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Workforce management under social Link Based Corruption☆

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ABSTRACT

Workforce management has long been an integral part of operational efforts aimed at maximizing revenues. The recent literature in this area has recognized the positive impact of social ties on workforce productivity, motivating new re-formulations of conventional operations research problems to more explicitly consider team building. This paper inspects a different – negative – aspect of social tie formation. Indeed, such ties may enable the spread of negligent or corrupt behavior, presenting a hindrance to the productivity of larger businesses with limited capacity for workforce monitoring. Through model-based analyses, this paper quantitatively establishes the benefits of workforce rotation as a means to curb corruption, and presents rigorous investigations into rotation policy-making. To this end, the Link Based Corruption (LBC) model is introduced. The modeled agents are assumed to be embedded into a directed peer-to-peer monitoring network; e.g., employees working on the same task or in the same room can be viewed as being supervisors of each other. Corruption is taken to be a threat whenever an agent and their supervisor(s) are all corruption-prone (ready to go corrupt); once they identify each other as such, which takes time, a productivity loss takes place. Under the LBC model, this paper addresses the policy-maker's problem of fixing the agent monitoring structure and timing the workforce rotation so as to minimize the expected long-time loss. The impact of the LBC model parameters – the fraction of corruption-prone agents in the workforce, productivity rate, costs, rate of corrupt link formation, etc. – on the choice of an optimal policy is quantitatively assessed. It is also shown that the problem of inferring the LBC model parameters in real-world settings can be addressed by "feeling the system", i.e., observing what financial outputs a given business generates when operating under different policy settings.

1. Introduction

The research of operations targeting profit maximization encompasses an array of modeling and optimization efforts. To ensure lower operating costs and higher productivity outputs, a variety of quantitatively justified strategies have been developed to optimally manage inventory, schedule and price products, optimally locate facilities and improve supply chain operations [41,49,53]. Many efforts in this domain also recognize the social and behavioral aspects of profit maximization, and formulate the problems that fall under the broad umbrella of workforce management [16,29,51].

Much of workforce management literature has focused on the assignment and scheduling of employees – optimally allocating their time/effort, – individually or in teams. Team formation problems in particular have received attention from the operations research community over the past years [14,23,26,59]. Here, the most recent research recognizes that the productivity of a team is influenced by the social ties between its members [5]: this observation has opened the door to exploring new challenges and opportunities in mathematical modeling [20,21,61].

This paper draws the attention of the research community to a previously unexplored – negative – aspect of social tie formation. Indeed, social ties may facilitate the adoption/spread of negligent, corrupt, and other malignant behaviors leading to reduced productivity across the workforce. This paper quantifies the expected losses due to such behaviors, and analyzes workforce management policies, in particular workforce rotation policies, as a means to curb these losses. The presented analysis takes into account the characteristics of the workforce population, costs of implementing the rotations, as well as other key variables. Henceforth, the behavior leading to the damaging effect enabled by workplace social ties is termed "corrupt" behavior, where corruption is defined as any "behavior or activity that deviates from formal duty for private gain". Experts from the Association of Certified Fraud

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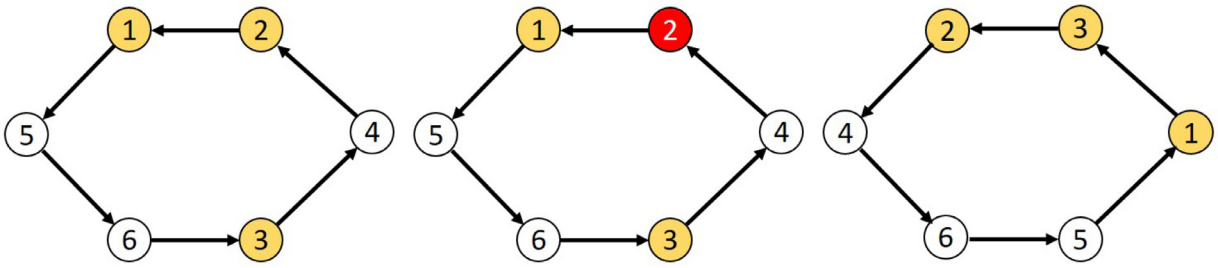

Fig. 1. Illustration of LBC and the effect of rotation: workers 1, 2 and 3 are corruption-prone, while workers 4, 5 and 6 are incorruptible (honest) – (a, b) corruption-prone worker 2 reports to corruption-prone supervisor 1, a bond develops between them, and under the supervisor's "protection", worker 2 begins to hurt the organization financially; (c) a scheduled rotation effectively stops the revenue loss, re-sets the network structure and restarts the formation of bonds.

Examiners estimate that an average organization loses 5% of its revenue to corrupt behavior of its own workforce. The corrupt behavior can present itself, e.g., in the form of theft, sloppy performance, sabotage, tardiness and/or absenteeism [44].

This paper presents a model that quantitatively captures the loss in productivity due to the emergence of corrupt behavior among workforce agents. It is assumed that the workforce under consideration has a sizable fraction of the agents that are "honest", i.e., those not willing to engage in corrupt behavior and striving to eliminate it in others. Specifically, we posit that in the presence of peer-to-peer monitoring – via supervisory ties/links, – corruption is necessarily a joint venture, i.e., the one where corrupt agents must collude in order to go unnoticed. This phenomenon, i.e., the activity pattern where corrupt individuals indulge in collusion (cover each other's back) to the detriment of their common cause, is henceforth referred to as Link Based Corruption (LBC).

The peer-to-peer reporting structure in an organization that aims to fight LBC in its circles is modeled as a social network. The structure of this directed-link network, defining the embeddedness of each agent into their respective ego-network, is controlled by the organization's management – the decision-maker. It is of interest to the decision-maker to find a policy that prescribes how often, if at all, the agents should be moved to new network positions so as to limit LBC (refer Fig. 1). This paper shows how the LBC model-based developments lead to a formal analytical approach to hamper corruption by limiting the probability of the formation of corrupt links through workforce rotation (scheduled relocation of worker(s)/supervisor(s) to different network positions).

The impact of the model parameters (proportion of corruption-prone agents in the network, normal productivity rate, costs, etc.) on the choice of an optimal policy is analyzed thereafter, and several patterns and insights are revealed, describing which policy is most profitable for different model parameter combinations. Moreover, in order to make the presented approach useful in real-world settings, where these parameters may not be known, the paper addresses the problem of learning them by "feeling the system", i.e., observing what financial outputs an organization generates when operating under different policy settings. It is shown that after a small number of policy-varying experiments, the organization can infer the hidden parameters, and then, deduce an optimal policy to limit LBC.

The remainder of this paper is organized as follows. The relevant literature is presented in Section 2. Section 3 begins with the basic assumptions and definitions and explains the logic behind the presented model of corruption emergence. It proceeds with the detailed treatment of several supervisory structure-based scenarios, and in each scenario, evaluates the expected revenue generated per agent. Section 4 formulates and solves the problem of optimizing the rotation timing for each of the scenarios by maximizing the expected revenue generated per agent per unit time. Section 5 provides the analysis of the impact of the model parameters (proportion of malignant agents in the network, productivity rate, costs, etc.) on the choice of an optimal policy, and discusses the gained insights. Section 6 presents a framework to infer LBC model parameters from observations, and tests it in a set of computational experiments. Section 7 assesses the performance of the developed inference algorithms by conducting sensitivity analyses. The findings and ideas for future research are summarized in Section 8.

2. Review of relevant literature

This section presents the relevant literature from the areas of research that influenced this paper. First, we briefly overview the workforce management literature in general that aims at helping operations managers maximize revenues by taking optimal decisions regarding the workforce. Second, we turn to the operations research works on various aspects of team formation and scheduling. Third, we survey the literature on corruption, paying particular attention to the previously proposed models and ways to curb corruption, thus setting the stage for the developments in the present paper.

Typically, decision-makers of the past had a tendency to focus on the operational aspects of running business to find ways to cut costs and increase revenues. However, it was soon recognized that workforce management decisions, encompassing resource utilization, planning and control, have a direct impact on the business processes and output [30,36]. Indeed, given that modern businesses expend much effort in hiring and training their employees, it makes sense to also invest effort into making sure that these resources are used properly and realize their potential. To manage workforce, scheduling techniques have been developed, with many algorithms designed to optimize cyclic schedules [2,3] as well as schedules recognizing the differences between weekdays and weekends [31]. Separately, domain-specific scheduling problems have been addressed, e.g., at call centers [9,25,62] and hospitals [39,50,58]. See Ernst et al. [18] for a more comprehensive overview of the literature on staff scheduling; also, see the literature on flexible workforce management [17,55,56]. In all those efforts, staff or part-time workers are scheduled/assigned to tasks optimally so as to maximize the total productivity. Note, however, that the use of operations management techniques does not always lead to an improved performance, as the workforce could oppose certain policies depending both on the nature of tasks assigned and their own motivation, which, as suggested by Boudreau et al., calls for a new research into unifying the operations management and human resource management fields, in particular by incorporating social aspects into conventional operations research problem formulations [12].

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