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Friends in Locked Places: An Investigation of Prison Inmate Network Structure

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1. Introduction

The US currently houses over 2.2 million inmates in prisons and jails (Kaeble et al. 2016) and has the highest incarceration rate in the world (Walmsley 2015). At current rates, an estimated 6.6% of the US population born in 2001 will be incarcerated at some point during their lifetime (Bonczar 2003). The costs of incarceration are multifold, and include negative physical and mental health outcomes (Massoglia 2008; Wildeman 2010), high recidivism risk, and collateral consequences for families, communities, and racial and economic stratification (Clear and Frost 2013). Despite these far-reaching effects, little is known about the mechanisms through which incarceration affects social outcomes (National Academy of Science 2014). Outside of prison, many of these outcomes are driven, at least in part, by social processes that began behind bars. Understanding prison social conditions from a network perspective can offer insights to improve inmate well-being (Moreno 1934) and inform prison policy (Schrag 1954).

From a network perspective, prisons offer a fascinating contrast to other social network contexts. Incarceration represents one of the most extreme shocks to the web of social affiliations that people accumulate over their lifetimes. Prisons are total institutions that instantaneously disconnect inmates from their network members who remain in the community, with some relationships never recovering (Bui and Morash 2010; Lopoo and Western 2005; Volker et al. 2016). Though visitation and other communications (e.g., phone calls and mail) are possible, such modes are unsuitable for addressing day-to-day needs for

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companionship, support, and material resources that friends inside prison can provide (Bronson 2008). Thus, inmates' daily interactions and the fulfillment of social needs fall primarily to similarly-situated peers.

Unlike most other foci that filter network connections (Feld 1981), membership in prison is involuntary. Inmates enter prison against their will, with only a general sense of when they will be released (i.e., minimum and maximum release dates), and oftentimes knowing no one in the prison. The composition of the prison population means that inmates' choices are limited to criminally-sanctioned peers, many of whom may have violent histories, making social affiliation risky. Trusting the wrong person can lead to victimization or even death. The riskiness inherent to the prison setting creates stress and makes it imperative for inmates to quickly ascertain how to maintain their security and with whom they can and cannot establish a modicum of trust. Adding to this stress is the constant flux of the prison population as inmates are released or transferred to other facilities and new inmates enter (de Viggiani 2006). The prison social context is a highly fluid environment where inmates are simultaneously dependent upon others, yet may place limited trust in one another. Surviving in such an environment requires constant monitoring of others and assessments of one's relationships (Crewe 2009). Overall, this represents a unique, understudied, and valuable context in which to examine how patterns of social affiliations develop.

The current study follows a line of research investigating informal structure among prison inmates. In particular, we study and map the network of inmates who "get along with" one another – which is an approximation of friendship in other settings. As we outline below, recent prison research has underscored the importance of race during inmate interactions. We thus pay particular attention to how race and ethnicity structure inmate peer relations. Data come from the Prison Inmate Network Study (PINS), a project focused on a unit of a Pennsylvania men's medium security prison. Analysis of this unit serves as a conservative test of whether prisons necessarily differ from the outside world because the unit houses Custody Level 2 (minimum security, "good behavior") inmates. We give context to our findings by comparing them to prior prison studies, however because these are so few in number we also compare our results to school-based networks. Results from this project offer a richer depiction of the complex social world inside the prison walls and how their structure differs from networks of informal associations outside prison.

2. Background

Though several studies have examined the network structure of delinquent populations, often gangs (Grund and Densley 2014; Hughes 2013; McCuish et al. 2015; Papachristos 2006, 2013; Sarnecki 2001), these tend to focus outside the prison. Only a limited set of researchers have entered the prison to investigate social structure with formal network methods. In the ensuing pages we draw upon a wider array of literature, not just network-based, to begin answering the question of how prison networks are structured.

2.1 Relationship quality among delinquent/criminal individuals

Prisons differ markedly from conventional sites for social network research (e.g., schools, workplaces) in several ways that have the potential to impact network processes – whether

they do or not is an open question. Beyond the contextual factors noted above, the composition of prisons is unique. Prison inmates more often possess attributes strongly correlated with crime and arrest, such as low socioeconomic status, substance abuse, low self-control, racial minority status, and poor mental health – all of which have been shown to affect relationship processes (Schaefer 2015; Schaefer et al. 2011; Steglich et al. 2011). Indeed, there is a long-standing debate over potential differences in the quality of ties for delinquents and criminals in comparison to their non-offending peers. This debate is defined by two polar approaches: the *social ability* and *social disability* models (Hansell and Wiatrowski 1981). The social disability model, derived from social control theory (Hirschi 1969), posits that the friendships of delinquents and criminals are "cold and brittle" relative to their non-delinquent counterparts. The social skills of those who engage in crime are said to be immature, yielding network structures that are unstable and high in relationship turnover, lacking in reciprocal exchange, and exploitative in nature. By contrast, the social ability model views delinquents as having similar social skills as their non-delinquent peers. Consistent with the underlying causal logic of differential association theory (Sutherland 1947), subcultural theories (e.g. Cohen 1955), and the more general social learning theory (Akers 2009), the social ability model posits that criminal friendships parallel non-criminal friendships, as both are shaped by normative influence and the reproduction of criminal attitudes and behavior. Those who engage in crime can be popular with their peers, have strong and meaningful friendship ties, be mutually liked by nominated friends, and belong to cohesive cliques or small groups (i.e. group solidarity).

Research testing these competing claims has typically focused on adolescence. In one of the earliest studies to address this issue, Hirschi (1969) found a negative association between attachment to friends and delinquency. Similar findings are echoed by Marcus (1996), who noted that compared to those who do not engage in delinquency, delinquent youth report greater conflict and less cohesion with parents, greater conflict in friendship relationships, more impulsivity, lower social competence, and poorer social skills. Giordano and colleagues (1986) also found that delinquent youth report relationships somewhat more prone to conflict, however, their relationships are otherwise as stable and trusting as youth who do not engage in delinquency. More recent work has moved beyond individual reports of peer relationships to study delinquents within complete networks. In a study actually focused on incarcerated youth, Clarke-McLean (1996) found that delinquent youth formed groups that were nearly as stable as in a comparable public school, with part of the difference likely attributable to the greater population turnover within the training school. Moreover, she found no differences in relationship quality (e.g., care, trust) between the most and least delinquent youth within the setting. Studying adolescents in Dutch schools, Baerveldt and colleagues (2004) found a positive correlation between delinquency and being named as a best friend, suggesting such youth were more popular among their peers. In addition, although delinquents named as many best friends as non-delinquent youth, they also tended to avoid more of their peers (i.e., were more selective). Using a more sophisticated SABM approach, Snijders and Baerveldt (2003) found no differences in the tendency for delinquent youth to send or receive friendship ties, nor that delinquent youth friendships turned over more rapidly.[1] Finally, several studies suggest that being popular, versus marginalized or isolated, is *positively* associated with delinquency among adolescents

(Agnew and Brezina 1997; Demuth 2004; Gallupe, Bouchard, and Davies 2015; Kreager 2004).

In sum, research has found that networks of delinquent youth more often than not exhibit many of the same structural properties as non-delinquent youth, though they may also be marked by more turmoil and conflict. Thus, the majority of research is consistent with the social ability model, but notable departures exist. Part of the explanation for these mixed findings likely stems from the heterogeneous composition of youth networks in naturalistic contexts. Prior research has primarily drawn upon *school-based* networks of adolescents, where the range of delinquency is wide and includes less serious levels. In addition, many youth in schools have a mixture of delinquent and non-delinquent friends (Haynie 2002; Weerman and Bijleveld 2007), which would obscure differences in their networks. It may be that the social inability model applies only to individuals who are engaged in more serious forms of delinquency. If this is the case, then networks among prison inmates – settings composed entirely of serious offenders – would be most likely to reflect the social disability model and exhibit a structure that departs from networks outside prison. The current study aims to shed light on this supposition.

2.2 Prison ethnographies and case studies

Beyond adolescent delinquency and friendship, a long tradition of prison ethnographies and case studies has focused on describing and explaining inmate informal organization (Simon 2000; Crewe 2007). One of the most influential works in this vein was Sykes' (2007[1958]) *Society of Captives*, which provided a detailed account of the inmate roles and relationships within the New Jersey State Prison. For Sykes, inmate social structure is inherently unstable and cohesion only tenuously achieved by "real men" who mediate conflicts, promote mutual toleration, and facilitate the equitable division of community goods. It is then the combination of respected inmate leaders with a non-totalitarian prison regime that overcomes "alienative" and exploitive inmate adaptations to prison's inherent deprivations.

In the ensuing decades, subsequent prison ethnographers complicated Sykes' (2007[1958]) vision of inmate society and connected it to sharp changes occurring both outside and inside prison walls. In his case study of an Illinois prison, Jacobs (1977) documented the racial tensions, political activism, and gang-related violence that swept through Chicago in the 1960's and penetrated prison life. The result was stronger racial and gang identification within prisons and increased violence as groups sought to consolidate power and control. Irwin (2005) later argued that stability in such a balkanized system is only found through the détente of group segregation and strict boundary maintenance. More recently, Skarbek (2014) similarly asserted that race-based drug gangs create prison order by filling gaps in formal and informal control that accompanied the rise of mass incarceration (see also Trammell 2009). Much prison research therefore suggests that subgroup affiliations based on race, gang identification, or other demographic characteristics (e.g., religion or hometown community) strongly structure prison relationships and status hierarchies. Such structures can dominate even when individuals themselves have no race-based preferences for

[1]Snijders and Baerveldt (2004) also report finding that friendships homophilous on delinquency form and dissolve more quickly – which is consistent with the inability model for delinquents, but perplexing for non-delinquents.

affiliation as prison norms may dictate who can and cannot associate (Colwell 2007; Skarbek 2014). Prison administrative practice may also dictate relations. For instance, some prisons have adopted the strategy of assigning inmates to housing based on race/ethnicity in an attempt to segregate rival gang members (a policy that may have had the perverse consequence of intensifying inter-ethnic animosities; Chong 2013; Walker 2016).

Similar patterns of race/ethnic homophily are evident in studies of non-prison gangs and co-offending (offenders who are linked based on involvement in the same offense). Hughes' (2013) network-based re-analysis of the classic Short and Strodtbeck gang data demonstrated strong clustering by race into gangs, simply referring to gangs as "Black" or "White." Numerous studies have documented race/ethnic homophily among co-offenders (Conover-Williams, Clemons, and Schwartz, 2012; Conway and McCord, 2002; Daly, 2005; Reiss, 1988). In a more stringent test using ERGMs to control for relational interdependence, Grund and Densley (2014) found ethnic homophily in co-offending relations among London gang members, an effect that grew stronger for members embedded in triads. Thus, consistent with studies of largely non-delinquent populations across many settings (McPherson, Smith-Lovin and Cook 2001), homophily on race/ethnicity is evident among delinquent populations, and likely to be quite strong within prison.

2.3 Sociometric network studies

Closer aligned with the current project, a handful of studies have examined inmate associations from a relational or network perspective. One line of research has used network methods to quantify the availability of social support among inmates. Such research finds evidence that many inmates do turn to one another, with friendships often developing. For instance, Lindquist (2000) found that 46% of jail inmates report at least one close friend and 53% report having someone to confide in within the jail. Among female inmates, Kruttschnitt and Gartner (2005) found that 61% disagreed with the statement, "I don't care to associate with the kinds of women who are in this prison," and 61% spent their free time with one or more fellow inmates. Similarly, Kreager, Palmen, Dirkzwager, and Nieuwbeerta (2015) recently found that 58% of Dutch detainees reported trust in at least one fellow inmate.

Additional carceral research has sought to understand *who* has better access to peer support. For instance, Lindquist (2000) found no differences in inmate social support by gender. Other researchers have examined the association between age and inmate friendships, with mixed findings. Some studies report a positive association between age and quantity of friends and confidants (Gallagher 1990) and others report a negative association (Bond et al. 2005). Thus, some inmates are either more capable of friendship and/or more willing to invest effort in developing friendships, but there may be differences in social integration by inmate status.

A smaller subset of (older) studies has used formal network methods to ascertain global prison network structure and individual network position. Indeed, Moreno's (1934) foundational sociometric study investigated the structure of relations between women in a New York reform school. Moreno documented several features that have come to be prototypical network patterns, including unequal degree distributions, propinquity (based on

housing location), subgroups, race/ethnic homophily, and peer influence. Drawing upon Moreno's method, Schrag (1954) examined the network of leadership nominations among men in a Washington state prison. Key among his findings was homophily on ethnicity, intelligence, and type of offense (though the latter is offset by violent offenders being more popular), but no evidence of homophily on age or education level.

Subsequent work on prison inmate networks has generally sought to identify sets of inmates who constitute subgroups. For instance, perhaps the most widely known inmate dataset is Gagnon's Cook County jail data, first reported by MacRae (1960) to illustrate his subgroup detection method. MacRae identified 11 communities, but did not otherwise offer insight to their character. This dataset has become a canonical test case for new analytical methods (e.g., Arabie 1984; Moody 2001a). Arabie (1984) offered particularly useful insight by integrating survey data gathered by Gagnon, finding that race was one of the strongest defining features of subgroups. Killworth and Bernard (1974) used mixed-gender networks from a youth detention center in West Virginia to illustrate their *catij* community detection method. Blending formal analysis with ethnographic insight, they uncovered a social structure with subgroups of varying sizes and unique profiles. In describing each of the 11 subgroups they emphasized race/ethnic composition, finding that 9 were homogenous, and their geographic basis, with inmates originating from either the same hometown or region. Interestingly, Killworth and Bernard also found that most individuals were categorized as belonging to multiple communities.

In sum, although network research has been conducted with incarcerated populations, the cumulative body of knowledge is still thin. Most network-based research has aimed to understand prison structure in terms of subgroups, with consistent findings regarding the segregating role of race/ethnicity, and varied other sociodemographic background factors.

2.5 Current study

The goal of the current study is to offer an in-depth look at prison social structure that addresses many of the themes found across prior studies of delinquent, gang, and prison social relationships. We focus our inquiry around assortativity on race and ethnicity given its prominence in prior work, yet we also examine a number of additional background factors (e.g., age, religion, gang status, prison tenure, power) that previous studies suggest may structure the network. We use social network methods to quantify the insights garnered from the mostly qualitative research on prison social worlds. In addition, our study addresses the following gaps in the field. First, whereas prior research has focused on inmate groups and their composition, we emphasize *relationships*. This provides insight to the fundamental question of whether criminals are capable of meaningful relationships in a setting comprised solely of other criminals. Second, we are better able to ascertain the relative importance of attributes like race, religion, and prison tenure for network structure. With the exception of Schrag's (1954) mixing matrix, prior research has not quantified the strength of attribute-based associations nor assessed their contribution to network structure net of other processes. Third, we focus on a prison unit without a large gang presence. We thus provide an alternative illustration of prison informal organization that complements the multitude of contemporary case studies set in high security or gang-infested environments. Fourth,

following Kreager and colleagues (2015), we provide a systematic and replicable analysis of prison social structure that can be used to inform prison policy (Schrag 1954; Killworth and Bernard 1974).

3. Data and Analysis

3.1 Data

Data come from a Custody Level 2 (minimum security, "good behavior") unit of a medium-security men's prison located in Pennsylvania. The unit is physically segregated from the rest of the prison. Assignment to the unit was voluntary and unit staff could have inmates removed from the unit at any time due to misbehavior. Because unit residents had recent histories of good behavior, they were allowed to freely associate with one another when not working, being counted by correctional staff, or confined to a cell overnight. Association with inmates not in the unit was restricted to meals and shared time in the yard. The unit is arranged with two wings that house inmates in two-person cells and a larger bunk room consisting of rows of beds. Inmates are able to make requests for bunk assignments and cellmates, which are fulfilled based on seniority, thus the more desirable two-person cells are inhabited by inmates who have been on the unit longer. Approximately one-third of the unit was parole-eligible and preparing for release, leading to high turnover in the unit (10–20% per month). Of the 205 residents on the unit, 12 were ineligible to participate in the survey given that a mental illness designation in their correctional file raised concerns about their capacity to give consent.[2]

Data come from two sources. First is a survey, administered through face-to-face interviews using a Computer Assisted Personal Interview (CAPI) protocol that lasted approximately one hour per inmate. We interviewed 133 of the 193 eligible unit inmates (69%). Second, we obtained official data from the Pennsylvania Department of Corrections (PADOC). Unlike the interview data, PADOC data are available for *all* eligible inmates on the unit whether they were interviewed or not. Comparisons between respondents and nonrespondents using PADOC data found the only difference to be that participants were less likely to be White.

The survey provided information on inmate relationships, and in particular two types of ties. Of primary interest is positive relationships between inmates, which was obtained by asking respondents which other inmates on the unit they "get along with most." This item is akin to friendship in that it represents who inmates tend to spend time with and otherwise have a positive relationship. We chose not to ask about friendship itself given that some inmates are adamant about not having "friends" in prison, only "associates" (Crewe 2009). In addition, we consider relational data on the local status hierarchy by asking respondents whom they perceive to be "the most powerful and influential in the unit." We use indegree in the power/influence network to represent each inmate's position in the unit's status hierarchy. For both items, an alphabetized list of unit inmates was presented on the computer screen and respondents could nominate as many alters as they wished (i.e. no fixed-choice). The survey

[2]We did not learn which inmates had been given a mental illness designation until after data collection, thus some ineligible inmates were interviewed. Our IRB protocol requires that we exclude such inmates' responses from the analysis.

also replicated an item by Krutschnitt and Gartner (2005) asking inmates how they spend their free time – alone or with others.

PADOC provided official data on sociodemographics, including inmate race/ethnicity, religion, age, education (highest grade in school), and the city where inmates resided prior to incarceration. PADOC also provided information on severity of the sentencing offense, misconduct in the past 18 months (none, informal resolution, documented misconduct), and start date of current prison sentence, which we recoded into current prison tenure measured in years. We combined PADOC data on Security Threat Group classification with self-reported gang membership to create a single dichotomous measure of gang involvement.

As shown in Table 1, the unit was racially/ethnically diverse, with distributions closely corresponding to the distribution within the prison more broadly. The unit was also criminally diverse, with offense severity ranging from 1 (least severe) to 18 (M=10, SD=3.4) and prison tenures ranging from 7 months to 45 years (M=6, SD=7.2). Not surprising given the "good behavior" nature of the unit, less than one-third of the inmates had any sort of misconduct in the past 18 months and less than 7% were gang involved. Table 1 also quantifies the association between individual attributes and two aspects of network structure: indegree – to assess popularity – and homophily. For categorical variables we compare group means on indegree and the odds of ingroup vs. outgroup ties (Moody 2001b). For continuous variables we calculate their correlation with indegree and Moran's I measure of autocorrelation.

3.2 Analysis plan

We use multiple methods in order to gain perspective on the structure of the prison social network and compare our results to other social contexts to explore similarities and dissimilarities. We begin by presenting several descriptive statistics about the network. We would like to give context to our descriptive and other findings, however there is a paucity of studies on prison inmate networks, and those studies that exist often represent different types of contexts (e.g., women's prisons, youth detention). We can compare our results to Gagnon's prison data, but this is one data point and a relatively limited one as its public version is not accompanied by individual attributes. As a solution, we turn to another bounded setting that focuses the social relationships of inhabitants – middle school and high school friendship networks (settings often metaphorically compared to prisons by students). At first glance, schools appear categorically distinct contexts from prisons, but they offer similarity in several important regards: type of actor (human), type of relation (positive affiliation), and self-report (Skvoretz and Faust 2002). School settings have received more attention from network researchers than any other type of setting, providing a rich context for comparison. If prisons are so different from the outside world then we would expect them to be outliers in comparison to schools. However, strong structural similarities between schools and prisons may increase confidence that prisoners are not as socially disabled as some theorists propose. For our purposes, we compare the prison network to the schools in the National Longitudinal Study of Adolescent Health (Add Health) dataset (Udry 2003). Add Health data have the benefit of representing a large number of schools (N=125) of varying size and sociodemographic composition. Importantly, Add Health schools vary

greatly in their race/ethnic composition (Moody 2001b) making them an ideal point of comparison for our primary questions about race/ethnicity.

Building on our descriptive analysis, we use community (i.e. subgroup) detection methods to discern inmate segregation into groups. We approached the community detection analyses from multiple angles in the hope of observing convergence in the number and type of subgroups identified. We considered two broad families of methods: 1) *modularity-based methods* that force every node into being member of a single subgroup and 2) *clique-based methods* that allow for overlap in group membership. After experimenting with multiple methods in preliminary analyses, we settled on one algorithm from each family of methods, the Louvain method and the clique percolation method, respectively. The Louvain algorithm developed by Blondel et al. (2008) is a modularity method that proceeds in two steps. In the first step, the Louvain algorithm assigns each node to a distinct subgroup, then assesses whether fit can be improved by moving nodes to a neighboring subgroup. When no improvement in fit is possible, the second phase builds a network but at the subgroup level, consisting of ties between the various subgroups produced in phase 1. The between subgroup links are weighted based on the sum of the existing links between nodes of the two communities considered. These steps are repeated on the new weighted network until no improvements in fit are possible, with fit measured using modularity (Newman 2006). The Louvain method is computationally efficient and has been shown to perform well in many contexts, including in large, complex networks (Blondel et al. 2008; Lancichinetti and Fortunato 2009). We used the Organizational Risk Analyzer (ORA) software (Carley et al. 2013) for these analyses.

The clique percolation method (CPM) was developed by Palla et al. (2005) to combine the appeal of community detection approaches in efficiently describing complex social structures with the flexibility of clique-based methods in allowing for overlaps between communities. Instead of simply describing cliques of size k, the CPM extracts "communities of cliques" of size k. A subgroup is defined as the union of all k-cliques that can be reached from each other through a series of adjacent k-cliques, where adjacency means sharing k - 1 nodes (Palla et al. 2005: 815). The CPM first locates all cliques in the network and then identifies the communities through a standard component analysis of the clique–clique overlap matrix (p. 815). In allowing for subgroup overlaps, the method highlights what we will call "subgroup brokers" in the network, which are inmates belonging to cliques that otherwise do not share k-1 members. All CPM analyses were run using the directed networks module in CFinder (Palla et al. 2005), available at http://www.cfinder.org/. Once we obtain subgroups (using both community detection methods) we investigate their sociodemographic and criminal composition in order to provide "profiles" that shed light on the nature of each subgroup (cf. Arabie 1984).

To determine the salience of observed differences between subgroups on individual attributes, we estimate an exponential-family random graph model (ERGM) (Frank and Strauss 1986; Holland and Leinhardt 1981). ERGMs specify "network configurations" to explain the observed social structure through localized substructures (Lusher et al. 2013; Robins et al. 2007). We test three ways that attributes are associated with network structure. For attribute k, outdegree terms are based on the sum of the k_i values across each i,j tie in the

network. Indegree terms are based on the sum of the k_j values across each i,j tie in the network. We include outdegree and indegree terms for all attributes. Homophily is inferred in one of two ways, depending on whether the variable is continuous or categorical. For continuous variables (e.g., years in prison), homophily is measured using the absolute difference between two actors; smaller differences represent stronger homophily. For categorical variables (e.g., race/ethnicity), homophily is measured as whether two actors have the exact same value on the attribute. Several of our measures are right skewed and were logged prior to placing them in the ERGM (age, years in prison, years on unit, and power indegree).[3]

A strength of the ERGMs is that they are able to model, and hence control for, network structure. We control for the indegree and outdegree distributions using the *gwidegree* and *gwodegree* terms respectively. The *mutuality* term accounts for the likelihood of a tie from *j* to *i* given that *i* has sent a tie to *j*. Triadic closure is parameterized using the geometrically weighted edgewise shared partner distribution (Hunter 2007; Hunter and Handcock 2006) where the likelihood of a tie between *i* and *j* increases if both *i* and *j* share a tie with *k*, increasing further for each *k*, though at a decreasing rate. We use a *two-path* term to control for the tendency to have open two-paths (i.e., indirect paths from *i* to *k* through *j*).[4] Lastly, we include an *edges* term to model the overall likelihood of observing a tie. Models were estimated and goodness-of-fit diagnostics performed using the *ergm* (Hunter et al. 2008) package in R (http://www.r-project.org). The ERGMs showed no signs of degeneracy and fit well as indicated by goodness of fit tests using the triad census and the distributions of indegree, outdegree, edgewise shared partners, and geodesic distances.

Lastly, our interest in race/ethnic organization of the unit leads us to ask whether some inmates are more likely to bridge racial/ethnic groups than others. We evaluate this question by conducting a brokerage analysis (Gould and Fernandez 1989) using the *brokerage* function in the R *sna* package (Butts 2014). For each inmate, we calculate how often they occupy one of the five brokerage positions identified by Gould and Fernandez (1989). We are particularly interested in inmates who connect a member of their own group with a member of a different group (gatekeepers and representatives) or who connect members of different groups, neither of which the broker belongs to (liaisons). To address our question of who is more likely to bridge racial/ethnic groups, we use a negative binomial regression model (for count outcomes) to regress brokerage frequency on several individual attributes.

All analyses except the ERGM utilize the sample of 133 survey respondents. The ERGM incorporates all 205 inmates on the unit, including those with a mental illness classification who, along with non-respondents, are constrained during estimation to have outdegree = 0. Using the larger sample allows us to incorporate information about ties to non-respondents and, because we have official data on all inmates, obtain better estimates of attribute-based mixing.

[3]The log of 0 is undefined, thus we added 1 to power indegree before logging.
[4]We attempted to include a *gwdsp* effect but could not achieve convergence. This omission is not problematic for our inferences regarding individual attributes as goodness-of-fit for all measures, including the triad census, is good for a simplified version of our model that only includes structural terms - no individual attributes.

4. Results

4.1 Network descriptive statistics

Our first objective is to describe the prison network and, whenever possible, offer context to our findings by comparing them to other prison and school contexts. Nearly all surveyed inmates (98%) indicated getting along with at least one of their fellow inmates, with 92% naming alters (10 inmates reported they got along with others but were reluctant to provide names). On average, inmates nominated 3.9 alters in the get along with network, which falls in the range of prior estimates of friends within correctional settings (1.8, Gallagher 1990; 2.7, MacRae 1960; 6.3, Colsher et al. 1992; and 7, Killworth and Bernard 1974) and is close to estimates of the number of inmates liked (4.8, Goldweber et al 2014). In comparison, Hughes (2013) reports an average degree of 3.8 across the 11 gangs she studied; and the Add Health schools had a mean friendship degree of 4.3 (sd = 1.1) with a minimum of 1.6.

Turning to the question of how inmates spend their free time, only 20% spent time mostly alone, which is half the 39% reported by the female inmates in Kruttschnitt and Gartner's (2005) study. Inmates in our sample associated mainly with one or two unit residents (37%), with a group of 3 or more (17%) or with many residents but not one group (26%). The corresponding rates from Kruttschnitt and Gartner's study of female inmates were 42% with 1–2 inmates, 7% with mostly one group, and 12% with many inmates but no one group. This suggests that the male inmates in the observed prison unit were far more interested in being social (or perhaps permitted), associated more in groups, and sometimes even spanned groups.

Structurally, the observed proportion of edges reciprocated was .30, which compares closely with the rate of .28 observed in Gagnon's friendship network. An alternative measure of reciprocity is rho, provided by Katz and Powell (1955), which adjusts for the baseline reciprocity expected given the outdegree distribution. We use rho to compare our results for prison networks to Hughes gang data[5] and Moody's (2001b) results for 125 Add Health schools. Rho is .29 for our prison data, which is far below .42 for Gagnon's data and .38 for the Add Health schools (sd = .05). For Hughes' data, mean rho was .10, though it varied from a minimum of .01 to a maximum of .15 (sd = .10). Thus, our observed prison had lower rates of reciprocation than both the Add Health schools and Gagnon's prison once controlling for the outdegree distributions, but higher rates than Hughes observed in the gang data.

Figure 1 presents a sociogram of the 131 inmates in the largest component in the prison unit network. As nodes are shaded by race, this provides early evidence of race homophily. In particular, many of the Hispanic inmates are clustered together in the lower-right portion of the network, while the upper half of the network is predominantly White. Note, however, that the distinctions by race are not clear cut partitions in the network. Indeed, isolated racial subgroups do not exist, as Black inmates in particular are distributed throughout the network. Nodes are sized according to how often they were nominated as being powerful and influential. For the most part, powerful inmates tend to be either Black or White and

[5]Personal communication.

reside toward the center of the network. An exception is the Hispanic pendant node in the upper-left corner. This powerful inmate is a former gang leader who is ‘doing his own time’ and intentionally avoiding integration within the unit.

4.2. Community structure and composition

Our next question is about the structure and composition of cohesive subgroups. Discerning prison subgroups and their respective sociodemographic profiles has motivated much prior prison research, particularly network-informed studies (Arabie 1984; Killworth and Bernard 1974). Our analysis of community structure begins by describing results for the Louvain method, which assumed mutually exclusive subgroups, and follow with results for the CPM method that allowed overlapping subgroups.

4.2.1 Louvain cohesive subgroups—Our preliminary runs of the Louvain (Blondel et al., 2008) and Newman (Clauset, Newman, and Moore 2004) methods all point to the existence of eight subgroups. The fit statistics and “best solution” from the two methods were consistent (Q in the .42 to .45 range), with the eight group solution having face validity over other solutions (ranging from 2 to 10 subgroups). Once the communities were assessed against inmate attributes, we found that the Louvain method provided the best fit to the data (see Figure 2).

In order to understand the character of each subgroup, we summarized the attributes of their members (see Table 2). Looking down the columns for each subgroup provides quick insight to their character. For instance, subgroup 1 is mostly Black and has the highest concentration of non-religious and gang members. Subgroups 2 and 4 are the longest-tenured (10+ years) and most powerful (mean power/influence indegree is 1.63 for subgroup 2 and 3.19 for subgroup 4) compared to other subgroups, making them the “old heads” of the unit. However, these “leading” subgroups have different race and religious compositions: White non-Muslim in subgroup 2, and Black Muslim in subgroup 4. And although these are not the highest density units, their members exhibit around 3.5 ties with one another on average, which is the highest internal mean degrees across all subgroups and suggests higher relative levels of solidarity within them. Two other subgroups contain fairly young Black Muslims with elevated levels of recent misconduct (3 and 8). Subgroups 5 and 6 are less extreme versions of these communities. And subgroup 7 is a Hispanic Catholic group.

Looking across subgroups also reveals important aspects of their structure. First, the unit does not have hard racial or religious boundaries. All religious views are found within the vast majority of subgroups, and all subgroups but one (7: 100% Hispanic) are represented by multiple races. That said, the racial composition of seven of the subgroups show a tendency toward either Black (1, 3, 4, 8), White (2, 5), or Hispanic (7). In addition, five of the eight subgroups show a stronger tendency for one religion over others. Second, gang members do not congregate within the same subgroups. Instead they are spread across the unit and persist in all but 2 subgroups. Thus, the subgroups identified do not appear to be proxies for race/ethnic-based gangs as found in prior studies of prison social structure.

It is also informative to examine how subgroups are related to one another. In general, between-group densities are low, which is a byproduct of the community finding algorithms.

We defined a tie as existing between subgroups if the inter-group density exceeded the mean intergroup density (M = .015). Figure 3 provides a depiction of the 8 Louvain subgroups and their racial composition. Here we can see that subgroups 2 and 4 -- the most powerful subgroups -- accomplish their roles in slightly different ways. Subgroup 4 is in the center of the network, finding itself on the receiving end of power/influence nominations coming from inmates in other groups. Subgroup 2, for its part, is externally connected exclusively from its members sending ties to inmates in other groups. And although subgroup 2 is predominantly White, it does not share ties with other groups that have the highest proportion of White members (5 and 6).

4.2.2 Clique percolation subgroups—There is theoretical and empirical justification for allowing inmates to belong to multiple communities. The clique percolation method (CPM) creates overlapping subgroups based on cliques of a predefined size. For this analysis, we explored cliques sized 3–5. To evaluate whether CPM is a suitable method to capture subgroup structure and the appropriate clique size to report we examine its coverage, defined as the proportion of nodes belonging to at least one subgroup (Palla et al. 2007). In our case, 76% of the inmates belong to at least one k-3 clique, which is considered good coverage and indicates the tendency to form k-3 cliques is relatively common. Analyses with larger cliques sizes had poorer coverage (34.8% of inmates belonging to k-4 cliques and 7.5% of inmates belonging to k-5 cliques) and are less informative. The 141 k-3 cliques are structured around 12 partially overlapping subgroups, including a large subgroup of 79 inmates that alone contains 122 k-3 cliques (see Figure 4). The 11 other subgroups share at least one inmate with the large subgroup.

Table 3 provides the characteristics of each subgroup. Even when considering groups at the smaller clique-level, racial and religious mixing is more evident than segregation. None of the 12 groupings were religiously homogeneous, and only three of the 12 clique groupings were racially homogenous, all three were of size 3 (3, 8, 9). Gang members are only present in 3 of the 12 groupings (3, 7, 12). In fact, many gang members (4 of 12) are not part of a grouping. We also notice a grouping pattern around prison tenure. Two subgroups (8 and 9) had less than 2 years of prison tenure, which may have resulted from entering the unit near the same time (a cohort effect).

A benefit of the CPM is it allows us to investigate overlaps between subgroups and answer questions about the types of inmates most likely to span groups. The CPM identified 19 individuals who belong to multiple subgroups, including two inmates who are members of three different subgroups. These group brokers were predominantly White (68%), 40 years old on average, with relatively long average prison tenure of 7.25 years. All religions were represented among brokers, with 58% either of them reporting being either Catholic or Protestant. In addition, the 19 brokers were present across all Louvain groups, without exception (see the last row of Table 3).

In combination, these results support the notion of a successful incorporation of a vast majority of inmates into the social realm of the unit. The Louvain approach illuminates the broader clusters of association while the CPM helps uncover the finer details of how this

unit is able to function together as a whole, highlighting the diverse set of subgroup brokers who maneuver between various groups and integrate the unit.

4.3 Exponential random graph models

Thus far our analyses have mirrored prior studies of prison social structure by examining basic network properties and the presence and composition of subgroups. This analysis revealed communities characterized by particular sociodemographic profiles, though these do not appear to be strict divisions. Our next question pushes the study of prison networks forward by evaluating the relative strength of association on varied attributes associated with subgroups. We are especially interested in which inmate characteristics are the most salient dimensions of association and whether their effects persist net of one another and endogenous network structure – questions that have yet to be asked with prison network data. For instance, although clustering on race is evident, it as yet unclear how much race homophily is due to direct preferences for race homophily versus associating based on attributes correlated with race (i.e., "consolidation;" Blau 1977) or amplification through network processes (Wimmer and Lewis 2010).

Given our primary interest in race/ethnicity, we estimated a number of ERGMs that, in series, allowed for finer specification of ingroup and outgroup associations. Model 1 constrained groups to have uniform homophily; Model 2 freed the homophily, indegree and outdegree parameters to allow differences by group.[6] As religion is associated with race, we followed a similar strategy across models for the measure of religion. Table 5 presents the estimated coefficients for the ERGMs. We focus our interpretation on Model 2 (for reasons noted below).

The negative *gwodegree* effect indicates that inmates with higher outdegree were less likely outside of the other effects in the model. As is typical in ERGMs of friendship networks, effects for mutuality and transitivity (*gwesp*) were significant and positive. The tendency toward reciprocity observed earlier persists even after controlling for other factors on which inmates select one another. Indeed, the estimate of close to 2 is similar in magnitude to many studies of friendship networks (e.g. Steglich et al. 2011), but lower than the average in Add Health Schools (2.83 reported in Schaefer and Simpkins 2014). In combination, the positive *gwesp* and negative *two-path* effects indicate a tendency toward triad closure and away from open triads. The *gwesp* estimate of .74 is in the same range as reported for Add Health schools of comparable size (Goodreau, Kitts and Morris 2009, fig. 4).

Of the attributes considered, all had an effect on tie likelihood, with the exceptions of offense severity and recent misconduct (omitted from models shown). Three of the attributes are fairly simple to interpret. Beginning with grade, inmates with more education had higher outdegree. The indegree and similarity effects for highest grade were not significant and, being of less theoretical interest, excluded from the final model shown. Second, the positive indegree effect for power indegree indicates that inmates nominated as being more powerful

[6]We encountered estimation errors when including all possible indegree and outdegree effects for each race and religion category. Accordingly, we estimated dyad-independence models with all indegree and outdegree effects for each attribute, then retained significant effects in the models reported.

were also named more often in the ‘get along with’ network. Third, the significant absolute difference of prison tenure effect reveals the presence of homophily. The negative coefficient indicates that dyads of inmates with larger differences in prison tenure are less likely to exhibit a tie.

For the remaining attributes, multiple terms were significant. This complicates their interpretation as the likelihood of a tie is contingent upon the joint values of ego and alter on the attribute. To help explain the remaining effects, we calculated how different combinations of ego and alter attributes contributed to the log-odds of a tie. The plots in Figure 5 can be used to compare the likelihood of different types of dyads, assuming all other modeled effects remain equal between the dyads.

Beginning with age, the predicted plots reveal a clear pattern of homophily as the darkest regions of the plot are areas where ego and alter are similar in age (Figure 5c). Ties were slightly less likely from older inmates to younger inmates (lower right), and least likely from younger to older inmates (top left). Figure 5d presents the results for unit tenure. Inmates who have been residing on the unit the longest are most likely to report getting along with one another. Newcomers to the unit are less likely to report getting along with others, and far less likely to be nominated by others in the ‘get along with’ network. As shown in Figure 5e, non-gang members were indifferent regarding their alters’ gang membership. However, gang members displayed a strong tendency toward homophily, favoring gang members versus non-gang members. This latter finding is notable in its contrast to the descriptive results presented earlier (Table 1). Whereas the ERGMs indicate homophilous preferences among gang members, the descriptive results indicated no overall homophily on gang status. It is likely that the homophilous preference of gang members was masked in the descriptive results by their relatively small group size.

We now turn our attention to race/ethnicity and religion. This model allowed homophily to vary in strength across groups and accounted for differences in indegree and outdegree by group (due to estimation problems, only significant indegree and outdegree effects were retained in the final model). The results for religion indicate a clear pattern of homophily, with the strongest levels among Catholic and Muslim inmates (Figure 5b). Though Catholics have the greatest likelihood of getting along with one another, the difference in likelihood of selecting someone of the same versus different religion is starkest for Muslim inmates. This implies that the preference for homophily is strongest among Muslim inmates, net of other model effects.

In terms of race/ethnicity, homophily is strongest among Hispanic inmates: ties between Hispanic inmates are 3.5 times more likely than ties between inmates with different racial/ethnic backgrounds (exp[2.11 – .871]). By contrast, White inmates are twice as likely (exp[.72]) and Black inmates are 1.4 times more likely (exp[.44]) to have a tie compared to inmates of different race/ethnicity. These results reveal a fair amount of heterogeneity in the strength of homophily across groups race/ethnic groups.

We now turn our focus to the results for race in Model 1, which constrained homophily to be uniform across groups. Although constraining homophily to be equal across groups masks

group differences, it has the benefit of allowing us to make some insightful comparisons. First, these coefficients can be converted into odds ratios and directly compared with the odds ratios reported in the earlier descriptive analysis (Table 1) to ascertain how much homophily is due to other selection forces captured by the ERGM. We see that odds of race/ethnic homophily decreased from 3.47 to 1.92 (exp[.652]). This decrease in magnitude comes from controlling for alternate selection effects. Such a change implies that the high levels of homophily observed in prison cannot be attributed solely to inmate preferences for homophily. Other network processes are at work, magnifying the amount of homophily that results.

Second, we can compare the level of homophily net of other modeled effects to other settings, which helps to answer the question of whether homophily is stronger in prison. Moody's (2001b) study of race/ethnic homophily across Add Health schools offers a nice comparison point as he includes schools with a wide range of race/ethnic heterogeneity. Figure 6 presents Moody's plot of school heterogeneity by the odds of same race friendships (what he terms net homophily, based on a p* model similar to the ERGM used here). We calculated corresponding statistics for the prison network and superimpose the prison on his graph. We note that the observed prison network is more heterogeneous than the majority of Add Health schools (IQV = .61). Given the observed level of heterogeneity, the prison unit displays net race homophily that falls in the middle of the school distribution. This suggests that the extent of net race homophily observed in the prison context is about the same as expected among adolescents in US middle and high schools.

4.4 Brokerage

The level of race/ethnic homophily observed on the unit is rather "normal" compared to adolescents in schools (Figure 6), and most subgroups are racially/ethnically heterogeneous. This was surprising and warrants greater attention. In particular, we ask whether some types of inmates are more likely to bridge race/ethnic groups? To investigate this in greater detail we conducted a brokerage analysis that evaluates two possibilities. First is that the presence of a number of "old heads" on the unit who have spent more time in prison, are more respected, and by nature of serving longer sentences have a greater stake in maintaining order on the unit. Such inmates are both in position to violate prison norms regarding race/ethnic segregation without negative sanctions, and incentivized to reach across racial lines in order to preserve peace. Second, we evaluate whether individuals who connect subgroups, as found in the CPM analysis, are also bridges between race/ethnic groups. This is not a competing explanation to the status argument, but rather, offers a more complete picture of who bridges race/ethnic groups. On average, brokerage frequency was 6.7, however the standard deviation of 11.8 and median of 2 both point to a highly skewed distribution. We estimated a series of negative binomial regression models to understand the complex association between power, subgroup brokerage, and race/ethnic bridging (see Table 5).

Our first step was to estimate models representing the associations between race/ethnic bridging and power (M1), subgroup brokerage (M2), and both predictors (M3). Effects are positive in each model, indicating that more powerful inmates and inmates who broker subgroups are also more likely to counter tendencies toward homophily by having ties to

inmates from multiple race/ethnic backgrounds. Model 4 introduces controls for individual attributes that may be associated with bridging and the predictors of interest. None of the added effects are significant, and the effects of interest have somewhat dipped in magnitude, but remain strong. Model 5 introduces controls for indegree and outdegree. As expected, these effects are positive, as individuals with more ties will also tend to have more bridging ties on average. However, we also find that the effects of power and subgroup brokerage decrease in magnitude, with power actually becoming negative. The results from model 5 suggest that the effects of power and subgroup brokerage may be mediated by the degree effects. That is, powerful inmates and broker inmates span race/ethnic boundaries because they have more ties within the prison unit. The negative effect for power may be evidence that such inmates have a stronger preference for homophily, but, through the role expectations of their powerful position they accumulate more diverse ties. These results weaken further in the full model specification (M6); though this is not a preferred model according to the BIC (which prefers model 5).

5. Discussion

The prison social world is a topic of longstanding interest as evidenced by a multitude of case studies and in-depth ethnographies. Our goal in this study was to offer a structural perspective on the social relations among prison inmates. Our formal network approach quantifies patterns of relations, allowing us to evaluate several themes that have emerged across studies of varied prison contexts. Moreover, given that the most recent complete network study of prison social structure was more than 40 years ago (Killworth and Bernard 1974), in the era of the civil rights movement, deindustrialization, and urban decay, we offer a contemporary snapshot of prison social relations in the era of mass incarceration.

Prior prison research has universally identified race/ethnic homophily as a principle structuring inmate relations. We observed homophily on race/ethnicity as well: each race/ethnic group displayed ingroup tendencies, with Hispanic inmates in particular clustering more than Black or White inmates. Nonetheless, homophily was not as strong as would be expected based on prior research. In fact, we observed a rather mundane level of race/ethnic homophily, similar in strength to schools with comparable racial/ethnic heterogeneity (i.e., Moody 2001b). The ERGM analysis – the first of prison inmates – allowed us to quantify the strength of homophily and how it differed across race/ethnic groups. By comparing the odds ratios for homophily to odds ratios based on the ERGM results, which controlled for alternate bases of selection, we found that much of the observed level of homophily was not solely due to direct preferences, but instead attributable to the convergence of multiple selection mechanisms that exacerbate homophily (Wimmer and Lewis 2010). Given less extreme homophily than anticipated, we investigated whether some inmates were more likely to bridge the racial divide. Our brokerage analysis indicated that it was the well-respected “old heads” who played an important role in holding the unit together by bridging race/ethnic groups.

Another theme in prior research has been the existence of prison subgroups (Killworth and Bernard 1974; MacRae 1960; Moreno 1934) including gangs (Jacobs 1977; Skarbek 2014). We also found subgroups, which ranged in size from 8–24 inmates and were differentiated

on several dimensions, including sociodemographics, criminality, prison tenure, and power. However, the subgroup structure was not exceptionally strong, as 98% of inmates belonged to a single component and several inmates were positioned as brokers between subgroups. In addition, subgroups were not nearly as differentiated by race/ethnicity and gang involvement as one might expect given the attention to gangs in recent studies (Knox 2005; Skarbek 2014). This raises the question of why there was a lack of a strong community structure within the observed prison unit? Part of the explanation likely has to do with the relatively small population of gang members on the unit (less than 7%), which is consistent with the nature of the unit as a "good behavior" unit. These inmates are likely among the most prosocial inmates in the prison.

Our results offer perspective on the nature of ties among criminally-involved individuals – whether they are socially inhibited relative to those not criminally-involved. We found that the network largely resembled networks observed among adolescents in schools, who, like inmates, spend their days confined and their interactions restricted to fellow captives. The inmates in our study had nearly as many friends as observed among adolescent students. Perhaps more surprising was that the drivers of friendship (e.g., transitivity, race/ethnic homophily) were similar to comparable school-based networks. Rates of reciprocity were lower than found in schools, suggesting perhaps that the relationships in the unit were somewhat weaker than in schools. Nonetheless, nearly all inmates had ties to other inmates, and our community detection analyses indicated that subgroups were not sharply demarcated, with most being sociodemographically heterogeneous and having multiple brokers between them. Finding a fairly well-integrated unit with virtually no isolates has implications for the social inability and social ability perspectives on criminal relationships. Long ago, Sykes (1958) argued that inmate society has the potential to swing between a Hobbesian "all-against-all" egoistic social structure toward a cohesive and stable community, thus paralleling the inability and ability models. In the unit we observed, there was considerably more evidence of the latter pattern than the former. From social learning and subcultural perspectives, this is the type of social structure that could facilitate diffusion of attitudes and behaviors consistent with group expectations and inmate social ability.

According to the *situational* model, inmate society is responsive to ecological conditions associated with prison managerial regimes, aggregate inmate demographics, and facility physical properties (Camp et al. 2003; Huebner 2003; Wooldredge et al. 2001). In some contexts inmates seem capable of forming meaningful and lasting prison relationships (Crewe 2009), while other contexts are plagued by rampant mistrust (Krutschnitt and Gartner 2005; Liebling and Arnold 2012) or the explicit disintegration of inmate interactions through institutional practices (DiIulio 1990). Thus, in pondering our findings, it is imperative to keep the nature of the particular prison unit in mind. Our observed unit is a relatively desirable place for inmates to reside, which gives prison staff leverage they can use to discourage misbehavior. This is critical for understanding the pro-social structure and in making connections with policy. This is also why caution must be used in attempting to generalize our findings to other prison settings (even within the same prison). What we can clearly say is that at least some inmates (even those who have committed serious crimes) are capable of creating and sustaining multiple peer relationships (i.e., the social ability model) and that racial partitioning or warring gangs do not dominate unit relationships, which alone

are contributions to the literature. However, we cannot say (and indeed may not expect) similar social structures and inmate relationships in general population units or other prison contexts. Further research is required to test if inmates can create cohesive social structures in contexts with more violent or gang-involved populations.

From a policy perspective, these results suggest it may be helpful in some cases to design units that enable an informal structure, as the emergent structure may foster stability and reduce active resistance of formal authority. However, success of such units may require the right composition of inmates. In the unit we observed, the ability of staff to select and retain well-behaving inmates helped foster a pro-social environment. Had a different mix of inmates been brought together, such as a greater share with violent backgrounds (Skarbek 2014), it would likely have been more difficult to build the trust necessary for relationships to develop, potentially balkanizing the unit and allocating power to highly violent inmates out of fear.

Comparing the observed prison unit to networks of adolescents in schools revealed mostly minor differences in network structure. Thus, despite the seemingly stark differences in context and composition, prison networks do not necessarily differ in structure from networks outside of prison. However, it is too early to conclude that theories developed to explain adolescent social structure can be directly applied to prisons. Several operational aspects of prisons necessarily differ from schools. For instance, an important distinction to keep in mind when comparing our unit to schools is that the unit has a rolling turnover rate of about 10–20% per month (principally due to the transfer of parolees), whereas schools have closer to a 25% turnover rate occurring once per year (due to graduation and matriculation). Additionally, new inmates in our unit are likely to be among the first to leave, creating churn at the margins. For peripheral inmates, there may be little incentive to invest in unit relationships as they are likely preparing for transfer (see Kreager et al [2016] on temporary confinement). Because new inmates enter the unit individually and not as cohorts, there is also no easy alliance based on shared condition, compared to schools where freshmen can band together for social support through common identity. It will be useful for future research to investigate how network structure evolves over time with ongoing changes in unit membership and composition. Such a longitudinal design would ideally allow for the distinction between effects of tenure in the unit versus sociodemographic and criminogenic attributes.

In sum, our results suggest that the observed prison unit consists of a fairly cohesive network, one that is driven by similar mechanisms as those found within vastly different subpopulations outside of prison, such as adolescents in schools. At the heart of the unit are two internally well-connected subgroups of inmates – “old heads” – each with a distinct race and religious profile. Groups were connected to one another through multiple brokers, thus maintaining the unit’s global integrity. The interconnected and central subgroups are likely keys to unit stability and normative influence. Groups of churning and temporary inmates at the unit’s periphery may threaten community cohesion and goals, but may also provide the greatest opportunities for pro-social peer influence.

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Highlights

- The first complete network study of prison inmates in the era of mass incarceration.
- 98% of inmates “get along with” at least one other inmate (average degree = 3.8).
- Weak subgroups that include “old heads” but no gang or race/ethnic clustering.
- Inmates who are more powerful or broker subgroups also bridge race/ethnic groups.
- The inmate network resembles friendship networks in other settings.

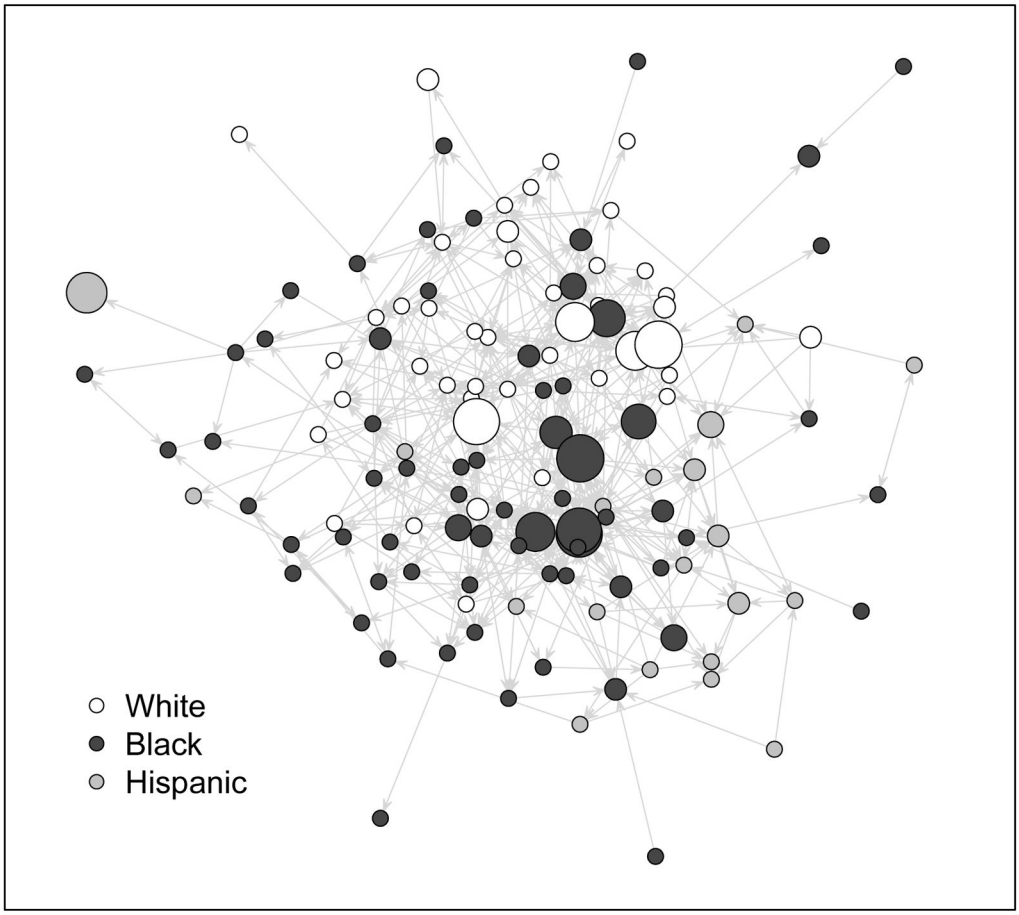

Figure 1.
Inmate "get-along with" network with nodes sized by power (N=133)

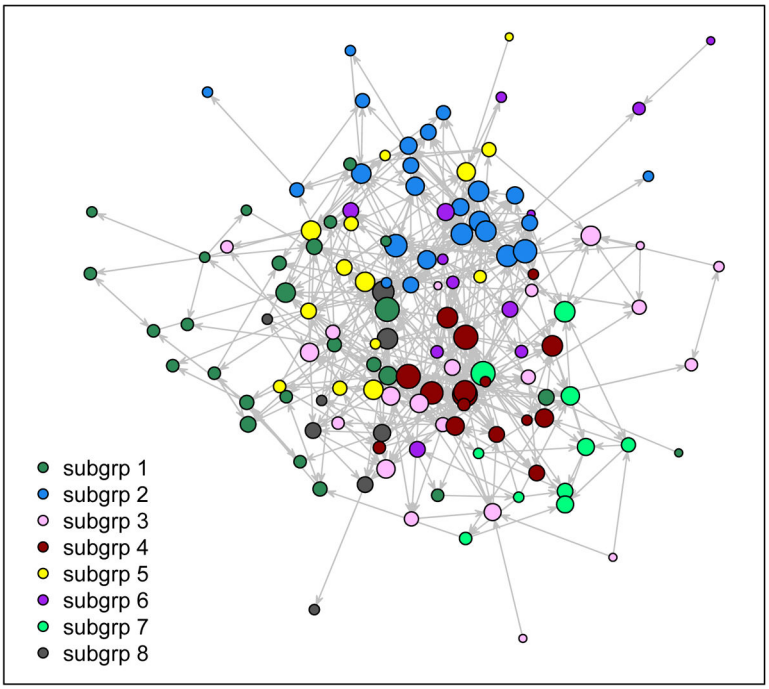

Figure 2.
Inmate get-along with network with nodes shaded by Louvain community membership and sized by indegree

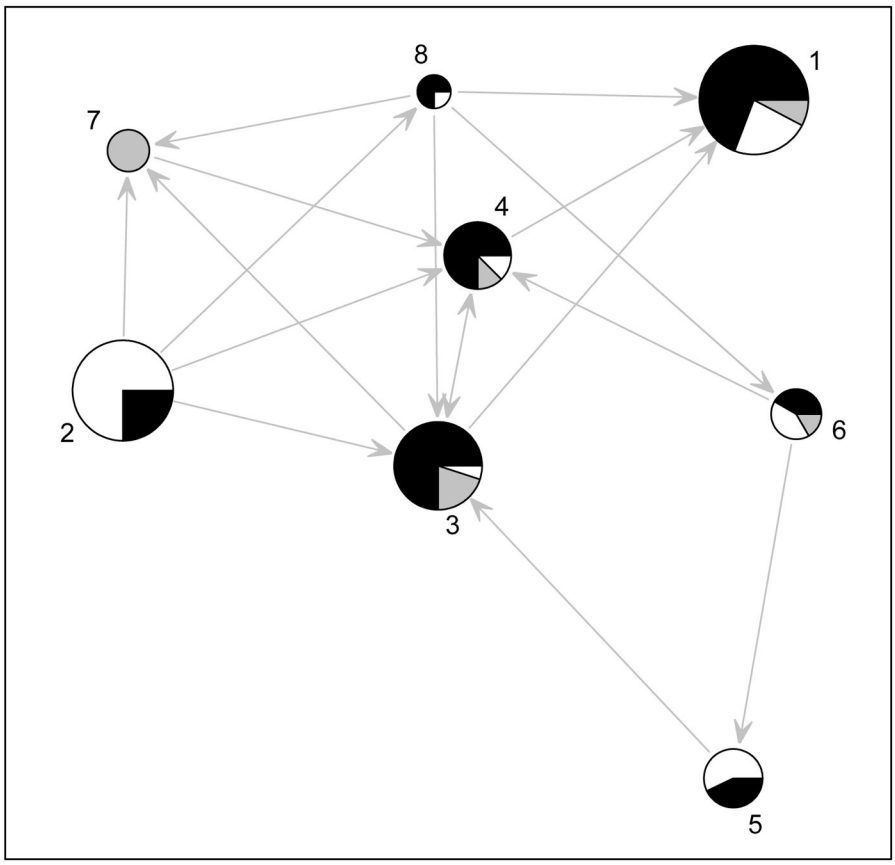

Figure 3.
Overlap and racial composition of the 8 Louvain subgroups. Nodes shaded by race/ethnic composition and sized by number of inmates in subgroup.

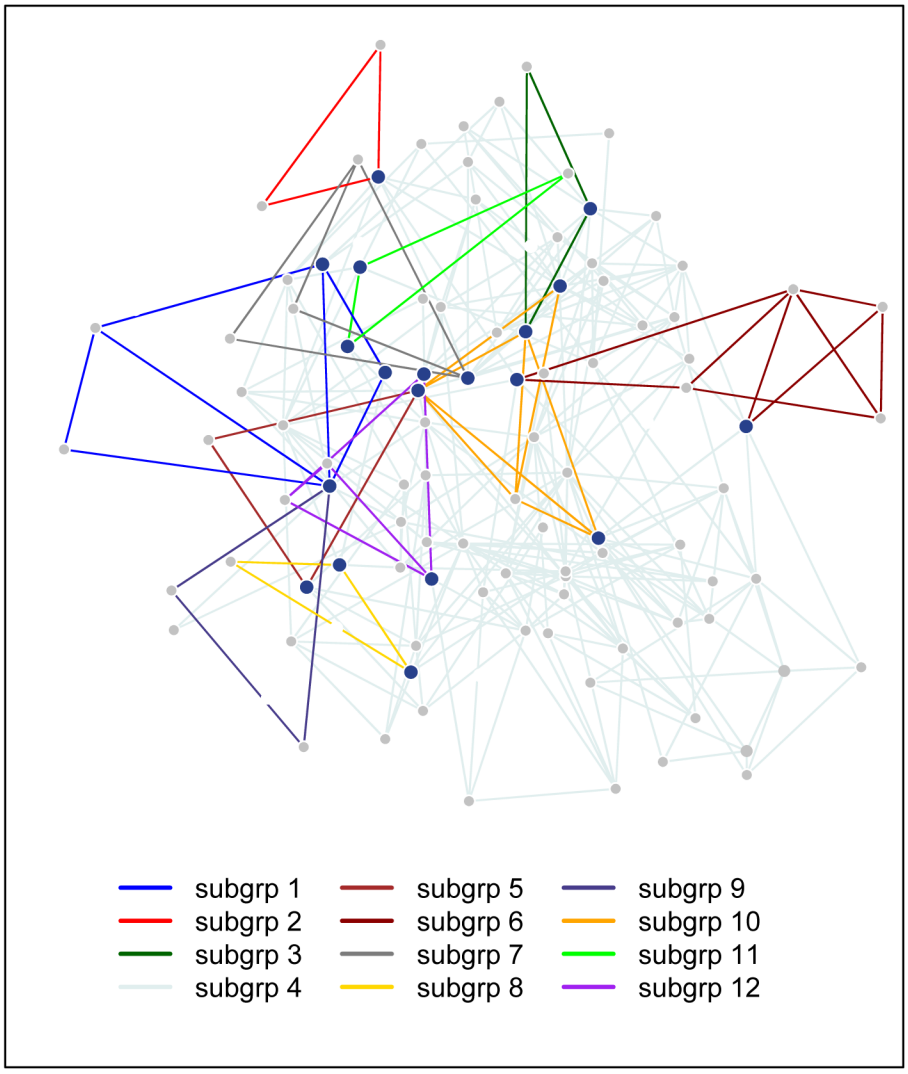

Figure 4.
Inmate get-along with network with nodes shaded by CPM community membership and edges shaded by common community membership. Dark nodes belong to multiple communities. Nodes with an unassigned community are not shown.

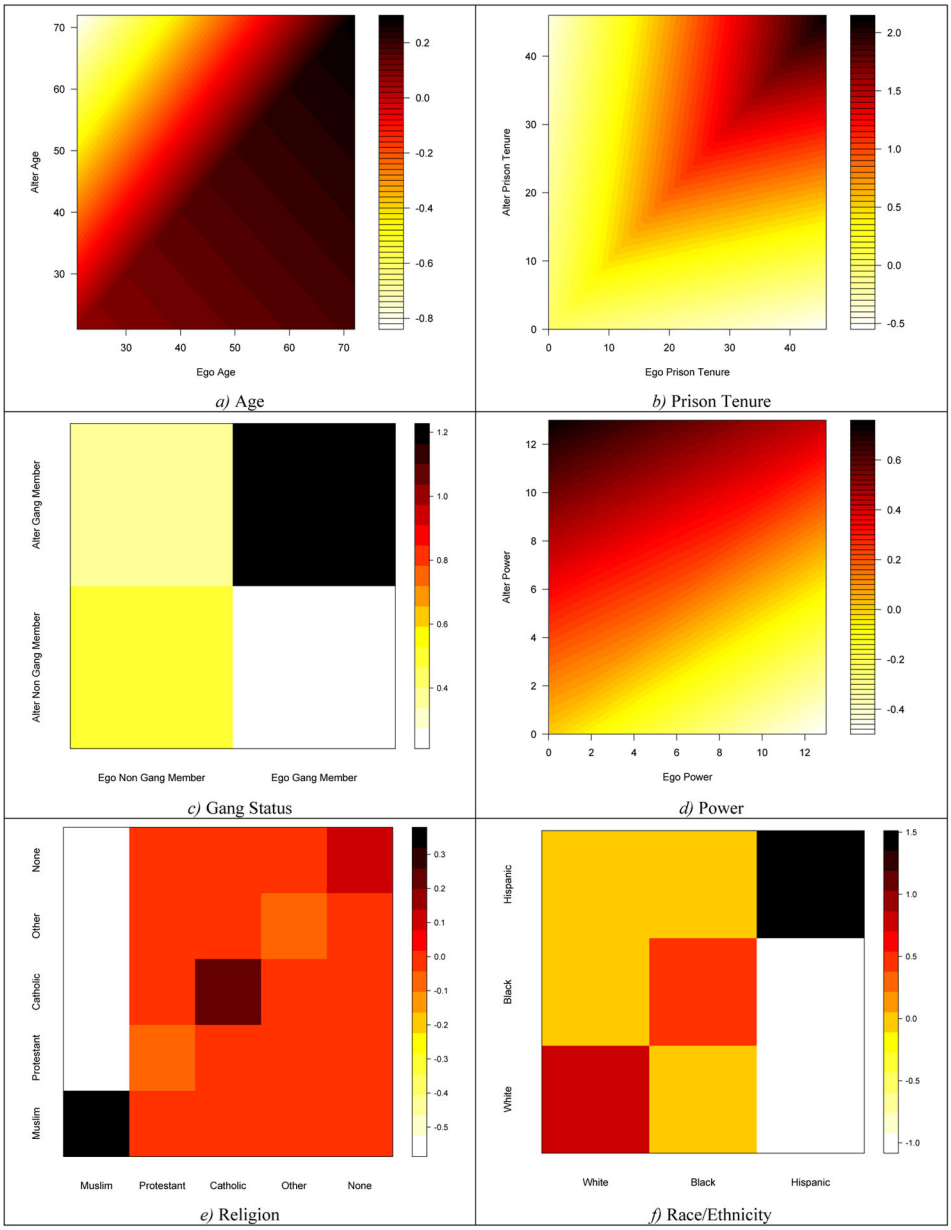

Figure 5.
Contribution to the log-odds of a tie based on joint ego and alter attributes and parameters from Model 2.

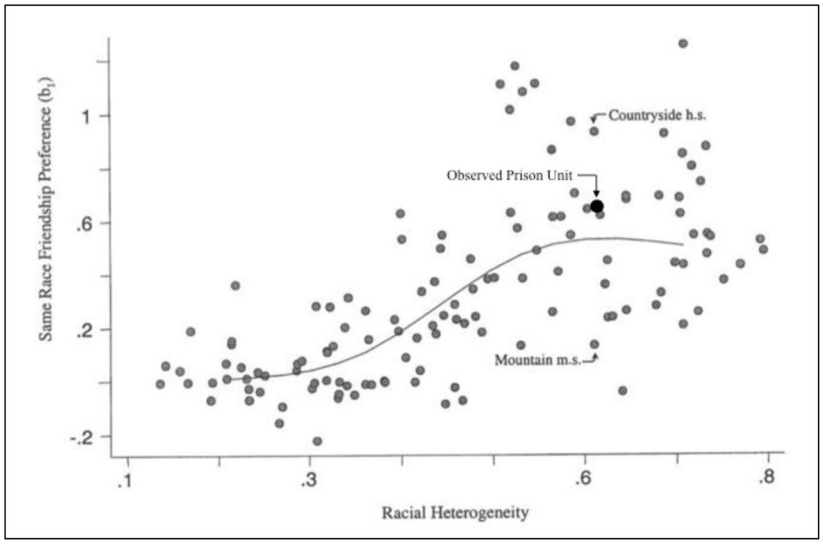

Figure 6.
Race/ethnic heterogeneity by homophily preference: Moody's school results (2001: 699) with observed prison unit superimposed

Table 1

Descriptive Statistics (N=205)

	Mean, %	SD	Indegree (M, *r*)	Homophily (OR, Moran's I)
Race				OR = 3.47***
White	38.5%		3.50	
Black	46.9%		4.06	
Hispanic	14.1%		3.83	
Religion				OR = 1.76***
Muslim	21.4%		4.25	
Catholic	18.5%		3.97	
Protestant	20.5%		4.10	
Other	24.4%		3.28	
None	15.1%		3.03	
Gang or Security Threat Group	6.8%		.11†	OR = .94
Misconduct (past 1.5yr)	29.3%		−.06	OR = 1.21***
Age	39.5	11.1	.15*	I = .30***
Highest Grade	11.2	1.6	.11	I = .06
Offense Severity	10.0	3.4	.32***	I = .14***
Years in Prison	6.0	7.2	.47***	I = .37***
Years on Unit	1.4	2.2	.40***	I = .26***
Power Indegree	.8	2.4	.57***	I = .29***

† $p < .10$;

* $p < .05$;

** $p < .01$;

*** $p < .001$ (two-tailed tests).

Table 2

Characteristics of Members in each Louvain Community, Means and Proportions (N=131)

	1	2	3	4	5	6	7	8
N	26	24	21	16	14	12	10	8
Density	.07	.15	.10	.25	.17	.09	.27	.25
Mean degree within	1.75	3.45	2.00	3.75	2.21	.99	2.43	1.75
Race								
White	.23	**.75**	.05	.13	.57	.42	.00	.25
Black	**.69**	.25	**.71**	**.75**	.43	.42	.00	**.75**
Hispanic	.08	.00	.19	.13	.00	.17	**1.00**	.00
Religion								
Muslim	.15	.00	**.48**	**.50**	.14	.17	.00	**.63**
Catholic	.15	.33	.14	.19	.07	.08	**.50**	.13
Protestant	.12	.25	.05	.13	**.36**	.17	.10	.13
Other	.27	.29	.24	.19	.21	**.50**	.30	.00
None	**.31**	.13	.10	.00	.21	.08	.10	.13
Gang or STG	**.15**	.04	.10	**.13**	**.14**	.08	.00	.00
Misconduct (past 1.5yr)	.27	.17	**.43**	.19	.14	**.42**	.10	**.88**
Age	36.69	**48.33**	31.24	41.13	41.93	38.17	37.70	31.00
Highest Grade	11.35	11.25	11.14	11.25	11.79	11.00	10.40	11.00
Offense Severity	8.96	11.63	11.05	11.75	8.79	7.67	10.00	9.38
Years in Prison	3.55	**12.94**	3.42	**10.78**	5.21	4.60	4.12	3.55
Years on Unit	.65	**4.13**	.79	**2.43**	.53	.46	1.02	.83
Power Indegree	.85	**1.63**	.19	**3.19**	.21	.50	.40	.00
Num. of CPM Brokers	2	5	2	1	4	1	2	2

Notes.

Two isolates were removed prior to running the community detection analyses Newman modularity: .43

Community 3: % does not equal 100% for race because one inmate reported being Asian (the only one in the sample).

Bold indicates characteristics of communities that notably exceeded the unit average.

Table 3

Characteristics of Members in each CPM clique grouping, Means and Proportions (N=100)

	1	2	3	4	5	6	7	8	9	10	11	12
N	4	3	3	61	3	6	4	3	3	3	3	4
Race												
White	.50	.33	1.00	.30	.67	.17	.50	1.00	0	.67	.67	.25
Black	.50	.67	0	.56	.33	.33	.50	0	1.00	0	.33	.50
Hispanic	0	0	0	.15	0	.33	0	0	0	.33	0	.25
Religion												
Muslim	.25	0	0	.31	.33	0	0	0	0	0	0	.75
Catholic	0	0	.33	.21	.33	.67	.25	.33	0	0	.33	.25
Protestant	0	.33	.33	.16	0	0	.50	0	.33	.67	.67	0
Other	.25	.67	.33	.21	0	.33	0	.33	0	.33	0	0
None	.50	0	0	.10	.33	0	.25	.33	.67	0	0	0
Gang or STG	0	0	0	.08	0	0	.25	0	0	0	0	.50
Misconduct	.25	.33	0	.25	.67	.50	0	0	.67	.33	.33	.75
Age	37.00	52.67	35.00	41.25	39.00	36.67	40.75	39.33	33.33	41.33	28.67	31.75
Highest Grade	11.50	10.33	11.67	11.21	10.67	10.17	11.75	11.67	11.00	12.33	12.00	11.00
Offense Severity	9.75	9.33	9.67	10.98	9.33	11.33	9.75	7.00	8.00	12.67	6.33	11.50
Years in Prison	3.09	7.05	7.42	9.13	4.96	4.50	6.88	1.14	1.56	10.28	2.81	6.41
Years on Unit	.96	.83	2.24	2.16	.61	1.28	4.06	.11	.19	4.15	.86	.44
Power Indegree	0	0	0	1.66	0	.50	.25	0	0	2.33	.33	.25

Table 4

Coefficients and Standard Errors from Exponential Random Graph Models (N = 205)

	b	(1) SE		b	(2) SE	
Edges	−6.045	.689	***	−5.309	.788	***
GW Indegree (α=.5)	−.119	.276		−.118	.250	
GW Outdegree (α=.25)	−1.602	.321	***	−1.751	.313	***
Mutuality	2.258	.180	***	2.167	.179	***
Two-path	−.087	.011	***	−.074	.011	***
GWESP (α=1)	.813	.056	***	.738	.056	***
Grade Outdegree	.105	.028	***	.091	.031	**
Match City	.136	.081	†	.279	.083	***
Race/Ethnicity						
Match	.652	.068	***			
Match - White				.707	.087	***
Match - Black				.302	.090	***
Match - Hispanic				2.107	.270	***
Outdegree - Hispanic				−.871	.239	***
Religion						
Match	.207	.076	**			
Match - Muslim				.788	.141	***
Match - Protestant				−.122	.156	
Match - Catholic				.403	.144	**
Match - Other				−.146	.183	
Match - None				.024	.247	
Outdegree - Muslim				−.449	.127	***
Age (log)						
Indegree	−.276	.141	†	−.241	.162	
Outdegree	.505	.129	***	.336	.143	*
Absolute Difference	−.603	.161	***	−.523	.165	**
Prison Tenure (log)						
Indegree	.028	.058		.022	.057	
Outdegree	.060	.054		.068	.051	
Absolute Difference	−.207	.052	***	−.212	.050	***
Unit Tenure (log)						
Indegree	.114	.036	**	.110	.037	**
Outdegree	.008	.034		−.010	.032	
Absolute Difference	−.104	.034	**	−.133	.038	***
Gang or STG						

	b	(1) SE	b	(2) SE
Indegree	.517	.192 **	.501	.154 **
Outdegree	.329	.183 †	.345	.153 *
Match	.507	.192 **	.559	.146 ***
Power Indegree (log)				
Indegree	.236	.061 ***	.247	.063 ***
Outdegree	−.090	.059	−.063	.067
Absolute Difference	.005	.062	−.004	.059

† $p < .10$;

* $p < .05$;

** $p < .01$;

*** $p < .001$ (two-tailed tests).

Table 5

Coefficients and Standard Errors from Negative Binomial Models Regressing Frequency of Brokerage between Race/Ethnic Groups

	b	(1) SE	b	(2) SE	b	(3) SE	b	(4) SE	b	(5) SE	b	(6) SE
Intercept	1.58	.15 ***	1.66	.15 ***	1.16	.15 ***	−3.16	2.30	−.86	.16 ***	.67	1.40
Power Indegree (log)	.58	.19 **			.75	.18 ***	.43	.23 †	−.33	.12 **	−.22	.15
CPM Broker			1.02	.38 **	1.43	.34 ***	1.32	.35 ***	.20	.19	−.06	.21
Grade							.17	.10			−.05	.07
Black							−.14	.30			−.42	.18 *
Hispanic							.32	.40			−.07	.24
Age (log)							.55	.51			−.32	.32
Prison Tenure (log)							.15	.19			.04	.12
Unit Tenure (log)							.11	.11			−.12	.06 †
Gang or STG							−.21	.44			−.20	.26
Misconduct							.47	.23 *			−.05	.14
Offense Severity							.02	.04			.02	.03
Outdegree									.22	.02 ***	.25	.02 ***
Indegree									.29	.03 ***	.28	.03 ***
BIC	742.8		748.2		727.1		762.7		614.2		652.0	

† $p < .10$;

* $p < .05$;

** $p < .01$;

*** $p < .001$ (two-tailed tests).