Replication and Extention of Colby (2021)*

Maya A. Dalton

PLSC 508: Networks

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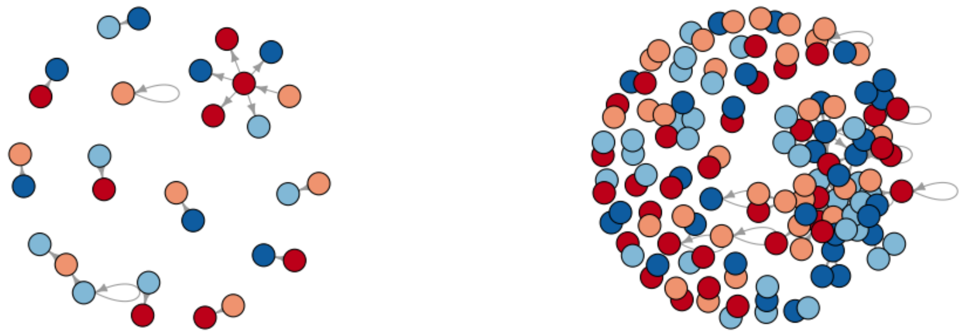
Visualization and Replication

The data for my final project replication and extension are from Colby, Darren, 2021, "Chaos from Order: A Network Analysis of In-fighting Before and After El Chapo's Arrest"[link]. The main plots of the network can be found in Figure 1 below, with Figure 1a showing the network prior to El Chapo's arrest in 2017, and Figure 1b showing the network following his arrest.

*Please find my replication materials here.



a Pre-Arrest Cartel Network　　　b Post-Arrest Cartel Network

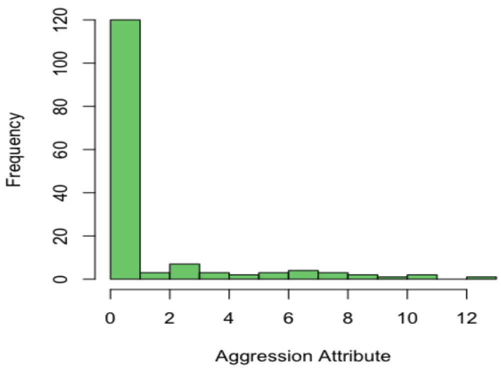
Figure 1: **Pre- and Post-Arrest Networks from Colby (2021)**

Vertex Attributes

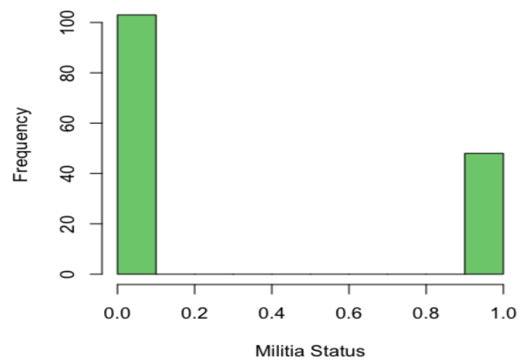
Vertex attributes include group aggression, militia status, subfaction status, and role as a small or large cartel group, as shown in Figure 2. Figure 2a shows the distribution of group aggression, with a majority of groups having lower aggression scores. Aggression is the log of the number of attacks conducted by each actor during both periods. Figure 2b shows a majority of cartels being non-militia, but still a decent amount being militia groups. Figure 2c shows that most groups are not sub-factions of larger groups, but instead independent organizations.

Figure 2d shows the distribution of cartel roles. The most powerful cartels – the Gulf, Jalisco Nueva Generacion (NG), Los Zetas, and Sinaloa cartels are less frequent roles. Small cartels and militias that control small swaths of territory are the most frequent roles. These cartels tend to specialize in a small number of subtasks of drug trafficking and align themselves with larger cartels. There are a smaller amount of Rising Challengers, which are relatively new cartels that are rapidly growing. Finally, the White Dwarfs represent cartels that are on the decline.

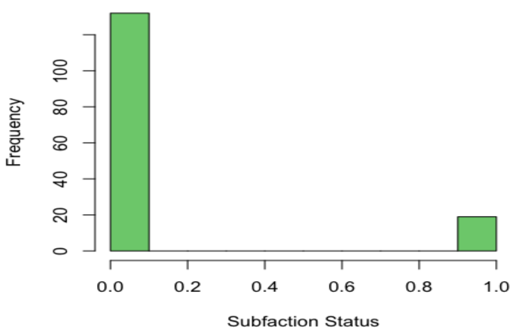
Figure 2e shows the count of cartel groups in periods 1 (pre-2017 arrest) and 2 (post-2017 arrest). There are many more cartels in the second period.



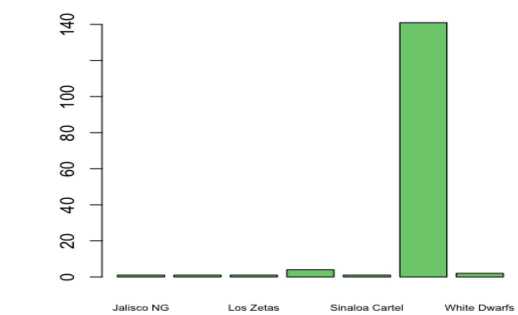
a Aggression Attribute



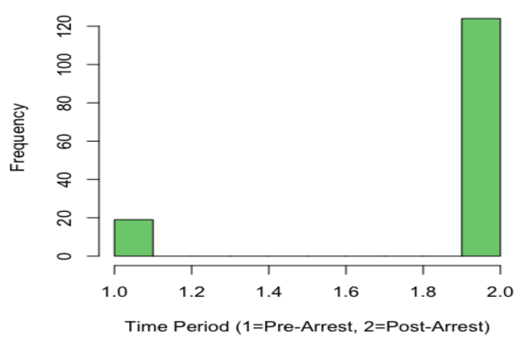
b Militia Status



c Subfaction Status



d Cartel Roles

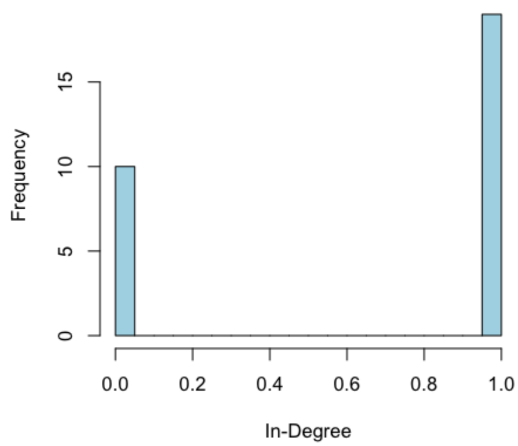


e Time Attribute

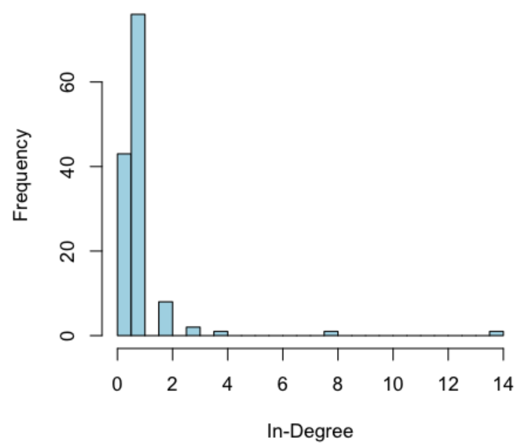
Figure 2: **Vertex Attributes**

Degree Distributions

Figure 3 shows the replicated in-degree centrality distributions for the pre-arrest and post-arrest networks (Figure 2, row 1 in the main analysis of Colby (2021)). In-degree is the number of incoming edges, and the distribution of that number increases after the arrest.



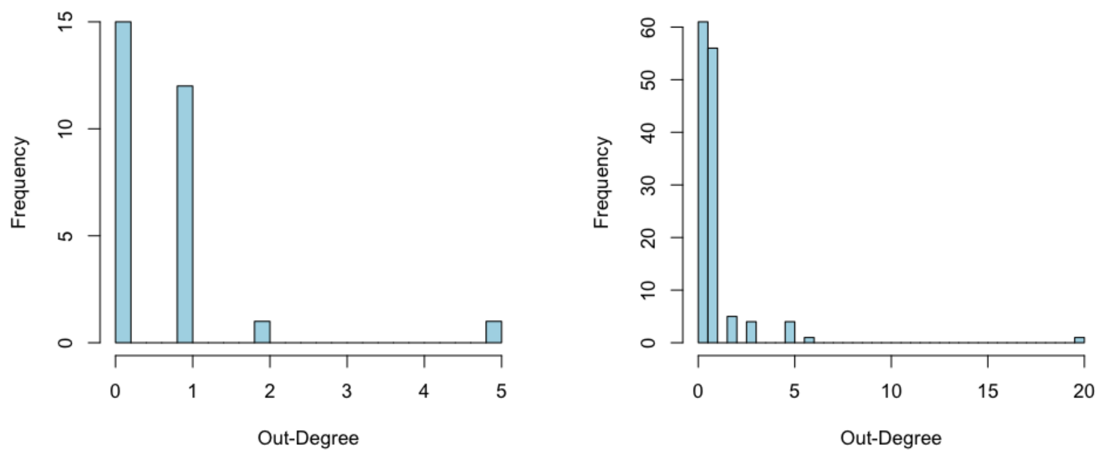
a Pre-Arrest In-Degree



b Post-Arrest In-Degree

Figure 3: **In-Degree Distributions from Colby (2021)**

Figure 4 show the replicated out-degree centrality distributions for the pre-arrest and post-arrest networks (Figure 2, row 2 in the main analysis of Colby (2021)). Out-degree is the number of outgoing edges, with the number decreasing after the arrest.



a Pre-Arrest Out-Degree

b Post-Arrest Out-Degree

Figure 4: **Out-Degree Distributions from Colby (2021)**

SAOM Estimation

The main analysis of Colby (2021) includes estimating four stochastic actor-oriented models (SAOM). Each of these estimates the alliances, reputations, strength, and clustering of the cartels based on descriptive network statistics (similarity, assortativity, transitive closure, homophily, and reciprocity). Table 1 below depicts these results, which show that (1) alliances had virtually no effect on cartels' and militias' decisions to fight one another; (2) after El Chapo's arrest, cartels and militias faced greater reputational costs for appearing weak, and; (3) El Chapo's arrest did not greatly affect certainty about territorial control and relative power of other cartels (p. 9).

Table 1: SAOM Estimation

	Alliances	Reputation	Strong-vs-weak	Clustering
Jaccard Similarity	0.13			
	(3.29)			
In-degree Popularity		0.18		
		(0.10)		
Out-in-degree Assortativity			-0.90^{***}	
			(0.23)	
Transitive Closure				0.34
				(0.63)
Aggression Homophily	-0.20	-0.19	-0.30	-0.20
	(0.47)	(0.44)	(0.43)	(0.47)
Subfaction Homophily	2.06^{***}	2.04^{***}	1.87^{***}	2.05^{***}
	(0.58)	(0.56)	(0.54)	(0.55)
Militia Homophily	1.23^{***}	1.20^{***}	1.32^{***}	1.24^{***}
	(0.34)	(0.35)	(0.32)	(0.33)
Role Homophily	-1.91^{***}	-1.55^{***}	-2.65^{***}	-1.89^{***}
	(0.39)	(0.45)	(0.48)	(0.37)
Reciprocity	4.72^{***}	4.73^{***}	4.83^{***}	4.72^{***}
	(0.76)	(0.96)	(0.69)	(0.84)
Iterations	19176	19176	19176	19176

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Descriptive Extension

While Colby (2021) controls for some descriptive statistics in the SAOM estimation, descriptive measures will better probe the underlying formation of networks. I conduct analysis into the reciprocity (which has positive, significant effects in Table 1) and transitivity (which has positive, but insignificant effects on clustering). I also investigate preferential attachment, which has positive but insignificant effects on reputation. Finally, I analyze the networks via community detection to further analyze clustering.

Reciprocity and Transitivity

Figure 5 and Table 2 show that the reciprocity and transitivity scores increase after El Chapo's arrest. Before the arrest, there were no stable relationships in which the nodes exchanged resources. Afterward, reciprocity is a bit stronger, meaning that more cartels are forming ties with one another. The transitivity scores show similar results, however, after the arrest the score is still very small, meaning very few triads are forming in the cartel network. These findings align with those from the SAOM model in Table 1, as transitivity is not strongly present in the network and will not be significant. Additionally, reciprocity is positive across all models and is more present in the network. This also confirms the hypotheses from Colby (2021), where leadership decapitation will decrease clustering but increase ties between groups.

Figure 5: **Reciprocity and Transitivity Scores**

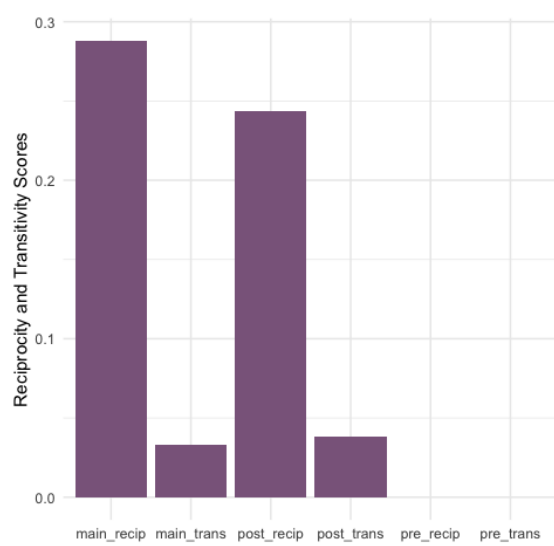
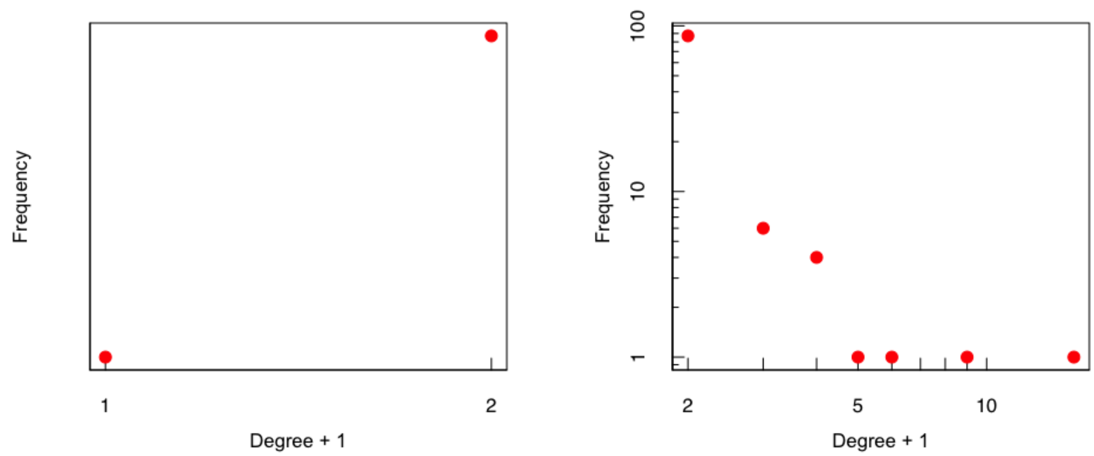


Table 2: Reciprocity and Transitivity Scores

	V1
Reciprocity	
Pre-Arrest Recip	0.000
Post-Arrest Recip	0.243
Full Graph Recip	0.288
Transitivity	
Pre-Arrest Trans	0.000
Post-Arrest Trans	0.039
Full Graph Trans	0.033

Preferential Attachment

The main theory for preferential attachment is related to violence between cartel groups. If alliances break down, smaller cartels that were part of alliances should be less protected from violent confrontation with rivals, eliciting a preferential attachment for future violence. The findings from the main analysis show that preferential attachment is positive, but insignificant for reputation costs to cartels. This points to the possibility that cartels attack smaller ones following the arrest. Figures 6 show the degree centrality before and after the arrest. Before the arrest, there were only a few cartel groups engaging with one another, all with lower centralities. However, after the arrest, only a handful of cartels have larger degrees meaning they are more central to the network and attack the disbanded cartels after El Chapo's death.

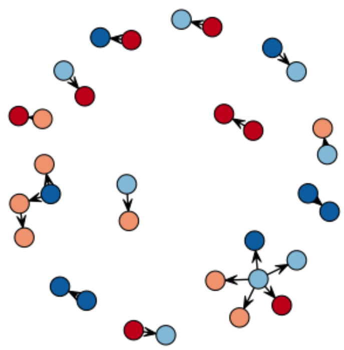


a Pre-Arrest Degree Centrality

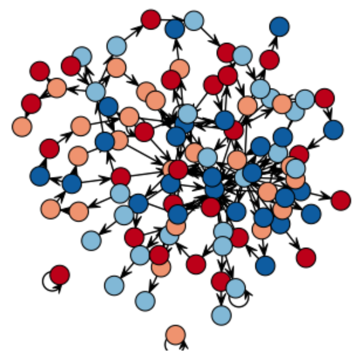
b Post-Arrest Degree Centrality

Figure 6: **Degree Centrality Pre- and Post-Arrest**

Figures 7 confirm this possibility, showing that there were few cartels fighting with one another before 2017, but many afterward. This also points to the presence of hub nodes in the network. The estimated attachment exponent (α) is 3.209 without temporal aspects (shown in Table 3), meaning the attachment process is *super-linear*. Basically, high-degree nodes are even more likely to attract new connections. The higher the degree of a node, the disproportionately higher the probability that new nodes will attach to it. In the case of the data, the process is highly skewed toward high-degree cartel groups, which act as "hubs" and attack a lot of the new or disbanded groups. If one of these hubs were to suddenly disappear, it would significantly impact the network.



a Pre-Arrest Preferential Attachment



b Post-Arrest Preferential Attachment

Figure 7: **Preferential Attachment in Cartel Networks**

Table 3: Preferential Attachment

Estimated attachment exponent	3.826

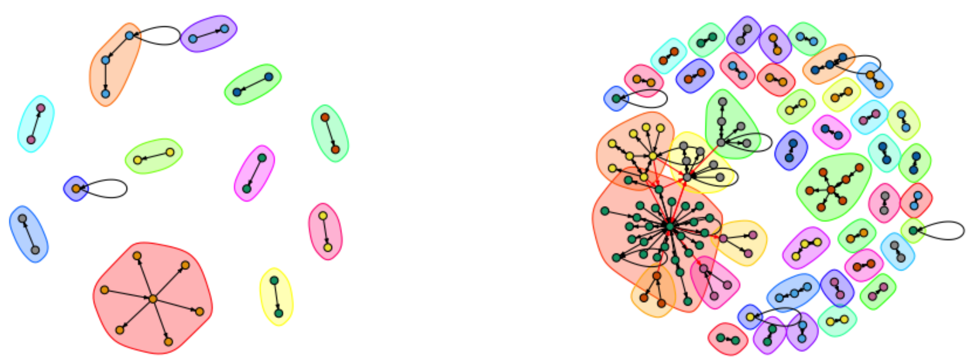
Community Detection

Finally, I use community detection to further examine the cartel data in terms of clustering. Table 4 shows the modularity scores for four community detection algorithms used on the entire network: Infomap, Leading Eigenvector, Spinglass, and Walktrap. Of these, Infomap performs the best. When analyzing modularity scores for the network before and after the arrest, the results are the same.

Table 4: Modularity Scores

Infomap	0.791
Leading Eigenvector	0.742
Spinglass	0.641
Walktrap	0.730

Figures 8 shows the plotted community clusters for pre- and post-arrest, depicting many more communities after the arrest, with a presence of some larger communities (left-side of Figure 8b). These are likely the more established and stronger cartels, engaging in attacks toward smaller, weak, or new cartels.



a Pre-Arrest Communities

b Post-Arrest Communities

Figure 8: **Cartel Network Communities (Infomap)**

Colby (2021) finds that leadership decapitation will (1) decrease clustering between groups and (2) increase preferential attachment. However, the SAOM model estimation shows these two independent variables (using transitive closure and in-degree popularity, respectively) are insignificant. The previous analyses into preferential attachment and community detection do not necessarily support these findings, showing firstly, that preferential attachment is extremely strong in this network. The preferential attachment of strong cartel nodes to attack small, weak, or new nodes should significantly increase the cost of reputation after leader decapitation, yet Colby (2021) does not find such effects.

Secondly, there are a handful of strong community clusters shown via community detection. While reciprocity has strong, positive effects on alliance formation, reputation costs, strong-vs-weak, and clustering, there are no additional attributes to accurately capture what is shown in Figure 8. Estimating the effect of clustering should have included something outside of transitive closure, as cartels naturally may not form triads of attacking other groups.

References

Colby, Darren. 2021. “Chaos from Order: a network analysis of in-fighting before and after El Chapo’s arrest.” *Independent Student Projects and Publications* .
URL: $https://digitalcommons.dartmouth.edu/student_projects/4$