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Research Article

Organized Catalytic Converter Theft: An Exploratory Social Network Analysis of a Nationwide Catalytic Converter Theft Network

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Abstract: This article provides a mixed methods social network analysis case study of a nationwide catalytic converter theft network. Catalytic converter theft is understudied, and this article seeks to contribute an empirical case study which argues for the application of social network analysis as a law enforcement investigative strategy to better combat organized crime catalytic converter theft. The findings suggest that police targeting actors scoring high in terms of betweenness centrality, a measure that identifies actors in positions of brokerage, would be highly disruptive to these types of networks. Despite network structures that attempt to insulate them, targeting them would also help to disrupt demand and raise the costs of these illicit markets, potentially weakening demand for catalytic converter theft.

Keywords: Social Network Analysis, Catalytic Converter Theft, Organized Crime, Metal Theft, Theft Ring

Introduction

This article constructs a case study of a criminal enterprise primarily engaged in the theft and sale of catalytic converters. The authors used Department of Justice press releases and publicly accessible court documents to construct the case study and conduct an exploratory social network analysis to understand how this criminal enterprise operated. Catalytic converter theft is not an emerging crime type, but one that has existed for many years and has recently seen dramatic increases in frequency.[1] Theft of catalytic converters, targeted for the value of the precious metals inside, takes only a saw, a target vehicle with high enough ground clearance to access the converter, and a few moments of the thief's time, making each and every parking lot a target rich environment for the perpetrators of this crime.[2] There is a dearth of literature on catalytic converter theft networks which this article seeks to ameliorate.[3]

The present case study which the authors dub the "DG Auto Catalytic Converter Theft Network" begins in October 2022, when the United States Department of Justice announced that several individuals had been charged as part of an organized theft ring engaged in stealing catalytic converters.[4] It should be noted that indictments are allegations and all actors named publicly in court documents by US prosecutors and discussed here, are considered innocent until proven guilty in a court of law. Allegedly, one group of these thieves often stole from more than 10 vehicles in a single night, one night targeting 26 vehicles, in addition to stealing from jewelry stores and federally insured banks.[5] The alleged thieves sold stolen catalytic converters through a middleman, a fence with a seemingly legitimate scrap metal business, who then allegedly sold those and more converters purchased from other theft groups to a recycling company, whose owner and employees have also been indicted in separate cases included in this study for interstate transport of stolen property.[6] This case is an example of an organized network of criminals whose alleged thefts led to the federal government seeking more than $500 million in asset forfeiture,[7] providing an opportunity to study an emerging phenomenon at the intersection of metal theft and organized crime. This study seeks to understand how this network of criminals operated and identify avenues for further study in this area. These may inform law enforcement practitioners and policymakers in their decisions of tactics to control the growing problem of catalytic converter theft. We find that the removal of actors with high betweenness centrality (brokers) would be highly disruptive to this network and likely other large scale catalytic converter theft networks based on the high betweenness centralization in this network and an analysis of its overall structure.

The study will proceed in the following sections: (1) a brief review of the existing, but limited, research around organized crime's involvement in metal theft, (2) a discussion of the methods used in the present study, (3) a qualitative description of the network being studied, (4) results of the study and discussion, followed by (5) conclusions and areas for future research on the topic.

Literature Review

To date, there is a dearth of literature examining catalytic converter theft, and even less on organized crime or criminal networks engaging in the theft and sale of catalytic converters. This is particularly problematic given that this increasing problem is highly relevant to law enforcement and police investigators. There exists some literature on metal theft, less specifically focused on the theft of catalytic converters, and connections between organized crime groups and metal thieves. The issue of metal theft predates the COVID-19 pandemic. In a 2017 ethnographic study, Benjamin Stickle defined a taxonomy of scrappers and metal thieves.[8] Stickle found that the incidence of metal theft is difficult to study because there is typically not a separate criminal charge specific to metal theft instead of theft in general, which may help explain the limited literature in this area.[9] Additionally, the Federal Bureau of Investigation (FBI) referred to copper theft as a threat to public safety and America's critical infrastructure as long ago as 2008,[10] further indicating that metal theft is not a new challenge. However, more recent work indicates that the COVID-19 pandemic stressed the supply chain in metal mining, production, and refining, which resulted in the increased trading of resources, including the illegitimate acquisition and sale of metals.[11] Although global supply chains are currently in a better state that at the start of the pandemic, they have not fully recovered.[12] Samantha Fox has shown that the increased cost of precious metals is a driving factor behind catalytic converter thefts,[13] and data from the National Insurance Crime Bureau and private organizations indicates that thefts continue to rise.[14]

While not academic in nature, it is notable that the FBI has described different types of actors in catalytic converter theft networks.[15] The authors assume these definitions have been established by the FBI through knowledge and expertise gained during complex criminal investigations. However, the authors also recognize that these definitions have not been studied or discussed in existing academic literature and suggest that future research examine the validity of these definitions. These definitions, as described by the FBI in an indictment from one of the included cases, are described in Table 1.

The FBI defines the following types of actors in a catalytic converter theft network:[16] 1) A "cutter" is a person who steals catalytic converters from privately owned vehicles. 2) An "intermediate buyer" is a person, organization, or entity that purchases or receives stolen catalytic converters from cutters. The intermediate buyer then re-sells the catalytic converter to third parties. 3) A "core buyer" is a person, organization, or entity that purchases or receives stolen catalytic converters from intermediate buyers. Large-scale core buyers purchase the stolen catalytic converters to repackage and transport shipments to third parties, including foreign refineries. 4) "Recyclers" or "refineries" are industrial recycling plants that purchase or receive stolen catalytic converters from core buyers. Recyclers extract the precious metals and pay core buyers once the quantity of precious metals is determined.

Table 1: FBI typology of actors in catalytic converter theft networks

Fox's research has indicated that metal theft and catalytic converter theft often has links to other organized crime activities, and it is understood that metal thefts in the United Kingdom are often committed by organized crime groups.[17] However, other researchers, such as Matthew Ashby, have concluded that law enforcement organizations in the United Kingdom often overestimate the involvement of organized crime groups in metal theft,[18] casting some doubt on the reports cited in Fox's work that indicate links to other organized crime activities. This work noted that British law enforcement often made blanket statements attributing whole categories of crime to organized crime groups.[19] Similarly, a spokesperson for the FBI told a Dallas newspaper that it considers catalytic converter theft to be an organized crime,[20] indicating that American law enforcement may do the same. Ashby suggested that one reason for law enforcement to consider certain types of offenses to be organized crime would be the potential for additional investigative resources and prosecutorial practices,[21] such as a bill being considered by the Texas legislature that would allow prosecutors to treat catalytic converter theft as organized crime.[22]

Ashby's work on metal theft's connection to organized crime groups identified four criteria that would indicate the involvement of organized crime groups in metal theft: prior convictions for organized crime related offenses, links to organized crime groups in intelligence databases, additional distance traveled to offend, and sophisticated means to offend.[23] In that study, 0.05% of those included in the sample had prior convictions related to organized crime, and it was noted that all four were related to laundering the proceeds of metal theft.[24] That these four organized crime related convictions were related specifically to metal theft was dismissed by Ashby (2016) as a lack of evidence of the involvement of organized crime groups in metal theft. That author also found a lack of sophisticated means used in metal theft offenses but did note that several incidents involved conspiracies between multiple offenders to steal large quantities of metal.[25] The network examined in the present case study fits this description, and charges for laundering the proceeds of catalytic converter theft were included in the examined court documents, so this is taken by the authors as evidence of similar groups being recognized, if not thoroughly studied, in previous work. Ultimately, Ashby concluded that the most prolific metal thieves are not those with links to organized crime, however, it was acknowledged that the study looked only at organized crime group involvement in metal theft, and that the illicit processing of stolen metal may be attractive to such groups.[26]

Some recent scholarly articles have addressed spatial aspects of catalytic converter theft. Reinhard and McDowell find that the best predictor of the crime is being near highways or freeways and recommend police focus on parking garages and lots near major roads.[27] This is a valuable contribution to the literature that is highly relevant to practical policing. We build on this research by suggesting that social network analysis be used as a policing and intelligence investigative tool to expand these investigations from their initial point of theft to surveillance, deterrence, or arrest.[28] Others have looked at the elasticity of the crime of catalytic converter thefts, finding that 10% price increases lead to 20% increases in thefts.[29] The existing literature on organized crime's connection to metal theft only considers existing or "traditional" organized crime being involved and does not examine the trend of organized rings of catalytic converter thieves, nor organized networks of middlemen and buyers processing these stolen goods. Owing to difficulties defining catalytic converter theft apart from other types of theft and metal theft, as well as the tendency of authors to overlook organization in the theft and processing of metals, including platinum group metals in catalytic converters, in favor of evidence that establish organized crime groups engage in these thefts, evidence of metal theft as an organized crime in itself, and specifically catalytic converter theft, is understudied in the current academic literature, and the present study seeks to address that gap.

Methods

This article utilizes social network analysis to map and analyze a network of individuals accused of conspiring to steal and sell catalytic converters for the value of the precious metals contained inside. Social network analysis (SNA) is a collection of tools developed to understand how social ties help define, enable, and constrain the knowledge, reach, and capacities of people and other actors.[30] SNA is used by researchers and practitioners to understand networks, how they operate, and in the case of "dark networks," how to disrupt them. SNA is not a new tool, but its application to dark networks was catalyzed by Krebs' 2002 mapping of the 9/11 hijacker network.[31] Krebs (2002) and Sparrow (1991) identified three major challenges in applying SNA to dark networks: network data is often incomplete, networks are dynamic, and networks have "fuzzy boundaries," all of which continue to pose a challenge to SNA research.[32] Early and continued scholarship on dark networks has found that analysis of network and actor centrality is important to assess illicit conspiracies which must balance security and efficiency.[33]

Existing research has identified the challenge of incomplete data as especially troublesome to researchers using investigative data and court documents, as actors and ties that law enforcement investigators deem unimportant to the investigation or criminal charges are excluded, and therefore not available for researchers to account for or consider in network analysis.[34] This problem is observed in the present study, as court documents reference a person identified as "co-conspirator" or "unindicted co-conspirator." From this we can surmise that investigators identified co-conspirators who were part of the network studied, but not relevant enough to law enforcement to charge in the same indictment. Further, given that the authors combined data from different indictments, care must be taken not to use non-unique identifiers lest the same actor appear in multiple networks under different identifiers and obscure the data.

Relational data for this network analysis was gathered from grand jury indictments brought against the actors in the network. The indictments were accessed through PACER,[35] the United States court system's website for public access to electronic court records. The files downloaded included 322 pages of court records, including criminal complaints against those charged, affidavits in support of those criminal complaints, appendixes including text messages between actors that law enforcement considered pertinent to the crimes alleged, and criminal case cover sheets. The majority of the relational data included in the present study was derived from the affidavits in support of criminal indictments and appendices. These records were considered reliable, as previous research (Berlusconi 2013) has concluded that arrest warrant data (referring to the affidavits supporting those warrants) is a reliable source of data to identify key actors in a network, regardless of the missing data, because the "purposive sample" compiled by law enforcement has a low probability of discarding key players.[36]

The boundary issues described by Krebs (2002) and Sparrow (1991) indicate that it is difficult for researchers to determine where a network ends and begins.[37] To avoid this issue in the present study, only individuals who could be identified by name were included. There were multiple instances where an "unknown" subject was mentioned by law enforcement indicating the possibility that investigators did not possess enough information to identify these individuals uniquely or to identify whether they were or were not actors already named elsewhere. There were other instances where investigators assigned a unique identifier to the unknown subject or co-conspirator. However, the authors decided that excluding all actors who could not be identified by name best protected the integrity of the data and subsequent analysis.

The relational data contained in the affidavits and appendices was coded into an edge list for a one-mode, person-to-person network using the coding rules described in Figure 1.

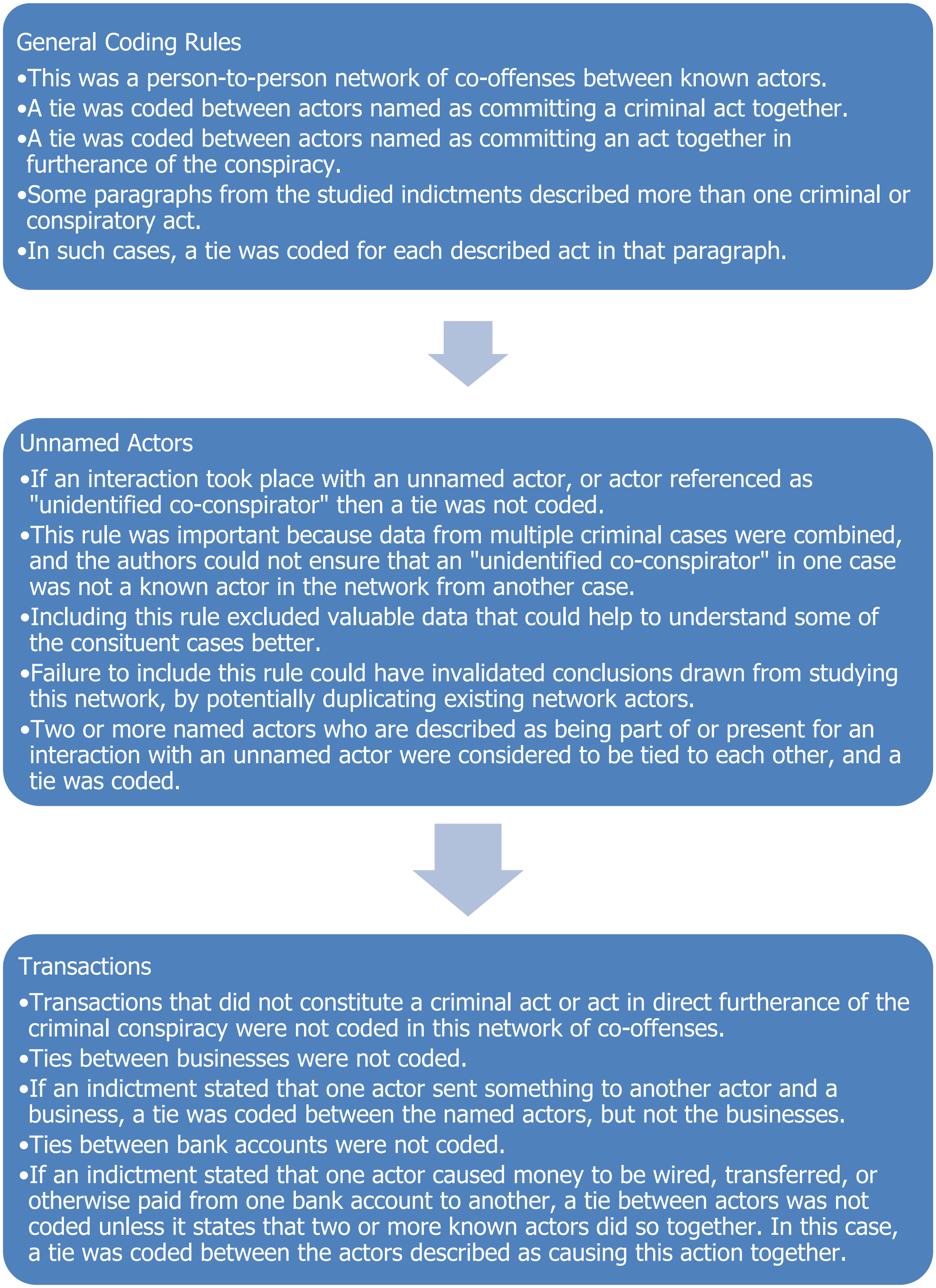

Figure 1: Edge list coding rules

Additionally, an attribute list was coded based on the following attributes, if known: age, gender, type of actor (as taken from the FBI's definitions),[38] prior crimes charged or convicted of, total known prior charges and convictions, total counts charged against the actor in the present indictment, and whether the actor owns a scrap metal or recycling business. The authors made the decision to include crimes that actors had been charged with, not only convictions, because many of the actors for which this data was available had several charges described for which the disposition had been described as "continued without a finding…and placed on probation"[39] and these additional charges seemed to be worthy of consideration since they lead to consequences within the criminal justice system. One actor had charges related to two cases for which he was identified as being on pre-trial release, in addition to previous charges and convictions. The charges for which this actor was on pre-trial release were included as well.

In coding attribute data for crime types that actors have previously been charged or convicted of, all degrees, enhancements, or descriptors of the crime are grouped together. For example, all instances of larceny are coded as larceny, regardless of what degree, and the same goes for other crimes. All crime types for which two or more actors were previously charged or convicted were included. For actors whose date of birth was included in the indictment, only the year was included. For example, those charged with a crime in one of these indictments have their date of birth displayed as "xx/xx/1997" (or other year). When coding age in the attribute list, a date of birth of January 1st on the given year was assumed for all actors. Descriptive statistics for the available attribute data are included in Table 2. In Table 2, "Valid n" refers to the number of actors for which the indictment provided information on the variable, and the percentage next to the valid n refers to the percentage of N (total network actors; 29) for whom this information was available. It is worth noting that among the actors in this network that could be identified as alleged "cutters," the street-level thieves taking catalytic converters from vehicles illegally, most had previously been charged with violent offenses. While this may not apply to all catalytic converter thieves nation-wide, it indicates that the "cutters" in this network are known to engage in violence and underscores the importance of studying this network and others in order to identify strategies for disrupting these organizations. Whether this is generalizable to other networks is a question which could be studied further in future research.

Attribute	Valid n (%)	Mean	Median	Minimum	Maximum
Gender					
Male	25 (86%)				
Female	4 (14%)				
Age at time of indictment	7 (24%)	33	34	26	37
Role in network					
Cutter	5 (17%)				
Intermediate Buyer	18 (62%)				
Core Buyer	5 (17%)				
Recycler	0 (0%)				
Other	1 (3%)				
Previous charges and convictions					
Larceny, burglary, or robbery	5 (17%)				
Breaking and entering or illegal entry	2 (7%)				
Possession of controlled substance	2 (7%)				
Receiving stolen property or motor vehicle	2 (7%)				
Altering the VIN on a motor vehicle, or possession/sale of motor vehicle parts with a defaced VIN	2 (7%)				
Negligent operation of a motor vehicle	2 (7%)				
Assault	3 (10%)				
Running from police or resisting arrest	3 (10%)				
Total known prior charges or convictions	7 (24%)	5.57	5	1	11
Number of counts charged with in present indictment	29 (100%)	4.48	2	0	36

Owner of or employment by a scrap metal, recycling, or automotive business	13 (44.8%)				

Table 2: Descriptive statistics for available attribute data

This edge list and attribute list were imported into Gephi, a software program for the analysis of social network data, for analysis and network visualization using Gephi, a program that produces sociograms using social network data.[40] The authors conducted their exploratory analysis of the network in Gephi, focusing on the network's topography as well as subgroups, central actors, and brokerage within the network.

A case study and description of the network was compiled using qualitative information from the court documents and media articles about the case. This informs the social network analysis and provides context to the alleged activities of the network. It should be noted that the court documents and media reports informing the case description, as well as the indictment from which relational data was taken, are not statements of guilt, but are merely allegations of criminal conduct. It should not be assumed that all actors named in the indictments are guilty. All actors described here are presumed innocent until proven guilty in a court of law.

The DG Auto Catalytic Converter Theft Network

The DG Auto Catalytic Converter Theft Network, so named by the authors for the primary auto parts company whose owners or employees are charged in the federal criminal cases examined in this study, is comprised of multiple elements. The first element is a theft ring, made up of "cutters" as well as intermediate buyers, from Massachusetts. This theft ring is the only example from the cases included in this study where investigators present relational data for the "street-level" thieves engaged in catalytic converter theft. The next element consists of several intermediate-tier buyers charged in cases from Oklahoma and California. The activities described in those indictments consist of the illegal sale and transportation of stolen catalytic converters after they are bought from "cutters" and the laundering of the proceeds from those sales. Finally, the network includes the owners and several employees of DG Auto, the auto parts company in New Jersey which is alleged to have conspired to purchase stolen catalytic converters to extract precious metals from and sell them to metal refineries. Members from this portion of the network are charged or mentioned in all criminal indictments examined for this study.

The following section describes three cases filed in federal courts, all of which can be connected to each other by shared actors, where the government alleges that the indicted co-conspirators stole and trafficked stolen catalytic converters. While each case is described separately and contains different types of relational and investigative data, the combination of all three cases presents the opportunity to study different levels of this enterprise from the street-level "cutters" allegedly stealing catalytic converters from vehicles, through intermediate buyers, and to the eventual core buyers. The subsections that follow describe each case as outlined in court documents. However, repetitive details are avoided, so each case description becomes shorter.

The DG Auto Catalytic Converter theft network described here represents an interesting phenomenon, given the existing but limited literature in metal theft and organized crime. While previous researchers have looked for evidence of established organized crime groups being involved in metal theft, they have not examined the concept of certain types of metal theft (specifically catalytic converter theft) being an organized crime itself. An organized crime group is defined as, "a structured group of three or more persons, existing for a period of time and acting in concert with the aim of committing one or more serious crimes or offenses…in order to obtain, directly or indirectly, a financial or other material benefit," by the United Nations Convention Against Transnational Organized Crime.[41] Ashby noted that applying the definition of an organized crime group from the UN to metal theft would likely label all instances of multiple offenders engaged in metal theft as examples of organized crime groups.[42] However, this study suggests that the network meets the UN definition of an organized crime group, that its activities are consistent with a continuing criminal enterprise, and that this case should be studied as an example of metal theft as an organized crime network.

The Massachusetts Case

In April of 2023, the United States Department of Justice (USDOJ) announced the arrest of several members of an organized theft crew who were allegedly responsible for more than $2 million in losses from stolen catalytic converters, in addition to several thefts from jewelry stores and federally insured banks.[43] While this "organized theft crew" does not have an official name specified in court documents or press releases, for the purposes of this study it will be referred to as the Davila Ring, which is part of the DG Auto Catalytic Converter Theft Network (sometimes referred to in this article as "the network"). The authors chose to specify the group as part of a catalytic converter theft network because, while the crew was allegedly responsible for some thefts that were not related to catalytic converters, the primary alleged activity of the group described in the available data was the theft and sale of catalytic converters. The membership of this ring is all individuals specifically named (not only those who were charged) in the available court documents as being involved in the criminal activity described in those documents.

Investigators across Massachusetts and New Hampshire identified many catalytic converter thefts involving a maroon Acura,[44] which was later determined to belong to Rafael Davila,[45] and noted that these incidents involved at least two individuals in dark clothing who targeted residential and commercial vehicles. The targeting of commercial vehicles suggests that the FBI's previous warnings about metal (copper) theft as a threat to US critical infrastructure also apply to catalytic converter theft, as the theft from and disabling of commercial vehicles causes additional stress to the transportation systems sector. Additionally, Rafael Davila, Santo Feliberty, and Alex Oyola allegedly conspired to steal from jewelry stores and federally insured banks, further defining this group as a threat to the financial services sector in their non-catalytic converter theft activities.

Davila allegedly led all of the thefts. This included planning the thefts and providing transportation in his own vehicle, in addition to determining the current price values for catalytic converters to target, and purchasing needed materials.[46] This differs somewhat from Stickle's findings that metal thieves typically operate in groups, but that they typically do not have a hierarchy or identifiable actor who leads or is in-charge of the group.[47] While Davila seems to have been a leader in this ring of thieves, he did not appear to have been a leader in the larger network.

Davila and his ring of thieves, once in possession of stolen catalytic converters, would allegedly sell them to Jose Torres, who allegedly accumulated stolen converters from multiple theft crews (although only one group is identified in the presently available court documents), and would sell them to scrap dealers.[48] In addition to fencing the stolen catalytic converters, Torres allegedly used a digital pricing application and communication with other buyers to provide Davila, his crew, and other theft crews with prices for catalytic converters based on the vehicle make and model. Knowledge of the current prices, and the ability to reach out to Torres to inquire about the value of a particular vehicle's catalytic converter prior to theft, allowed the theft crew to target the vehicles which would yield the greatest return for the stolen parts. It is alleged that the theft crew often stole from more than 10 vehicles in a single night, and one night stole from at least 26 vehicles.[49]

Torres was alleged by investigators to have trafficked between $30,000 and $80,000 per week between his seemingly legitimate scrap metal business and his buyers, who have also been charged federally under separate indictments for the interstate transportation and sale of stolen property.[50]

The Oklahoma Case

The USDOJ filed charges with the Northern District of Oklahoma against several persons alleged to be involved in the illicit sale and transportation of stolen catalytic converters in October 2022.[51] Here the FBI describes the alleged activities of Tyler Curtis, an intermediate buyer in the DG Auto catalytic converter theft network, as well as several other intermediate buyers in the network. In this indictment, the FBI describes multiple levels or a typology of actors in catalytic converter theft networks, referenced earlier in this article. However, this indictment describes intermediate buyers affiliated with DG Auto as being further divided into two tiers: low-tier intermediate buyers, who purchase stolen catalytic converters from cutters, and high-tier intermediate buyers, who purchase stolen catalytic converters from low-tier intermediate buyers and are allegedly the only source from which DG Auto purchases catalytic converters.[52] Allegedly, high-tier intermediate buyers such as Tyler Curtis and Adam Sharkey, among others, purchased stolen catalytic converters from several low-tier intermediate buyers before repackaging, transporting, and selling those catalytic converters to DG Auto.[53]

The California Case

Also in October 2022, the USDOJ filed charges in the Eastern District of California against persons alleged to be involved in a conspiracy to transport and sell large quantities of catalytic converters across state lines, some of which had been previously charged in the Oklahoma Case.[54] This case centered on two groups, an intermediate buyer in California who allegedly bought stolen catalytic converters from cutters and then sold them to DG Auto, and the other being several DG Auto employees and the company's owners.[55] The indictment describes an enterprise which massively profited from allegedly stolen catalytic converters, where the actors allegedly knew that the merchandise was stolen and worked to avoid speaking to that knowledge.

Results and Discussion

Network Topographical Results

Understanding the topography of criminal networks is critical to identifying strategies to disrupt them. Cunningham, Everton, & Murphy (2016) describe measures for exploratory social network analysis.[56] Whole network measures for the person-to-person network coded via edge list were assessed using Gephi.[57] Network measures are described in Table 3 for the combined network.

Number of Nodes	29
Edges	79*
Average Degree	2.724
Average Weighted Degree	56.069
Average Clustering Coefficient	0.478
Average Path Length	4.048
Density	0.097
Network Diameter	10
Degree Centralization (no edge weights)	0.2262**
Degree Centralization with Edge Weights	0.0468**
Freeman Betweenness Centralization Index	55.23%**

*The authors coded more than 1600 edges (Gephi sums and appears to report only unique edges. Notice the average weighted degree in 56.069 which means each of the 29 actors has an average of 56 ties).
**Calculated in UCINET[58]

Table 3: Whole network measures

The number of nodes (29) represents the total number of known actors in this network. The true number of nodes in the overall network may be significantly larger than this, but 29 actors were identified and included here based on the coding rules discussed earlier. Average degree is a measure that is determined by taking the sum of each actor's degree centrality and dividing it by the number of actors in the network[59] and represents the average number of connections that an actor has in the network.[60] The average degree in this network (2.724) represents a network that is not highly interconnected, indicating that a law enforcement strategy targeting players of high centrality may be successful.

The average clustering coefficient of this network (0.478) suggests that this is not a network which is highly locally interconnected and does not generate many cliques. The average path distance in this network (4.048) indicates that information and resources would take time to spread through this network.[61] This is supported by the network's low density (0.097). Its wide diameter of 10 indicates that to get across the longest geodesic in the network would require 10 steps. This again suggests a sparse and compartmentalized network with insulation for core buyers.

The network has a relatively high betweenness centralization index of 55.23%.[62] This suggests the network would be susceptible to disruption via the removal of key figures scoring high in betweenness centrality, e.g. Navin Kanna (See Figures 2 and 3). The degree centralization scores were low and suggest that targeting actors based on degree centrality would not be as disruptive as focusing on betweenness centrality.

Visualizations

While topographical measures provide a basic understanding of the network, graphical representations of the network in the form of sociograms add to this understanding by providing visual context to the network analysis. A few basic visualizations are discussed here, and were created using Gephi,[63] a software platform that generates sociograms and basic analysis measures from data provided about a social network. Figure 1 depicts the network where nodes are colored based on community detection and sized based on betweenness centrality.[64] Community detection algorithms seek to identify clusters of actors where the ties between them are greater than what we would expect in a random network of the same size and density.[65] Betweenness centrality is known as a centrality that is good for identifying brokerage within a network.[66] Thus, actors such as Khanna have high potential to serve as brokers and their targeting in law enforcement strategies could lead to high levels of disruption in these networks.

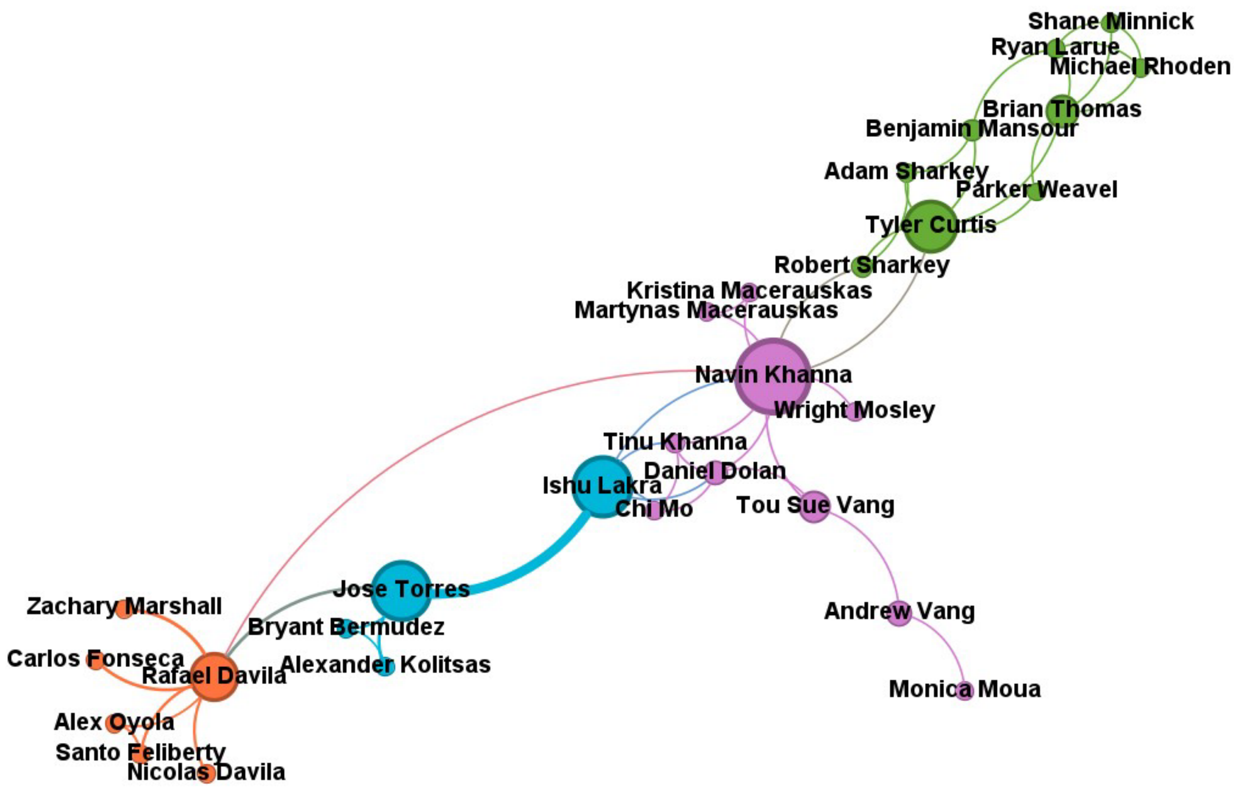

Figure 2: Nodes colored based on community detection and sized by betweenness centrality.

This visualization depicts four communities within the network.[67] The actors shown in orange are part of the theft ring run by Davila as described in the Massachusetts case. Those shown in blue are Jose Torres, the intermediate buyer who allegedly bought stolen catalytic converters from Davila and sold them to Downpipe Depot and DG Auto, which can be seen in the other actors in this community including the owner and an employee of Downpipe, in addition to an employee of DG Auto. The actors shaded in pink represent a mix of actors from the California and Oklahoma cases, including the remaining employees and owners of DG Auto and intermediate buyers from whom DG Auto made purchases. The remaining actors in green represent additional intermediate buyers described in the Oklahoma case.

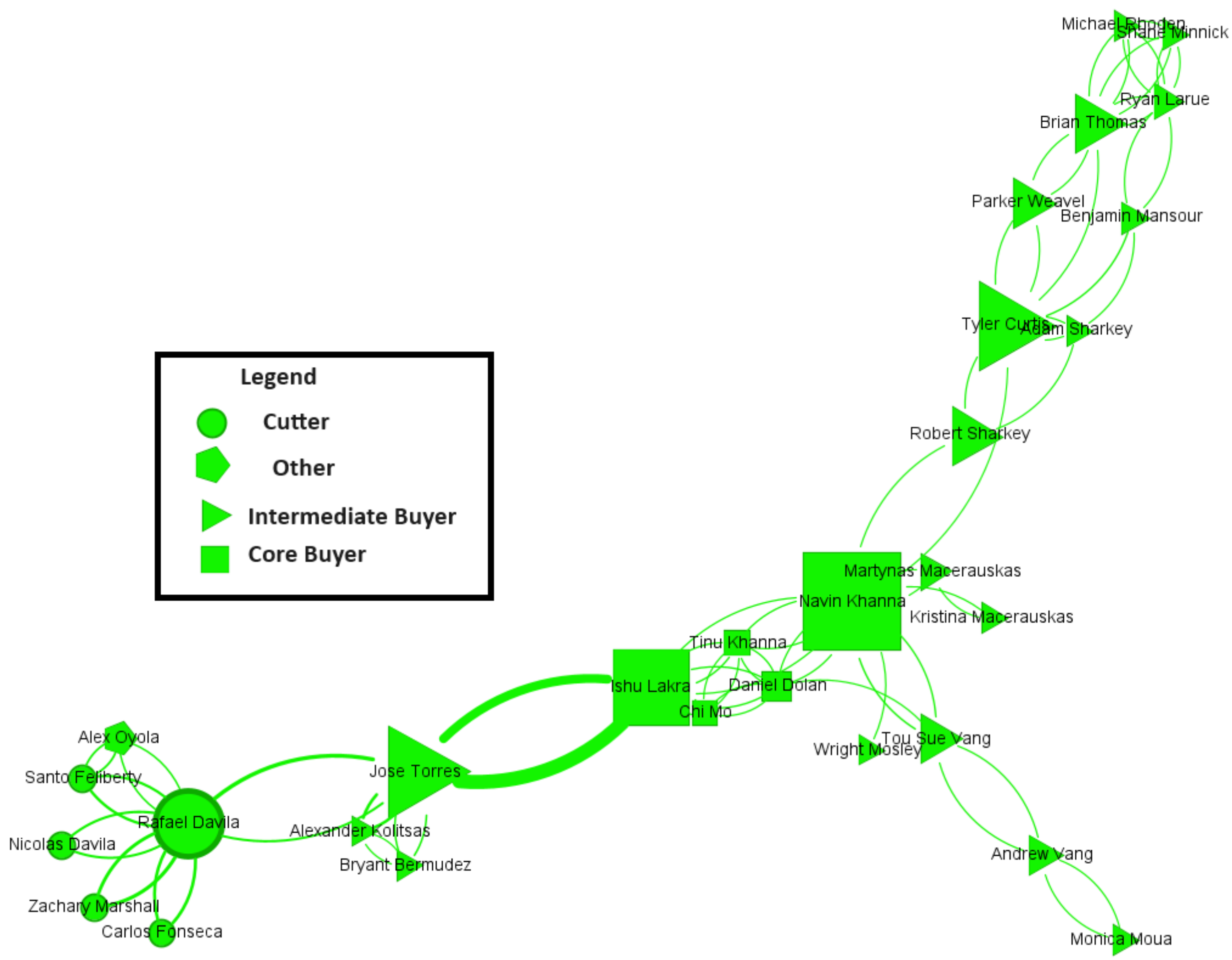

Figure 3: Node Shapes based on network role and sized by betweenness centrality.

Figure 3 depicts the network where nodes are shaped based on the actor's role in the network and are sized based on the actor's betweenness centrality. Most members of the Davila Ring were cutters (circles), although there was one member of the theft ring that was never identified as being a cutter in the indictment. The remaining actors in this network are either intermediate buyers (triangles) or core buyers (squares). Figure 3 demonstrates that the core buyers in this network were well insulated from the actual theft of stolen goods, as they purchased goods exclusively through intermediate buyers. This is consistent with the existing academic literature on illicit networks.[68]

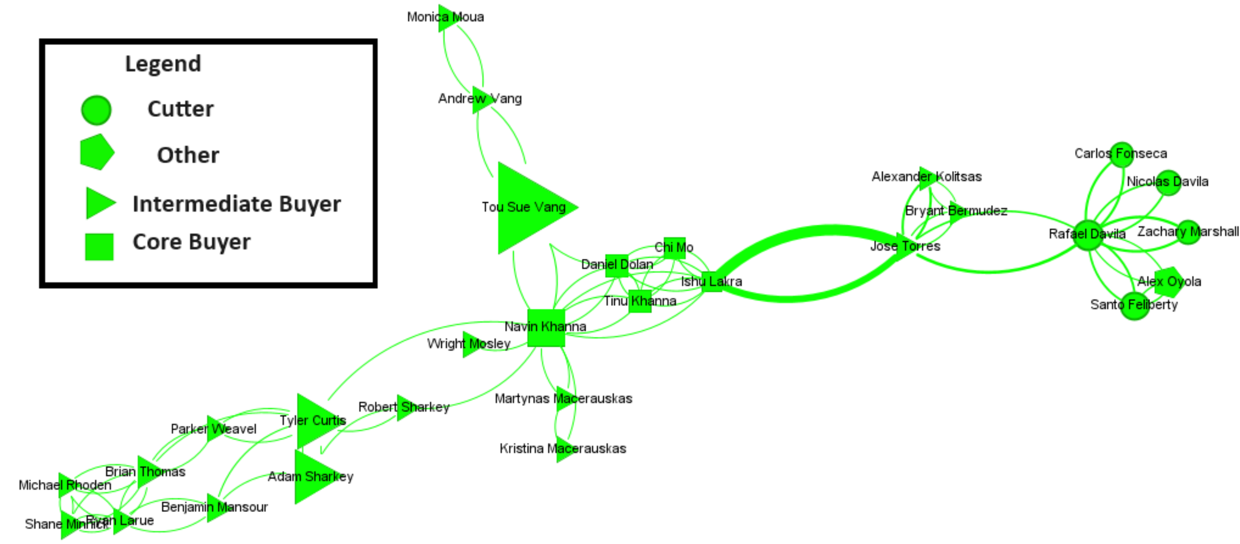

Figure 4: Node Shapes based on network role and sized by the number of criminal counts charged in the present indictments.

Figure 4 depicts the networks where the nodes are shaped based on the actor's role in the network and sized based on the number of criminal counts that the actor was charged with in the present indictments. This visualization demonstrates that those most heavily charged tended to be high-tiered intermediate buyers, as described in the Oklahoma Case, the leader of the organization of core buyers, or the leader of the ring of cutters. However, it also depicts that within that group, the high-tier intermediate buyers tended to be more heavily charged than the core buyers, or even the leader of the core buyers. This may be an indication that the way the organization was structured provided some protection from criminal exposure and liability to the leader of the overall network, Navin Khanna, who owned DG Auto. This finding is consistent with some of the earliest SNA research on criminal conspiracies.[69]

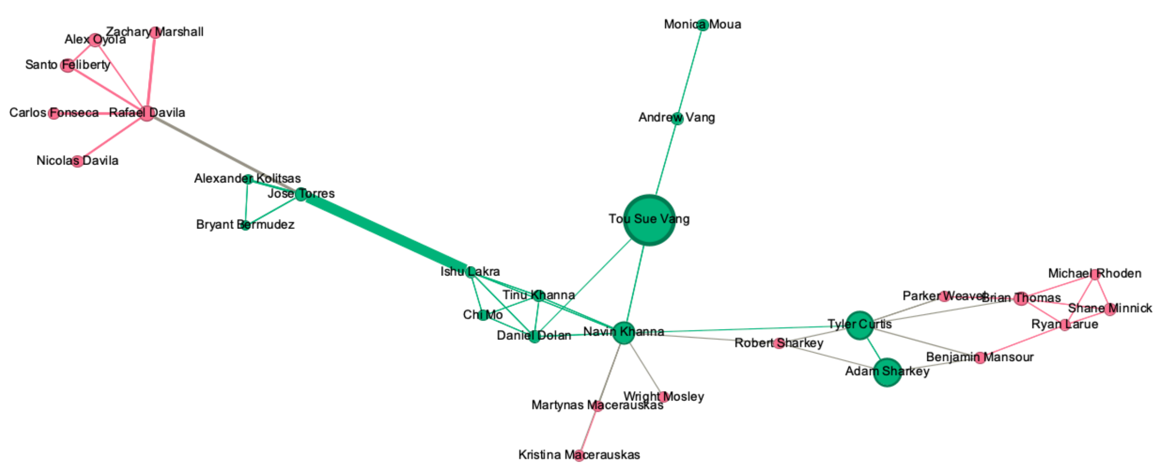

Figure 5: Nodes colored based on known ownership or employment by a scrap metal, recycling, or automotive business (green), and are sized by number of criminal counts charged in the present indictments. Nodes which are not known to be affiliated with a scrap metal, recycling, or automotive business are displayed in pink.

In Figure 5 the nodes of the network are colored based on whether the actor was known to be the owner of or an employee of a scrap metal, recycling, or automotive business (green), where nodes with no known affiliation with one of these businesses are displayed in pink. This visualization demonstrates that high-tiered intermediate buyers and core buyers within the network tended to conduct these illicit transactions under the guise of a legitimate business.

Through these SNA visualizations we have demonstrated a high degree variation along the lines of betweenness centrality within this network. That means that the targeting of key people in brokerage positions (i.e., those with high betweenness centrality scores) would result in a significant disruption of the network. These high centrality score individuals and those who were core network buyers should be top priorities for law enforcement as they seek to eliminate or reduce catalytic converter theft. While this is a network-based approach, it is not antithetical to a market-based approach. By this we mean that by targeting core buyers, it may be possible to limit the demand for catalytic converter theft, or at least raise the costs of engaging in catalytic converter theft and thus reduce its overall profitability even for those individuals engaging in the activity at low levels where it does the most immediate damage to crime victims, such as actor Johnny Wactor who in May 2024 was shot and killed when he came upon thieves stealing the catalytic converter from his car,[70] or Harris County Sheriff's Deputy Darren Almendarez, who was shot and killed in 2022 when he confronted three thieves stealing the catalytic converter from his truck while off-duty.[71] With this case study we have shown that social network analysis is demonstrated as an effective law enforcement investigative and intelligence analytical approach to address this problem. This work builds upon recent research looking at the geospatial characteristics of catalytic converter thefts and metal theft broadly.

Conclusions

This exploratory social network analysis of the *DG Auto Catalytic Converter Theft Network* represents some of the first academic literature to examine catalytic converter theft in the context of organized criminal activity using social network analysis. This work contributes to the literature by presenting a limited case study of a criminal enterprise primarily engaged in the theft and sale of catalytic converters, framing this enterprise as an organized crime group, and examining the network's basic structure. This study demonstrates the utility of SNA for studying catalytic converter theft networks to better design law enforcement strategies to target them. It assists policymakers, lawmakers, and law enforcement agencies in treating catalytic converter theft as organized crime. Additionally, this article's findings support a law enforcement approach targeting the leaders (high betweenness centrality actors) of catalytic converter theft rings as a disruptive strategy more than targeting individual "cutters" without leadership roles, in addition to secondary targeting of buyers in catalytic converter theft networks. The present work supports the use of social network analysis as a tool to help investigators identify the central actors in theft networks to target for prosecution.

Avenues for Future Research

The present work is one article addressing a substantial lack of academic literature on catalytic converter theft as a form of organized criminal activity. Other researchers have examined the involvement of other established types of organized crime groups, such as drug-trafficking organization or mafias, in metal theft.[72] However, existing literature dismisses evidence of organized metal theft, or catalytic converter theft, specifically, as evidence of organized crime's involvement in metal theft.

Future research should examine catalytic converter theft beyond this limited case study to further understand the criminal enterprise behind it. There are likely to be other cases of catalytic converter theft rings in the United States and elsewhere, which should be studied for a fuller understanding of the differences in structure that these groups take on in different circumstances. Additionally, each of the cases examined in the present study could be further studied individually. In coding the present cases to be studied together as a single network, the authors had to exclude any actors who were not named, because the authors had no available method to verify that these individuals were not the same named or unnamed actors described in other cases included in the study. In doing so, valuable network data was sacrificed to view the known actors in the nation-wide network. Further research into the present individual cases presented in aggregate here would allow for these unique but unnamed actors to be included. This may provide valuable insights into the structures and roles seen in different networks, as well as different elements of the same network.

Future research could also apply more advanced SNA statistical methods to catalytic converter theft networks to identify key actor attributes that correlate with the centrality of actors in the network.[73] In addition, the application of predictive algorithms could forecast new criminal relationships, allowing police ways to predict change in and disrupt catalytic converter theft networks.[74]

Further research could seek to examine the validity of the FBI's typology of actors in catalytic converter theft networks. Additionally, cases should be selected, where possible, that have sufficient data about network actors' criminal histories to identify trends, particularly whether actors in these networks tend to have violent histories.

While the authors identified some suggestions for future research in this area, catalytic converter theft is an understudied topic. There are many additional avenues for future researchers to contribute to understanding and addressing this problem. Social network analysis provides a useful tool for understanding network structures, however, other methods should be employed by researchers from multiple academic fields to create a broader and more complete understanding of the topic.

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