The Stability and Efficiency of Economic and Social Networks

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Abstract. This paper studies the formation of networks among individuals. The focus is on the compatibility of overall societal welfare with individual incentives to form and sever links. The paper reviews and synthesizes some previous results on the subject, and also provides new results on the existence of pairwise-stable networks and the relationship between pairwise stable and efficient networks in a variety of contexts and under several definitions of efficiency.

1 Introduction

Many interactions, both economic and social, involve network relationships. Most importantly, in many interactions the specifics of the network structure are important in determining the outcome. The most basic example is the exchange of information. For instance, personal contacts play critical roles in obtaining information about job opportunities (e.g., Boorman (1975), Montgomery (1991), Topa (1996), Arrow and Berkowitz (2000), and Calvo-Armengol (2000)). Networks also play important roles in the trade and exchange of goods in non-centralized markets (e.g., Tesfatsion (1997, 1998), Weisbuch, Kirman and Herreiner (1995)), and in providing mutual insurance in developing countries (e.g., Fafchamps and Lund (1997)).

Although it is clear that network structures are of fundamental importance in determining outcomes of a wide variety of social and economic interactions, far beyond those mentioned above, we are only beginning to develop theoretical models that are useful in a systematic analysis of how such network structures

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form and what their characteristics are likely to be. This paper outlines such an area of research on network formation. The aim is to develop a systematic analysis of how incentives of individuals to form networks align with social efficiency. That is, when do the private incentives of individuals to form ties with one another lead to network structures that maximize some appropriate measure of social efficiency?

This paper synthesizes and reviews some results from the previous literature on this issue,[1] and also presents some new results and insights into circumstances under private incentives to form networks align with social efficiency.

The paper is structured as follows. The next section provides some basic definitions and a few simple stylized examples of network settings that have been explored in the recent literature. Next, three definitions of efficiency of networks are presented. These correspond to three perspectives on societal welfare which differ based on the degree to which intervention and transfers of value are possible. The first is the usual notion of Pareto efficiency, where a network is Pareto efficient if no other network leads to better payoffs for all individuals of the society. The second is the much stronger notion of efficiency, where a network is efficient if it maximizes the sum of payoffs of the individuals of the society. This stronger notion is essentially one that considers value to be arbitrarily transferable across individuals in the society. The third is an intermediate notion of efficiency that allows for a natural, but limited class of transfers to be made across individuals of the society. With these definitions of efficiency in hand, the paper turns its focus on the existence and properties of pairwise stable networks, i.e., those where individuals have no incentives to form any new links or sever any existing links. Finally, the compatibility of the different efficiency notions and pairwise stability is studied from a series of different angles.

2 Definitions

Networks[2]

A set $N = \{1, \ldots, n\}$ of individuals are connected in a network relationship. These may be people, firms, or other entities depending on the application.

[1] There is a large and growing literature on network interactions, and this paper does not attempt to survey it. Instead, the focus here is on a strand of the economics literature that uses game theoretic models to study the formation and efficiency of networks. Let me offer just a few tips on where to start discovering the other portions of the literature on social and economic networks. There is an enormous "social networks" literature in sociology that is almost entirely complementary to the literature that has developed in economics. An excellent and broad introductory text to the social networks literature is Wasserman and Faust (1994). Within that literature there is a branch which has used game theoretic tools (e.g., studying exchange through cooperative game theoretic concepts). A good starting reference for that branch is Bienenstock and Bonacich (1997). There is also a game theory literature that studies communication structures in cooperative games. That literature is a bit closer to that covered here, and the seminal reference is Myerson (1977) which is discussed in various pieces here. A nice overview of that literature is provided by Slikker (2000).

[2] The notation and basic definitions follow Jackson and Wolinsky (1996) when convenient.