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Sanctions in networks: "The Most Unkindest Cut of All" [☆]

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ABSTRACT

The extensive literature on sanctions has mainly focused on a dyadic interaction between sender and target. In contrast, this paper examines sanctions when the sender and target are embedded in a network of linkages to other agents. The sender can assemble a sanctioning coalition of neighbors to sever their links (execute multi-link cuts) to the target and her allies. Efficacy of sanctions is now crucially dependent on the network architecture. We characterize the structural properties of networks in which a sender can effectively sanction a target in the short run (when links can only be deleted) and the long run (when links can be both deleted and added).

1. Introduction

Sanctions are ubiquitous and refer to the coercive measure exercised by some agent(s), called *sender*(*s*) and labeled S, against an agent called the *target* and labeled T. The punitive measure is triggered when T refuses to take an action that is deemed desirable by S but is costly to T. This desired action could be providing a social favor when asked, making a monetary transfer to an agent affected by an adverse shock, dismantling trade barriers, or contributing towards a public good (please see the examples in section 2 below). The existing literature has mainly examined sanctions in the context of a dyadic or two-way interaction between S and T (for example, Eaton and Engers, 1992, 1999). Our main contribution is to consider sanctions in an environment where S and T are embedded in a *network* of links – social, economic, or political – to other agents. The failure of T to take a desired action invites sanctions in the form of S (and possibly others) severing their network link(s) with T and those "close" to T. T has a resistance of $\beta > 0$ towards complying (for example, this could be the cost of undertaking the desired action) and is induced to take the necessary action only if sanctions impose a cost greater than β. Our main thrust is that if indeed S and T are part of a larger network, then the effectiveness of sanctions

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in eliciting the desired response from T cannot be properly analyzed in a purely dyadic framework. In fact the network *architecture* will critically determine whether sanctions can exact compliance from T.

In relatively rare instances S will be able to effectively sanction T *unilaterally* through a one-link cut. Typically S will have to proceed *multilaterally* by leaning on other agents to implement multi-link cuts that induce T to comply. The network architecture concisely captures S's ability to assemble a sanctioning coalition to exert pressure on T. In this paper we utilize the *components* model in which an agent's utility is a function of those she is connected to directly or indirectly. This model is prominent in the network literature and, as we show in section 2 below, encompasses a large variety of examples of sanctions. We call a network *effective* if its architecture induces T to comply and switch to the desired action when S threatens to sanction. To examine effective networks it will be helpful to distinguish between short run and long run. In the *short run* agents can only delete existing links in a historically given network. In contrast, in the *long run* agents can also bilaterally form costly new links with others. The underlying rationale is that deleting a link can be achieved unilaterally and immediately. However forming a new link requires acquiescence of the two agents involved which in turn needs time to inculcate mutual trust and muster the resources needed to consummate the link.

In the short run effective networks have to meet a two-fold requirement: (i) S can cobble a sanctioning coalition capable of restricting T to a sufficiently small component; (ii) The sanctioning coalition has an incentive to participate in sanctions by dissolving appropriate links. Our main result (Proposition 1 below) characterizes the architecture of effective networks in terms of spanning trees. A *spanning tree* in a network is a connected acyclic sub-network that can be construed as a (non-unique) skeletal frame on which the network rests. The "order" of a spanning tree formally captures the radius of influence exerted by S in the network as well as the potential sanctioning coalition that S can assemble and prevail upon to delete links. We show that a network is effective in the short run if and only if its architecture is founded on an appropriate spanning tree. If a network is not effective in the short run, then the long run affords S the possibility of engineering an appropriate spanning tree by forging new links. Since link formation is costly, a network is long run effective if and only if its architecture permits crafting an appropriate spanning tree while keeping costs below some prespecified "tolerance" threshold of S (Propositions 2–4 below).

Research on sanctions in a framework that explicitly accounts for network relationships is relatively sparse. Basu (1986) was among the first to formally extend the analysis of sanctions beyond dyadic interactions. Since then a small number of papers in the network literature have explicitly considered a deliberate dissolution of *profitable* links. Ballester et al. (2006) develop a model in which a planner attempts to effect the maximum change in an aggregate outcome by removing the most central player from the network. In our paper, the "key player", T, has already been identified and the objective is to induce T to take a costly action. Moreover, in case of noncompliance, S realistically lacks the kind of ability afforded to a central planner to completely excise T from the network and has to work within the network to coax compliance from T. Bloch et al. (2008) and Jackson et al. (2012) focus on characterizing networks in which informal risk-sharing agreements or reciprocal favors can be supported by punishments involving severance of links, while Ambrus et al. (2014) examine the extent of informal risk-sharing in a given network. Our paper shares similar concerns but emphasizes the network topology that enables S to assemble a punitive coalition against T. While technically closest to Bloch et al., there are also important differences. In the repeated interaction framework of Bloch it is enough to break up T's component. The resulting loss in utility, however small, ultimately overwhelms any short term gain from noncompliance for a sufficiently patient T. In our static model it is not enough to break up T's component; rather, the component has to be broken up by enough to ensure that T's loss in utility exceeds her resistance. Further, our construction of sanctions differs from the punishment scheme of Bloch et al. and we additionally consider formation of new links in the long run. The papers by Ali and Miller (2013) and Wolitzky (2012) have examined punishments via delinking of recalcitrant agents but the focus is very different from ours. Ali and Miller examine the incentives of agents to truthfully communicate to others whether their immediate neighbors have been guilty of a deviation. Wolitzky examines the maximum level of cooperation that can be achieved as a function of the characteristics of the network and the monitoring technology it affords.

Our paper is organized as follows. The model and examples are presented in Section 2. Sections 3 and 4 examine sanctions in the short run and long run respectively. Section 5 concludes. Proofs are contained in an appendix.

2. The model

Let $\mathcal{N} = \{1, 2, \ldots, N\}$, $N \geq 3$, denote the set of agents. Let $g^{\mathcal{N}}$ denote the collection of all two-agent subsets of $\mathcal{N}$. A bilateral relationship between i and j is denoted by the link ij and the collection of all such links that currently exist is denoted by $g \subset g^{\mathcal{N}}$. A *network* (or *graph*) is the tuple $(\mathcal{N}, g)$ though for brevity we will simply refer to g as the network. The network is historically given. The set $\mathbf{N}_i^{(1)}(g) = \{j \in \mathcal{N} \backslash \{i\} : ij \in g\}$ denotes agents who are only one link away from i and called 1-*neighbors* of i in g. An agent $k \notin \mathbf{N}_i^{(1)}(g)$, $k \in \mathbf{N}_j^{(1)}(g)$ for some $j \in \mathbf{N}_i^{(1)}(g)$, is a 2-neighbor of i who is two links removed from i and belongs to the set $\mathbf{N}_i^{(2)}(g)$. Recursively, agent l is a m-neighbor of i if $l \notin \mathbf{N}_i^{(s)}(g)$, $s = 1, 2, \ldots, m-1$, and $l \in \mathbf{N}_k^{(1)}(g)$ for some $k \in \mathbf{N}_i^{(m-1)}(g)$; the set of all m-neighbors of i is $\mathbf{N}_i^{(m)}(g)$.

A *path* in g connecting i and j is the sequence of *distinct* links $ii_1, i_1i_2, \ldots, i_{n-1}i_n, i_nj \in g$ and denoted as $ii_1i_2 \cdots i_nj$. A network is *connected* if there exists a path between any pair $i, j \in \mathcal{N}$; otherwise the network is *unconnected*. The historically given network g will be assumed to be connected. A path whose initial and terminal nodes are the same is called a *cycle*. A sub-network, $C(g) \equiv (\mathcal{N}', g')$, $\mathcal{N}' \subset \mathcal{N}$, $g' \subset g$, is a *component* of the network $(\mathcal{N}, g)$ if it is connected and if $ij \in g$