

Title of the paper:

Organizational Social Capital (OSC): A Theoretical and Mathematical
Treatment
(Understanding the structural and reputational aspects of OSC)

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Abstract

This paper opines that Organizational Social Capital (OSC) is a function of the socio-economic structure in which the firm is embedded (i.e. structural perspective) as well as the relational content of that embeddedness as a collective (i.e. collective/individualist perspective). However, dominant literature in social capital subscribes to the structural perspective and ignores the individualist perspective. This paper synthesizes both the perspectives and argues that organizational social capital is a function of both Structural Social Capital (SSC) and Reputational Capital (RC) where SSC represents structural perspective and RP represents individualist perspective. Contemporary literature measures the effect of SSC by analyzing the network structure of embedded firm in a socio-economic network. This paper argues that absence of a dependency based power index to measure the effect of SSC has limited our understanding of network effect on firm performance and industry dynamics and has constrained our understanding of dependency structure in a networked economic system. To overcome this shortcoming the paper introduces the concept of Nodal Power based on principle of mutual dependency and develops indexes to measure the effect of SSC. This paper proposes Nodal Power as a proxy for firm's profit potential. Considering organization as a collective this paper also shows the dynamics of reputational capital and its potential effect on organization. Based on the theoretical arguments made, propositions are developed to facilitate empirical validation.

Key Words:

Organizational Social Capital, Nodal Power, Network Analysis, Reputational Capital

Organizational Social Capital (OSC): A Theoretical and Mathematical Treatment

(Understanding the structural and reputational aspects of OSC)

Social capital literature has immensely contributed to organization and management science by enhancing our understanding on how an actor and its activities, including economic activities, is dependant on the context of social structure in which it operates. The conceptualization of social capital as an value enhancing system resource and a tradable asset stock (Black and Boal, 1994) has given rise to study it's affect on performance and success at individual, organizational and inter-organizational level (for an overview of such literature, see Adler and Kwon, 2002). The two perspectives on social capital i.e. structural view and individualist view have been analyzed for their positive as well as negative effects. Structural view emphasizes that social capital available to a firm is dependant on its external links and structural position in the larger network such as industry (c.f. Adler and Kwon, 2002; Coleman, 1990) where as individualist view (also termed as bonding view, collective view) opines that social capital is sourced from the internal ties, structure and capabilities of a collective such as firm (c.f. Adler and Kwon, 2002; Kilduff and Tsai, 2003). However, most of the studies have treated social capital from structural perspective in inter-organizational and organizational context even if social capital has long been accepted as a resultant asset sourced from internal attributes and capabilities of the organization, as highlighted by the individualist view. In this background this paper throws light on the necessity to consider both the perspectives simultaneously. This paper argues that the social capital available for an organization i.e. organizational social capital (OSC), is the net of the social capital derived from external sources (epitomized by structural view) termed as structural social capital (SSC) as well as from internal sources (epitomized by individualist view) termed as reputational capital (RC).

The structural view of social capital, having its epistemological underpinning on social network analysis, assumes that social capital primarily has three benefits such as (a) information (b) influence, control and power (3) solidarity, abidance to norms and beliefs (Adler and Kwon, 2002). However, most of the studies focus on information flow and the benefit accrue to the subject there of. In organizational and inter-organizational context very few studies have considered social capital as a function of power. A few present constructs of power in social capital study are either proxies for control over information flow or measures of effect of number and distance of ties in a network. This impediment has severely restrained the measurement of social capital as a real function of power, especially in a socio-economic network (SEN). In this context this paper proposes that in a SEN, power is a function of mutual dependency and argues that structural social capital can be quantitatively captured by mapping the structural position and magnitude of dependency. Resultantly this paper contributes to the structural perspective by introducing a dependency based power index called Nodal Power. The second part of the paper contributes to the individualist perspective by studying the dynamics of social capital sourced internally. Considering organization as a collective, the net social capital from internal source is conceptualized as the resultant effect of the capability of all internal sources including human resource and their relations within. This paper assumes that the net social capital from internal sources has a reputational value for organization and theoretically shows the dynamics and effect of this reputational capital on organization over time.

Subsequent sections of this paper are designed as follows. First it will have a quick look back on the genesis of social capital and define organizational social capital. This definition will synthesize both structural and individualist perspectives. The next section will delve into structural i.e. network perspective of social capital and introduce the concept of nodal power. This section will use elementary mathematical logic and graph theory to do so. The next section will focus on the dynamics of reputational capital. Finally propositions will be developed based on the introduced concepts followed by a brief discussion and conclusion.

SOCIAL CAPITAL IN ORGANIZATIONAL CONTEXT: A BRIEF LOOK BACK

The concept of social capital is not new¹ and dates back to several centuries. However, the modern literature on social capital originated with the work of Hobbes (1651), who in his book *Leviathan* established distinction between individual's social and political resources and argued that the individual's standard of living depends on the resources at his disposal. Weber (1922) furthered this argument and opined that individual's standard of living can improve with three types of resources: economic, political, and symbolic, where the latter two resources are subject to the quantity and quality of social interaction. The whole perspective of social capital is built on the idea that an actor and its activities including economic activities can't be proscribed of the context and social structure in which it operates. The action and consequence affects and is affected by this social structure which creates an intangible asset at disposal of the actor and can be mobilized to facilitate socio-economic gain. This intangible asset is termed as social capital in management, sociology, and economics literature. This conceptualization of social capital as an value enhancing system resource and a tradable asset stock (Black and Boal, 1994) has given rise to study it's affect on performance and success at individual, organizational and inter-organizational level in the field of organization and management science.

In the context of business firms, the positive effect of social capital on resource allocation, innovation and learning, it's effect on availability of human resource and attrition, as a facilitating function to strengthen relation with members of value chain (for overview of the breadth of social capital literature in the context of business organization, see the review paper by Adler and Kwon, 2002), to explain longevity and economic performance of firms including prospect of start-ups (Ingram and Baum,1997; Maurer and Ebers 2006), relation between investment in social capital and economic growth of firm (Westlund and Nilsson,2005; Wu and Leung, 2005); effect on pre-investment behavior (Sorheim, 2003) has been investigated, to name a few. Most of the researchers mentioned above, has explored the effect of social capital on variables those have direct impact on firm's existence, firm performance and profit potential. Though description of the detail of the results is out of scope of this paper, the literature in social capital fairly establishes that there is a positive relationship between organizational social capital and organizational performance (Adler and Kwon, 2002).

¹ Fables in *Panchatantra*,(300 BC) describe the virtue of having good friends, good social circle which helps an individual in creating political, economic and reputational resources and facilitates socio-economic transactions. *Arthashastra* (200 BC) prominently discusses the social capital of State and opines that it affects and is affected by the conduct and capability of the ruler and its citizens which not only facilitates well being of the state but also enhances performance of institutions in the state.

In organizational context, conception of social capital is viewed from two main perspectives. The structural perspective views social capital 'as the resource located in the external linkage of a focal factor' (ibid). Hence this view of social capital attributes more importance to the structure in which the organization operates and takes into account the number of ties, structure, and content of relation as the base of analysis. It considers organization as one single unit like an individual. It also considers impact of social norms, rules and obligations and treats individual action and consequences from a holistic view (Kilduff & Tsai, 2003). The other view called individualist view (also named as collective view and bonding view) focus 'on collective actor's internal characteristics' (Adler and Kwon, 2002). According to this view social capital of a collectivity such as organization is not so much in its external ties but originates from its internal structure and cohesiveness (ibid).

However, the basic feature of social capital analysis is the tie between two single units, either individual or a collective, and their reciprocal relation. From this standpoint social capital involves expectation and reciprocal obligation between two units (Degenne and Forse, 1999: 116). Thus it is not sufficient to know how many other members one is attached to but it is also important to judge whether the individual is capable enough to meet the expectation of its network members and will be able to continuously manage reciprocal action up to their satisfaction. In such a scenario and in case of an individual, its traits such as individual capability, efficiency, and personality definitely affect the quantity and quality of relations the individual establishes within its network. These components also affect creation and leveraging of social capital at its disposal. In case of organization, where it is considered as a single unit, meeting the reciprocal obligation requires the resources of organization, their efficient and effective utilization, internal human resource, their interaction, cohesiveness, and support of internal structure of the collective. In organization context the collection of these mentioned attributes can be conceived as the capability of organization. This statement is in agreement with Nahapiet and Ghoshal's (1998) assertion that organization as a collective is a cohesive entity and its capability is the net resultant of the internal resources available and the interaction among them. This internal capability of organization when successfully meets expectations increases organizational social capital.

Defining Organizational Social Capital (OSC)

Social capital is defined differently by different authors and the definition varies according to the importance given to structural aspect, relational aspect or content aspect of the actor's network. However, defining social capital for organizations in a socio-economic network such as industry has its own peculiarity because of two reasons. (1) As structural view suggests, organizations considered as a single unit can generate social capital by the virtue of their structural position in the network and (2) As individualist view suggests, an organization is a network by itself consisting individuals and groups, and hence the organization as a separate entity also enjoys social capital from its internal network. Therefore, prior to define organizational social capital we need to have a look back into the existing definitions and in the context they were defined. Adler and Kwon (2002) while synthesizing social capital theory list eighteen definitions of social capital, both from structural as well as individualist perspective. However, they favor the definition those are neutral to both the perspectives and opine that the two views are not mutually exclusive as the definition varies according to unit of analysis. This

suggestion seems very appropriate in the context of organization as it can be observed that behavior of actors and their relationship inside organization affects social capital of the organization as a whole which in turn affects the network structure in which it operates (Maurer and Ebers, 2006). Thus, in organization context definition of social capital should acknowledge both the structural contribution and individual contribution to the resultant social capital of the organization.

Adhering to this principle and considering an organization as a separate entity having its own existence this paper defines organizational social capital as, “The aggregate of intangible assets and resources available at the disposal of firm for facilitating socio-economic gain in its interaction with internal and external constituents of network. It is the aggregate of structural social capital (SSC) and reputational capital (RC). Structural social capital is sourced from the organization’s position, relation and dependency embedded in the structure of network where as Reputational social capital (or simply Reputational Capital) results from the relation, action and shared belief of the collectiveness that is internal to the organization.” $\Rightarrow OSC = f(SSC, RC)$

This definition synthesizes both structural and individualist perspective and acknowledges the mutual reciprocity of both perspectives. The definition adheres to the structural, relational and cognitive dimensions of social capital (Nahpiet and Ghoshal, 1998) and simultaneously considers it as a tradable asset stock (Black and Boal, 1994). The definition of structural social capital is synonymous with Uphoof’s (2000) definition where structural social capital is referred as ‘a relative objective and externally observable social structure such as networks, associations and institutions they embody’. Reputational capital is subjective and is based on Nahpiet and Ghoshal’s (1998) cognitive and relational aspects. It is the net result of interaction between organization capabilities, norms, behavior, shared values which builds organization’s reputation over time. Because organization is itself a network this definition assumes that the net contribution of this internal capital results in reputational capital.

MEASURING STRUCTURAL SOCIAL CAPITAL (SSC) WITH NODAL POWER

This part of OSC caters to the structural perspective of social capital and is based on social network analysis. The fundamental logic of this perspective is that an organization, its action and resultant consequence is embedded in the structure of the context in which it operates. This context includes its competitors, suppliers, consumers and all those who affect and are affected by the organization and functions as a networked economic system. In a networked economic system each individual participant seeks an exchange with others, hence form a network based on mutual dependence and division of work. Such type of network is stable but not static because relationships often go through renovation, change, or even disruption. These relationships are complementary in nature and are specific to inter-firm dependence (Johanson and Mattsson, 1987). Power of a participant in such an economic system is naturally derived from the variation in mutual dependence. However contemporary network analysis lacks to inculcate the dependency based power perspective while analyzing the effect of network structure. Centrality based indexes, which contemporary network analysis subscribe to, conceive power as a function of importance of a node in the network and measures the same as the number

of connections to a node, the distance of the node from alters² or their path of connection. Hence, power in these indexes is based on absence or presence of links but based neither on the quality of links nor on mutual dependence. More over, the strength of relation between a node and alter is calculated by its direct or indirect connectedness i.e. either an alter is directly attached to the node or is having an indirect path with other alters in between. In some cases, strength is calculated by frequency of contact which is by any means a qualitative judgment (Degenne and Forse, 1999). This shows, in contemporary network analysis, primary importance is given to distance and accessibility of a node to alters. This perspective is very effective from sociological epistemology but, the missing consideration of need based mutual dependency and direct economic reciprocity, limits our understanding of networks based on economic activity such as industrial networks and value nets. Such networks, whose primary action entails economic transactions, are termed as socio-economic network (SEN) in this paper.

The next section constructs Nodal Power as a function of mutual dependency and argues that the network effect on organization or structural social capital (SSC) can be quantitatively captured based on the structural position, relations and dependency it establishes with other members in the network. In the context of SEN, this paper quantifies the power index based on economic dependency, which can be objectively measured in value terms. However the power index can also be used in pure social networks if social dependency can be quantified.

Defining Nodal Power in a Socio-economic Network (SEN)

The concept of nodal power is based on the very idea of mutual dependency of actors in an economic network. A socio-economic network is defined as a relationship between a node and more than one alters where at least one alter enjoys a one-to-one relationship with the node.

Definition 1 (Socio-Economic Network, SEN) : Let $X = \{x_1, x_2, \dots, x_n\}$ represent a finite node set of cardinality n , and $R = \{r_1, r_2, \dots, r_k\}$ represent a finite set of relationships of cardinality k , such that $X, R \neq \emptyset$ and $\forall x_n \in X, \exists r_k \in R$

Then, a socio economic network $N := (X, R)$ such that

- (i) $X = \{x_1, x_2, \dots, x_n\}$
- (ii) $R = \{r_1, r_2, \dots, r_k\}$ elements of the Cartesian product $X \times X = \{(x, y) / x \in X, y \in X\}$ and
- (iii) $k \leq n(n-1)/2$.

Note: r_k is a bidirectional relationship and for each one-to-one bi-directional relationship there exists two uni-directional relationships. The maximum number of uni-directional relationships possible in SEN is $K_{\max} = n(n-1)$.

By definition a SEN is a set of nodes and their relationships. These nodes are quasi-independent units such as individual or organization those either as individuals or as collective³ constitute a socio-economic system such as SEN.

² In a network, all other nodes except the node on focus are termed as alters. This is a standard network terminology.

³ An economic entity such as organization by itself is a collection of internal ties and can be considered as a network by itself. As organization action and its consequences are the result of its internal ties, resources, collective cohesiveness and collective goal it can be considered as the outcome of its structural embeddedness of the internal network (Coleman, 1990). Again organization is embedded in a social structure including other organizations and

SEN can be considered as a system of mutual need satisfaction and so is a one-to-one relationship. The need may be economic, social, or personal. Higher the need, higher the dependency, stronger is the desire to build relationship with someone. In a need based relation the strength of relationship depends on the magnitude of need that one satisfies or seeks to satisfy from the other which includes present need(s) or anticipated need(s). The needs may not be mutually exclusive but can be valued independently. So in a one-to-one relationship node's strength is negatively related to the need it satisfies from alter and positively related to the need it satisfies of the alter. The resultant magnitude determines the power; the node has in its disposal. This adheres to Emerson's (1962) view that "Dependency in a socio-economic relation is the reverse of power" and subsequently provided the main urge in finding out the factors that cause variance in dependency and power in organizational context. This treatment of power is inherently different than the earlier 'number of relation' or 'connectedness' based measures as it consider the relative strength of each node.

Definition 2 (Nodal Power) In a SEN, the 'Nodal Power' P_i for any node 'i' is defined as the net power derived by the node from the variance of dependency in a given relationship. For $N=(X, D)$, the net nodal power P_i for any node i is defined as

$$P_i = \sum_{j=1}^k (d_{ji} - d_{ij}) \quad ; \text{ such that } -1 \leq (d_{ji} - d_{ij}) \leq 1 \text{ and } k \leq |R|$$

As mentioned, d_{ij} is dependence of node i on alter j and d_{ji} is dependence of alter j on node i . Both d_{ij} and d_{ji} are termed as *dependency factors*. $(d_{ij} - d_{ji})$ is called the '*Marginal Power Contribution*' for P_i from the one-to-one relation between i and j .

In this definition each uni-directional relationship with the node represents one unit of dependency having minimum value 0 and maximum value 1. That means, if i is fully dependant on j and no one else for a specific unique need then dependency of i on j , $d_{ij} = 1$ and if j is not at all dependant on i then $d_{ji} = 0$. However in a SEN, for all practical purpose, it is assumed that each uni-directional dependency is non-zero. Note that when both d_{ji} and d_{ij} are positive and equal it represents symmetric relation and when $d_{ji} \neq d_{ij}$ the relation becomes asymmetric. Hence this formula is applicable to both symmetric and asymmetric networks.

Case 1: Imperfect substitutes having equal value: In $N(X, R)$, iff $\exists S_i \subset X, C_j \subset X$ such that

- (i) $S_i = \{s_1, s_2, \dots, s_i\}$ and $C_j = \{c_1, c_2, \dots, c_j\}$
- (i) One-to-one relationship set $R_{ij} = \{r_1, r_2, \dots, r_k\}$ elements of the Cartesian product $S_i \times C_j = \{(x, y) / x \in S_i, y \in C_j\}$ and $r_1 = r_2 = \dots = r_k$
- (ii) $\forall r_k \in R_k \exists! d_m \in D$ then

Then for $s_i \in S_i$ and $c_j \in C_j$; the relationships $r_k \in R_{ij}$ are imperfectly substitute, as each relationship fulfills/ has potential to fulfill the same need. Hence, $d_{ji} = 1/|S_i|$; $d_{ij} = 1/|C_j|$

extra-organizational individuals. This forms a greater network such as industry or economy where a single organization is considered as a single 'collective'. However, in a larger network like industry firm is considered as a single node for all practical purposes.

Case 2: Imperfect substitutes having unequal value: In $N(X,R)$, iff $\exists S_i \subset X, C_j \subset X$ such that

- (i) $S_i = \{s_1, s_2, \dots, s_i\}$ and $C_j = \{c_1, c_2, \dots, c_j\}$
- (ii) One-to-one relationship set $R_{ij} = \{r_1, r_2, \dots, r_k\}$ elements of the Cartesian product $S_i \times C_j = \{(x,y) / x \in S_i, y \in C_j\}$ and $r_1 = r_2 = \dots = r_n$
- (iii) $\forall r_k \in R_k \exists! d_m \in D$

And there exists a Value set $V_{ij} = \{v_1, v_2, \dots, v_z\}$ such that $\forall r_n \in R_{ij}, d_m \in D \exists! V_z \in V_{ij}$ then

$$d_{ji} = V_{ij}/V_i; d_{ij} = V_{ij}/V_j$$

That means for an unique utility of i and j

d_{ji} = the value of utility provided by j / total value of the unique utility for i

= value of i 's dependence on j / i 's total value of dependence

d_{ij} = value of i 's dependence on j / j 's total value of dependence

Note that the total value of dependence for i and j is the total value of utility of i and j respectively.

Case 3: Multiple Utility/dependency: In $N(X,R)$ iff $\forall r_k \in R_k \exists d_{1 \text{ to } m} \in D$ then

$P_i = \sum_{j=1}^k \sum_1^m (d_{ji} - d_{ij})$; such that $-1 \leq (d_{ji} - d_{ij}) \leq 1$ for each dependency of 1 to m derived from each relation of 1 to k

Case 4: Critical Complements: In $N(X, R)$, $r_k \in R$ is called a critical relation, iff $\exists d_m \in D$ such that for the $d_m \in D \exists! r_k \in R$

If a need is divisible and is a function of multiple dependencies then a critical complement is defined as the colligating dependency of a node on an alter such that all other relations don't satisfy that need if the colligating dependency is not satisfied. Thus critical complement has a dependency factor of one irrespective of the monetary value of the dependency and remains critical if and only if only a single one-to-one relation satisfies that dependency i.e. no imperfect substitute available.

Measures of Nodal Efficiency:

Definition 3: (Average Nodal Power). The average nodal power is defined as the nodal power per relation per dependency and is denoted as P_{avg}

$$P_{avg\ i} = \left[\sum_{j=1}^k \left\{ \sum_1^m (d_{ji} - d_{ij}) \right\} / m \right] / k \text{ such that } -1 \leq (P_{avg\ i}) \leq 1;$$

where m is the number of utility per relation and k is the number of one-to-one relation.

It signifies the efficiency of relationship i.e. the power derived from each relationship and power derived from each utility. In a dynamic situation it will reflect power derived from

each transaction that in turn will affect the future of the relationship. This index has critical implications from the view that there is a natural limitation for a node to have number relationships. The number of direct relationships a node can maintain simultaneously is a function of its capability. In this scenario the index proves to be beneficial as it helps in establishing the optimal number of relations for a node and the trade-off between number of relations and *marginal power contribution*.

Definition 4: (Space of operation). In $N(X,R)$, iff $\exists S_i \subset X, C_j \subset X$ such that

- (i) $S_i = \{s_1, s_2, \dots, s_i\}$ and $C_j = \{c_1, c_2, \dots, c_j\}$
- (ii) $s_{1 \text{ to } i} \in S_i$ and $c_{1 \text{ to } j} \in C_j$ are homogenous but $S_i \cap C_j = \emptyset$
- (iii) E_i is the set of “established” one-to-one relationship set and $e_i \in E_i$ elements of the Cartesian product $S_i \times C_j = \{(x,y) / x \in S_i, y \in C_j\}$
- (iv) $E_i \subset R_{ij}$ and $|E_i| \leq j(j+1)/2$

Then the ‘Space of Operation’ $SO = 1 - [2E_i / j(j+1)]$ such that $0 < SO < 1$

Property of Nodal Power (P_i)

Here I briefly describe the operational properties of nodal power as an index. Each property described here after corresponds to at least one characteristic of various indexes⁴ developed in the contemporary network analysis literature.

- (1) P_i is directly proportional to the number of relations if and only if for each one-to-one relation the marginal power contribution is positive. (This takes care of the earlier shortcoming of network analysis where power was a function of number of relations but not the nature of relation. It adheres to the principle of Network centrality)
- (2) P_i is inversely proportional to the number of imperfect substitutes available for alter j . (This considers the structural accessibility of alters while determining nodal power)
- (3) P_i is directly proportional to the alter’s dependency on a second alter if and only if the second alter have high dependency on the node. (It adheres to the principle of complementary relationship and the principle of transitivity)
- (4) If there exists more than one utility for a relationship between a node and an alter then P_i is directly proportional to the number of utilities it provides. (It includes the possibility of multiple value addition and adheres to the principle of multiplexity)

The definition of Nodal Power considers only direct relationships. However it is essential to consider the effect of both direct and indirect relations of a node because the action of a node and consequences there of is considered to be embedded in the whole network, not only to the direct relations. Careful observation of the concept of nodal power will reveal that the ‘net nodal

⁴ For a detailed description of indexes such as centrality, transitivity, multiplexity and other characteristics of socio-economic networks refer works of Ronald Burt and J.S.Coleman. Books such as ‘Introducing Social Networks’ by Degenee, Forse translated to English by Borges (1999); ‘Social Network Analysis’ by Wasserman and Faust (1994) also provide a detailed explanation of structural network analysis.

power' captures the trickle down effect of entire network on node such as effect of indirect relations. The reason as follows *One* It can be observed that total utility⁵ of an alter is divisible⁶. Hence each relationship it establishes with others caters to a part(s) of that utility. Thus the part of utility an alter derives from node is also dependant on the utility it derives from all other alters except the node. Thus the power of node not only depends on its relationship with the alter but also on the alter's relationship with all other's in the network. *Two* According to the principle of substitutability the alter can substitute the node provided availability, thus can reduce its power. If many nodes are available for the alter offering the same utility and if the alter can establish relationship with all of them, then the power derived by a single node decreases proportional to the established relationship with other nodes offering same utility. Thus the direct relationships of a node is affected by alter's direct relationships with all other alters. Hence the node's indirect relationships are taken care of in the dependency-based power structure. In other words an alter's nodal power is affected by it's direct relationships, hence the nodal power a node derived from its relationship with that alter is also affected by alter's other relationships and this takes care of nodes indirect relationships⁷. For a more detailed explanation with an example refer *Appendix I*. For a brief comparison of nodal power with other transformations (i.e. how nodal power corresponds to and different from Coleman's and Burt's treatment of social capital) refer *Appendix II*.

DYNAMICS OF REPUTATIONAL CAPITAL: THE INDIVIDUALIST PERSPECTIVE

The individualist perspective considers an organization as a single collective. Being a network by itself, an organization has its own capability derived from its internal resources and the people involved in it. It is similar to an individual, who is not only known by his/her external relations but also by his/her personality, reputation and other personal traits, which more often than not is internal (which affect his/her capability of establishing and sustaining relationships). In the context of organization, this paper argues that the intangible capital sourced from the internal sources of organization has a reputational value which complements the structural social capital. Researchers have already shown that reputation not only affects network formation but also triggers structural change by affecting performance (e.g. Sherwood, 2006; Stuart, 1998). As described earlier, this reputational capital is a function of firm capability and is path dependant.

Social capital from this perspective has been studied by different authors by assuming that organization's social capital (in this case the reputational capital) is simple aggregation of individual capitals. For example, Pennings, Lee & Witteloostuijn (1998); Tsai and Ghosal (1998) have measured entrepreneurial firm's social capital as the aggregate of social capital of individual firm members. Maurer and Ebers (2006) have opted for the same when studying dynamics of social capital for start-up biotechnology firms in Germany. However this conception has one drawback. It doesn't recognize separate identity of an organization. It is indeed perfect to identify an organization with entrepreneurs in the very first stage of firm's birth but as firm grows its takes its own identity and creates its own reputation which is different from the

⁵ Utility of a node is the whole of benefit that others get from a particular node. It is the reason of other's dependency on that particular node.

⁶ Recall that network is established for accessing complementary resources, capabilities, and division of work.

⁷ The mathematical proof of the argument is based on matrix algebra and is available with the author.

individuals involved⁸ (even though not mutually exclusive). Hence this paper considers organization as an ongoing concern which is separate from individuals or sum of them. Resultantly internal sourced social capital for a firm (reputational capital) though dependant on individuals is considered to have its own existence, dynamics, and effect. It is already established that the internal sourced social capital not only have positive impact but also negative impact on firm performance (Edelman, Bresnen, Newell, Scarbrough & Swan, 2004; Maurer and Ebers, 2006; Gargiulo and Benassi,2000) depending upon changing environment, internal structure, capability, and their in-firm, out-firm relations. As internal sourced social capital affects performance which affects reputation, we can reason that decrease in internal sourced social capital decreases reputation and vice-versa. Because this reputational capital is path dependant and is based on capability, it changes with time and with firm's internal capability. Thus it doesn't remain the aggregate of entrepreneurs' social capital with the pass of time even though it still depends on them. With passing of time the organization creates its own value, its own identity and own structural position in the network.

Capability is derived from resources at the disposal of an organization which includes human resources among others. Organization's reputational capital directly depends on its capability. In inception stage it depends on the number of persons in the organization. It also depends on the numbers of relations they have in and out of the organization because organization as a collective is a network by itself. This is in agreement with the view that for a start up reputational capital is the addition of entrepreneurs' individual capital hence more individuals more will be reputational capital and from more diverse background they are, more is the reputational capital (Maurer and Ebers, 2006, Burt, 2000). Again we know increase or decrease in social capital depends on the action of related persons and nature of relations. Combining these perspectives we can study the rate of change of reputational capital for a firm for given number of relations and nature/type of action. There are three types of action i.e. positive action, negative action and inaction or absence of action. From organizations perspective any inaction is assumed to have no value addition, thus considered as inactive form of negative action. The following sections study the dynamics of reputational capital for negative action/inaction (i.e. rate of change w.r.t time). The result is also applicable for positive action and will help in measuring reputational capital at a given time for a given capability. The next section measures the effort taken to replenish the lost reputational capital as a result of negative action.

Rate of change of Reputational Capital

Preceding arguments consider reputational capital as a collective good which is particularly true in case of internal sourced social capital which is nonrivalrous (Adler and Kwon, 2002).As reputational capital is directly proportional to the number of individuals in an organization (in the inception stage) and net value it gains there of, we can assume that the change in reputational capital (i.e. increase or decrease) is proportional to the number of individuals (or resources) internal to the organization.

⁸ For example Infosys social capital in its inception might be equal to all the entrepreneurs' individual social capital but it is not so now. Infosys as a separate entity has created its own reputational capital based on its own capability and resources that is different but may not be mutually exclusive than that of entrepreneurs.

Let $S(t)$ is the total unit of social capital present with the organization at time t . Note that $S(t)$ is not the simple addition of numbers of individuals attached but it is the whole total of intangible asset available at firm's disposal. We also know that if expectation of individuals attached to the organization (internal stakeholders) doesn't match with performance of organization then reputational capital decreases (c.f. Sherwood, 2006). This may happen because of firm's inaction or negative action. Lets denote the unit of social capital decreases per unit time as ds/dt because unit of social capital decay is proportional to $S(t)$. The change in t is always positive and it represents passing of time, changing circumstances, or environmental change.

Clearly $\frac{-ds}{dt} \propto s$ {Negative symbol denotes decrease and $S(t)$ is simply denoted by S }

$$\Rightarrow \frac{-ds}{dt} = ks \quad \text{where } k > 0 \text{ ----- (1)}$$

k is the *decay constant* for a specific action or inaction. It signifies the gravity or value of a specific inaction or action. Here a negative sign signifies inaction or negative action.

The above equation reflects Adler and Kwon (2002) view of social capital, where they explain the nature of social capital and comments, "Social capital needs maintenance. Social bonds have to be periodically renewed and reconfirmed or else they lose efficacy. Like human capital but unlike physical capital, social capital doesn't have a predictable rate of depreciation for two reasons, *First*, it depreciates with non-use and abuse but not with use; *Second*, while social capital some time is rendered obsolete by contextual changes (Refer Sandefur and Laumann, 1988 for examples), the rate at which this happens is typically unpredictable"

$$\Rightarrow \frac{ds}{s} = \frac{-k}{dt} \quad \text{integrating we get } \log S = -kt + \log I \quad \text{where } I \text{ is a constant and defined below.}$$

$$\text{Thus } S = I e^{-kt}$$

\Rightarrow At $t=0$, $S=I$ where I = initial social capital or social capital at time of inception of organization and this is equal to the net aggregate of individual social capitals of entrepreneurs.

By treating an organization a different entity than its founders we can safely assume that an organization at its inception (time t_0) doesn't have any social capital of its own. The social capital it uses is sum of founder's social capital (Pennings et al, 1998; Tsai and Ghosal, 1998; Maurer and Ebers, 2006). This situation is reflected in the above equation. Lets S_0 is sum of promoters' social capital at time t_0 . Thus $S_0 = I$

$$\Rightarrow S = S_0 e^{-kt} \text{ ----- (2a) where } 1 \leq k \leq \infty \text{ for negative action and inaction and } -1 \geq k \geq -\infty \text{ for positive action}^9$$

Hence for positive actions equation (2) becomes, $S = S_0 e^{+kt}$ ----- (2b) which signifying increase in social capital

⁹ For example positive action is matching stakeholder's expectation or adhering to principles of corporate social responsibility etc

Thus the change in social capital at any time t_n is the initial social capital at time t_0 exponentially multiplied with elapsed time and *decay constant* k which captures the gravity of the situation/negative action, thus specific to the situation. The more the value of k , more is the seriousness of negative action.

$$\text{So Reputational Capital at time } t_1 = S_1 = S_0 e^{\pm kt} \Rightarrow RC = S_t = S_{t-1} e^{\pm kt} \text{ ----- (3)}$$

Where; negative sign ($-k$) signifies inaction or negative action and positive sign ($+k$) signify positive action or expectation match at time t_0 .

This equation provides insight to a few important properties of social capital and reputational capital. It says social capital is not only the sum of individual social capitals in an organization but also it is a function of how the firm manages its relations. It is a function of firm's positive or negative action. Implicitly it points towards firm's capability to satisfy stakeholder's expectations. It is also dependant on time thus path dependant. As t will always increases, hence to maintain the same level of reputational capital an organization has to do positive action, i.e. to increase capability and matching the expectations in a changing environment. From, equation (1) it can be observed, as t increases with no change in $-k$ value (inaction) the net social capital decreases. Only with positive action, i.e. $+k$ value, the net social capital increases. It subscribes to Maurer and Ebers (2006) finding that, with change in environment one has to change the capability and the nature of relations to have positive impact of social capital on firm performance. It shows inaction is paid by heavy price as reputational capital decreases exponentially. It also shows if one matches the expectation then reputational capital increases exponentially (For example It can explain word-of-mouth phenomena). Relating this with firm performance we can infer that, firm performance will increase when increased expectation is matched by increased capability, thus having a $+k$ value. If expectation increases without increase in capability then the equation takes $-k$ value thus decreasing performance. However, one of the interesting finding is, if capability increases without increase in expectation, then performance is unaffected. For example a capacity increase with no additional business (means no new relation/ no additional demand from existing relations) doesn't increase the revenue of a firm. The equation also says that each positive and negative action, inaction has its effect on the reputational capital of the firm.

Replenishment of Lost Reputational Capital

Suppose for inaction or a negative action some amount of reputational capital is lost. Let's assume the period of inaction / negative action started at time t_{-1} and reputational capital was lost according to equation (1) up to time t_0 . In other words we can say that some amount of reputational/social capital was utilized for that specific action. This statement is in agreement with social capital's properties of 'tradable asset stock' and 'substitutability across time'¹⁰

¹⁰ For example in a team if a member free rides, other members may not effectively restrain him because either he is a good friend or he has already worked in another assignment of the same group when the other members haven't worked or the other members expect to have some benefit in future by keeping him in good humor. In all these cases the free rider is substituting its already existing social capital or prospect of social capital in future for the capital loss in present. This describes the issue of 'substitutability across time' of social capital.

Lets the social capital lost or amount of social capital used in the above-described scenario is termed as ‘social capital debt R’. Thus R_0 is the social capital debt at time t_0 .

Let $R(t)$ = Unit of existing capital debt at time t . Now onwards it will be denoted as R . Lets t is the time taken by an alter to extract information from a node who is affected by inaction or negative action. In other words t is the rate of information dissemination in a social network. For simplicity lets assume that the information dissemination is liner (i.e. It takes same time to transfer from one affected alter to other alters).

Let $W(t)$ = Amount of inaction or that specific negative action (for which social capital was lost) up to time t . Now onwards it will be denoted as W . In an economic system this amount may be valued in monetary terms i.e. loss in value for alter.

Let $S_N(t)$ = Social capital needed (Effort/action needed which will result in positive reputational capital) to replenish the lost social capital which will result in regaining the original position. For example if a firm lost some sales or lost goodwill because of a negative action that is the value of social capital they lost (i.e. W) and S_N is the value/money/effort they need to come to the initial position. From now on it is denoted by S .

Lets in a time interval Δt , say from t to $t+\Delta t$, an organization’s amount of inaction/negative action results in Δw such that an amount of Δs was needed to replenish it. Because amount of social capital debt is directly proportional to amount of inaction ($w \propto r$); the net change in Δr , in time Δt is given by

$\Delta r = k\Delta w - \Delta s$ ----- (4) as loss of social capital is simultaneously replenished by social capital created by positive action in the specified time length. Here k is the *decay constant*.

Dividing by Δt to get the rate of change and obtaining the value as $\Delta t \rightarrow 0$ we get

$$\frac{dr}{dt} = k \frac{dw}{dt} - \frac{ds}{dt} \quad \Rightarrow \quad \frac{dr}{dt} = kP(t) - \frac{ds}{dt} \quad \text{---- (5) Where } P(t) = \frac{dw}{dt} = \text{negative work done .}$$

It is the unit loss of reputational capital for change in unit time. This is a function of capability of the firm and the rate at which information disseminates among alters in the given network.

The rate at which reputational capital/positive action is needed is proportional to the deficiency/lost social capital. In other words social capital needed is directly proportional to amount of capital debt

$\Rightarrow \frac{ds}{dt} = c r(t)$ -----(6) where c is called *capability constant* specific to the firm. It is the capability or power of the firm that affects the rate of replenishment. High capability will result in swift and effective corrective action. Thus c is directly proportional to the rate of replenishment.

Note: In a structural analysis, nodal power can be taken as a proxy for c .

Combining equation (5) and (6) we get

$$\frac{dr}{dt} + c r = kP \text{ ----- (7)}$$

Equation (7) is a first order liner differential equation and can be solved to

$$r e^{ct} = \int kP e^{ct} dt + C_1 \text{ ----- (8)}$$

If r_0 is the amount of reputational capital existing at time t_0 then $C_1 = r_0$

$$\Rightarrow r(t) = r_0 e^{-ct} + k e^{-ct} \int P(t) e^{ct} dt \Rightarrow r(t) = r_0 e^{-ct} + k \int P(t) dt \text{ ----- (9)}$$

The above equation can be used to determine $r(t)$ for different function of $p(t)$ where t is the time period as defined above. The simplest case will be, if $P(t) \equiv 0$, i.e. no negative work done at time t_0 (remember negative work started at t_{-1} and stopped at t_0)

$$\text{Then, } r(t) = r_0 e^{-ct} \text{ ----- (10)}$$

This shows the unit of reputational debt at time t is the product of previous reputational debt and exponential of the product of capability constant and elapsed time. As t will always be positive, the equation means more is the time taken to initiate corrective actions more is the reputational debt. More is the capability of firm; less is the prospect of reputational debt. The equation also shows that reputational debt should be replenished exponentially after the negative action is stopped. For any bad action followed by a time of inaction, the price will be paid exponentially and depends on value of the negative action and the length of time of inaction¹¹ i.e. the time period at which no corrective measures were taken following negative action. This equation shows that every negative action is exponentially punished in a network where free flow of information is possible (efficient market) with the condition that negative action is identifiable and containable.

ORGANIZATIONAL SOCIAL CAPITAL (OSC) AND FIRM PERFORMANCE

This section follows the discussion of preceding sections and provides a few propositions those enumerate the effect of structural social capital (measured as nodal power) and reputational capital on firm performance.

¹¹ For example; suppose a firm cuts cost by compromising product quality that is detrimental to consumers' interest. This was not known to consumers for a significant time period after which they came to know about it. The value of that negative action is the cost advantage gained by the firm. After the incident is known, the firm's reputation decreases and sales decrease. This is a function of the speed of information dissemination from the affected parties/or from the source of information. The price that the firm pays to replenish this loss of reputation and to come to original position will be exponential to the achieved profit by cutting cost. This price includes value of corrective actions, lost sales and any resulting compensations.

Profit, as we know, is a function of both value creation and value appropriation. In a network relationship variance in dependency for a single utility should reflect the valuation of that particular utility by concerned organizations. This valuation of utility is directly proportional to the post-processed value of that utility (firm creates value by processing input into output) and is also proportional to the rareness of fulfilling the utility from the network relation. Thus value creation is a function of variance in dependency. Appropriation of value is a function of creation of value, position, or indispensability of the source and user of utility and organization's control over the network. While Nodal Power as a measure of structural social capital considers these variables, it also affects and captures the extent of values appropriation. Based on this link the under mentioned hypotheses were formed.

P1a: No profitable business organization exists with net negative Nodal Power.

P1b: Nodal Power is directly proportional to the profit potential of a firm.

The existing power of node makes it attractive for alters to establish a relationship with the node for utilizing its nodal power (c.f. Stuart, 1998). But in a one-to-one relation a low dependant node will be less vulnerable to alters expectancy and vice-versa. It results in a positive variance of dependency for the node. Combining these to it can be reasoned

P2: In any one-to-one alliance/relationship bargaining power will be directly proportional to the Nodal Power.

As discussed, a node in socio-economic network has finite capability to establish and maintain relations. Thus after that limit is met any new relation will have a negative effect to the aggregate gain from relations. It happens as constrain in capability of the node makes it vulnerable to the reciprocal expectation of alter. Hence constrain in capability will result in a negative 'marginal power contribution'. Conversely an optimum selection of number of relations those contribute to positive marginal power will increase the net nodal power with less vulnerability to alter's expectation. Thus

P3a: There exists an inverse 'U' relationship between nodal power and number of direct relations.

P3b: Profitability will be directly proportional to average nodal power

P3c: The node with highest number of connections and highest average nodal power will appropriate value most in a network.

In growth phase of an industry, firms try many business arrangements. However, in this stage a relative stable industry structure is still in the phase of development. This is because of continues technological and market innovations and absence of standards. The established relationships are low in this phase because of unproven capability of individual firms in various segments of value chain. Many firms enter and exit in this phase making it a situation of continues flux. As a result the established relations are only a fraction of potential relations. Thus

P4a: In the growth phase of industry high space of operation will be available contributing to increase in nodal power of existing competitors. In that case profit potential will be more a function of industry growth than structural social capital.

P4b: In a mature industry low space of operation will be available and there won't be any significant variation in profit potential among firms after controlling for firm size.

Fulfillment of alter's dependency on node depends on the capability of node where alter's dependency is a function of its expectation. Organizational Social Capital will be positively affected if capability of node matches with expectation of alters. If both capability and expectation increases and have a match then there will be net increase in social capital. This also holds good for internal-stake holders. Thus

P5a: Increase in capability matched with increased expectation increases both structural social capital and reputational capital.

P5b: Low capability with high number of relations decreases structural social capital. Low capability with high expectation from internal stakeholders decreases reputational capital.

P5c: Low expectation/number of relations with high capability doesn't change the level of reputational or structural social capital.

Business environment for an organization changes because of changing expectation of internal or/and external stakeholders including consumers. This may be triggered by technological breakthrough, changing need set, competition or for any unforeseen circumstances. In such a case the firm needs to take action to adapt to that situation. As shown in equation (2a) and (9) social capital decreases if action is not taken. Thus

P6a: Any inaction in a changing environment decreases organizational social capital. Negative action increases the rate of decrease of organizational social capital in the absence of any corrective positive action.

Considering shareholders as internal stakeholders we can infer that if their expectation is not matched by organization then they have higher incentive to detach themselves from organization and if the reverse is true then many persons will try to be internal stakeholders. Assuming an efficient share market, the change in reputational capital will also be reflected on performance of firm's shares. Combining this with proposition 5b and 5c we can reason.

P6b: If environment is stable then reputational capital doesn't have an effect on firm's share prices but in unstable environment high reputational capital effects share prices positively and low reputational capital affects share prices negatively.

As discussed above, the nodal power changes with the conduct of network members. In the presence of 'co-density' where two parties indulge in a thick alliance like behavior facilitating free flow of information and willingly helping and warning in case of contingencies (Baker and Faulkner, 2002) the conduct of individual actors affect other members of the network by either changing the substitutability power or space of operation. In this case

P7a: A co-density in same segment of value chain increases the nodal power of a node in the specific value segment but reduces the nodal power of nodes operating in the next/previous value segment. (For example a co-density of suppliers will increase supplier's nodal power where as decreasing producer nodal power).

P7b: A co-density across value segment will increase the nodal power of all those who are involved in co-density but will decrease the nodal power of competitors those are not involved in co-density.

DISCUSSION AND CONCLUSION

This paper explored the possibility of synthesizing both structural and individualist perspective while defining organizational social capital in a socio-economic network (SEN). The paper opines that organizational social capital is a function of social capital sourced from its structural position in the network and the net intangible asset the organization gets from the resources that are internal to it. Both internal-sourced intangible asset and external-sourced intangible assets and their interaction determine the net social capital of an organization. The paper argues that in a socio-economic network we limit our understanding of network dynamics by focusing only on aspects of connectedness while calculating the effect of external-sourced social capital. Though the ‘connectedness’ based analysis provides visual configuration of a network, it doesn’t explain the power of network members explicitly. To overcome this shortcoming this paper introduces the concept of ‘Nodal Power’ which is based on mutual dependency of relations in a SEN and argues that Nodal Power determines the relative power position and a node’s potential for value appropriation in a that network. Subsequent to the conceptualization that internal-sourced social capital has reputational value for an organization, this paper shows the dynamics of reputational capital for negative actions, inactions, and positive actions. It proves that in an efficient market any negative action or inaction is paid for exponentially.

Potential Research Opportunities

Theoretical research need: Though this paper introduced the concept of nodal power which reflects dependency based power structure in a network, it is yet to be examined as to what extent it captures the insight provided by ‘connectedness’ based analysis. This needs studying the effect of nodal power vis-à-vis other contemporary indexes. Such analysis is important to prove that both Burt’s view and Coleman’s view are special cases of nodal power based formulation. The explanation provided in Appendix I and II which compares Nodal Power with Burt’s transformation (i.e. Z transformation) is a first step. However it is highly inadequate as it is based on a single example of closure type network. Hence, the effectiveness of the proposed index is yet to be studied for networks showing ‘structural hole’ property. Theoretical exploration is also needed to substantially validate that ‘nodal power based on direct relations takes into account all other indirect relations that affects the node’.

Empirical research need: Though this paper shows the effect of conduct on network structure and on firm performance, empirical validation is needed to prove the propositions. It is still not clear how nodal power captures the dynamics of competition between rival networks and the winning probability of one network over the other in the same competitive space, even if both networks have net positive nodal power. The dynamics of reputational capital is another area of research to understand how the rate of flow of information affects the “t” value in the equation and what the optimal time length is in a specific network to assign a “t” value. The other shortcoming is the lack of objective quantification of organizational capability except that of number of human resources. One of the ways is to measure the mentioned capability in ordinal scale. However it is still subjective and problematic while comparing two organizations. Though Nodal power provides insight about organizational social capital, greater understanding

will be achieved by demystifying the ‘capability’ of a collective i.e. organization, in a network context.

To study network dynamics in a longitudinal setting over time, it is important to study the structure and effect of existing relationships. It is so, because these developments facilitate making and changing of future relationships over time. This paper contributes to the first stage of this development by throwing light on power structure in an existing network and the value appropriated by members because of their relative power position and their conduct in the network. It also contributes by providing insight on the nature and dynamics of reputational capital of an organization.

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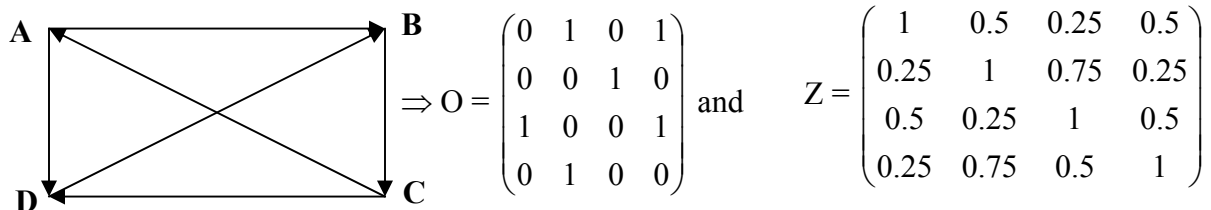
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Appendix – I

Nodal Power and Indirect relations

Proof: Direct relationships of a node reflect the effect of all indirect relationships possible for that node. Consider the below figure



In the above figure “A→B” denotes A depends on B. For simplicity of analysis one part of dependency in the bidirectional relation is taken as zero thus making it an asymmetric network. In the above figure A depends on B but B doesn’t depend directly on A. This view is also synonymous to the traditional analysis. Also it is assumed that each unidirectional relationship reflects equal dependency thus has equal value/contribution to the power. For the notation “A→B”; B gets a single unit of power. Assume no multiplexity i.e. multiple utility .Thus the variables like multiplexity and unequal value of relations are controlled for and the only variable that will affect the power of a node is its position in network i.e. direct relation or indirect relation. The power analysis table–1 represents the traditional analysis (also called Burt’s transformation) which takes into account both direct and indirect relations.

Relation	Power contribution			
	A	B	C	D
A→B & A→D		1		1
B→C			1	
C→A & C→D	1			1
D→B		1		
Total	1	2	1	2

Table-1

Relation	Power contribution			
	A	B	C	D
A→B & A→D		0.5		0.5
B→C			1	
C→A & C→D	0.5			0.5
D→B		1		
Total	0.5	1.5	1	1

Table-2 (Case1, k=1 and n=4)

Observe that the power contribution distribution in table-1 is the exact as the socio-metric choice matrix ‘O’. From this table we can observe A and C have equal power of 1 unit each where as B and C have equal power of 2 units each. We can observe both B and D establish two relationships each where as A and D have one each. This is reflected in the power table which is similar with the concept of centrality, strength of link that is used in contemporary analysis. But this kind of analysis has an inherent flaw. Because no multiplexity is assumed A’s dependence on D and B is for the same utility. As a result though the power derived by B and D will be equal

but not as equal to D's relationship with B where D is only dependant on B. Thus B and D's gain of power from A will be half of one unit i.e. number of established relations with substitutes factored by number of parts of utility. Thus even if each utility has same value contribution to power of a node, each dependency's contribution varies with the nature of contribution and other relations that the alter established except with that of node.

Now consider the network relations in the above figure .Clearly A doesn't have any power over B as B doesn't depend on A and similar situation for B and C. But C depends on A and B depends on C, thus naturally there exists indirect power of A on B because of its relationship with C. That means effect of AC relationship trickles down to AB relationship which has a positive contribution to the power of A. Except this A depends both on B and D but B depends only on C. So A's power contribution to B is definitely less than B's power contribution to C. Like wise both of D's dependences are also dependant on others; but D is only dependant on B. So even if B and D have same number of dependant B's power will be more than D's power, simply because of the nature of their respective dependences. Similarly, though A and C both have one dependant each C enjoys exclusive dependence of B but it is not the case for A. So naturally power derived by C will be greater than that of A simply because of the nature of their dependants. The difference of power between C and D not only depends on numbers of dependants but the value that each dependant contributes which in turn depends on their established imperfectly substitutable relationships. From the above analysis the power structure that evolves will look like $P_B > P_D \geq P_C > P_A$.Clearly table-1 misses this analysis but table-2 reflects the analysis. This shows that the concept of nodal power capture the trickle down effect of indirect relationships.

Hence, in this case we can conclude that by taking into account the direct relationships of a node in a given network, the effect of indirect relationship are also taken care of. Intuitively we can argue that if a node is dependant on an alter then the node is in fact using the power of the alter to the proportion the node is dependant on the alter. So nodes utility from alter includes all the relation the alter has with others in the network except that with the node. The same is true for other direct relationships making it redundant to calculate the effect of each and every indirect relationship of the node in the network.

Note: While the above example proved the point subsequent simulation analysis and research is needed to generalize it to all kind of network analysis

Appendix - II

Comparison with 'Z' based Transformation.

The nodal power calculates the net intangible asset available for a node emanating from the structural position of the node in a network. It signifies the structural view of social capital. Nodal Power not only considers the number of relations and nature of that relation but also considers other relations the alter has in the network and their effect on nodal power. This is a modification to the indexes based on number of relations and path. For example in the given figure in Appendix-I both B and D has equal number of dependants thus has equal power as shown in table-1 but in calculation of nodal power it is shown that both have unequal power ($1.5 > 1$: table-2). Hence it captures both the quantity and quality of relation. It also captures both positive and negative trickle down effect of alters on node (for B, in table 2 N_p is 1.5 not 2). Thus making it redundant to calculate the effect of indirect relationships of node. While doing network analysis of fairly closed and dense networks like intra-organizational networks calculation of nodal power includes all the structural power available to the node as a result of membership of that network.

In Burt's transformation matrix Z which depends on the path concept i.e. based on geodesic distance, the power derived by each node from their position is as follows. $A=1, B=1.5, C=1.5, D=1.25$. This follows the hierarchy of $P_B = P_C > P_D > P_A$. The hierarchy according to nodal power is $P_B > P_C = P_D > P_A$. Note that both the formulas don't alter the hierarchical position of nodes. The hierarchical position of nodes only shifts in the same hierarchical space (i.e. $>$ sign don't change into $<$ sign; $=$ signifies the meeting point of two hierarchical space). It is also clear that Burt's transformation gives too much power to the indirect relations and undermines the importance of direct relations. This supports Degenne and Forse's (1999) view that Burt's transformation attributes more importance to infrequent relations even with several intermediaries while minimizing the effect of direct links. In the example this is the reason for B's equal importance to C in Burt's transformation. The other reason is it focuses on distance but nodal power is based on dependency. This way nodal power captures the property of Burt's transformation and enhances it by considering the numbers and utility function of alters attached to it.

Coleman approached the structure of interaction in an economic system from competitive equilibrium perspective and indirectly treated dependency while describing linear system of action (Coleman, 1990:681). His treatment is fundamentally a demand model that describes the extent to which first person is interested in what the second person provides/controls and heavily depends on classical (i.e. rationality) and neo-classical (i.e. declining marginal utility) economic theory thus indifferent to empirical applicability in its present form (Gibbs, 1990). It also doesn't explicitly consider the established relation of actors which is fundamental to the network theory, neither it assumes reciprocal relations based on mutual dependency. It subscribes to institutional and socio-structural assumptions based on hyper rationality where the general idea is that each actor in a system can communicate with others and takes decision (Coleman, 1990:686) where as a network structure given its boundary condition works in a bounded rationality mode. Thus

even though the concept of dependency is implicitly approached by Coleman, the assumptions and treatment is different from that of “Nodal Power”