The Effect of Homophily on Co-Offending Outcomes

Extended Abstract

Abstract. This study explores how similarity preference among offenders impacts the structure of co-offending networks and the diffusion of information, modeled through skill exchange. Co-offending provides certain advantages, but factors such as trust and usefulness of co-offenders significantly influence these criminal collaborations. Using an Agent-Based Model, we simulate interactions between offenders based on varying levels of similarity preference, allowing us to observe network characteristics such as density, transitivity, average degree, tie weight, and skill acquisition. The results show that stronger similarity preferences lead to sparser but more stable criminal networks with a higher number of repeated interactions between the same offenders. However, increased exclusivity in partner selection reduces the information diffusion within the network, limiting the number of skills acquired by offenders. Conversely, inclusive partner selection facilitates greater skill exchange but results in fewer strong ties between offenders. This study highlights the trade-offs between stability and skill diffusion in criminal networks. Networks with high homophily tend to be more stable but less skilled, while more open networks allow for greater exchange of knowledge at the cost of connection strength. These findings contribute to the understanding of how offender collaboration shapes criminal network structures and the spread of criminal opportunities.

Keywords: Criminal Networks, Homophily, Partner Selection, Agent-Based Modeling, Social Network Analysis.

1 Introduction

Studying the motivation that leads individuals to collaborate with someone else for a crime commitment has been of interest to criminologists for several decades (for an overview see [1]). As shown, participation in a group crime can be more advantageous than solo crime. For example, Weerman suggested that co-offending can be perceived as a mechanism for achieving material and immaterial goods [2]. He categorized these goods into six distinct categories: services, catch, payment, appreciation, acceptance, and information. For instance, demonstrating a new technique to a partner can be as helpful as physical assistance during criminal activities.

Co-offending interactions can be represented by social networks, where offenders are shown as nodes, and crime incidents committed by them are shown as ties between those nodes [3], [4], [5]. By studying these networks, researchers can detect changes in their structure. In a hypothetical example, if group crime was always beneficial and offenders were always willing to co-offend with someone else, we would expect that all crimes would be committed by several people and, eventually, all the possible ties would be present in the network. However, this is not what we see in real life. On the one hand, studies reported the proportion of co-offenses among all crimes ranging, on average, from 0.1 to 0.6 [6], [7], [8], which indicates that around half or even the majority of crimes are committed individually. On the other hand, in terms of network structure, research has shown that criminal networks tend to be sparse, with a network density mostly being less than 0.01 (e.g., [4]). In other words, out of all possible connections between offenders, only less than 1% of such connections exist.

While there are positive aspects to co-offending, there are also several negative consequences that should be taken into consideration. For instance, group crime can increase the risk of getting caught [9], and as the number of offenders per offense increases the profit per individual offender decreases [10]. In addition to the possible risks and profit loss, scholars have acknowledged that criminals face a non-trivial problem of partner search and selection [2], [11], [12], [13]. As proposed by [11], ideally, offenders want to find partners that are both, trustful and useful. While trustful connections ensure long-lasting relationships with low chances of failure or betrayal [14], useful connections provide important information to expand one's criminal opportunities [7].

Research has shown that there is a link between trust and homophily, a tendency of individuals to connect with those who are similar to [15], [16]. Even though bonds between offenders are relatively “cold and brittle” [17], co-offending networks prioritize similarity as a means of identifying trustworthy associates [18]. Moreover, homophily promotes the stability of connections between individuals [19], [20].

The usefulness of connections can be measured by how information spreads within the network [21]. In useful networks, the spread of information creates new opportunities for its members. For example, when one part of the network gains access to profitable criminal activities, sharing that information expands the potential for profit across the entire network. It has been shown that homophily also plays a role in information diffusion [22], [23], [24]. For example, [22] showed that within highly clustered networks homophily facilitates diffusion between clusters of the networks but inhibits diffusion between those clusters.

2 Aims and goals

While previous studies on homophily have examined its role in network formation and information diffusion, results are still relatively sparse. More importantly, there are no empirical or simulation studies that have looked at both together, particularly in the context of criminal networks. We aim to fill this gap by designing a simulation model that shows how similarity preference affects the criminal network structure and, consequently, the information diffusion. We modeled information diffusion through the exchange of skills, as it has been demonstrated that skill exchange is one of the primary attributes of co-offending [2], [7], [11], [25], [26].

We turn to using simulations as an alternative method to build the missing link in the literature. While using real-life incident data we can measure characteristics of criminal activity, it is hard to estimate the reasoning of offenders and why they have selected one partner and not another. More importantly, real-life data does not give the freedom to test different scenarios and how they affect the outcome. Therefore, we developed an Agent-based Model (ABM) to study co-offender interactions. ABMs have emerged as a powerful and innovative tool in criminology research, offering a dynamic and flexible framework for studying complex social phenomena, including the formation and evolution of criminal networks [29], [30].

3 Description of the Agent-Based Model

The algorithm of the model can be described as follows. The environment is initialized with N agents (offenders), each of whom starts with a personal value, and a skill set, which consists of one skill out of M possible skills, chosen uniformly at random. A personal value represents a combined set of arbitrary characteristics (such as sex, age, or ethnicity) in the form of a single value that is chosen at random. The closer the values are, the more similar the agents are. For example, an agent with a personal score of 0.2 is more similar to an agent with a score of 0.3 than to an agent with a score of 0.9. At each time step agents select a partner from (N-1) neighbors. Each potential partner receives a probability of being selected based on the softmax function, which in turn depends on the similarity preference in the environment β and the similarity value between agents. Six values of β were selected as the main parameters of the model, 0, 20, 40, 60, 80, and 100. The higher values of β represent a stronger preference for similar partners.

Only one potential partner can be selected, therefore, a co-offense can only happen with two offenders. If selection is mutual, a co-offense happens. If it is the first interaction between the agents, the tie between them is created in the criminal network with the weight of 1. If it is a repeated interaction, the weight of the tie is increased by 1. After the co-offense, a skill exchange takes place. One skill is selected uniformly at random from a combined set of skills. This skill will be added to the skill set of an agent, who does not have this skill yet. The simulation stops when the time step reaches the maximum allowed time.

We were interested in the density D and transitivity C the resulting co-offending network to assess its structure, as well as the average degree $\bar{k}$ and average tie weight $\bar{w}$ to evaluate partnership stability. Additionally, we calculated the average skill level (ASL) based on the number of skills acquired by each agent to assess information diffusion.

4 Results

Characteristics of criminal networks are represented in Fig.1. Results were averaged across all iterations for each value of β. Similarity preference resulted in sparse (Fig.1a), but highly clustered networks (Fig.1b) although there were no significant differences between the transitivity levels for positive values of β compared to the case of the random selection β=0. Additionally, as similarity preferences increased, the average number of connections per agent decreased (Fig.1c), but the number of repeated interactions increased (Fig.1d). Results for the ASL show that similarity preference decreases the overall skillfulness of the agents (Fig.1e). However, in the case of random selection, on average, the ASL was the lowest across all values of β.

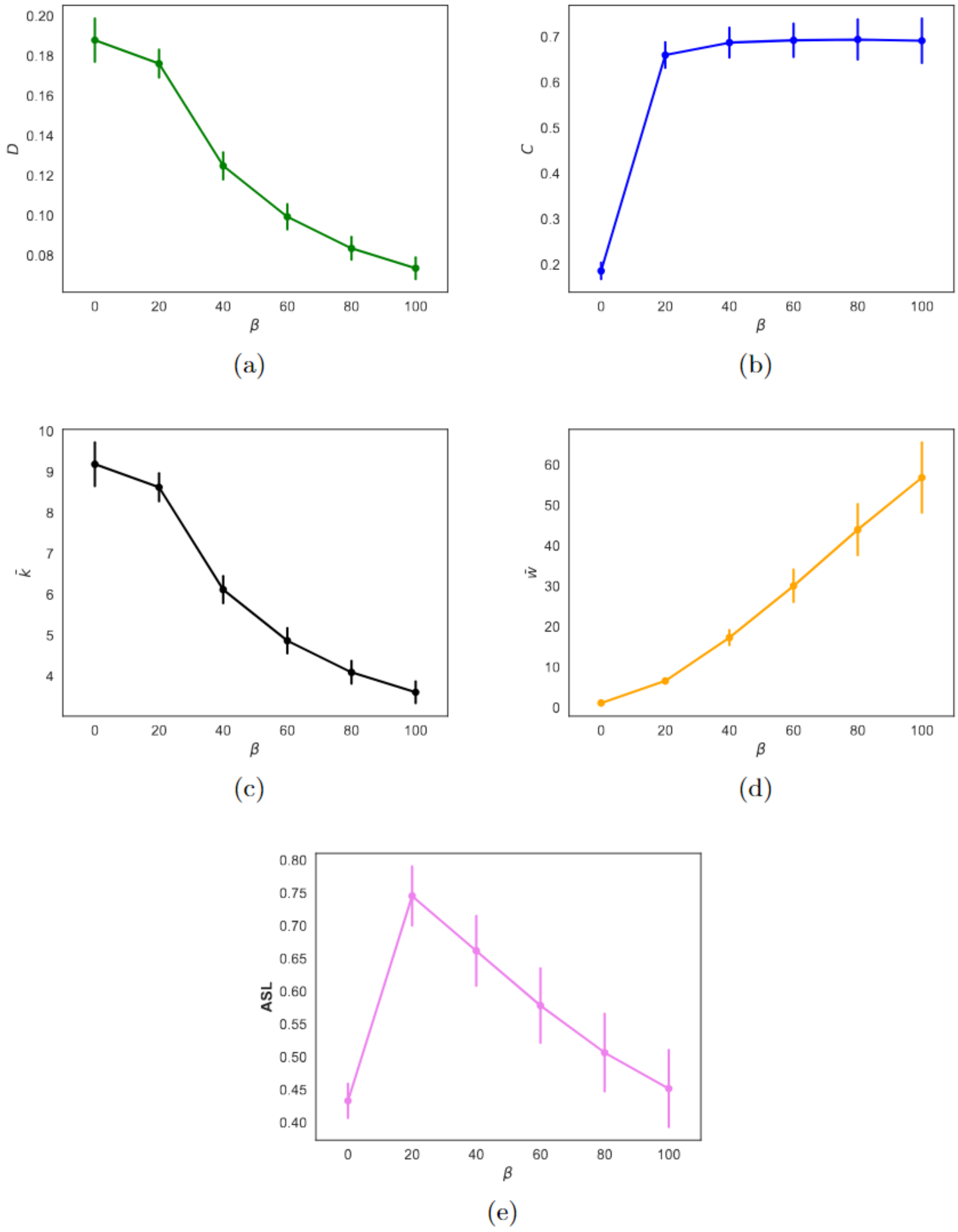
For the individual outcomes, only the agents with at least one successful co-offense were selected. Results were summarized by the number of skills agents could acquire during the simulation run for each value of β. There was a positive association between the number of learned skills and the degree regardless of the similarity level. This means that on average agents who have the highest degree, are the ones who have learned the most skills throughout the simulation run. Lastly, there was a negative association between the density of the ego-centric network and the number of skills acquired, or in other words agents who have learned the most skills are the ones that have the sparser egocentric networks.

5 Conclusions

Similarity preference affects the structure of the network between offenders and consequently the information flow in the network. On the one hand, when offenders are exclusive during the partner selection process, they develop stable partnerships, which can be seen as strong ties. This in turn results in a low ASL acquired by offenders. On the other hand, when offenders are more inclusive, they learn new skills from each other to a greater extent. However, this comes with the consequences of having fewer connections.

These findings highlight the trade-off between network stability and skill diffusion, suggesting that criminal networks prioritizing similarity may have less capacity for information sharing. Conversely, more diverse and open networks, although less stable, foster greater information sharing and skill acquisition, which may enhance offenders' opportunities. The study emphasizes the importance of considering both homophily and diversity in understanding the evolution of criminal networks, shedding light on how different partner selection strategies can influence network dynamics, offender success, and overall criminal opportunities. Future research could explore how additional factors such as law enforcement policies or network disruption influence these dynamics, offering a broader perspective on criminal network behavior.

Fig. 1. Network-level results of the ABM. Dots represent the average values across 1,000 simulation runs for each value of β. Bars represent the standard deviation.



6 References

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