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Interactive knowledge exchanges under complex social relations: A simulation model of a developing country cluster

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ABSTRACT

This is a model of knowledge exchange by informal interaction among agents in a low technology cluster. The paper studies these knowledge exchanges in an environment of complex social relations. This study tests whether the small-world network structure is the most favorable for knowledge exchanges in these environments, and explores the influence of social relations and network distance on magnitude and equity of knowledge diffused. The results show that, when knowledge exchanges are undertaken in environments of complex social relations, a small-world network structure may still be the best network structure facilitating the highest performance, but it is not the best in terms of the most equitable knowledge distribution. The results also confirms that the highest and most equitable knowledge distribution is achieved when there is perfect affinity among the agents. These results contribute to the existing series of studies on efficient network structures for knowledge diffusion, and on the broader literature on the social forces shaping learning and knowledge diffusion.

1. Introduction

This research develops a model of information sharing involving informal interaction among agents in low technology clusters. These clusters constitute a large proportion of interacting knowledge clusters in a developing country like India. In addition, these clusters survive primarily on informal information exchanges, without which agents may often become trapped with obsolete knowledge, and incapable of sourcing the new knowledge required to progress towards the technology frontiers and remain competitive. Knowledge exchange by informal interaction through social networks is well developed in the knowledge diffusion literature [1], hence this paper does not seek to re-investigate simple barter-like information exchanges. Instead, it colors these exchanges by placing them in environments of complex social relations, tests whether the small-world network structure is the most favorable for information sharing in these environments, and explores the influence of social relations and network distance on magnitude and equity of knowledge diffused.

The literature on knowledge diffusion across networks has mainly dealt with the importance of network structure for equity and efficiency of knowledge distribution; an enquiry that remains necessary when we deal with clusters whose only source of new information is informal interaction. But the analysis has to be extended by setting it in environments of complex social relations that are often inevitable in such clusters. On the one hand informal information exchanges with co-located agents may be clean and untouched by any sort of social barriers among units (as in an environment of universal affinity between agents), while on the other hand, these exchanges may arise as emergent properties of the social differences in a more heterogeneous environment (as in a regime of complex social relations, or, at its extreme, of severe homophily). Community based demarcations and long existing social prejudices and affinities (such as caste differences in India and their consequences on economic life) may still hold.

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These complicate social interactions and generate implications for vital knowledge flows. It might pay for agents to cross these long existing social group demarcations to access new information, but at times it may not benefit since reciprocity, value introjections, and solidarity may take primacy over economic self-interest. It is in these environments that we question, in this paper, the supremacy of the *small-world* network structure, which is often held by the literature as the most efficient network architecture for efficiency and equity in knowledge diffusion.

Hence, this paper has two objectives. First, we test the hypothesis that the small-world network structure may not be the most efficient (in terms of performance and equity) for information diffusion through informal information sharing in a cluster in a complex social relations environment. And second, we explore the effect of – (1) intensity of social relations in a cluster, and (2) influence of network distance as a concern among information exchanging agents – on the performance of the cluster. These enquiries are the contribution of this paper to the existing series of studies on efficient network structures for knowledge diffusion. These objectives are tackled by employing a simple network model and simulation of knowledge exchange among networked agents. In the next section, we review the background to this model, by visiting studies on informal knowledge exchanges, network structure, and efficient diffusion of knowledge.

2. Network structure and efficient knowledge diffusion

Exchanging new information on the latest and best production practices and technologies, on a continuous basis, free of monetary cost, even to rivals, is an oft invoked practice, since it is almost impossible and often expensive to keep information under secrecy and it may sometimes work to the information-giver's professional advantage to actually release the information [2]. Most information flows through informal channels of word-of-mouth information exchanges and through social circles [3]. Networks gain prominence, serving as vehicles not only for learning but also for reinforcing social norms and values, defining the nature of the social capital of the region. They become a cluster's principal component and the vehicle on which learning is facilitated. Consequently, investigation into social networks emerges as more than just an appealing metaphor or vocabulary, with the provision of a precise way to test theories and propositions about social relationships [4].

To understand learning, diffusion, and innovative performance especially where tacit knowledge is freely shared or bartered to a subset of potentially interested agents, network dynamics and the structure of the network have to be examined, for which network models of diffusion provide an ideal venue. A series of studies by Cowan and Jonard [5–7] on knowledge diffusion across networks provide the basis for the model and analysis in this paper. In these models, the network structure is the pivotal element that decides the nature of information exchanges and long run performance (in terms of mean knowledge level in the system, and speed and equity of knowledge distribution). They demonstrate that while short paths (and therefore a random network) diffuse information the fastest, and while cliquishness brings about advantages that provide the very basis for clusters, it is generally a small-world network structure – employing the advantages of both short path lengths and cliquishness – that reigns. Small-worlds enjoy the best of local cohesiveness with proximity (which provide rapid initial growth) as well as distant links (to access information beyond the immediate locale which provide for continued growth).[1] This rigorously demonstrates an established theme in the diffusion literature that while strong ties (and therefore strong cliques in networks) provide obvious benefits, it is weak ties (and therefore short path lengths) that provide the basis for continued progress and to source new ideas and know-how; this based on the premise that with fewer indirect contacts, an agent will be more encapsulated in terms of know-how [8]. Small-world networks have been shown to arise in a wide variety of organized systems, from power grids to brain cells to scientific collaborations; which has led to the speculation that there is something fundamental and generalizable about how their capacities to organize and govern success in social systems [9].[2]

Cowan and Jonard [5] study the importance of network architecture on collective invention and the rate of innovation, and find that the structure of the network plays a fundamental role. They demonstrate the qualities of the small-world network as an efficient structure, especially when absorptive capacity is low.[3] Cowan and Jonard [6] study diffusion, treating it as a process of barter and sharing, where the barter occurs when it is mutually profitable for the exchanging agents. Their results also demonstrate that the small-world network structure is the most efficient architecture where average knowledge reaches its highest steady state and coefficient of variation is

[1] While Watts and Strogatz [11] and Watts [16] are popular citations for the small-world network structure, Freeman [17] points out that it was Ithiel De Sola Pool and Manfred Kochen who introduced the term 'small-world' in the network context, through a 1958 manuscript, which was republished as De Sola Pool and Kochen [18], twenty years later. A 1967 article by Stanley Milgram drew from the 1958 manuscript, and it was only subsequent to this that Watts and Strogatz (apparently unaware of the de Sola Pool and Kochen study) based their popular 1998 work on the small-world structure [17:164].

[2] However, Uzzi and Spiro [9] have shown that even when agents in social network are connected as a small-world, there is a high probability of cohesion stemming in. They demonstrate that the relationship between a small world and performance follows an inverted *U*-shaped curve. They describe how when separate clusters of agents become more interlinked, cohesion in turn increases, reducing the probability of innovativeness, of fresh ideas, and consequently of high performance. Uzzi and Spiro construct and employ what is termed as a 'small world quotient' *Q*, which tells how connected and cohesive agents in the network are, and consequently how productive or unproductive performance and creativity can get. Using the example of Broadway musicals, they find out that the financial and artistic success of a production increases at medium levels of *Q* and decreases at either low or high levels of *Q*. That is, the positive effects of connectivity backfire by homogenising the pool of creative material, and rendering agents incapable of breaking out of conventional ideas and styles.

[3] The only situation where the small-world network structure does not rule in this model is when knowledge is easy to transmit and absorb. A random network is most efficient in this case.