Networks, organizations and knowledge

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Conclusions

In the first chapter, I provided an introduction to the topics raised in this thesis. In the second chapter, I presented a survey of literature on economic networks. The aim of this chapter was to highlight the rising importance of networks in economic literature, and to draw a framework of the fields which use network analysis. One issue of confusion commonly encountered is that networks in economics are both used as a conceptual tool to view systems, and also they point to a particular form of governance structure, which is the so-called network based organization. This survey covers both of these, because the theoretical problem that I address is concerned with the emergence of network-based organizations, and the method that I undertake is to use network analysis as a tool to view organizations.

In the third chapter, I presented the central arguments in this thesis. I focused on a growing literature on two organizational structures. In the first, there is intensive knowledge sharing among a network of small and specialized firms. These systems are characterized by variety and specialization at the same time accompanied by rapidly changing market conditions, uncertainty, intensive informal know-how trading and collaboration and the boundaries of the firms get blurred. Networks integrate the knowledge of diverse actors taking role in innovation and production. If there is inertia or stability in the network, this process is facilitated by a shared culture and development of a common code of communication among parties, which reduces the costs of transferring highly tacit knowledge. The emergence of networks is largely an endogenous process driven by the complex and dynamic interplay between institutions,

products, technologies, the market and innovative actors. In this sense they are characterized as being self-organizing, such that there is no authority to impose a certain structure, but the interaction of firms is the main mechanism that generates the rules underlying emerging structures.

While in the case of networks specialization and variety co-exist at the same time, in the case of large firms variety takes a different form, usually studied under the heading of diversification. The diversified hierarchical structure is the second type of organization that I covered in chapter three.

From these observations, it can be seen that variety is sometimes found in a network of specialized firms, and at other times in the diversification patterns of large hierarchies. The underlying reasons for this phenomena forms the starting point of this thesis. The question is, why do we see these activities within the boundaries of a large firm in some cases, and distributed to a set of small firms who interact with each other frequently in others? The question then becomes, how do the existing theories on firm boundaries explain this critical level above which networking activities among firms intensify?

Taking these in the background, I presented the various theories of the firm in Chapter three. The two central questions that most theories of the firm focus on are, why do firms exist and what determines their boundaries. Traditional approaches to these consist of neoclassical theory and transaction cost economics. While both of these have their strengths, they have been criticized by scholars on a number of issues. Some of these are their behavioural assumptions, like homogeneity of actors, opportunism, and perfect rationality. More recent theories consist of the resource-based view of the firm, and the knowledge-based theories. This thesis is very close in spirit to the knowledge-based theories of the firm. According to this approach, firms exist to integrate the knowledge of a diverse range of specialists, and their boundaries are determined by the knowledge requirements of production. In this chapter, I discussed all these approaches in detail, also covering their criticisms directed towards the TCE approach.

There are four main building blocks upon which I base my thesis. Firstly, authority is a mechanism that is posterior to the formation of firms, and the main function of authority is to coordinate the integration and transfer of the knowledge of diverse actors in the firm. Secondly I follow Kogut and Zander (1992, 1996), in their explanation of the existence of the firm as a social community within which coordination, communication and learning takes place. Thirdly, I follow Grant (1996) in his emphasis of the role of the firm as integrating the knowledge of diverse specialists. Fourth, I emphasize the importance of the knowledge base of the industry in explaining how the boundaries of the firms are shaped.

Against this background, the questions that I address in this thesis are how the knowledge base influences the structure of the firms, in terms of specialization, diversification and networking? What types of organizational structures emerge under different knowledge bases? Does increased relatedness among products, in terms of their knowledge bases, prepare a suitable basis for the dominance of specialized firms with porous boundaries, or diversified hierarchies?

To approach these problems, I adopt a network perspective, and view all organizations as emerging networks. In this sense, both network based industries, and firms themselves are seen as self organizing networks of interacting agents. In a network representation, firms can be visualized as clusters of economic agents, who interact with each other more frequently than they do with outsiders. Network based systems would consist of such clusters where the linkages among clusters are also intensive.

In the fourth chapter, I presented the skeleton of the model, and gave some analytical results concerning collaboration among two producers in a two-good economy. The essential factors that determine collaboration among producers are as follows. Collaboration depends on capabilities of producers, and their relative knowledge levels. Since collaboration will only take place when both parties are willing to do so, there is a space of relative knowledge levels which will result in collaboration. The more specialized are the goods, the closer producers should be to each other in their respective expertise types to form partnerships. I also incorporated effects of learning in the analytical model. However, the analytical model that I present here is too simple to permit general conclusions. Firstly, the dynamics of the system changes considerably when we take into account a large number of producers. Moreover learning takes place in every period that may change the dynamics of the system in unexpected ways in future periods. Thirdly, the analytical model is largely deterministic in nature whereas in the real world there is uncertainty. Finally with only two products, it is difficult to model adequately the characteristics of the knowledge base. In the following two chapters, I carry out an agent based simulation study to incorporate these.

The aim of the model is to highlight the effect of the characteristics of the knowledge base on interaction patterns among producers. To model the knowledge base, I develop the concepts of breadth and depth. Breadth refers to the range of different knowledge types that the production requires. Depth refers to the extent to which a single knowledge type is used more intensively than others in the good. Using the concepts of breadth and depth also permits me to model the relatedness among products in the economy with respect to the similarities in their knowledge levels. For example, when two goods utilize

the same types of knowledge in exactly the same amounts, then they are highly related. If one good is very intensive in a certain knowledge that is only minor for another one, then relatedness is low.

In Chapter five, I carried out a simple simulation study, in which the breadth is held constant (every product takes a input three knowledge types) but in which the intensity of use is different. Depending on the depth, I analyzed the structure of resulting networks. My findings in this chapter reveal that, when depth is high, that is when the goods are using intensively a certain knowledge type, but a major input in one is only minor in the other, the network is denser. High depth also means that there is little relatedness among goods in terms of the similarities in their knowledge bases. As products utilise a more even distribution of knowledge types, relatedness among them increases, and at the same time the intensity of interactions fall.

I carried out a more realistic and detailed simulation in Chapter six. Here, the analysis is extended to cover the influence of both breadth and depth in a two dimensional space. I found that highest network density occurs when breadth and depth are both highest. In this chapter, I used social network analysis tools to decompose the resulting networks into subgroups to be used as proxies for the firm. The clique is an appropriate subgroup for my purposes mainly because cliques overlap. Taking clique as the firm permits to measure the extent of networking among firms by measuring the overlap among cliques.

I analysed the structure of cliques in the breadth and depth space, in terms of their specialization, diversification in goods and knowledge, overlap among them, and expertise. I found that high breadth and high depth region is characterised as having firms with high specialization, low diversity, and high overlap. This region can be associated with network based industries. In this region, goods are related but not too much. Another region of interest is where relatedness among goods is very high (high breadth and low depth). In this region, the cliques are characterised by high degree of diversification, very low overlap and low expertise. I associate this region with multi-product and multi-technology hierarchical structures having more concrete boundaries.

What are the implications of the simulation results? In chapter three, I argued that the relatedness among the products in an industry influences the point at which diversified hierarchies or networked small firms emerge. Too much variety increases costs of communication inside the firm, whereas diversification lowers marginal costs when human capital can be put to produce a variety of related products. I argued that the knowledge base of an industry, then, should influence the structure of firms in terms of their diversification, specialization and networking. In other words, I argued that the boundaries of the firms is a function of the characteristics of the knowledge base.

My simulation results confirm this reasoning. When the products are too similar to each other in terms of their knowledge bases, multi-product firms are more efficient. In another extreme, when there is no similarity in goods at all, there are specialized firms and no networking among them also. Only when the relatedness among the products are at an intermediate level do we see specialized firms which are involved in significant networking.

The nature of the simulation model is highly abstract, which makes it possible to apply it in different contexts than the original context in which it is developed, namely industrial structures. To test the essential arguments developed in the model, in the final chapter I carried out an empirical study using the EPO/CESPRI database. In this analysis, I took a patent to be a product that is produced by integrating the knowledge levels of different specialists. I positioned 30 main technology fields into the breadth and depth space. I also analysed the effect of breadth and depth on the network density. Particularly, I constructed a relation between the density of firm-based inventor networks and breadth and depth measures of patents held by these firms in biotechnology and telecommunications. I found that the effect of both breadth and depth on network density depend on the level of the other. The higher the breadth (depth) of a firm, the more positive is the effect of depth (breadth) on network density. These results point to the fact that the firms with highest breadth and depth measures have highest inventor network densities in accordance with the arguments I developed in my simulation model.

The arguments developed in this thesis should not be seen as the only explanation for the emergence of diversified hierarchies or network-based systems. Obviously, there are many factors that influence structure of organizations, as a huge literature reveals, ranging from institutional factors, demand side effects, cost considerations, firm strategies and many more. Therefore, my results do not point to an 'if and only if' explanation of organizations. But the aim of a model is not to model the world with all its complexities, rather, to be able to isolate the effect of the theme of inquiry. In a world in which knowledge is in the core of both business and academia, and in which networks are the main mechanism through which knowledge diffuses, the impact of knowledge bases on network structure deserves a central role.