequency of accounting information exchanges. The higher the size of the tie, the higher the frequency with which accounting information is exchanged.

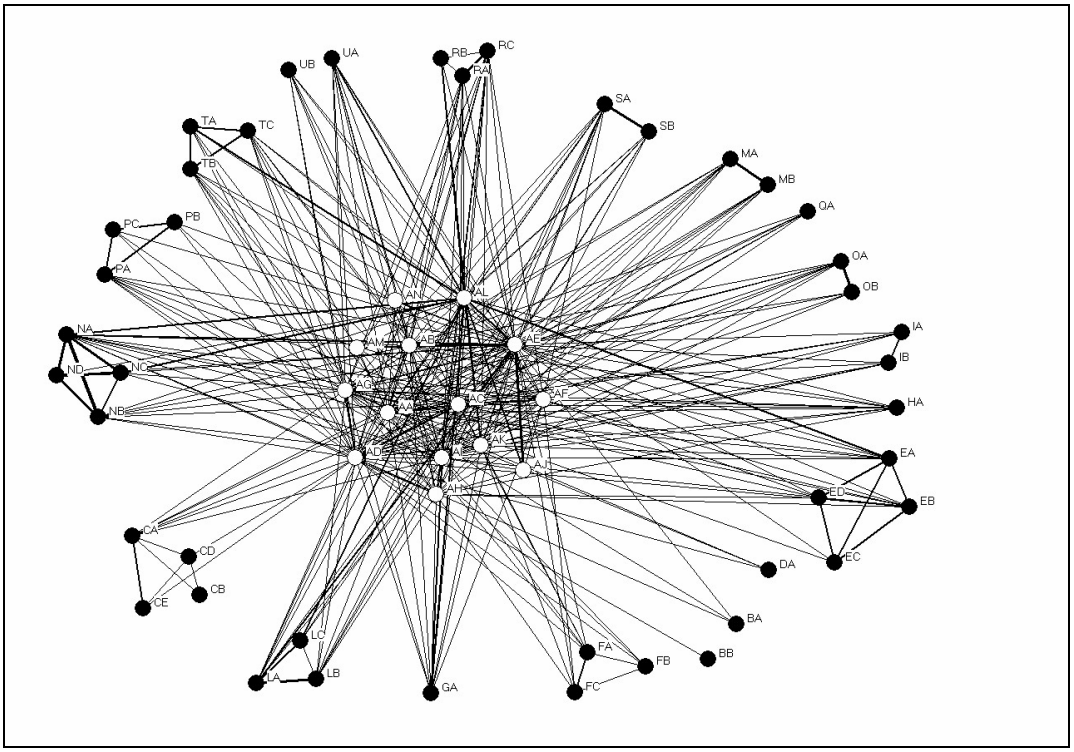

Fig. 3 – The time spent working jointly (Density (matrix average) = 0.1570)

Note: each tie indicates that two individuals spend time working jointly. Those represented as white nodes and coded as AA, AB etc. are individuals of the fashion firm while those represented as black nodes are the individuals of the suppliers. These latter have been coded with the same initial letter if they belong to the same supplier. The strength of the ties specifies the amount of time spent to carry out activities with the partners. The higher the size of the tie, the higher the time employed jointly with the partners to work.

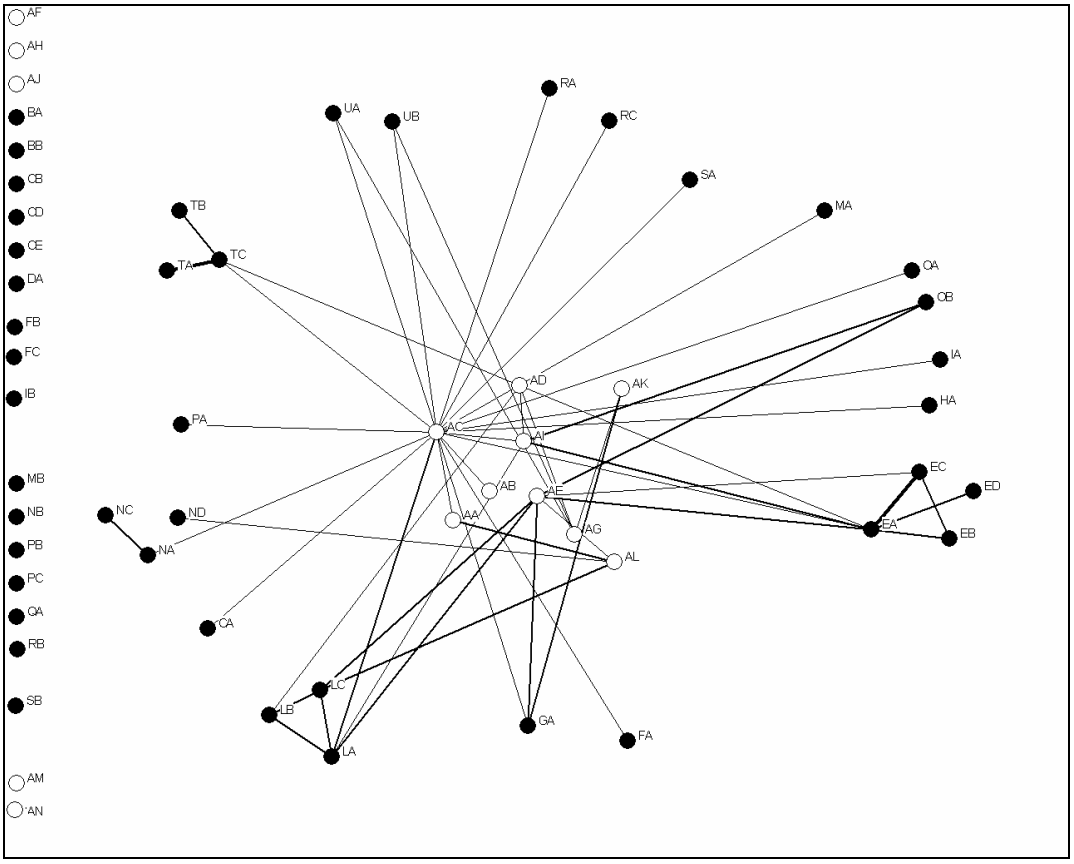

Fig. 4 – Time investment in competences and procedures (Density (matrix average) = 0.0182)

Note: each tie indicates the time invested by two individuals to develop competences and procedures to manage the relationship. Those represented as white nodes and coded as AA, AB etc. are individuals of the fashion firm while those represented as black nodes are the individuals of the suppliers. These latter have been coded with the same initial letter if they belong to the same supplier. The strength of the ties specifies the amount of time invested. The higher the size of the tie, the higher the time employed to acquire competences and define procedures.

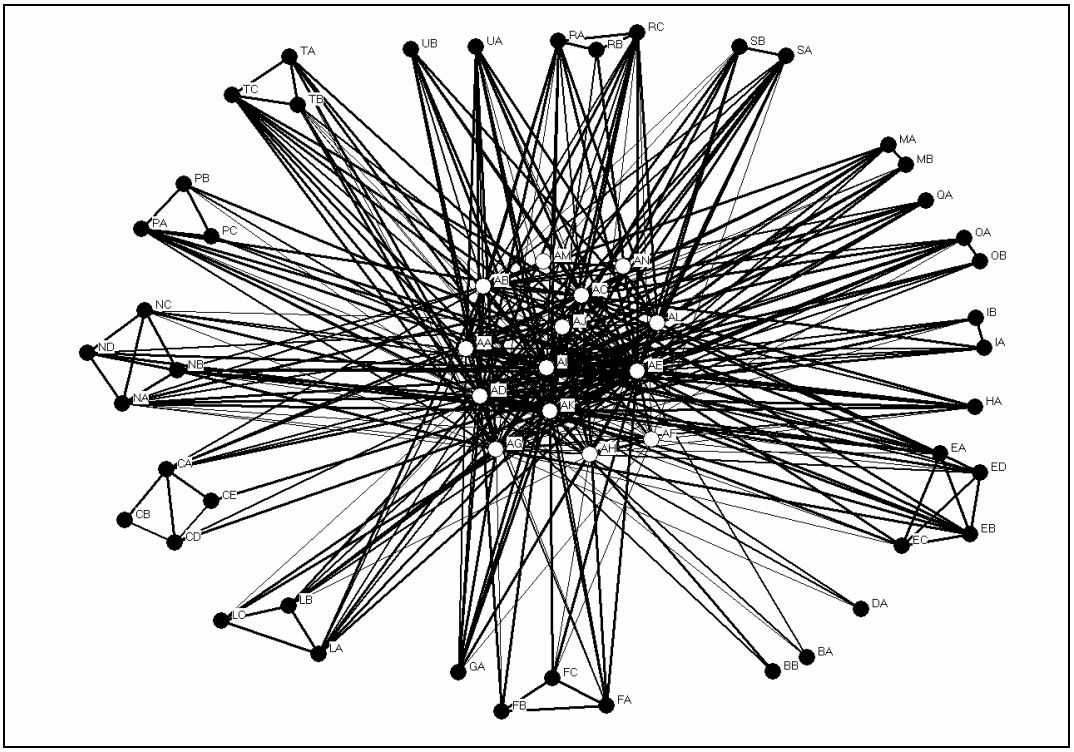

Fig. 5 – The dependence on the inputs provided by the actor (Density (matrix average) = 0.1677)

Note: each tie indicates that two individuals depend on each other for the inputs necessary to carry out their activities. Those represented as white nodes and coded as AA, AB etc. are individuals of the fashion firm while those represented as black nodes are the individuals of the suppliers. These latter have been coded with the same initial letter if they belong to the same supplier. The strength of the ties specifies the degree of reliance on the inputs provided. The higher the size of the tie, the higher the level of dependence on the partner for the inputs.

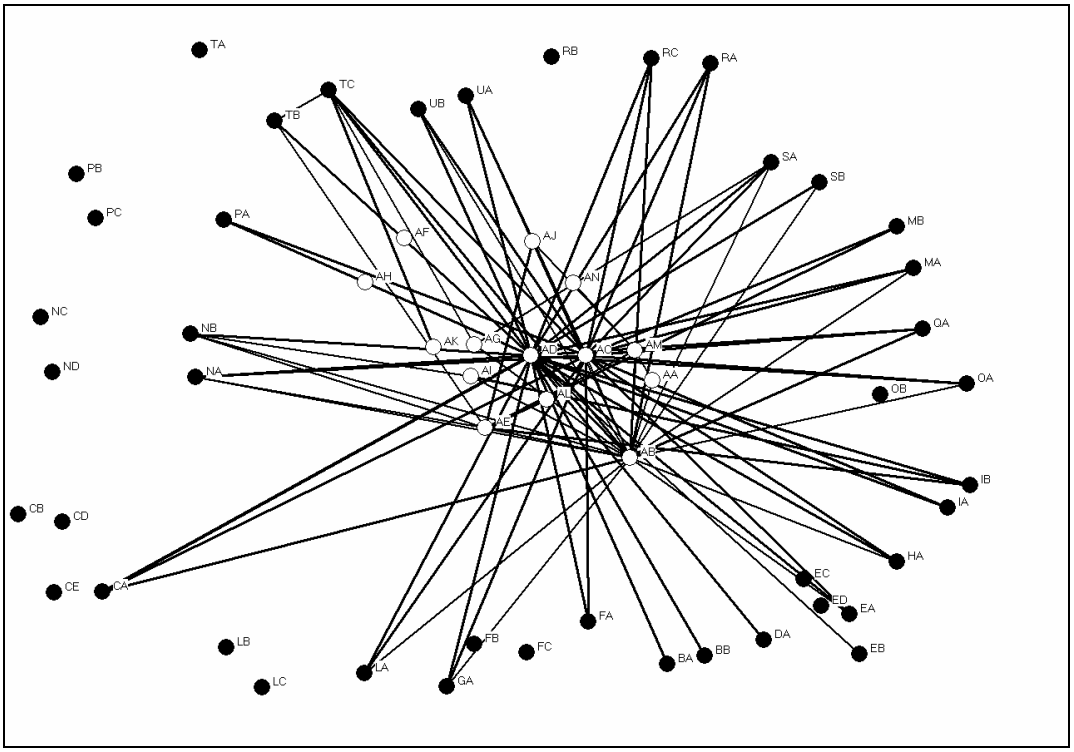

Fig. 6 – The degree of formalization of the relationship in a contract (Density (matrix average) = 0.0341)

Note: each tie indicates how much the terms of the relationship have been included in a contract. Those represented as white nodes and coded as AA, AB etc. are individuals of the fashion firm while those represented as black nodes are the individuals of the suppliers. These latter have been coded with the same initial letter if they belong to the same supplier. The strength of the ties specifies the degree of formalization. The higher the size of the tie, the higher the amount of aspects of the relationship contractually formalized.

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