Research Statement

Basak (Uysal) Horowitz

Department of Economics, Rutgers University
75 Hamilton St. New Brunswick, NJ 08901
buysal@econ.rutgers.edu

My research interests are microeconomic theory, the economics of networks and matching, industrial organization and game theory. I study communication and information networks, and the main motivation for my research is a desire to answer questions concerning the kinds of network structures that will emerge at equilibrium, and how these structures are different from the efficient ones. Currently, I am working on network formation games with endogenous link strength.

Following the seminal papers of Jackson and Wolinsky (1996), and Bala and Goyal (2000), the majority of the literature dealing with models of network formation assumes that the agents make binary decisions; they choose whether or not to link to another agent. However, in a wide variety of situations, such as friendships, sharing of information, and trade of goods and services, agents decide not only whom to connect to but also how much to spend on each connection they make. In the first chapter of my dissertation, I analyze the formation of networks when players choose how much time to invest in other players. As opposed to the distance-based utility weighted link formation game of Bloch and Dutta (2009) in which only the shortest or most reliable path is considered, my model assumes the information can be transferred using all possible paths in the network. I assume that each player has an intrinsic value of information to share and one unit of endowment to invest in relationships with others. Once a direct link is formed, the information is transferred both ways with decay. Moreover, indirect links can transmit indirect information. However, the benefits from indirect information transfers are zero when two agents are connected by more than two links.

I study the model assuming two different link strength functions. First, I assume that link strength is the arithmetic mean of agents' investment levels, that is, the agents are perfect substitutes. As a positive investment of an agent is enough for a link to be formed, this specification allows players to form links unilaterally with other players. Therefore, it is reminiscent of the model by Bala and Goyal (2000). Alternatively, I assume that the link strength function is Cobb-Douglas in which players have to have bilateral agreement to form links with each other, which is similar to Jackson and Wolinsky (1996)'s model.

I show that, when the investments are perfect substitutes, every player is connected to another either directly or indirectly with no more than two links under any Nash equilibrium. This result duplicates the findings of Bala and Goyal (2000) and additionally, eliminates the empty network from the set of Nash equilibria. Moreover, I find that the strict Nash equilibrium structure is a star network, in which there exists a player (the center) such that all other players are connected to the center. On the other hand, using the Cobb-Douglas link strength function, I show that paired networks in which players are matched in pairs, are Nash equilibria. However, I also consider a sequential game in which players choose and announce their strategies publicly according to a random ordering. I show that an Assortative Pair Equilibrium, in which players are assortatively matched in pairs according to their information levels, is the subgame perfect equilibrium of the sequential game for all possible orderings of the players. Therefore, I conclude that the Assortative Pair Equilibrium is the only strongly robust Nash equilibrium. Moreover, for both link strength functions, Nash equilibria may not be strongly efficient, i.e., a surplus-maximizing outcome.

Unfortunately, a complete characterization of Nash equilibria and strongly efficient outcomes is difficult in network formation problems. In the second chapter of my dissertation, I consider the model introduced in the first chapter and fully characterize the Nash equilibria and surplus-maximizing outcomes for a three-player game, in order to investigate how equilibrium structures are different from the efficient outcomes and how these structures differ under different link strength functions. At equilibrium, the agents choose to invest all their time with only one agent regardless of the link strength function. More links are formed when the agents are perfect substitutes compared to Cobb-Douglas link strength, in which bilateral agreement is required for link formation. As opposed to the findings of Jackson and Wolinsky (1996), Bala and Goyal (2000) and Bloch and Dutta (2009)[1], the results show that the agents have a tendency to connect to fewer agents with higher investment levels from an efficiency perspective.

The model in the first two chapters of my dissertation assumes that once the agents are connected, the information is shared. However, if the interests of the agents are not aligned, they may strategically withhold information. In the third chapter of my dissertation, I investigate a model of communication with two agents and a principal. I consider a model by Bora (2010) with two agents and a principal and allow for asymmetric interdependencies between the agents. Each agent has private information on different dimensions of the state of nature. The interdependencies are characterized as action complementarities or substitutabilities between different agents within the same economic environment. A typical example of such an environment would be a multi-product firm. Since most of the information held by different departments within the firm is not verifiable, I model communication between the agents as cheap talk messages. Therefore, under these conditions, one of the main problems of the principal (the headquarters) is to determine the optimal decision making mechanism. There are two options. The first one is a centralized decision mechanism in which the headquarters makes the production decisions after observing the reported private information of each department. The second one is the decentralized mechanism in which the agents are allowed to communicate with each other via cheap talk and then make the production decision for their departments. Initial results show that the centralization allows more informative communication compared to decentralization. Therefore, when the actions of the departments require coordination, centralization may perform better than decentralization. Whereas, if the need for adapting decisions to the private information of the departments are relatively high, then decentralization may become optimal.

In the future, I would like to continue working on communication and information networks by introducing additional heterogeneity among agents. In the first two chapters of my dissertation, I assume that agents differ only in their intrinsic value of information. However, the agents can exhibit asymmetries in terms of endowment levels, that is, some agents may have more time to invest in relationships with others. It would be interesting to examine the effect of this additional availability on the decisions of agents. Another line of asymmetry is the coefficient for decay. In the real world, people are heterogeneous in term of their communication skills. Thus, the effectiveness of the communication may differ accordingly. This situation could be examined by allowing for different levels of decay.

Lastly, another possible direction for future work is to modify the agents' objective functions in the third chapter so that they are concerned about the value of the firm as well as their departments. The motivation behind this modification is to analyze whether or not the communication becomes more informative if the agents are concerned about the value of the firm. Moreover, this would allow us to examine additional decision mechanism where the two agents communicate via cheap talk and then one of them makes the production decision for both.

REFERENCES

Bala, V. and Goyal, S., 2000. A noncooperative model of network formation. *Econometrica*, 68(5), pp.1181-1229.

Bloch, F. and Dutta, B., 2009. Communication networks with endogenous link strength. *Games and Economic Behavior*, 66(1), pp.39-56.

Bora, R., 2010. Communication and allocation of decision rights in multi-agent environments (Master's Thesis, Koc University).

Jackson, M. and Wolinsky, A., 1996. A strategic model of economic and social network. *J Econ Theory*, 71, pp.44-74.

[1] Jackson and Wolinsky (1996) show that stable networks are over-connected for the co-author model. Bala and Goyal (2000) find that the star is the unique efficient network and is also a strict Nash network for a range of parameters. In Bloch and Dutta (2009), under additively separable link strength function, the stable and efficient network architectures are stars.