

CRIME EXCHANGE - METRICS TO EVALUATE GROUP SIZES AND CRIME RATES

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ABSTRACT

Differences in crime rates are among the central symptoms of challenges related to the social integration of racial/ethnic groups in both the US and in the EU. In this paper, we contribute to the literature on the racial/ethnic patterning of crime by adding a focus on victimization. We develop metrics to analyze the amount of “crime exchange” that occurs both within and between racial/ethnic groups, and we apply these metrics to Danish administrative data on all perpetrators and victims in cases of violence in Denmark in 2001-2015. Results show that although there are large differences between the offense rates of the groups, higher minority offense rates do not materialize as substantially higher victimization risks for the majority population. In fact, the overarching conclusion from our benchmarking exercise is that excess minority criminality is predominantly an in-group phenomenon, causing substantially higher victimization rates among the minority group itself. The trends in the crime exchanges during 2001–2015 indicate, however, that social integration (in terms of violent crimes) increases over this period.

INTRODUCTION

Concern over racial/ethnic patterns of crime permeates public debate in both the US and the EU, and public opinion as well as policy makers are not shy to address the issue. Research generally confirms the concern, as racial/ethnic differences in crime rates are found to be substantial (e.g., Andersen and Tranæs 2011 in Denmark; FBI 2016 in the US), although studies also show that taking into account compositional differences between racial/ethnic groups on factors that are also important for crime risks tends to lower or even statistically explain away racial/ethnic disparities in crime (e.g., Andersen, Holtmark, and Mohn 2017; Andersen and Tranæs 2011).

Existing studies, however, almost exclusively focus on crime rates and thus inevitably on the racial/ethnic patterning of perpetrators. But in crime there are victims too. In this paper, we add a victimization perspective to the literature on the racial/ethnic disparities in crime. To do so, we develop metrics aimed at evaluating how the observed number of perpetrators, victims, and perpetrator-victim pairs relate to the numbers we should expect statistically if rates were to reflect relative population sizes and if all perpetrators chose their victims at random. The idea is, when we focus only on perpetrator and victim rates with our general metric, to compare relative crime rates to relative group sizes. This measure provides knowledge on the behavior in each group. But taking the direction of the violence into account, our metric of crime exchange takes the relative sizes of the victims' group into account too. The idea is that when a perpetrator selects his or her victim at random, then the risk that the victim is of majority background is much larger than the victim being of minority background, simply because there are many more potential victims from the majority group to choose from. The resulting metrics allow us to *a)* evaluate what the higher/lower crime rate of a numerically smaller minority group implies for the overall (population level) victimization risk, and *b)* evaluate whether specific combinations of perpetrators and victims

(as defined from race/ethnicity) occur to a larger or smaller degree than group sizes and differences in crime rates would suggest.

The metrics that we develop in this paper provide important demographic knowledge on the impact of differences in population sizes and crime rates on the overall victimization risk and provide detailed knowledge on the nature of the crime exchange that occurs within and between groups. We thus make an important contribution to this literature, just as criminologists and criminal justice researchers can use the metrics that we promote to better grasp the race/ethnicity and crime nexus.

Empirically, we apply the metrics to administrative data from Denmark. Denmark is an ideal case for applying our metrics of crime exchange because here, a numerically small (around 8 percent of the population, Statistics Denmark 2017) group of ethnic minorities of non-Western backgrounds have much higher crime rates than the ethnic majority group, native Danes. By showing the number of perpetrators (panel a) and victims (panel b) of violent crimes by 10,000 and by ethnic backgrounds in 2001-2015, Figure 1 underlines the phenomenon in Denmark. From the figure, it is obvious that people of ethnic minority backgrounds have much higher violent crime rates than natives. There were almost 70 perpetrators per 10,000 of ethnic minority backgrounds in 2001. The corresponding number for native Danes was less than 30. The rate decreases for both groups over the observation period, consistent with a general crime drop over the period, yet also in 2015, the minority group's rate was close to double that of native Danes'. The victimization rates are, however, much more similar, implying that there could be substantial crime exchange occurring across the ethnic groups. Victimization rates decrease from around 30 per 10,000 in 2001 to 20 per 10,000 in 2015.

[Insert Figure 1 about here]

The case of Denmark also has the advantage that Statistics Denmark offers full population administrative data for research purposes. We thus have access to official police and court data on all filed cases of violence in the country during 2001-2015. Unique case numbers allow us to match perpetrators and victims on each case. And because the data can be linked to other registries, such as the population registry, we are able to observe the ethnicity of perpetrators and victims in each of these cases, something we require to estimate our metric of crime exchange.

Figure 2 shows the overall distribution of perpetrator-victim pairs by ethnic backgrounds in all solved cases of violence in Denmark during 2001-2015. The figure shows four important findings. First, there is a general decrease in (solved) violent crimes over the period, which is consistent with the crime drop that occurred more broadly over this period in Denmark. Second, although minority perpetrator rates are high, as was shown above, by far most violence in Denmark is committed by the majority population of native Danes and is directed at their own ethnic group (around 75 percent). Third, cases with victims of minority backgrounds are uncommon and constitute around 10 percent of cases. Fourth, a large proportion (around 70 percent) of the violence that people of ethnic minority backgrounds are convicted of is directed at native Danes. Whereas the latter two findings from Figure 2 at a first glance seem to support populist claims about the directionality of the violence of ethnic minorities, a demographic view on the numbers presented in the figure deem it necessary to evaluate the findings against the relative sizes of the groups. The observed pattern could, for example, also be driven by the relative sizes of the different groups within the pool of potential victims.

[Insert Figure 2 about here]

The main ambition of this paper is to quantify the patterns observed in Figure 2 and relate those to the statistically expected patterns if all perpetrators chose their victims at random (i.e. without discriminating by the ethnic background of the victim). This exercise, as will be clear throughout the paper, will document the importance of population sizes for how we should evaluate the nature of minority groups having higher or lower crime rates than the majority population.

The next section describes our conceptual model of crime exchange, explains a few basic assumptions of the model, and formalizes the metrics. Before presenting our empirical results, we provide more details on the Danish context and on Danish registry data and our specific dataset. Last, we discuss the implications of our findings, not only related to our metric of crime exchange and our victimization perspective on racial/ethnic disparities in crime; we also discuss what the contribution of our paper is to scholars from contexts in which it may be hard to obtain data on matched perpetrator-victim pairs by ethnic backgrounds (or some other relevant characteristic).

A CONCEPTUAL MODEL OF CRIME EXCHANGE

We add a victimization perspective to the literature on racial/ethnic disparities in crime by developing a model of crime exchange that takes into account differences between population sizes. Specifically, we establish a metric which expresses what the number of perpetrators and victims *would be* if perpetration and victimization corresponded to the relative group sizes and we establish a metric which expresses what the number of perpetrator-victim pairs *would be* if perpetrators always chose their victims at random, without attention to ethnic group membership. Comparing actually observed crime patterns with these statistically expected patterns then allow us to evaluate two margins that are important to demographers.

First, focusing on relative group sizes we evaluate the overall consequences of a smaller minority group having higher (or lower) crime rate than the majority population. If, for example, the minority group is very small, even an extraordinarily high crime rate in the group might not translate into a substantial increase in the overall crime rate, simply because the minority group is too small to substantially do so. Second, focusing on perpetrator-victim pairs we may evaluate the extent of in-group and out-group “favoritism”. We may do so from the deviation between observed rates of crime exchange and the scenario in which perpetrators choose their victims at random. Here, our metric takes into account that differences in group sizes have the idiosyncratic consequence that, for example, the risk that a victim is of majority background is much higher than the victim being of minority background, simply because there are many more potential victims from the majority group to choose from.

Whereas both metrics we advance are relevant to demographers, the importance of the latter metric is not confined to demographic research. This is because the distinction between in-group and out-group favoritism represents a fundamental yet often implicit distinction in politicized debates about ethnicity/race and crime. Arguably, a populist view of the higher crime rates among ethnic minorities more or less implicitly assumes a specific direction of the higher crime rate – that the majority population is strained by it. But whereas this may or may not be true, not taking the relative sizes of the population groups into account when discussing these crime rates and their consequences constitutes a significant flaw in the debate; if differences in population sizes may “explain away” the directionality of crime exchanges, this would render the question of in-group and out-group favoritism redundant. Likewise, if the opposite result emerges and the level of crime exchange across ethnic/racial groups exceeds what may statistically be expected from the relative group sizes, this would signal a substantial social challenge.

Basic Assumptions

A few basic assumptions permeate our metrics. First, we assume that rates of reporting (violent) crimes to the police are similar across groups, even irrespective of the group membership of the perpetrator and victim. For the victim, the group membership of the perpetrator thus should not matter for his or her tendency to report the incidence. Whereas there is no available research on ethnic disparities in crime reporting in Denmark, general victimization surveys find that just below half of victims of violence in Denmark file report to the police (Pedersen, Kyvsgaard, and Balvig 2014; in 22 percent of the unreported violence incidents the victim did not view the incident as serious enough to file a report). Second, we assume that conviction rates (conditional on report) are similar across the groups, implying that we assume high accountability in the Danish criminal justice system. Two persons of different ethnic backgrounds and who committed identical crimes should thus have identical risks of conviction. Although not directly related to the report-to-conviction ratio, this assumption is challenged by studies that document a higher rate of groundless charges (charge-to-conviction ratio), also for violent crimes, among men of ethnic minority backgrounds in Denmark (Holmberg and Kyvsgaard 2003). Third, more of a note than an assumption, in the metrics we develop in this paper, the numbers of perpetrators and victims are identical as we view criminal offenses as a closed system (all perpetrators and victims are identified, which means that we focus only on cases that are solved by the police).

Assumptions such as the ones we rely on are necessary for developing our metric of crime exchange. We do, however, fully acknowledge that supplementing our data with, for example, victimization surveys (including questions on reporting tendencies by ethnicity of

both perpetrators and victims, for example) would be fruitful future advances to investigate the credibility of the assumptions.

Comparison of Perpetrator and Victim Rates

If perpetrators (p) find their victims (v) at random, by which we mean without conditioning on (ethnic) group membership ($g=i, j$), both the statistically expected number of perpetrators (p^*) and the statistically expected number of victims (v^*) within each group would simply reflect the relative sizes of the groups:

$$p_g^* = \frac{p_i + p_j}{N} \times N_g = v_g^* = \frac{v_i + v_j}{N} \times N_g \quad \text{where } g = i, j \quad (1)$$

Comparing the observed number of perpetrators/victims (p_g or v_g) to the expected amount defined in Equation (1), by ethnic status, then shows whether the group is more ($\pi^{general} > 1$) or less ($\pi^{general} < 1$) likely to be convicted or victimized than we would expect from their relative population sizes. The metric is, for perpetrators p and for victims v :

$$\pi_{pg}^{general} = \frac{p_g}{p_g^*} \quad \text{and} \quad \pi_{vg}^{general} = \frac{v_g}{v_g^*} \quad (2)$$

The ratios defined in Equation (2) show whether fewer or more members of a group are perpetrators (or victims) than we would statistically expect from the group sizes, which is a commonplace practice for evaluating whether a population group is overrepresented in crime or not (e.g., Andersen, Holtmark, and Mohn 2017; Andersen and Tranæs 2011). Such general ratios, however, fail to provide any information regarding the “direction” of the crimes. In lack of such information the directionality of crime is left for implicit assumption, which from a research perspective is problematic.

Crime Exchange

To address the issue of directionality and explicitly focus on the consequences of differences in population sizes, we now establish ratios that consider the group membership of victims.

With two groups (i and j) there are four perpetrator-victim pairs ($i \rightarrow i$; $i \rightarrow j$; $j \rightarrow j$; $j \rightarrow i$), as crime exchange may both be an in-group or an out-group phenomenon. Again, we can use differences between the perpetrator rates and group sizes to calculate the expected number of each perpetrator-victim pair *if perpetrators find their victims at random*. Let $c_{gp \rightarrow gv}^*$ denote the expected number of cases with perpetrator from group $gp \in \{i, j\}$ and victim from group $gv \in \{i, j\}$ when victims are randomly drawn from both groups i and j :

$$c_{gp \rightarrow gv}^* = \frac{\min(N_{pg}, N_{vg}) \times (p_i + p_j)}{N_i + N_j} \quad (3)$$

The metric in Equation (3) takes into account that although the crime rates of the groups may differ, perpetrators could still select victims at random. If so, each group would be targeted by the perpetrator group's crime rate corresponding to the victim group's proportion of the total population. From the group sizes we can then obtain the expected number of cases for each pair and compare the observed number of cases ($c_{pg \rightarrow vg}$) to the statistically expected number of cases ($c_{pg \rightarrow vg}^*$) with each combination of perpetrator and victim. This exercise yields our evaluative metric of crime exchange:

$$\pi_{pg \rightarrow vg}^{exchange} = \frac{c_{pg \rightarrow vg}}{c_{pg \rightarrow vg}^*} \quad (4)$$

If perpetrators choose their victim at random, the ratio in Equation (4) would simply be one (subject to statistical error). But if a perpetrator-victim pair occurs more ($\pi_{pg \rightarrow vg}^{exchange} > 1$) or less ($\pi_{pg \rightarrow vg}^{exchange} < 1$) than random victim selection (while taking differences in group

size into account) would imply, this could have potentially important theoretical implications, and could be informative regarding the consequences of racial/ethnic patterns of crime rates.

CONTEXT AND DATA

We focus on Denmark because this country offers high quality administrative data which allow us to merge perpetrators and victims and add each person's ethnic background. As was already mentioned, such merging is required to apply our conceptual model to empirical data. Denmark is a small Scandinavian country with strong welfare state institutions and a comparatively mild penal regime (the Danish incarceration rate is around one-tenth the US incarceration rate and sentences are generally short). The distribution of offenses differs between the US and Denmark, and whereas Denmark has one of the highest rates of burglary crimes in the world, rates of violent crime is generally low. The rate of violent crimes in Denmark is 19 per 10,000 among 15 to 69-year-olds (own calculations based on data from Statistics Denmark), which may be compared to 40.4 per 10,000 in the full US population (FBI 2011). As was already mentioned, ethnic minority groups of non-Western descent constitute around 8 percent of the population (the proportion increased over our study period), and the crime rates of these groups are higher than in the majority population (Andersen and Tranæs 2011).

We focus on violent crimes for two reasons. First, in violent crimes there is necessarily some amount of interaction or exchange between the involved partners, and at the very least the perpetrator uses force on the victim. Thus, although ethnicity per se may not be precisely known to perpetrator or victim, the interaction itself deems ethnicity more relevant than in, for example, burglary, where the victim most often never meets the perpetrator, nor the other way around. Second, police clearance rates in Denmark are much higher for violent

crimes than for property crimes, and as much as 80 percent of reported violence is solved. This high rate comes with the advantage that our results are less likely to be caused by a potential ethnic patterning of police clearance rates (we are, however, not aware of any studies documenting ethnic disparities in police clearance rates in Denmark).

Data

We use high quality Danish administrative data, available from Statistics Denmark. We exploit the fact that in Denmark all residents have a unique identification number which can be used to merge information at the individual level from various registries – and unique case IDs from the National Police (reported to Statistics Denmark) that can be used to track all people involved in a criminal case along with the case’s progression through the criminal justice system (for details on Danish register data in relation to criminal justice research, see Andersen 2018). We rely only on solved cases where the perpetrator and victim are both identified in the data.

We first obtain the personal identification numbers of perpetrators and victims in all cases of violent crime which occurred during 2001-2015 and was solved by the police, using case IDs from the official charge register and the official victimization register. We focus only on cases in which the perpetrator was between 15 and 45 years of age, because large differences in the age composition of the majority and minority group could otherwise bias results substantially (see Statistics Denmark 2017 for demographic details on the groups). We then merge unto these data the ethnicity of each perpetrator and victim. As is done in previous research using Danish data (Andersen and Tranæs 2011) we adhere to the official definitions from Statistics Denmark and distinguish between ethnic Danes (“majority”) and people with non-Western immigrant backgrounds (“minority”). A person is counted as

majority if at least one of his or her parents is born in Denmark and is a citizen of Denmark. Minority is defined as everyone else, including immigrants and children of immigrant parents (even if the child is born in Denmark), that have roots in a non-Western country.¹ A total of 46,848 cases of violence adhere to our selection criteria (Figures 1 and 2 above are based on these cases too).

The distinction between majority and minority ethnic groups that we rely on for our analyses is admittedly crude, and although we follow the official definition from Statistics Denmark, the groups are likely to be very heterogenous and consist, for example, of people migrating to Denmark (or being the children of parents) from different regions of the world and for different reasons. We fully acknowledge this issue and invite future studies that focus on heterogeneity within the broad categories that we use. Here, however, we stick to the crudely defined majority and non-Western minority groups, as we wish to display the relevance and strength of our conceptual model of crime exchange while keeping the analytical setup as simple as possible.

RESULTS

The General Metric

Table 1 reports results from 2015 (which is the end point of our observation period) regarding the first metric we develop in this paper: the general metric. This metric compares observed

¹ Western countries include countries within the EU, other European countries (Andorra, Iceland, Lichtenstein, Monaco, Norway, San Marino, Switzerland and Vatican City), Canada, the US, Australia and New Zealand. Non-Western countries are any other country. If the country of origin differs for two immigrant parents, the child receives the maternal country of origin, and priority is given to birth country over citizenship country if both are known. See the official definitions here: <https://www.dst.dk/da/Statistik/dokumentation/Times/moduldata-for-befolkning-og-valg/opr-land>.

patterns of perpetrators and victims in cases of violence in Denmark for the 2,207 solved cases with 15 to 45-year-old perpetrators in 2015, and thus constitutes a figure example.

The 2,207 incidents relative to the size of the full population produces an overall rate of violent crime at 19.4 incidents per 10,000 in the population (column 6 in Table 1). Yet focusing on perpetrators (upper panel of Table 1), a substantial difference emerges by ethnic backgrounds. The perpetrator rate for people of ethnic minority backgrounds is observed as 36.1 per 10,000; for native Danes (majority) it is 17 per 10,000 (column 4). The rate for ethnic minorities is almost 1.9 times the statistical expectation if perpetrators were randomly distributed – a difference that is statistically highly significant (column 7). For the majority population, the perpetrator rate is correspondingly lower than expected, slightly more than 10 percent lower (also column 7). The difference mirrors what has been found in previous research using Danish data (and, as previous research has shown, the difference diminishes but does not disappear when controlled for background characteristics; Andersen and Tranæs 2011): people of ethnic minority backgrounds have higher rates of violent crime in 2015 than Danes of ethnic majority background.

Contrary to perpetrator rates, the lower panel of Table 1 shows that victimization is overall distributed as statistically expected across the groups. Although observed victimization rates are slightly higher for the majority population and lower for the minority population than statistical randomness would suggest, these differences are not statistically significant. Higher minority perpetrator rates thus do not materialize as substantially higher victimization risks for either population group in 2015.

Figure 3 shows the general metric that was just shown for 2015 across the entire study period, 2001-2015. Results show that the observed perpetrator rate (panel a) for the minority population is consistently higher than expected, but also that the ratio decreases quite

substantially over the observation period. In 2001, the perpetrator rate was almost 2.5 times the statistical expectation; at the end of the observation period it has decreased to below 2 (which is still a baffling overrepresentation). For the majority population of ethnic Danes, the perpetrator rate is consistently and very stable below 1.

[Insert Figure 3 about here]

Focusing on victimization rates in panel b of Figure 3 shows that the statistically insignificant ratio for people of ethnic minority backgrounds that was reported above for 2015 constitutes the endpoint of a numerically small but substantially important decrease over the years. In fact, before 2014 most observed victimization rates for this group were significantly higher than statistically expected, and during the beginning of our observation period the difference in rates was noticeable. Taken together with results for perpetrators, the general metric thus leads to a two-fold conclusion. First, although people of non-Western ethnic backgrounds are responsible for a much larger proportion of violent crimes in Denmark than the relative sizes of the groups would suggest, this overrepresentation does not translate into substantial increases to the native/majority population victimization risk. Second, over our observation period, there appears to occur an increasing alignment of perpetrator and victim rates to a scenario that reflects the relative sizes of the groups. This “integration process” (in terms of violent crime) is not complete – especially considering the still remarkably high perpetrator rate among people of ethnic minority backgrounds. But the declining ratios do seem to indicate that the challenge of the link between ethnicity and crime decreases somewhat in importance over the years. And, indeed, focusing on victimization, the gradual decrease of the general metric, and with the ratio not differing significantly from one over the last couple of years in our observation period, are good news.

The Crime Exchange Metric

Table 2 reports results from 2015 regarding the crime exchange metric. Cases in which both victim and perpetrator are of ethnic majority background make up by far most of the cases, almost 1,600 out of the total of 2,207 cases (as was also expected from Figure 2). Again, this result is expected because of the great differences in population sizes across ethnic background. But relative to the population sizes, this number is even slightly higher than what we would expect (around 6 percent higher, column 4 in Table 2).

Because there are comparatively few victims of ethnic minority backgrounds to choose from, the observed amount of cases in which both perpetrator and victim have this background is remarkably high. Just above 160 cases are recorded, yet from the size of the group we would only expect 62.1 cases. The ratio (reported in column 4) there skyrockets to 2.6, with the confidence interval covering anything between 2.3 and 2.9. Relative to the group's size, the amount of cases in which both perpetrator and victim are of ethnic minority backgrounds thus indicate a strong in-group favoritism in 2015.

Another striking result from Table 2 is that the amount of crime exchange between the ethnic groups is much lower than we would expect statistically from the group sizes. This result contradicts an assumption of out-group favoritism that nonetheless seems to permeate public debates on the topic. In fact, if crime exchange patterns were to reflect the relative group sizes in 2015, the majority population should have been exposed to almost 30 percent more violence of minority perpetrators than was the case ($\text{expected} / \text{observed} = 442.9 / 343 = 1.291$, numbers from columns 2 and 3). Likewise, the minority population should have been exposed to around 70 percent more violence committed by perpetrators with ethnic majority background.

Figure 4 shows the results from our crime exchange metric across our observation period, 2001-2015. The figure shows three important points. First, because the majority population is responsible for the vast majority of both perpetrators and victims (because the group is so large), there is very little deviation between observed and expected numbers for this group. Second, results for the other exchange types generally follow the same pattern as was just described for 2015: minority-on-minority violence occurs far more often than expected, whereas violent exchange across the groups occurs much less than expected. Third, as was also observed with the general metric, the number of cases with minority perpetrators and victims seems move in the direction of convergence with what is statistically expected over the period – although the level is still very high at the end of the period the decrease across the period is substantial. Thus, we again observe a sign of increasing integration over the period. But the ratios for out-group favoritism are consistently below one and are quite stable across the period which can hardly be interpreted as increased integration. In the case of increased integration, these ratios should narrow in on one over the period. It is thus possible that results do not signal real integration (in terms of violence) but instead in-group favoritism in combination with decreasing crime rates for the minority group.

DISCUSSION

Research on racial/ethnic crime rates has typically focused only on perpetrators, thereby neglecting the victims. In this paper we add a victimization perspective by developing metrics aimed at evaluating how the observed number of perpetrators, victims, and perpetrator-victim pairs relate to the numbers we should expect statistically if rates were to reflect relative population sizes and if all perpetrators chose their victims at random.

Our empirical results, which are based on administrative data from Denmark, show that because there are comparatively few 15 to 45-year-old people of ethnic minority backgrounds in Denmark, the much higher crime rate in this group – around twice as high as statistically expected – does not translate into substantial increases in the majority’s victimization risk. This result holds more true towards the end of our observation period (where the small increase is also statistically insignificant) and seems to be the product of a generally declining trend.

Focusing on the distribution of perpetrator-victim pairs relative to the expected distribution under statistical randomness shows very few signs of out-group favoritism (i.e. far fewer cases where perpetrator and victim do not share ethnic background than expected) and instead shows strong signs of in-group favoritism. In fact, minority-on-minority in particular and, although to a much lesser extent majority-on-majority violence is more predominant than expected.

Just like in research, public debates about the link between ethnicity/race and crime tends to also focus on the distribution of offenses, not on the impact on victimization. It is instead simply the assumption that offense patterns signal victimization patterns too. Results from this paper showcase that this assumption is incorrect. When a large proportion of the victims of the violence conducted by ethnic minorities come from the ethnic majority group this does not necessarily mean that the minority perpetrator strategically seeks out victims with whom they do not share ethnicity. It could also be the case that there simply are more victims of majority background to choose from. As we have shown in this paper, the latter seems to be true, and the amount of in-group favoritism indeed seems to be stronger than the out-group favoritism that seems to form the basis of debates.

Overall, the metric we developed in this paper contribute to research on racial/ethnic patterns of crime by establishing metrics to explicitly include victims and evaluate the joint consequences of differences in group sizes and differences in crime rates, both at the general (population) level but also at the level of exchange between population groups. Specifically, by applying both the general metric and the metric of crime exchange that we have proposed here, researchers get the chance to evaluate both the extend of different perpetrator-victim pairs and the simultaneous impact of group sizes and group crime rates on the overall population level victimization risks. At an even broader level, notice how the metrics we propose are not restricted to the study of racial/ethnic groups. In fact, our metric is general and could be applied to any type of groups and any type of interaction for as long as one can find data that links “senders” (perpetrators) to “receivers” (victims).

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Table 1. Comparison of Observed and Expected Rates of Perpetrators and Victims of Violent Crimes, by Ethnic Backgrounds. Denmark 2015.

Group	Observed		(3)	(4)	Expected		Ratios
	(1)	(2)			(5)	(6)	(7)
	Population Size	Proportion of Population	Frequency	Frequency per 10000	Frequency	Frequency per 10000	Observed / Expected
g	N_g	$\frac{N_g}{N_{total}}$	p_g or v_g	$\frac{p_g \text{ or } v_g}{N_g/10000}$	p_g^* or v_g^*	$\frac{p_g^* \text{ or } v_g^*}{N_g/10000}$	$\pi^{general}$
Perpetrators							
Majority	998391	0.877	1702	17.0	1936	19.4	0.879 [0.859–0.900]
Minority	139887	0.123	505	36.1	271	19.4	1.862 [1.715–2.009]
Total	1138278	1.000	2207	19.4	2207	19.4	
Victims							
Majority	998391	0.877	1922	19.3	1936	19.4	0.993 [0.997–1.008]
Minority	139887	0.123	285	20.4	271	19.4	1.051 [0.940–1.161]
Total	1138278	1.000	2207	19.6	2207	19.4	

Note: There were 2,207 cases of violence with identified perpetrator and victim in the data in 2015. Table compares the statistically expected perpetrator and victimization patterns to observed patterns. Columns (1)-(4) report observed population sizes and proportions and observed perpetrator or victim frequencies and rates per 10,000, respectively. Columns (5)-(6) report expected perpetrator or victim frequencies and rates per 10,000 in the case where group g 's proportion of perpetrators or victims equals group g 's proportion of the population. Column (7) reports the ratios (and corresponding 95% confidence intervals in brackets) between observed and expected perpetrator and victimization rates, and thus describe whether the group in question is more (ratio > 1) or less (ratio < 1) likely to be perpetrators and victims than one would expect relative to their population size. Standard errors (used to calculate the confidence intervals) are obtained using bootstrapping with 1000 replications.

Source: Own calculations on data from Statistics Denmark.

Table 2. Comparison of Observed and Expected Frequencies of Perpetrator–Victim Pairs of Violent Crimes. Denmark 2015.

Perpetrator	→	Victim	(1) Perpetrator's Observed Offense Rate	(2) Observed Frequency	(3) Expected Frequency	(4) Ratio
pg	→	vg	$\frac{p_{pg}}{N_{pg}/10000}$	$c_{pg \rightarrow vg}$	$c_{pg \rightarrow vg}^*$	$\pi_{pg \rightarrow vg}^{exchange}$
Majority	→	Majority	17.0	1579	1492.8	1.058 [1.043 – 1.072]
Minority	→	Minority	36.1	162	62.1	2.610 [2.283 – 2.938]
Minority	→	Majority	36.1	343	442.9	0.774 [0.729 – 0.820]
Majority	→	Minority	17.0	123	209.2	0.588 [0.485 – 0.691]
Any	→	Any	19.4	2207	2207	

Note: There were 2,207 cases of violence with identified perpetrator and victim in the data in 2015. Majority population was 998,391, minority population was 139,887, and total population was 1,138,278 in 2015. Table compares the statistically expected frequency of perpetrator–victim pairs by ethnic backgrounds to observed frequencies. Columns (1)-(2) report observed numbers, i.e. the perpetrator group's offense rate and the observed frequency of the perpetrator–victim pair in question. Column (3) reports the expected frequency of the perpetrator-victim pair in question under the assumption that perpetrators choose victims at random. Column (4) reports the ratios (and corresponding 95% confidence intervals in brackets) between observed and expected frequencies of perpetrator–victim pairs, and thus describe whether the pair in question is more (ratio > 1) or less (ratio < 1) likely to occur than one would expect relative to population sizes and under random victim selection. Standard errors (used to calculate the confidence intervals) are obtained using bootstrapping with 1000 replications.

Source: Own calculations on data from Statistics Denmark.

Figure 1. Perpetrators and Victims of Violent Crimes per 10,000 in the population, by Ethnic Backgrounds, Denmark 2001-2015.

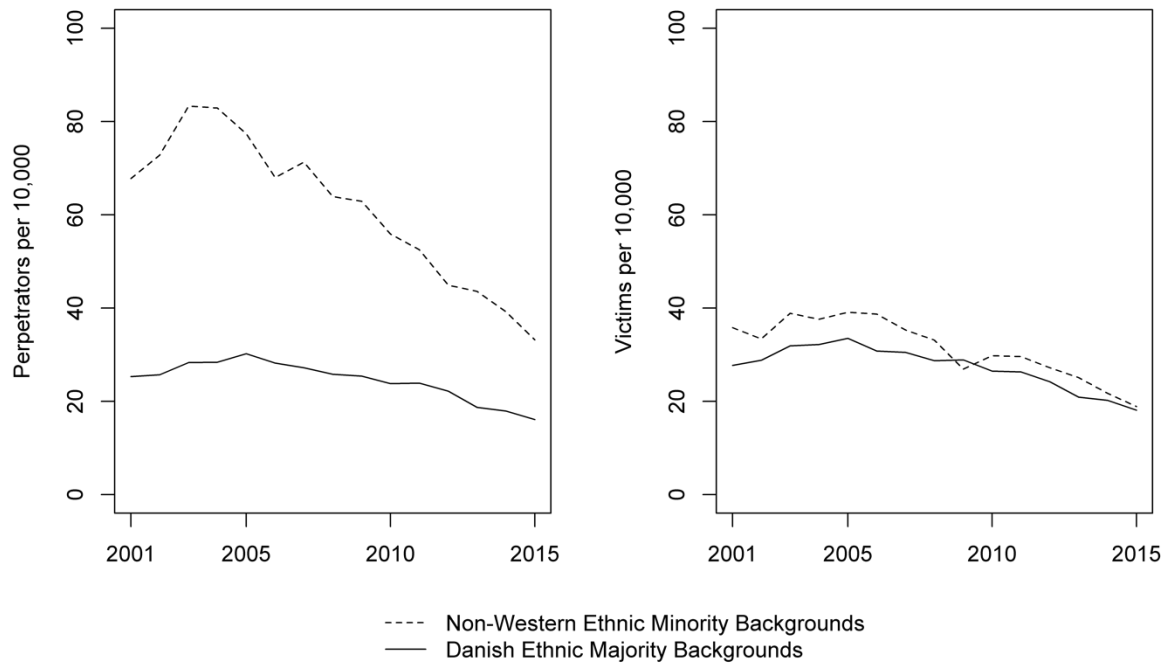


Figure 2. Number of Violent Crimes in Denmark, 2001-2015, by Ethnic Backgrounds of Perpetrators and Victims

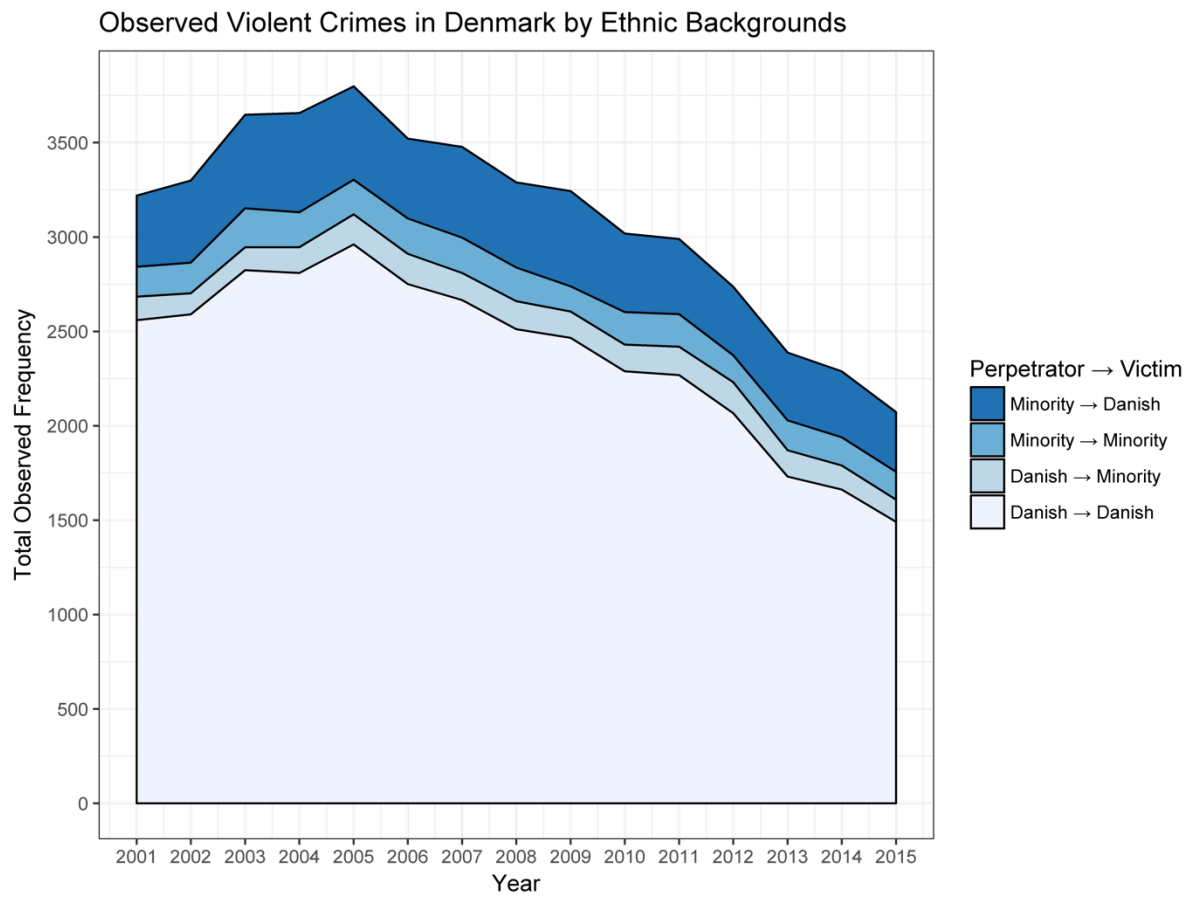


Figure 3. Ratios between Observed Frequencies of Perpetrators and Victims and Expected Frequencies if Rates Only Reflected Relative Group Sizes, by Ethnic Background, 2001-2015.

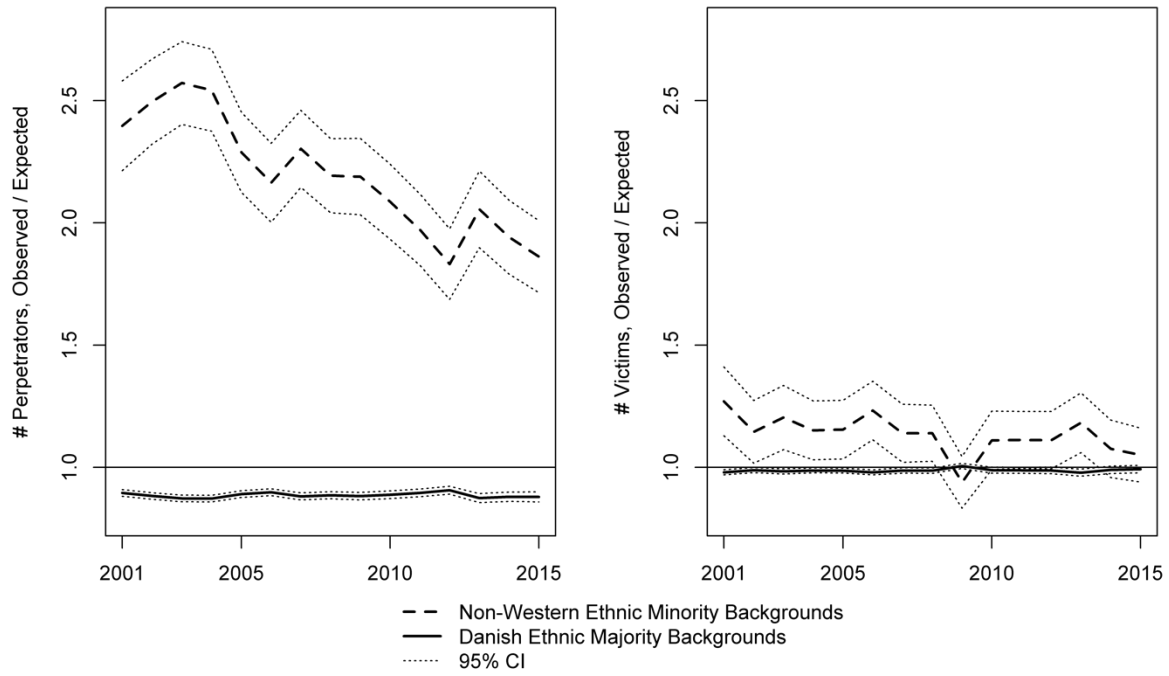


Figure 4. Ratios Between Observed Frequencies of Perpetrator-Victim Pairs and Expected Frequencies Under Assumption of Random Victim Selection, by Ethnic Backgrounds, Denmark 2001-2015.

