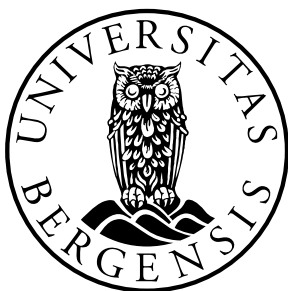


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Peer Effects in Prison



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Abstract

Peer interactions likely play an especially important role in the criminal sector due to its secretive nature and lack of formal institutions. Crucially, a large part of criminal peer exposure happens in prison, and is thus directly under the influence of policy makers and prison administrators. This paper provides a more comprehensive understanding of these prison peer effects, shedding light on how to reduce recidivism and criminal network formation through changes in the composition of inmates. Our research design causally identifies peer effects in prison using rich Norwegian register data on over 150,000 prison spells and leveraging within-prison facility variation in peers over time. We produce several novel findings. First, exposure to more experienced co-inmates increases recidivism. Second, our results underscore the role of homophily and suggests network formation rather than skill acquisition as an important mechanism. Third, exposure to “top criminals” plays a distinctive role in shaping recidivism patterns. Fourth, we provide the first explicit documentation of criminal network formation among prison co-inmates.

JEL Codes: K14, K42

Keywords: Criminal behavior, criminal experience, criminal networks, recidivism

*Preliminary version - Please do not circulate

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1 Introduction

Peer interactions likely play an especially important role in the criminal sector due to its secretive nature and lack of formal institutions. This underscores the particular importance of shedding light on these peer effects, not only for its theoretical implications for understanding criminal behavior, but also to inform practical policy decisions. Crucially, a large part of criminal peer exposure happens in prison, and is thus directly under the influence of policy makers and prison administrators. This implies that interventions targeted at peer interactions among prison inmates could make a real difference.¹

The central aim of this paper is to provide a more complete understanding of peer effects among prison inmates. More specifically, we explore how the characteristics and interactions of prison inmates influence post-incarceration recidivism, emphasizing the role of co-inmates' prior criminal experience. By exploring the heterogeneous nature of these peer effects, our findings provide actionable insights for policy makers on how future recidivism could be reduced by rearranging the group composition among prison inmates. Finally, we provide novel insights into the mechanisms through which peer effects operate in prison.

Peer effects in crime have captured the attention of scholars across several fields, including economics, sociology, and criminology. The central idea—that exposure to peers with a history of criminal behavior can increase an individual's propensity to commit crimes—traces its roots to [Bentham \(1830\)](#). He cautioned that “the indiscriminate association of prisoners”, suggesting prisons could become “schools of crime”. Empirically, the strong association between own and peer criminal behavior is documented in many studies, starting with [Glueck and Glueck \(1950\)](#). Other important studies on how peer effects shape criminal behavior include [Case and Katz \(1991\)](#); [Reiss Jr \(1988\)](#); [Glaeser et al. \(1996\)](#); [Ludwig et al. \(2001\)](#); [Jacob and Lefgren \(2003\)](#); [Kling et al. \(2005\)](#); [Ludwig and Kling \(2007\)](#); [Damm and Dustmann \(2014\)](#); [Drago and Galbiati \(2012\)](#); [Billings et al. \(2016\)](#).

¹Relatedly, studies on peer effects in the education context show that school administrators could have improved students' outcomes by reallocating students and teachers (see e.g. [Graham et al. \(2020\)](#)).

Within the literature of peer effects in crime, there is a handful of papers in economics devoted to the causal identification of peer effects among prison inmates. The seminal paper by [Bayer et al. \(2009\)](#) found evidence of peer effects that reinforce criminal behavior within crime types: Exposure to peers with experience in a particular crime type increases recidivism within this crime type, but only for inmates with prior experience in the given crime type. This pattern was found for six out of ten crime types, including burglary, larceny, assault, and drug- and sex-related crimes. While [Bayer et al. \(2009\)](#) studied juvenile inmates in Florida, [Damm and Gorinas \(2020\)](#) found similar reinforcing peer effects for young first-time offenders in Danish prisons, although smaller in size and only present for three of the seven crime types studied (drug crime, threats, and vandalism and arson). They further found that these reinforcing peer effects are increasing in the criminal experience of co-inmates. Returning to juvenile inmates in Florida, [Stevenson \(2017\)](#) compared the effect of peers' criminal experience, gang connections, and traits associated with criminal behavior (e.g. high levels of aggression) to shed more light on the underlying mechanisms of prison peer effects. She found that for inmates who were released into physically distant locations, recidivism is affected only by peers' crime-related traits, suggesting that peer effects in this setting are driven by social contagion of such traits. However, for inmates who were released into proximate locations, recidivism is indeed affected by peers' criminal experience (and gang connections), suggesting a potential role of criminal network formation.²

We provide several novel contributions relative to the existing literature. Emphasising the role of peers' criminal experience, we illuminate the potency of exposure to “top criminals”, i.e. those at the top of the criminal experience distribution. This allows us to explore popular beliefs surrounding the influence of the “kingpin” in shaping collective criminal behavior. Furthermore, we provide the first concrete evidence on the formation of criminal networks among prison inmates. While previous research all hint at the

²Other studies also suggest that spending time in prison can lead to lasting network formation. [Drago and Galbiati \(2012\)](#) use a 2006 Italian prison pardon to provide evidence that co-inmates' incentives to reoffend can affect own recidivism, while [Mastrobuoni and Rialland \(2020\)](#) find that Italian co-inmates of similar age and nationality are more likely to co-offend after release (as proxied by reoffending on the same date).

potentially important role of this mechanism in explaining the observed peer effects, none have been able to explore this mechanism explicitly. Finally, our rich and detailed data on more than 150 thousand prison spells in Norway allows for a more thorough exploration of peer effects than previously possible, which is absolutely key for informing policy makers on how to optimally allocate offenders to prisons.

To estimate prison peer effects, we adopt the research design outlined by [Bayer et al. \(2009\)](#), [Stevenson \(2017\)](#), and [Damm and Gorinas \(2020\)](#), yet we harness a vastly richer data set sourced from Norwegian administrative registers.³ To identify peer influence, we capitalize on the variability in peer composition within prison facilities over time. The identifying assumption is that—conditional on facility-by-year fixed effects—there is no systematic bias in inmates’ admissions to a given facility that would confound our results. To validate this assumption, we show that peer characteristics are conditionally orthogonal to pre-determined traits predictive of recidivism. Delving into network formation, we compare the post-incarceration co-offending of two sets of inmates who are similar except in one aspect: one set overlapped in prison, while the other did not. Similar to the first design, we here exploit the variation in peers over time within the same facility and a limited time window.

We present four key findings. First, exposure to more experienced peers (as measured by number of past arrests) increases recidivism. This is true both along the extensive margin (the likelihood of re-offending) and the intensive margin (the number of future charges). Specifically, a one SD increase in peers’ criminal experience increases the number of future charges within five years after incarceration by 6 percent. Second, our results underscore the role of homophily: the peer effect is accentuated among inmates of comparable age and origin. While this effect is also stronger for inmates with a higher level of own criminal experience, it is weaker for inmates incarcerated for the same crime type. Taken together, we interpret this as suggestive evidence on the mechanisms at play, hinting at the supremacy of network formation over skill acquisition. Third, we find that

³Our data encompass 150,000 prison spells, contrasting with previous studies that had fewer than 13,000 observations. Moreover, the linked administrative registers furnish more detailed data about each inmate and their prison spells.

exposure to “top criminals” plays a distinct role in shaping recidivism patterns, even after accounting for the average criminal experience of peers. Fourth, we document the formation of criminal networks among prison co-inmates. Overlapping with a given criminal in prison increases the likelihood of future co-offending by 38 percent. This network effects is particularly pronounced among co-inmates with shared attributes. Furthermore, the potency of this network formation is intricately linked with the prison’s characteristics.

2 Setting and data

2.1 Institutional setting

In Norway, prison is a method of punishment governed by the Penal Code. Prison sentences can range from 14 days to 30 years.⁴ All prisons in Norway are public, with the Correctional Service (“Kriminalomsorgen”) operating 56 prisons facilities in our period of study with a total inmate population of approximately 3,000 at any given time. The size of these facilities vary considerably, with capacities ranging from 10 to 392 inmates.

There are three types of prison facilities in Norway: High-security facilities, low-security facilities, and halfway houses. Inmates are allocated to these facilities based on the severity of their offense. Low-level offenders are generally placed in the low-security “open prisons”, which offer inmates the freedom of movement within the facility premises. In contrast, those convicted of more severe crimes are incarcerated in the high-security “closed prisons”. In these facilities, inmates are mostly confined to their cells, although they are permitted to spend some limited time in communal areas. Inmates who start their sentence in a high-security facility will often be transferred to a low-security facility or halfway home toward the end of their sentence with the goal of gradual reintegration into society.

A crucial aspect to consider in terms of peer interactions of inmates in the Norwegian prison system is the strict policy of housing only one inmate per cell. Therefore, the relevant measure of peers is at the prison level, not the cell level. It is important to note

⁴Evensen, Arne; Skjeggstad, Terje; Haugli, Willy; Storvik, Birgitte Langset: fengsel i Store norske leksikon. Retrieved 24.10.2023 from <https://snl.no/fengsel>.

that, at the prison level, the overall prison environment encourages frequent interactions among inmates due to the relatively small inmate population and their freedom to move around within the prison premises and engage with each other.

A cornerstone of the Norwegian prison system is inmates' engagement in activities. All inmates are mandated to partake in work, education, training, or rehabilitation programs as part of their sentencing. Approximately one-third of the inmate population enrolls in training or rehabilitation programs, while the remainder work on various tasks within the prison. Additionally, inmates have access to libraries and are entitled to daily physical exercise.⁵

Incarceration in Norwegian prisons has been found to reduce the likelihood of reoffending for criminals at the margin of being sentenced to prison as opposed to community work or a fine (Bhuller et al., 2020).

2.2 Data sources

Our analysis draws on a comprehensive range of administrative registers containing a rich set of information. To construct our prison peer groups, we use the Norwegian prison register, covering the period 1992 to 2019. This register contains individual-level data on all prison spells in Norway, including information on crime type and date, sentence length, and prison entry and exit dates. Crucially, the register also includes a facility identifier. Together with the information on the timing of the prison spells, this allows for the construction of peer groups of inmates overlapping in the same facility.

To facilitate our analysis of peer effects, we use a unique individual identifier to link the prison registers to centralized police registers that hold data on all reported crimes. This data includes information on the type, date, and location of the crime, as well as individual identifiers for those arrested or charged in relation to the crime. These data enable us to reconstruct the complete criminal record of each prison inmate, as well as post-incarceration criminal behavior.

⁵The execution of prison sentences is regulated by the Correctional Services Act, which details inmates' rights and obligations. This law also outlines the various ways a prison sentence can be implemented.

Our data contains important information not found in other data sources used in the previous literature. First, it is unique in including information of police-reported suspicions of crime, which includes arrests not leading to charges. This provides a more complete picture of criminal activity than relying solely on charge or prison data. Second, the unique individual identifier associated with each criminal case enables us to link criminal cases across multiple perpetrators. This linkage facilitates the approximation of criminal networks by identifying co-offenders who were suspected of involvement in the same criminal case. Overall, these unique features of our data offer valuable insights that are not readily available from other sources.

Finally, in order to explore the heterogeneity of prison peer effects along different dimensions of peer characteristics, we merge in supplemental information from administrative registers provided by Statistics Norway. These registers include yearly demographic information, such as sex, age, marital status, for each Norwegian resident from 1967 to 2019.

2.3 Sample construction

To ensure that we observe individuals in several years both before and after each prison spell, we restrict our baseline sample to those incarcerated between 2000 and 2010. This baseline sample includes 76,485 inmates who collectively account for 154,441 unique prison spells across 56 prison facilities. For each unique prison spell of these focal inmates, we define co-inmates as individuals who were incarcerated alongside the focal inmate for at least one day during that spell (at the same time and in the same prison facility). For all unique prison spells of the focal inmates, we then compute a weighted average of the co-inmates' characteristics. The weight assigned to each co-inmate is equal to the number of days he overlapped with the focal inmate in that unique prison spell. This leaves us with a main data set containing information on the weighted average characteristics of the co-inmates the focal inmate is exposed to in each separate unique prison spell.

Further, as we aim to investigate the role of network formation, we also construct

a secondary sample linking each focal inmate to both overlapping (those they shared prison time with) *and non-overlapping* co-inmates. In this expanded data set, the unit of observation is a unique focal inmate - co-inmate pair. This approach enables us to study whether the likelihood of co-offending among a given pair is affected by whether the pair overlapped in prison. To maintain comparability between overlapping and non-overlapping co-inmates, we restrict the pool of non-overlapping co-inmates to those who were entered the same facility as the focal inmate either four months prior to or four months following the focal inmate’s prison incarceration period.

2.4 Descriptive statistics

Table 1 provides a detailed overview of the characteristics of the focal inmates and their prison spells. Predominantly, the focal inmates are young, unmarried males, a trend consistent with broader incarceration demographics. The focal inmates in our sample also have extensive criminal records, averaging 19 arrests in the five years preceding their incarceration. The main type of crime they were incarcerated for varies, with violent crimes, property crimes, traffic offenses, and drug-related crimes each making up about 20% of all cases. Most serve short sentences, with the median prison spell served lasting one month. Due to these short durations and the frequent inmate turnover, a focal inmate overlaps with 194 peers on average. Figure 1 illustrates the spread of overlap durations, showcasing a median overlap of 20 days.

3 Empirical methodology

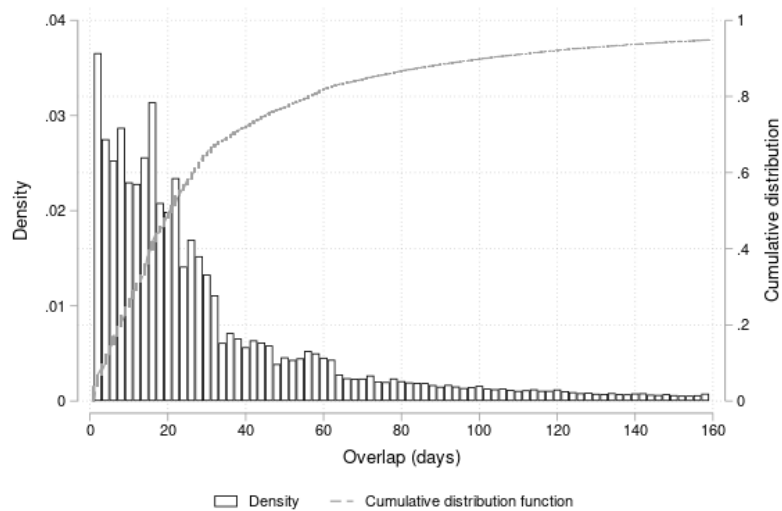
A naive regression of outcomes on peer characteristics would likely yield biased estimates due to the non-random allocation of inmates to prison facilities. To address this potential bias, our methodology exploits only the within-facility variation in peers over time. This within-facility variation in peer characteristics may still be endogenous to the focal inmate’s potential outcomes if the assignment of inmates to facilities changes over time. To circumvent this, our methodology relies only on the comparison of focal inmates who are incarcerated not only in the same facility but also at a similar time. Specifically,

Table 1: Descriptive statistics

	Focal inmate characteristics				
	mean	p10	p50	p75	sd
Age	32.4	20	30	39	10.8
Female	0.077				0.27
Married	0.091				0.29
Foreign-born	0.131				0.34
Number of charges years 1 to 5 before spell	19	1	9	26	35
Own violent crime	0.21				0.41
Own property crime	0.20				0.40
Own economic crime	0.09				0.28
Own drug crime	0.19				0.40
Own other crime	0.11				0.31
Own traffic crime	0.20				0.40
	Spell characteristics				
Prison spell length (days)	79	9	31	74	158
Number of peers	194	38	132	224	236
Observations	154441				

This table provides descriptive statistics of focal inmates in our main sample and their prison spells. The sample is restricted to prison spells that started between 2000 and 2010.

Figure 1: Distribution of the number of days of overlap



NOTE: This figure shows the distribution of number of days of overlap between the focal inmate and a co-inmate who overlapped with the focal inmate. The sample is restricted to prison spells that started between 2000 and 2010.

to identify the peer effects of co-inmates' average characteristics, we use OLS to estimate the following equation:

$$Y_{ifyc} = \beta_0 + \beta_1 P_{ifyc} + \beta_2 X_{i(s)} + \beta_3 \widetilde{X}_{j(s')} + \alpha_{fcy} + \nu_{ifyc} , \quad (1)$$

where Y_{ifyc} is the outcome for inmate i who entered prison facility f in year y for crime type c . Our coefficient of interest, β_1 , identifies the causal effect of P_{ifyc} , the weighted average of co-inmate characteristics. Importantly for the causal identification of this parameter, the equation includes facility-by-type-of-crime-by-year fixed effects, α_{fcy} . These fixed effects account both for the non-random allocation of criminals to prison facilities and for potential trends in this allocation over time which are specific to crime type or facilities. To further control for potential confounding differences between focal inmates who are exposed to differing peer characteristics, the equation includes $X_{i(s)}$, a set of pre-determined individual characteristics (i.e. age, sex, married, spell length, severity of the crime, type of crime, number of charges in the past 5 years), and $\widetilde{X}_{j(s')}$, the weighted averages of the same set of characteristics for the peers.⁶ As is standard in the literature, we cluster standard errors at the prison facility level to account for potential non-independence of individual errors for inmates within the same prison facility.

In different specifications of equation 1, we vary the outcome and peer characteristics Y_{ifyc} and P_{ifyc} . Our main outcome of interest is recidivism, measured either as the likelihood of being charged or as the number of charges within one to five years after entering prison. Our main peer characteristic of interest is criminal experience, defined as the number of prior arrests in the five years leading to incarceration. We choose to focus on criminal experience as it encompasses several dimensions that can influence peer behavior, such as age, the likelihood of reoffending, and the crime severity. Criminal experience is also easily observable to policymakers and can thus readily be used as a criteria to decide on the allocation of inmates across prisons.

⁶However, for peers we exclude the average number of charges in the past 5 years as this would be almost perfectly co-linear with our primary variable of interest, P_{ifyc} , which signifies arrests in the last five years.

3.1 Identifying assumptions

The validity of our research design is based on the identifying assumption that, within the same facility and limited time window, the timing of inmates' entry to a given facility is conditionally random. In other words, we assume that once we condition on the facility-by-type-of-crime-by-year fixed effects, there is no systematic bias in the timing of inmates' entry to a given prison facility that would confound our results. This core assumption underpins our ability to make causal claims about the influence of co-inmate peer characteristics on the focal inmates' outcomes.

To test the plausibility of this assumption, we conduct a two-step randomization check which follows the approach of [Bayer et al. \(2009\)](#): 1) In the first step, we predict the outcome of interest, e.g. the probability of being charged within five years after prison entry. For the prediction, we use the (pre-determined) characteristics of the focal inmate and the fixed effects specified in equation 1. 2) In the second step, we regress this prediction on the weighted average of the peer characteristic of interest, e.g. the number of arrests in the past five years. If the peer characteristic of interest is uncorrelated with the predicted outcome, then this two-step test provides suggestive evidence that the characteristics of the peers are conditionally orthogonal to pre-determined characteristics of the focal inmate that are predictive of recidivism.

We report the results of the second step in Table 2. The first three columns showcase that if we do not condition on any fixed effects, the weighted average of peers' criminal charges is indeed positively correlated with the focal inmate's predicted recidivism, as suspected given the sorting of inmates to facilities described in Section 2.1. However, this correlation disappears once we condition on the facility-by-year fixed effects (Columns (4) to (9))—a reassuring observation. The lack of correlation persists irrespective of the granularity of the fixed effects (whether just facility-by-year or the more granular facility-by-type-of-crime-by-year fixed effects) or the detail of prison spell and criminal history data included in the first stage of the randomization check.

Consequently, the evidence suggests that timing of inmates' entry to a given facility

is conditionally random and that our identifying assumption therefore holds. As such, we will interpret our findings as causal estimates of the peer effects of co-inmates' average characteristics on focal inmates' recidivism.

Table 2: Randomization test

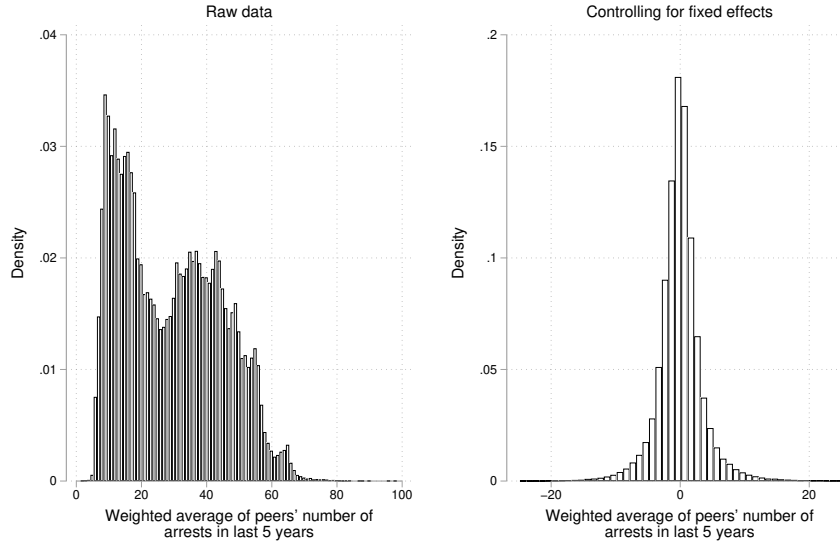
	Pr(Charged within 5 years after incarceration)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Weighted average of peers' suspected crimes in the last 5y	0.00055*** (0.00016)	0.00342*** (0.00026)	0.00236*** (0.00015)	-0.00009 (0.00010)	0.00034 (0.00026)	-0.00016 (0.00027)	-0.00011 (0.00007)	0.00009 (0.00012)	-0.00019 (0.00020)
Socio-Demographics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Current Spell Characteristics	-	Yes	Yes	-	Yes	Yes	-	Yes	Yes
Crime History	-	-	Yes	-	-	Yes	-	-	Yes
Facility-by-Year FE	-	-	-	Yes	Yes	Yes	-	-	-
Facility-by-Type-of-crime-by-Year FE	-	-	-	-	-	-	Yes	Yes	Yes
Outcome mean	0.7006	0.7031	0.7031	-0.2680	-0.3289	-0.2374	-0.2310	-0.3380	-0.2853
Observations	149541	145012	145012	149541	145012	145012	144920	144920	144920

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at the prison level in parentheses.

Sample of prison spells that started between 2000 and 2010. The probability of being charged within five years after incarceration is predicted using facility-by-year fixed effects in the first three columns, whereas the last three use facility-by-type-of-crime-by-year fixed effects. In columns (1) and (4), on top of the fixed effects, the prediction uses only socio-demographics, while current prison spell characteristics are added in columns (2) and (5), and crime history variables are further included in columns (3) and (6). The table reports the coefficients and standard errors from the regression of the predicted probability on the weighted average of peers' number of suspected crimes in the last five years.

While the inclusion of facility-by-year fixed effects in the regression model ensures that the allocation of peers is conditionally random, it also diminishes the available variation in the peers' characteristics. Figure 2 illustrates the distribution of the main peer characteristic of interest, the number of arrests in the five years leading up to incarceration. The left panel of the figure shows the raw data. Here, the density plot reveals two notable peaks, a dominant one around eight arrests and a lesser one around 40 arrests. In contrast, the right panel showcases the distribution of residuals after controlling for facility-by-type-of-crime-by-year fixed effects. Here, the distribution is centered around zero with similar tails on each side. The panel shows that, even after controlling for the most exhaustive set of fixed effects, there is still significant variation in the peers' characteristics, enabling us to identify its effect on the focal inmates' outcomes.

Figure 2: Distribution of peers' crime experience



NOTE: Sample of prison spells that started between 2000 and 2010. The left hand-side figure displays the distribution of the weighted average of peers' number of suspected crimes in the last five years. The right hand-side figure shows the distribution of the residuals of the same variable after controlling for prison-by-type-of-crime-by-year fixed effects.

4 Results

4.1 Effects of peers' criminal experience

Effect of peers' average criminal experience on recidivism. We start our analysis looking at the effect of peers' average criminal experience on focal inmates' recidivism from one to five years post-prison entry. In order to do so, we estimate equation 1 for the recidivism outcomes and with the explanatory variable of interest being the co-inmates' weighted criminal experience (average number of arrests over the preceding five years). In the following tables, we will report the coefficient, β_1 , on this first main explanatory variable of interest.

First, we look at the peer effect on the focal inmate's recidivism at the extensive margin. Here, the outcome variable is a binary indicator for whether the focal inmate has been charged with any criminal offense in a given time period after prison entry. Table 3 reports our findings. We look at both recidivism within a year of prison entry (Panel A) and within five years of prison entry (Panel B). As shown, the baseline recidivism

rates are high: 44% of focal inmates have been charged with at least one criminal offense within one year of prison entry, a rate which increases to 70% within five years after prison entry. In Column 1 of Table 3, we present the estimated β_1 from the naive specification of equation 1 which excludes the facility-by-type-of-crime-by-year fixed effects and the individual controls. As displayed, there is a strong correlation between the recidivism rates and the weighted average of peers' criminal experience. As this correlation could be driven by the non-random allocation of inmates to prison facilities, we next move to the estimates from our preferred specification, displayed in Column 2. These estimates comes from a specification which deals with the non-random allocation of inmates to prison facilities by including facility fixed effects interacted with type of crime and year of prison entry fixed effects, as well as a comprehensive set of controls for characteristics of both the focal inmate and his co-inmates.⁷ To help ease the interpretation of these causal estimates, we report in Column 3 standardized estimates from the same specification as in Column 2.⁸ Focusing on this third column, we see that a one standard-deviation increase in the weighted average of peers' criminal experience increases the likelihood of a focal inmate's recidivism within a year of prison entry by 1.4 percentage points—an increase of 3.2% relative to the baseline. Over a five-year span, this effect drops to 1.56% relative to baseline.

Next, Table 4 provides further results on the peer effect on the focal inmate's recidivism at the intensive margin. Here, the outcome variable the focal inmate's number of post-incarceration charges. Similar as above, Panel A displays the estimated effect on number of charges within one year after prison entry, while Panel B displays the estimated effect on number of charges within five years of prison entry. As in Table 3, Column 1 presents results from the naive specification, while Columns 2 and 3 present results from the preferred specification with facility fixed effects and other controls. A key take-way is the pronounced effect of peers' criminal experience on recidivism along

⁷i.e. focal inmate's age, gender, marital status, severity of the crime, spell length and number of charges in the last five years of the focal inmate, and co-inmates' average age, proportion of females, distribution of type of crime, and proportion married.

⁸In which we normalize the explanatory variable to have a mean of zero and a standard deviation of one.

the intensive margin recidivism as compared to the extensive margin. In particular, a one standard-deviation increase in peers' criminal experience causes a 10.4% increase in the focal inmate's number of charges in the short run (Panel A, column 3), and a 6% increase in the longer run (Panel B, column 3).

Table 3: Extensive margin: Effect of peers' criminal experience on probability of future charges

	(1)	(2)	(3) Standardized
Panel A: Pr(Ever charged in year 1 after prison entry)			
Weighted average of peers' suspected crimes in the last 5y	0.00863*** (0.00008)	0.00090*** (0.00031)	0.01413*** (0.00494)
Outcome mean	0.4433	0.4433	0.4433
Panel B: Pr(Ever charged in years 1 to 5 after prison entry)			
Weighted average of peers' suspected crimes in the last 5y	0.00734*** (0.00007)	0.00070*** (0.00022)	0.01108*** (0.00344)
Controls	-	Yes	Yes
Facility-by-Type-of-crime-by-Year FE	-	Yes	Yes
Outcome mean	0.7032	0.7032	0.7032
Observations	144760	144756	144756

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at the prison level in parentheses. Sample of prison spells in 2000-2010. Controls include age, gender, marital status, severity of the crime, spell length and number of charges in the last five years of the focal inmate, and controls for the average age, proportion of females, distribution of type of crime and proportion of married co-inmates.

Table 4: Intensive margin: Effect of peers' criminal experience on number of future charges

	(1)	(2)	(3) Standardized
Panel A: Number of charges in year 1 after prison entry			
Weighted average of peers' suspected crimes in the last 5y	0.09319*** (0.00186)	0.01788* (0.01060)	0.28182* (0.16700)
Outcome mean	2.704	2.704	2.704
Panel B: Number of charges in years 1 to 5 after prison entry			
Weighted average of peers' suspected crimes in the last 5y	0.39151*** (0.00502)	0.04816*** (0.01723)	0.75903*** (0.27150)
Controls	-	Yes	Yes
Facility-by-Type-of-crime-by-Year FE	-	Yes	Yes
Outcome mean	12.2421	12.2418	12.2418
Observations	144760	144756	144756

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at the prison level in parentheses.

Sample of prison spells in 2000-2010. Controls include age, gender, marital status, severity of the crime, spell length and number of charges in the last five years of the focal inmate, and controls for the average age, proportion of females, distribution of type of crime and proportion of married co-inmates.

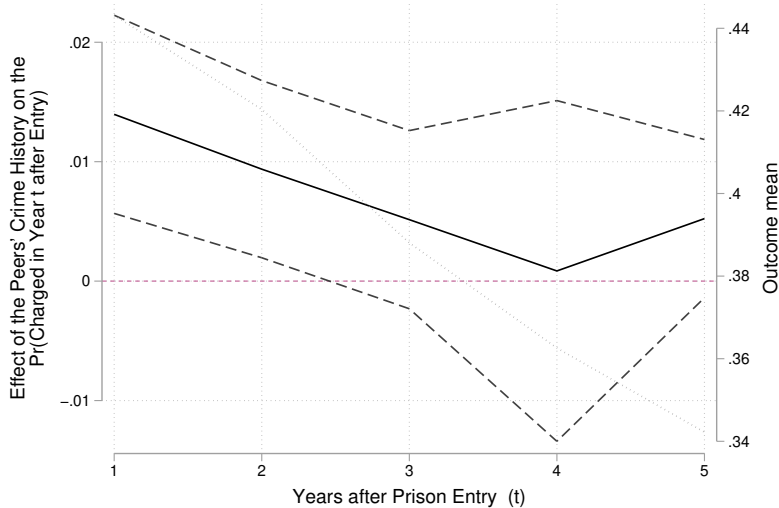
The results presented in Tables 3 and 4 indicates that the effect of peers' criminal experience on a focal inmate's recidivism fades in the longer run. To shed more light on this gradual attenuation of the effect, we illustrate the full dynamics of the effects in Figures 3 and 4. These figures report standardized β_1 coefficients and the associated 90% confidence intervals for the outcome measured each successive year from first to the fifth year post-incarceration.⁹ The results underscore the pattern suggested in Tables 3 and 4: The positive effect of peers' past criminal experience on the focal inmate's recidivism of the focal inmate declines over time, both at the extensive and intensive margins. With regards to the extensive margin, the effect on the yearly probability of being charged is statistically significant in the first two years but diminishes almost linearly over time (Figure 3). With regards to the intensive margin, results follow a similar decreasing trend, except for a drop in the effect at year two (Figure 4). This pattern of a declining effect is consistent with the idea that the influence of co-inmate peers weakens as time

⁹In the estimation of these yearly effects, we have used the same specification as in Columns 3 of Tables 3 and 4.

goes by and the focal inmate meets new peers.¹⁰

Our findings offer additional perspective to prior studies examining prison peer effects in different contexts. For example, both Bayer et al. (2009) and Damm and Gorinas (2020), employing similar research designs to ours, investigated how exposure to co-inmates with matching convictions—specifically drug crimes—affects recidivism. Their results indicate that, for focal inmates convicted of drug crimes, a one-standard-deviation increase in the exposure to drug-crime peers increases drug-related recidivism by 10.5% in the U.S. Bayer et al. (2009) and 1.3% Denmark Damm and Gorinas (2020). Our research diverges by examining the impact of peers’ overall criminal experience rather than the specific nature of their crimes. Still, our finding of a 3.2% increase in the likelihood of reoffending within a year seems in line with these prior findings. However, when comparing our findings, it is worth noting that drug crimes might inherently have stronger peer effects due potential skill transmission and networking.

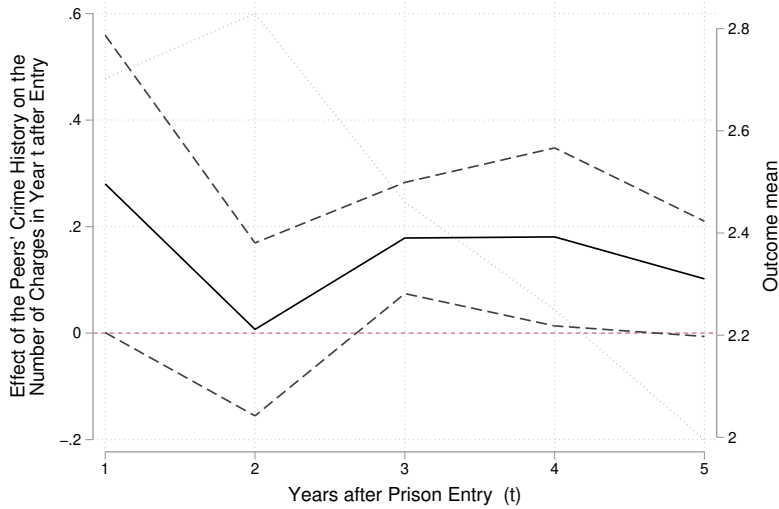
Figure 3: Extensive margin: Effect of peers’ criminal experience on probability of future charges



NOTE: Sample of prison spells that started between 2000 and 2010. The black solid line depicts the β_1 coefficients from the estimation of Eq. 1 on the probability of being charged each year, with the corresponding 90% confidence intervals in black dashed line. Standardized independent variable. The light gray line corresponds to the outcome mean each year.

¹⁰The corresponding effects on cumulative outcomes are shown in Figures 7 and 8 in Appendix A. Consistent with the yearly estimates, the cumulative effect increases in the first year after incarceration and remains fairly stable over time in absolute terms.

Figure 4: Intensive margin: Effect of peers' criminal experience on number of future charges



NOTE: Sample of prison spells that started between 2000 and 2010. The black solid line depicts the β_1 coefficients from the estimation of Eq. 1 on the number of charges each year, with the corresponding 90% confidence intervals in black dashed line. Standardized independent variable. The light gray line corresponds to the outcome mean each year.

Non-linear effects. We have shown that exposure to prison peers with more extensive criminal experience increases recidivism. We now further investigate whether this effect of average criminal experience is non-proportionally driven by exposure to the most experienced peers, i.e. the "top criminals". We hypothesize that if holding peers' average criminal experience fixed, being exposed to a few top criminals could increase recidivism more than exposure to a homogeneous peer group with mid-level criminal experience. This notion is especially relevant in Norway, where smaller prison sizes mean inmates are likely to interact with everyone. In this context, a single highly experienced criminal might be able to establish connections to all other inmates and transmit criminal skills to all.

To test the effect of exposure to top criminals, we compute alternative measures of peers' characteristics which identify whether a focal inmate is exposed to co-inmate belonging to the top 10% or top 1% of criminal experience.¹¹ Table 5 reports the effect of being

¹¹Our definition of top criminals is based on the distribution of criminal experience across all years and facilities, reflecting interactions with Norway's most experienced criminals during the studied period. While we could have used the distribution within a specific facility (and year)—assessing exposure relative to contemporaneous co-inmates—such a metric holds less relevance when the goal is recidivism reduction via strategic inmate allocation.

incarcerated with these top criminals on the likelihood of re-offense (extensive margin) within five years after incarceration. Column 1 of Panel A reproduces our main estimate of the effect of the weighted average of peers' suspected crimes in the last five years. Meanwhile, Columns 2 and 3 of Panel A report estimates of the effect of being exposed to a top 10% or top 1% criminal, respectively. Notably, exposure to a top 1% criminal increases likelihood of re-offending within five years by around 1%. The estimate for exposure to a top 10% criminal is similar in magnitude but not statistically significant. When defining exposure to top criminals as the total days of exposure to a top criminal, the effect of stays positive and is statistically significant for both top 10% and top 1% criminals (see Columns 4 and 5).

To delve deeper into the role of top criminals in shaping the observed peer effects, we also report results in Panel B from a specification that explicitly tests for whether exposure to top criminals has a distinct effect, even when controlling for the average level of peers' criminal experience. The findings show that, even when accounting for the weighted average of peers' criminal experience, exposure to a top criminal still increases the likelihood of recidivism.

Table 5: Effect of extreme values of peers' characteristics on Pr(Charged) within 5 years after incarceration

	Baseline	Dummy: exposed to		# days of exposure to	
		a top 10% criminal	a top 1% criminal	top 10% criminals	top 1% criminals
Panel A: Extreme values of peers' suspected crimes in the last 5y					
Extreme values	0.01108*** (0.00344)	0.00557 (0.00404)	0.00680** (0.00287)	0.00425** (0.00180)	0.00264** (0.00121)
Panel B: Extreme values of peers' suspected crimes in the last 5y controlling for the average					
Extreme values	-	0.00411 (0.00416)	0.00573* (0.00289)	0.00429** (0.00179)	0.00268** (0.00120)
Weighted average	-	0.00068*** (0.00022)	0.00064*** (0.00022)	0.00071*** (0.00021)	0.00071*** (0.00021)
Controls	Yes	Yes	Yes	Yes	Yes
Facility-by-Type-of-crime-by-Year FE	Yes	Yes	Yes	Yes	Yes
Outcome mean	0.7032	0.7032	0.7032	0.7032	0.7032
Observations	144756	144753	144753	144756	144756

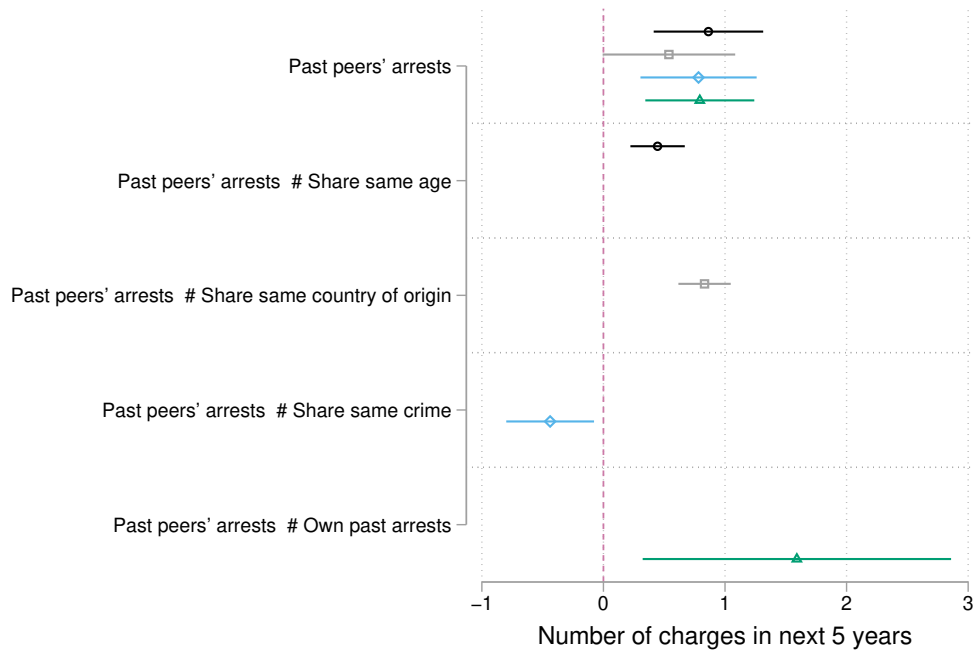
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered at the prison level in parentheses.

This table reports the coefficients measuring the effect of different measure of peers' criminal experience on the probability that the focal inmate is charged within 5 years after incarceration. Continuous independent variables (columns (1), (4)-(5)) are standardized.

Heterogeneity analyses. The peer effect of co-inmates' criminal experience could operate through various channels: (i) skill acquisition, if inmates learn more effectively from more experienced co-inmates; (ii) transmission of preferences and norms, particularly around risky behaviors; (iii) formation of criminal networks, reinforcing criminal behavior through e.g. increased criminal opportunities.

To illuminate the underlying mechanisms, we run a heterogeneity analysis, examining whether the effect of peers' criminal experience is stronger when peers are more similar to the focal inmate or when the focal inmate is more experienced himself. Determining the role of such heterogeneity dimensions is for pivotal policy considerations on prisoner allocation. The findings are presented in Figure 5 which displays the coefficient on peers' criminal experience as well as the coefficient on the interaction terms with various peer characteristics or the focal inmate's own criminal experience. Notably, the impact of peers' criminal experience is stronger the higher the share of peers of similar age or origin as the focal inmate, underscoring the role of homophily—peers with shared attributes tend to interact more. However, contrary to prior research, the effect of peers' criminal experience is decreasing in the share of co-inmates incarcerated for the same crime type as the focal inmate. Finally, there is a notable synergy between peers' and the focal inmate's criminal experience, suggesting that network formation outweighs skill acquisition as a driving force. This aligns with the notion that skills are predominantly crime-specific and would likely transfer between inmates with similar crime profiles but shorter criminal histories.

Figure 5: Effect of peers' crime experience on probability of future charges - by peer group



NOTE: Sample of prison spells that started between 2000 and 2010. 90% confidence intervals. Standardized independent variable. Each interaction term is examined in a separate regression which includes controls and fixed effects specified in Equation 1. Crime type classified is across six broad categories.

4.2 Network formation as a mechanism

Effect of prison overlap on future co-offending. After illuminating various channels in the previous Section, we now further investigate the important channel of network formation. Here, we compare two sets of inmates who are similar except in one aspect: one set overlapped in prison, while the other did not. Similar to the first design, we exploit the variation in peers over time within the same facility and a limited time window. This allows us to compare the outcome of one pair—the focal inmate and his peer—with the outcome of a different pair, made up of the same focal inmate and a different peer who is incarcerated in the same facility, but not at the same time as the focal inmate. The outcome we examine is co-offending, defined as the probability that the given pair is charged with the same criminal case in the future. Specifically, we leverage the pair-level

second sample¹² and estimate the following equation:

$$Y_{i(s)j(s')f} = \beta_0 + \beta_1 \text{Overlap}_{i(s)j(s')f} + \beta_2 \widetilde{X}_{j(s')} + \alpha_i(s) + \nu_{i(s)j(s')f} , \quad (2)$$

where $Y_{i(s)j(s')f}$ is a binary indicator measuring post-incarceration co-offending between focal inmate i in spell s and co-inmate j in spell s' in facility f . $\text{Overlap}_{i(s)j(s')f}$ is either a binary variable indicating at least one day of overlap between the two inmates or a continuous variable tallying days of overlap (including 0). $\widetilde{X}_{j(s')}$ controls for the peer characteristics. We exclude peers who had common charges in the 5 years prior to incarceration to avoid factoring in pre-existing networks.

Table 6 reports the β_1 coefficients from Equation 2. The results clearly indicate network effects of prison, as overlapping in prison significantly increases likelihood of co-offending within the next five years. The effect is robust to the inclusion of spell fixed effects, even when interacted with the type of crime of the peer. Given that the co-offending likelihood is assessed at the pair level and is inherently low, the actual values of these coefficients might seem diminutive. Yet, when viewed in relative terms, a prison overlap increases the chance of co-offending by 38%— in the most demanding specification.

¹²The construction of the second sample is described in subsection 2.3. Because this dataset is structured at the pair level, we can—and do—include spell fixed effects in this analysis.

Table 6: Probability of having a common charge in year 1 to 5 after incarceration (dummy)

	Co-offence in years t to t+5			
Overlap (dummy)=1	0.000118*** (0.000003)	0.000080*** (0.000004)	0.000064*** (0.000010)	0.000062*** (0.000010)
Relative effect (%)	76%	47%	39%	38%
Controls	-	Yes	Yes	Yes
Spell FE	-	-	Yes	-
Peer's type of crime FE	-	-	Yes	-
Spell-by-Peer's type of crime FE	-	-	-	Yes
Peer's entry month FE	-	-	-	Yes
Outcome mean	0.000156	0.000172	0.000164	0.000164
Observations	67985021	59068190	63251605	63245337

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors clustered at the prison spell level in parentheses. Sample of prison spells that started between 2000 and 2010. This table reports the coefficients measuring the effect of the spending some time in prison (dummy variable) with an inmate on the probability of having a common charge within 5 years after incarceration. The regression is run at the pair level.

To validate the results from this network analysis, we run a similar randomization test as in the first analysis. Here, we predict the probability of having a joint charge within five years of prison entry, using the age, sex, marital status, month of prison entry and crime severity of the peer, as well as spell fixed effects. We then regress this prediction on the two different definitions of $Overlap_{i(s)j(s')f}$. Reassuringly, overlapping with a given co-inmate is uncorrelated with the predicted probability of post-incarceration co-offending, as shown in Table 7.

Table 7: Randomization test

	Predicted Pr(Common charge within 1 year)			
Number of days of overlap	2.17e-09 (1.67e-09)		1.72e-09 (1.71e-09)	
Overlap (dummy)		1.46e-07 (1.10e-07)		1.22e-07 (1.09e-07)
	Predicted Pr(Common charge within 5 years)			
Number of days of overlap	2.60e-10 (4.74e-09)		-4.76e-10 (4.89e-09)	
Overlap		2.18e-07 (2.99e-07)		1.84e-07 (2.99e-07)
Controls	Yes	Yes	Yes	Yes
Spell FE	-	-	Yes	Yes
Peer's type of crime FE	-	-	Yes	Yes
Spell-by-Peer's type of crime FE	Yes	Yes	-	-
Peer's entry month FE	Yes	Yes	Yes	Yes
Outcome mean				
Observations	47850327	47850327	47857905	47857905

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors clustered at the facility level in parentheses.

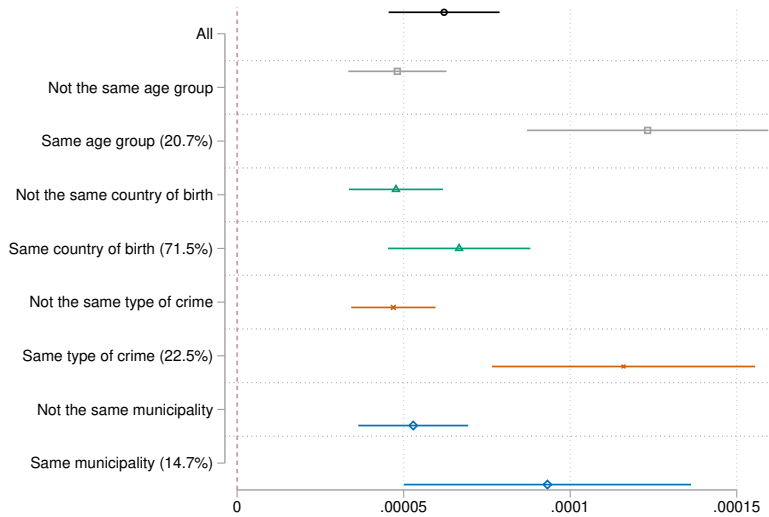
Sample of prison spells that started between 2000 and 2010. This table reports the coefficients measuring the relationship between the predicted probability of two peers offending together within one year and the number of days of overlap in the same facility (columns 1 and 3) or a dummy equal to one if there is any overlap in the same facility (columns 2 and 4). Columns 1 and 2 include spell-by-peer's-type-of-crime fixed effects, and columns 3 and 4 include non-interacted spell and peers' type of crime fixed effects. All columns include peer's month of entry fixed effects. The probability is predicted using the same fixed effects and the age, sex, marital status and crime's severity of the peer. We exclude inmates who had a common charge in the past 5 years.

Heterogeneity analyses. To shed further light on the observed network formation in prison, we explore the heterogeneity of the co-offending effect. As seen for the effect of criminal experience on recidivism, we might expect homophily to play a role in the formation of criminal networks. Further, if the prison environment strengthens criminal networks above and beyond what might occur outside the prison walls, then even pairs likely to interact outside (due to shared traits) should show enhanced co-offending rates from their time overlapping in prison.

To illuminate these points, we categorize different peer groups based on shared characteristics that between inmate pairs. Figure 6 reports the β_1 coefficients from the estimation of Eq. 2 on the likelihood of co-offending for each group separately. The findings confirm the role of homophily—for all considered characteristics (i.e. age, country of birth, type of crime and municipality of residence), the network formation is stronger among in-

mate pairs with shared attributes (although some confidence intervals overlap). In terms of network formation in prison above and beyond what might occur on the outside, note that we still find a positive effect for inmates from the same municipality even though they might naturally interact outside prison. This underscores the role of prisons in fostering criminal networks.

Figure 6: Heterogeneity: Effect of peers' criminal experience on the Pr(Ever being charged in year 1 to 5 after prison) by peer group



NOTE: Sample of prison spells that started between 2000 and 2010. The Figure reports the β_1 coefficients from the estimation of Eq. 2 on the probability of cooffending within five years after prison entry on each group separately. The share of each group in the sample is reporter in parentheses. 90% confidence intervals.

To understand if prison facilities characteristics modify the network formation effect, we estimate Eq. 2 separately for each of the 56 prisons facilities in the sample. We then compare (see Table 8) the characteristics of the facilities where the estimated network formation effect was in the top 10% of the overall distribution to the characteristics of the remaining facilities. Prisons with more pronounced network formation effects are significantly more likely to be open and smaller in size. This likely indicates that such environments encourage more inmate interactions, supporting our premise that the observed effects arise from peer interactions. Furthermore, the network formation effect is stronger in prison facilities with a higher average index of crime severity. This suggests

that inmates involved in more serious crimes may exert a greater influence on their peers.

Table 8: Characteristics of prisons with a high vs. low network effect

	Top10	Rest of the distribution	(1) - (2)
Closed prison	0.200	0.588	-0.388* (0.231)
Prison size	571.400	2972.235	-2400.835* (1338.324)
Share of violent offenders	0.253	0.240	0.013 (0.037)
Prison average severity of crimes	131.110	114.511	16.599* (9.469)

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses.

This table reports summary statistics comparing prisons where the effect of overlapping on cooffending is large versus prisons where the effect of overlapping is smaller. Prison size is measured using the total number of spells in each prison over the period.

All in all, our findings is consistent with a scenario where certain prison characteristics foster the development of criminal networks. Such insights offer valuable information for prison design aiming to curb the expansion of these networks. However, while our analysis suggests that smaller and open prisons are more prone to a high network effect, we recognize the potential positive impacts these very traits might have in other areas. For instance, in the Norwegian setting, research by [Bhuller et al. \(2021\)](#) suggests open prisons could be beneficial for inmates' mental well-being.

5 Conclusion

The secretive nature of the criminal sector, coupled with the lack of formal structures, underscores the importance of understanding peer interactions within this domain. In this paper, we provide novel documentation of how peer effects among prison inmates shapes post-incarceration recidivism. Exploiting the within-facility variation in peers over time, we show that prison peers' criminal experience increases the likelihood and extent of post-incarceration recidivism. This effect is stronger for co-inmates of similar age and origin, and for co-inmates with higher levels of own criminal experience. The effect is weaker for co-inmates who were incarcerated who the same type of crime. In addition to

exploring the effect of peers' average criminal experience, we also document the distinct role of 'top criminals' in shaping collective recidivism patterns. Finally, speaking to the underlying mechanisms of the observed prison peer effects, we confirm the hypotheses of earlier studies by providing the first unequivocal evidence of criminal network formation among prison co-inmates.

The evidence we show presents a promising opportunity for policy makers to curtail future recidivism. Our findings on the role of homophily and heterogeneity in the observed effects suggests that changes in the prison inmate composition has the potential to significantly reduce crime rates with all its related broader societal implications. Implementing such changes, however, requires a careful balancing act, taking into account other impacts of the prison system inmates' welfare and future outcomes.

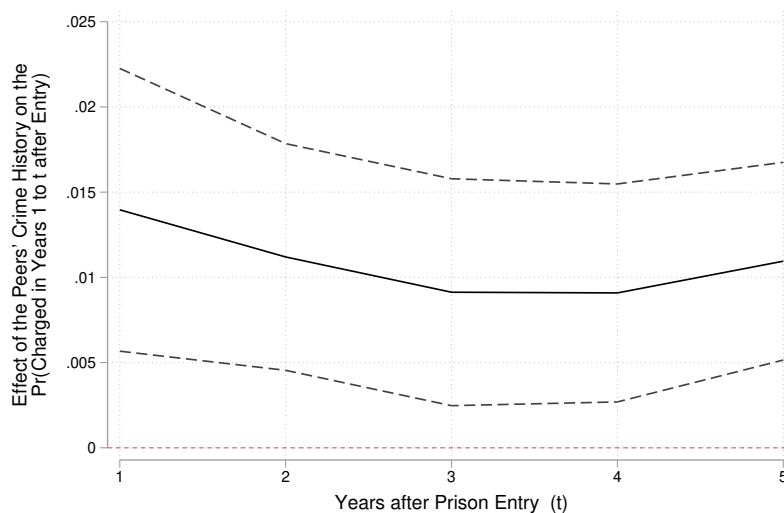
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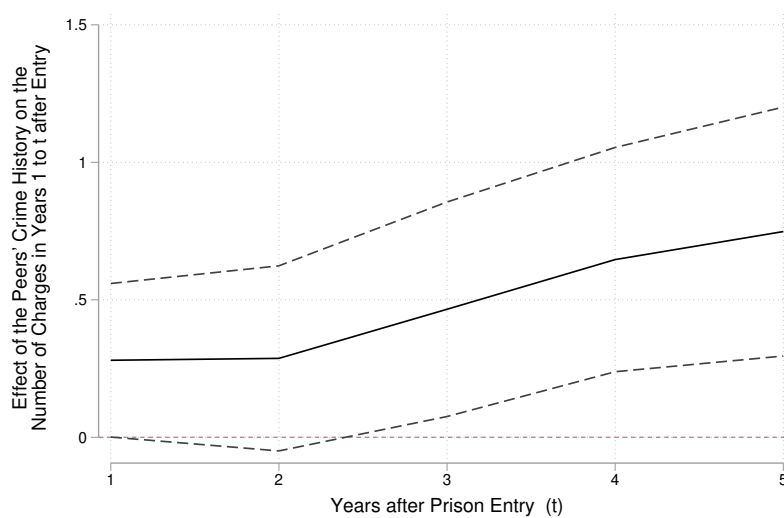
A Additional Tables and Figures

Figure 7: Extensive margin: Effect of peers' criminal experience on probability of future charges



NOTE: Sample of prison spells that started between 2000 and 2010. 90% confidence intervals. Standardized independent variable.

Figure 8: Intensive margin: Effect of peers' criminal experience on number of future charges



NOTE: Sample of prison spells that started between 2000 and 2010. 90% confidence intervals. Standardized independent variable.