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WHERE POVERTY MATTERS: EXAMINING THE CROSS-NATIONAL RELATIONSHIP BETWEEN ECONOMIC DEPRIVATION AND HOMICIDE

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Recent research on the role of economic deprivation in explaining cross-national homicide rates is inconsistent. These inconsistencies may be attributed to the use of samples composed primarily of developed countries, and the implicit assumption that the impact of deprivation is constant throughout the homicide distribution. The current study challenges this assumption and suggests a dynamic relationship between deprivation and homicide. Using a broad sample of 148 countries this work applies quantile regression to examine whether inequality and poverty have consistent impacts across the entire homicide distribution. Results indicate that inequality and homicide have a universal positive relationship. In contrast, poverty is only related to homicide in countries with lower homicide rates. Findings are discussed within the context of strain theory.

Key words: homicide, economic deprivation, correlates of homicide, cross-national criminology, quantile regression

Introduction

Nearly half a million people worldwide lost their lives as the result of intentional homicide in 2012 (UNODC 2013) and recent projections suggest that fatalities resulting from homicide are expected to become one of the 20 leading causes of death globally by 2030 (World Health Organization 2010). Cross-national studies of homicide have identified a variety of factors associated with country level homicide rates. Of particular interest to scholars is the role of economic deprivation (LaFree 1999; Nivette 2011; Trent and Pridemore 2012). The majority of cross-national criminological research demonstrates a positive association between relative deprivation (i.e. economic inequality) and homicide (LaFree 1999; Messner *et al.* 2002; Wilkinson 2004; Nivette 2011). This relationship suggests that in addition to being related to a number of social problems (Wilkinson and Pickett 2011), inequality is also a key factor in explaining disparities in cross-national homicide rates (Hsieh and Pugh 1993; LaFree 1999; Wilkinson 2004). However, recent research finds the relationship between inequality and homicide is reduced when a measure of absolute deprivation (i.e. poverty) is also included in the statistical model (Pridemore 2008; 2011; Rogers and Pridemore 2013; Pare and Felson 2014). These findings raise questions about whether the strong association between economic inequality and homicide may be the result of model misspecification, in which prior research failed to account for absolute deprivation.

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Although previous research has made substantial progress in understanding the role of economic deprivation in explaining cross-national homicide rates, our knowledge regarding this relationship remains incomplete in two respects. First, existing research is often restricted to a small sample of developed nations (Messner *et al.* 2010; Pridemore 2008; 2011; Rogers and Pridemore 2013). For instance Nivette's (2011) review of 54 cross-national homicide studies finds the average and modal sample size was 44 countries. Moreover, these countries are less violent compared to the rest of the world (Stamatel 2006), meaning that they are concentrated at the lower end of a global distribution of homicides at the country level. The reliance on a sub-sample of less violent countries may lead to conclusions regarding the relationship between economic deprivation and homicide that do not generalize to countries where homicide is endemic.

In addition, prior research has relied almost exclusively on linear regression models, implicitly assuming a constant relationship between economic deprivation and homicide across all countries. We challenge this assumption and suggest strain theory would predict the relationship between both absolute and relative deprivation and homicide to differ according to the level of homicide in a country. Moreover, we propose a theoretical explanation that integrates the constructs of poverty and inequality, and suggest that the presence of absolute deprivation may also manifest as relative deprivation, particularly in countries with lower homicide rates.

We assess this proposed explanation in the current study, which examines the relationship between economic deprivation and homicide in a broad sample of 148 countries, including many countries that are not usually included in cross-national homicide research. To examine the differential effects of economic deprivation across the distribution of homicide rates, the current study uses quantile regression. In the following section, we review prior literature on the cross-national relationship of economic deprivation and homicide. We highlight the limitations of prior research and present a theoretical argument for why the association between both relative and absolute deprivation and homicide is likely to vary across the homicide distribution. Next, we describe the sample, measures and our analytic approach. We then present our main findings and conclude by discussing the implications of the results.

Deprivation and Homicide

Macro-level homicide research conceptualizes economic deprivation in both relative and absolute terms. Relative deprivation captures the extent of economic inequality within a jurisdiction and is typically operationalized using the Gini coefficient or income-ratio. Economic inequality is hypothesized to increase homicide through several theoretical mechanisms including frustration stemming from blocked opportunities to achieve culturally defined goals (LaFree 1999), reduced social control resulting from the erosion of trust among members of a society and a lower quality of community life and social relations (Wilkinson 2004), and participation in deviant subcultures (e.g. Cloward and Ohlin 1960).

Absolute deprivation represents the fraction of a population unable to afford their essential needs, and is often operationalized using poverty rates (Pridemore 2002), consumption-based measures (Deaton 2005), or proxy measures such as infant mortality rate (Pridemore 2008; 2011). The theoretical link between absolute deprivation and

homicide is less clear as several sociological theories, including social disorganization, strain, control, sub-cultural, conflict and opportunity, all claim poverty as a central element in explaining variations in crime (Pridemore 2008; 2011). For instance according to strain theory, poverty creates pressure to commit homicide by generating psychological manifestations such as powerlessness, anxiety, and anger, which can increase the likelihood of interpersonal violence when conflict arises (Williams and Flewelling 1988; Messner and Rosenfeld 1999). In contrast, social control and social disorganization theories contend that living in extreme deprivation undermines legitimacy of the law and erodes one's bonds to society (Messner and Rosenfeld 1999).

Although the association between both relative and absolute deprivation with homicide has received considerable attention at the sub-national level (Pridemore 2002), such associations are only recently being explored at the cross-national level (Pridemore 2008; 2011; Cole and Gramajo 2009; Messner *et al.* 2010; Ouimet 2012; Rogers and Pridemore 2013; Pare and Felson 2014). Cross-national homicide studies have focused almost exclusively on relative deprivation, consistently finding economic inequality to be one of the strongest predictors of homicide rates (LaFree 1999; Messner *et al.* 2002; Wilkinson 2004; Nivette 2011). However, much prior work on the relationship between economic inequality and homicide has failed to account for a proper measure of poverty (Pridemore 2008). Measures commonly used in prior research, such as the proportion of the population living on less than US$2 a day, disregard differences in cost of living, changing economic conditions, and markets (Townsend 2002). Other commonly used measures, such as the gross domestic product (GDP) or gross national product (GNP), are problematic as these measures account for development or the average well-being of a country. Indicators based on the average well-being of a country cannot be considered a good measure of poverty as they fail to describe the actual prevalence of individuals deprived of essential goods and services (Pridemore 2008; 2011). Pridemore (2008) suggests a more appropriate methodological approach is to use the infant mortality rate as proxy for absolute deprivation in cross-national research. Several recent cross-national studies using infant mortality as a proxy for poverty typically find the strong association between inequality and homicide either disappears or becomes substantially attenuated after controlling for infant mortality (Pridemore 2008; 2011; Rogers and Pridemore 2013). Moreover, Pare and Felson (2014) find a similar pattern holds for other crime types including assault, robbery, burglary and theft.

Other research suggests the relationship between economic deprivation and homicide at the cross-national level is inconsistent or may be moderated by other factors such as economic development. For instance Messner *et al.* (2010) identify inconsistencies in the strength of infant mortality as a proxy for poverty in finding that both infant mortality and relative poverty remain positive and significantly associated with homicide when both are included in the same model. Cole and Gramajo (2009), however, find infant mortality was unrelated to national levels of homicide, whereas the Gini index was slightly associated with homicide rates. Ouimet (2012) finds economic development, as measured by the UN Human Development Index (HDI), conditions the relationship between economic deprivation and homicide in a sample of 165 countries. Specifically, Ouimet finds economic inequality is strongly related to homicide for the subsample of countries with moderate HDI scores, whereas poverty is more strongly related to homicide among countries at the top of the HDI.

As a whole, these studies suggest a complex relationship between both absolute and relative deprivation and homicide. However, prior research suffers from two limitations which inhibit our ability to understand the nature of this relationship at the cross-national level. First, cross-national homicide studies that focus on economic deprivation largely rely on samples consisting primarily of relatively safe countries in the developed world. The almost exclusive focus on relatively safe countries means that we know little about whether the factors associated with homicide in safer countries are also associated with homicide in countries where homicide is more common.

While criminologists have yet to consider how the level of homicide in society might influence the relationship between various social and economic factors and homicide itself, existing literature suggests differences in factors such as economic development may moderate the relationship between deprivation and homicide (Ouimet 2012). For instance, Stamatel (2006) notes key correlates of crime, such as income inequality and infant mortality, often differ across levels of economic development. In addition, the level of homicide in the developed world is considerably lower than that in the developing world (LaFree *et al.* 2015).

Next, existing research mostly focuses on the conditional mean effect of economic deprivation on homicide. Britt (2009) notes that this approach is limited as it require making the assumption that the effect of every independent variable is constant across the entire distribution of the dependent variable. This assumption may oversimplify the complex relationship between economic conditions and homicide rates (LaFree 1999; Messner and Rosenfeld 1999; Pridemore 2002) and may explain contrasting findings in previous literature (Pridemore 2008; 2011; Cole and Gramajo 2009; Messner *et al.* 2010; Ouimet 2012). To be sure, results based solely on average differences may mask true underlying associations, especially in circumstances when an average effect is not shared by countries across the distribution of homicides and instead reflects the aggregation of opposing relationships (Beyerlein 2014). Indeed, epidemiological research demonstrates the effect of economic inequality on overall mortality rates in US counties varies throughout the distribution of mortality itself which suggests 'the global one-model-fits-all approach (i.e. OLS regression) conventionally used in the field ignores information from the entire mortality distribution and … is unable to provide a complete picture of the inequality-mortality relationship' (Yang *et al.* 2012: 1908).

Cross-national homicide research has yet to consider whether the effects of relative and absolute deprivation are consistent throughout the distribution of national homicide rates. In this study, we draw on strain theory to suggest there is reason to believe that the relationship between economic deprivation and homicide is variable according to the level of homicide in society.

Economic Deprivation, Strain and Homicide

Although criminologists have yet to consider the possible differential relationship between economic deprivation and homicide across the distribution of homicide, there is reason to believe that the effects of relative and absolute deprivation may differ across countries and that these differences are related to national levels of homicide. In this section, we describe this theoretical relationship.

Absolute deprivation

Poverty is a unique concept from economic development as it captures a group in society that often lacks basic material needs. According to strain theory, poverty or absolute deprivation, may result in homicide when people are angered and frustrated by their inability to meet basic needs (Merton 1938; Williams and Flewelling 1988). Additionally, while individuals lacking basic material needs can also pursue instrumental crimes, such crimes may escalate into interpersonal violence under high levels of strain (Ouimet 2012).

The experience of poverty and the expectations that individuals have for economic achievement, however, may differ depending on levels of public safety within a particular country. For instance, Messner *et al.* (2010: 530) suggest that infant mortality may yield independent explanatory power beyond that of relative deprivation in advanced nations 'because it captures aspects of the adverse social conditions confronting excluded, marginalized populations that are not fully reflected in any of the income-based poverty measures'. Consequently, even countries with high aggregate wealth or income levels can experience high rates of homicide when part of their population does not have access to this wealth and is deprived of essential goods and services. Thus, aggregate economic measures may not fully capture the social conditions of the most marginalized and most economically strained portions of a population.

In addition, the absolutely deprived groups in safe and highly developed countries should also feel more *relatively* deprived when compared to the most economically deprived classes in less safe countries. As the quality of life within a country improves, individuals at the bottom end of the socioeconomic distribution might upwardly revise their estimates of what constitutes economic success. Therefore, the poverty experience should become increasingly frustrating in safer countries where the overall well-being is higher and fewer individuals are subject to a life of deprivation. This social distance between ones current position and a desired position in the social hierarchy should be greater in safer countries, thus intensifying the negative psychological manifestations associated with absolute deprivation as the lower classes are 'condemned to consider the successful with bitterness and [themselves] with shame' (de Botton 2004: 5). This alternative explanation departs from the consideration of absolute and relative deprivation as being independent economic indicators (i.e. inequality vs. poverty). Instead, this explanation suggests that high levels of absolute deprivation may result in increased homicide rates in safer, highly developed countries because the most improvised group feels more relatively deprived as well.

Empirically, this suggests that the correlation between absolute deprivation and relative deprivation should be strongest in the safest countries and weaker where the homicide rate is higher. Table 1 presents the correlation between infant mortality rate and

Table 1 *Correlation between infant mortality rate and Gini coefficient by homicide rate quartile*

	Full sample	1st quartile	2nd quartile	3rd quartile	4th quartile
Pearson correlation	0.307*	0.401*	0.014	0.067	−0.044

$N = 37$ in each quartile; $N = 148$ in full sample.

*Correlation is significant at the 0.05 level (two-tailed test).

the GINI coefficient using data on countries from the World Bank, which we describe in further detail below in the Data and methods section. The results in Table 1 support the above claim as the correlation between infant mortality rate and GINI is strongest among countries with the lowest levels of homicide, and weakens as levels of homicide increase.

Based on the reasoning above, we expect absolute deprivation to be most strongly related to homicide in safer countries where absolute deprivation is most frustrating and most likely to manifest as relative deprivation as well. In contrast, the relationship between absolute deprivation and homicide is expected to be weaker in unsafe countries where larger proportions of the population live in poverty and the expectation gap between poverty and economic achievement is smallest. One might say that poverty matters, but only in the midst of plenty.

Relative deprivation

Strain theory suggests that relative deprivation leads to homicide as blocked opportunities to culturally defined goals creates anger and frustration among people. An important distinction between relative and absolute deprivation is that relative deprivation requires (1) culturally defined goals and (2) opportunities to achieve such goals. Such opportunities and cultural goals are absent from the theoretical link between absolute deprivation and homicide. This is because absolute deprivation pertains to basic, universal needs for all people and is independent of achieving culturally defined goals that may vary across societies.

One impediment to individuals achieving their culturally defined goals is the level of safety within a country. Indeed, safety is one of the most basic elements in Maslow's (1943) hierarchy of human needs and the failure to provide for this basic need complicates individuals' efforts towards meeting higher order needs such as esteem and self-actualization (Hagerty 1999). Additionally, homicide is one of the main factors impacting the quality of life within a country. Past research demonstrates that quality of life as measured by psychological well-being is inversely associated with homicide rates at the country level (Lester 1990). Similarly, contemporary indices of societal well-being (i.e. OCED Better Life Index) often account for perceptions of personal safety and national homicide rates in their formulas.

We contend that differences between countries in terms of the quality of life of its citizens can lead to differences in aspirations and expectations regarding economic success. In addition, factors that affect the quality of life within a country may also influence the amount of strain felt when failing to achieve economic success. Safety is also vital in creating opportunities that allow people to flourish and achieve culturally defined goals because people may invest time in long-term goal achievement and worry less about basic things such as their safety. High levels of homicide within a country are a signal of instability and unstable countries are less able to provide a sufficient number of these opportunities for their citizens. Therefore, it is expected that the relationship between relative deprivation and homicide will differ according to the level of homicide within a country.

Based on the above logic, we suggest that the relationship between inequality and homicide will be strongest in the most violent countries due to relatively fewer opportunities to achieve culturally defined goals. Alternatively, societies with high levels of homicide may be less able to maintain the same economic aspirations that are found

in safer countries. In this way, a country's level of safety may directly impact the culturally defined goals of a society and effectively lower economic aspirations. In less safe countries, the strain felt for failing to achieve economic success may be less prevalent as individuals are more focused on meeting their day-to-day needs than long-term economic success. Accordingly, we also suggest high levels of homicide can decrease the expectations gap by diminishing economic aspirations, thereby mitigating the relationship between economic inequality and homicide.

The current study

Our discussion above highlights that following decades of cross-national research showing a strong relationship between inequality and homicide *without* controlling for a measure of poverty, more recent research demonstrates that controlling for a proxy of poverty substantially attenuates the inequality-homicide association (Pridemore 2008; 2011; Pare and Felson 2014). However, this research relies exclusively on linear regression models and therefore implicitly assumes the relationship between economic deprivation and homicide to be constant across the full range of the global homicide distribution. We aim to build upon this body of research and hypothesize that the relationship between both relative and absolute deprivation and homicide will vary based on the level of homicide in a country. Motivated by the arguments above, we propose the use of quantile regression to examine this relationship. Specifically, we investigate the following research questions:

(1) Are both economic inequality and poverty related to homicide across different points of the homicide distribution?
(2) Is the association between both inequality and poverty and homicide constant throughout the distribution of homicide rates?
(3) If the relationship is not constant, then how does the relationship between inequality, poverty and homicide vary at different levels of homicide victimization?

Data and Methods

Data and measures

The current study examines the relationship between homicide and economic deprivation using data from 148 countries (see Appendix A for the list of countries and corresponding homicide rates). This dataset represents one of the largest and most encompassing used in cross-national homicide research (Ouimet 2012; Trent and Pridemore 2012). This study uses data between the years 2005 and 2012. This period was selected due to its recency and data availability. Cross-sectional analyses were executed using the aggregated averages across all available years for each country.

Figure 1 presents a map of the sample countries and reveals two key features of the study. First, the sample includes a large number of countries, including many located in regions (i.e. Africa, Southeast Asia) often omitted from prior cross-national homicide research. Figure 1 also depicts the clustering of homicide levels across geographic region. This relationship is particularly prominent in Western Europe where homicide rates are relatively low, and the Central Africa and Latin America regions, which have some of the highest homicide rates in the world.

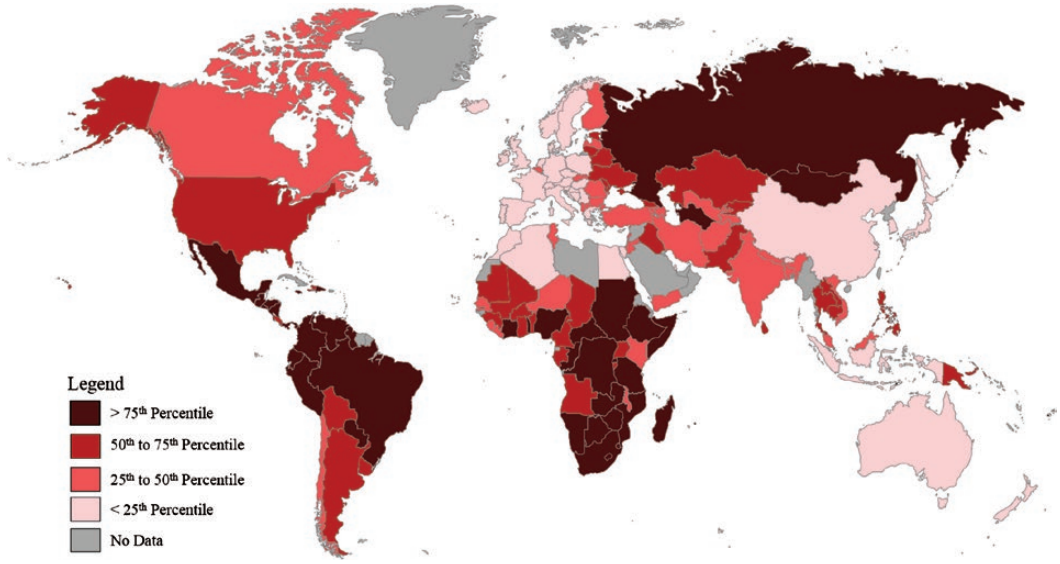

FIG. 1. Countries of the world by homicide rate quantile

Dependent variable

The dependent variable is the number of homicides per 100,000 residents according to the World Bank's World Development Indicators (WDI) database. These data were originally organized by the United Nations Office on Drugs and Crime (UNODC), and consists of a combination of vital registration data collected by the World Health Organization, and criminal justice statistics collected by the United Nations Survey on Crime Trends and the Operations of Criminal Justice Systems (WHO 2014*a*). Data from the countries and years shared in both sources are generally consistent, and the combined dataset was validated prior to its publication, with specific attention given to sudden changes in homicide over time, which were accounted for and corrected. Homicides in vital registrations are classified as such using the International Classification of Diseases (ICD), an internationally standardized instrument for the official classification of causes of death, which is sponsored by the World Health Organization and broadly used by member countries. Homicides are defined in the ICD as 'unlawful death purposely inflicted on a person by another person' (UNODC 2013: 9), which includes homicide victimizations resulting from interpersonal violence, predatory violence and killing by armed groups. This definition of homicide excludes intentional killings resulting from armed conflict committed by organized groups of up to several hundred members, such as deaths resulting from terrorism or acts of war.[1]

[1]Homicide data for 51 out of the 148 countries used in this article were obtained by WHO and UNODC with the support of statistical models used to obtain estimates for a larger number of years, and of countries than that are typically covered in previous cross-national reports and studies (WHO 2014*b*). Appendix A identifies these 51 countries with an asterisk. These model-based estimates were obtained using observed data on homicides, in addition to country-level data on economic and demographic variables that are highly predictive of homicides. We performed sensitivity analyses by excluding these 51 countries. Since the results were largely consistent with our main findings, we present the results with all 148 countries. These analyses are available upon request.

Independent variables

Consistent with prior research, the infant mortality rate is used as a measure for absolute deprivation (Pridemore 2008; 2011; Cole and Gramajo 2009; Rogers and Pridemore 2013; Pare and Felson 2014). Infant mortality is collected from the World Bank and is measured as the rate of infant deaths before reaching one year of age per 1,000 live births in a given year.[2]

Relative deprivation is measured using the Gini index according to the World Bank's WDI database (LaFree 1999; Messner *et al.* 2002; 2010). The Gini index specifies the degree to which the distribution of income or consumption expenditures among individuals or households deviates from a perfectly equal distribution. The Gini index ranges from 0 to 100, where 0 represents perfect economic equality and 100 represents perfect inequality. As data on the Gini index is missing for several countries in the WDI database, the Gini index from the Central Intelligence Agency (CIA) World Factbook was used as a supplement and the average Gini based on these two sources was used in the final analysis. This procedure added 21 countries to the sample, which otherwise would have been dropped from the analysis.[3]

Control variables

Several other variables were included as controls. *Urban ratio* is the ratio of people living in urban areas relative to those in rural areas. The measure is calculated using population estimates from the World Bank and urban ratios from the UN World Urbanization Prospects. The *ratio of population aged 15–24* is taken from the UN Population Division's World Population Prospects and measures all residents in a given population between 15 and 24 years old regardless of legal status or citizenship. This variable is coded as the ratio of those 15–24 in the population relative to all other age groups (including 0–14). *Education index* is the education component of the UN HDI. The education index is measured using a combination of the literacy rate for those 15 years and older and school enrollment rates. Both measures were collected from the UNESCO Institute for Statistics. *Sex ratio* is measured as the number of males per 100 females in the population according to the World Bank.

Descriptive statistics

Table 2 presents summary statistics for variables used in the current study. The average homicide rate is 8.56 homicides per 100,000 individuals. Overall, the homicide rate ranges from a low of 0.40 (Singapore) to a high of 67.00 (Honduras). The large variation in the homicide rates is further depicted by a standard deviation of 11.31 and differences across quartiles that range from a homicide rate of 1.60 at the 25th percentile to a rate nearly ten times higher (10.25) at the 75th percentile. Table 2 also shows large variation across countries in economic deprivation. The average Gini score is 39.20 and ranges between 24.53 and 65.77. Next, the measure of absolute deprivation (i.e. infant mortality) has an average value of 30.96 infant deaths per 1,000 live births and ranges

[2]Infant mortality and gross domestic profit per capita are significantly correlated ($r = -0.47$), and the logged variant of both variables are highly correlated ($r = -0.88$).

[3]We find a high correlation ($r = 0.89$) between the Gini index from these two sources suggesting strong reliability in combining information on the Gini index from the WDI and CIA databases into one measure.

TABLE 2 *Summary statistics (148 countries)*

Variables	VIF	Min	Max	Mean	SD	1st quart	Median	3rd quart
Homicide rate	–	0.40	67.00	8.56	11.31	1.60	4.86	10.25
Gini (combined)	1.41	24.53	65.77	39.20	9.02	32.75	37.85	43.96
Gini (WDI) ($N = 127$)	–	24.53	65.77	39.30	9.00	32.67	38.01	44.10
Gini (CIA) ($N = 136$)	–	23.75	70.61	40.29	9.95	32.99	38.72	45.67
Infant mortality (1k births)	6.46	2.04	118.38	30.96	27.79	6.83	21.44	50.23
Urban/rural ratio	2.20	0.11	57.69	2.86	6.20	0.61	1.25	2.55
Young/other ages ratio	2.67	0.19	0.56	0.35	0.08	0.29	0.36	0.40
Male/female ratio	1.12	0.84	2.84	0.99	0.16	0.96	0.98	1.01
Education index	3.99	0.17	0.91	0.60	0.18	0.45	0.62	0.76

SD = standard deviation; quart = quartile.

from a low of 2.04 to a high of 118.38. As with the Gini index, infant mortality rates vary widely across countries, with a low of 6.83 infant deaths per 1,000 births at the 25th percentile, to 21.44 at the median and 50.23 at the 75th percentile.

To examine for the presence of multicollinearity, Table 2 presents the variance inflation factor (VIF), which measures the degree of multicollinearity among independent variables. The square root of the VIF represents the degree to which the standard error is inflated as a result of correlations with other covariates. Generally, a VIF of 1 indicates no correlation among a given independent variable and all other covariates, a VIF exceeding 4 warrants further investigation, and a VIF over 10 indicates potential serious multicollinearity problems (Kutner *et al.* 2004). Although cross-national homicide research often includes alternative measures of economic development, such as GDP or HDI as controls, the inclusion of such measures often results in serious multicollinearity problems with measures of absolute deprivation (Pridemore 2008). Both the inclusion of GDP (VIF = 8.32) and HDI (VIF = 10.83) raise issues regarding multicollinearity and therefore these measures were omitted from the model (results not shown). Without these variables, multicollinearity would not appear to be a serious problem as the highest VIF is observed for infant mortality (6.46).[4]

Analytic approach

Quantile regression enables researchers to determine whether the effect of independent variables operate differently across the distribution of the dependent variable (Koenker and Hallock 2001). For the purpose of this research, quantile regression offers several advantages over traditional OLS regression. First, this non-parametric method is robust to non-normal distribution of error terms which are common in cross-national homicide research. Second, by utilizing the median and other cut-points of the distribution, the results are less sensitive to outliers. Third, quantile regression allows an examination of the relationship between independent and dependent variables across several points of the distribution of the dependent variable. This approach does not require the assumption that the relationship between economic deprivation and homicide is consistent across countries characterized by different levels of homicide. Accordingly,

[4]To further investigate the sensitivity of our analysis to multicollinearity we ran additional models excluding the infant mortality variable. These models did not result in substantive changes to our results.

quantile regression enables the exploration of how economic deprivation is related to homicide and whether these relationships are consistent across the distribution of homicide rates.

While OLS coefficients correspond to the average change in the conditional mean of the dependent variable given a one-unit change in a specific independent variable, coefficient estimates from quantile regression represent the change in the dependent variable from a one-unit change in an independent variable conditional at a specific point of the distribution of the dependent variable (Koenker and Hallock 2001). The estimated coefficients can be reported at any defined portion of the distribution within the range of 0–1. For the current study, quantile regression is used to estimate homicide rates conditional on selected quantiles (10th, 25th, 50th, 75th and 90th). Finally, in all models the dependent and all of the independent variables were transformed using natural logarithms. Since no variables had negative or zero values, the transformation does not come at any analytical cost.[5] The formulas used to estimate the quantile regression model and a brief explanation may be found in Appendix B.

Results

Table 3 presents the main results concerning the relationship between economic deprivation and cross-national homicide. The first column presents the results of the OLS regression model. The overall goodness of fit of the OLS model (0.62) indicates that the

Table 3 *Quantile regression (Ln) homicide rate (148 countries)*

Variables (*Ln*)	OLS	τ = 0.1	τ = 0.25	τ = 0.5	τ = 0.75	τ = 0.9
Gini	2.283**	1.729**	1.911**	1.824**	2.623**	2.521**
	(0.317)	(0.511)	(0.398)	(0.470)	(0.438)	(0.441)
Infant mortality	0.415**	0.724**	0.536**	0.430**	0.146	−0.166
	(0.194)	(0.255)	(0.159)	(0.187)	(0.232)	(0.321)
Urban/rural ratio	0.074	0.180	−0.116	−0.058	0.018	0.275
	(0.165)	(0.384)	(0.293)	(0.262)	(0.198)	(0.275)
Young/other	0.853	−0.179	0.277	1.103*	1.856**	3.006**
ages ratio	(0.550)	(0.777)	(0.504)	(0.557)	(0.641)	(0.941)
Male/female ratio	−2.472**	−5.755**	−4.734*	−1.753	−2.333	−3.512*
	(0.917)	(2.677)	(2.588)	(2.592)	(2.680)	(2.073)
Education index	0.251	1.010	0.226	0.325	−0.141	−0.716
	(0.389)	(0.621)	(0.543)	(0.473)	(0.614)	(0.657)
Constant	−7.288**	−7.744	−6.675**	−4.829*	−6.259**	−4.735*
	(1.404)	(2.121)	(1.727)	(2.140)	(2.088)	(2.577)
N	148	148	148	148	148	148
F(6, 131)	57.44	–	–	–	–	–
R^2/Pseudo R^2	0.624	0.375	0.446	0.450	0.392	0.434

Bootstrap standard errors are in brackets (reps = 1,000); results should be read as elasticity. Standard errors are in parentheses. The results report statistical significance but focus should be in the effect sizes. Given the extensive representation of countries, results need not be generalized outside of the population under analysis.
*$p \leq 0.10$; **$p \leq 0.05$ (two-tailed).

[5]This transformation has three main consequences. First, it normalizes the distribution of skewed variables. Second, it reduces the influence of extreme values on the dependent and independent variables. Third, it turns the regression coefficients into elasticities, interpreted as the percent increase in Y (homicide rate) from a one percent increase in the corresponding independent variable. Models were also performed without log-transformations for the dependent and independent variables and results remain consistent.

model explains a fairly large degree of variance in cross-national homicide rates. The results also suggest that both inequality and infant mortality are positively and significantly related to homicide when included in the same model. These results indicate a one per cent increase in the Gini index is associated with a 2.28 per cent increase in the homicide rate and a one per cent increase in infant mortality is associated with a 0.42 per cent increase in the homicide rate. While prior research has provided inconsistent results regarding the relative predictive power of inequality and poverty (Pridemore 2008; Messner *et al.* 2010), the results of this model suggest that both indicators are statistically significant predictors of homicide.

The remaining five columns in Table 3 present the results of the quantile regression model estimated using 1,000 bootstrap repetitions.[6] Figure 2 provides a visual illustration of the coefficient estimates in this table. The results from the quantile regression model differ from the OLS model in several interesting ways. First, although the relationship of economic inequality is variable across the distribution, it remains statistically significant and positively related to homicide across all quantiles. Specifically, the estimated coefficient for economic inequality is 1.729 at the 10th percentile and 1.911 at the 25th percentile of the homicide distribution. However, the inequality–homicide relationship decreases slightly at the median with an estimated coefficient of 1.824, reaches a peak value at the 75th percentile (β = 2.623) and then slightly drops at the 90th percentile (β = 2.521).

Compared to inequality, the association of absolute deprivation with homicide appears to be more variable across the homicide distribution. For instance, infant mortality has a positive, significant relationship with homicide (β = 0.724) at the 10th percentile. However, at the 25th percentile the estimated coefficient reduces in magnitude (β = 0.536). At the median, the magnitude of the estimated coefficient of infant mortality further drops to 0.430. By the 75th percentile, the estimated coefficient falls to 0.146 and fails to reach statistical significance at the 0.05 α level. Finally, infant mortality becomes negative and remains non-significant (β = −0.166) at the 90th percentile. These results suggest that the relationship between infant mortality and homicide

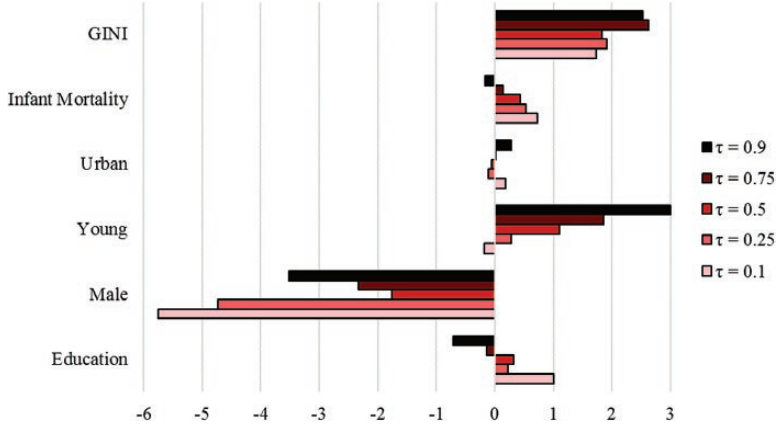

FIG. 2. Quantile regression coefficients

[6]The bootstrap is a flexible method to analytically compute the standard error and confidence interval of estimates by resampling with replacement from the observed data.

varies throughout the distribution of homicide rates and is most strongly related to homicide in countries with the lowest homicide rates.

Figure 3 presents a scatter plot that further illustrates the considerable variability in the relationship between the different measures of economic deprivation and homicide. Figure 3 shows a direct relationship between inequality and homicide with many of the countries with the highest homicide rates also having the highest levels of inequality. However, the relationship between infant mortality and homicide is not as straightforward as many countries in the highest quantile of homicide rates also have some of the lowest levels of infant mortality.[7]

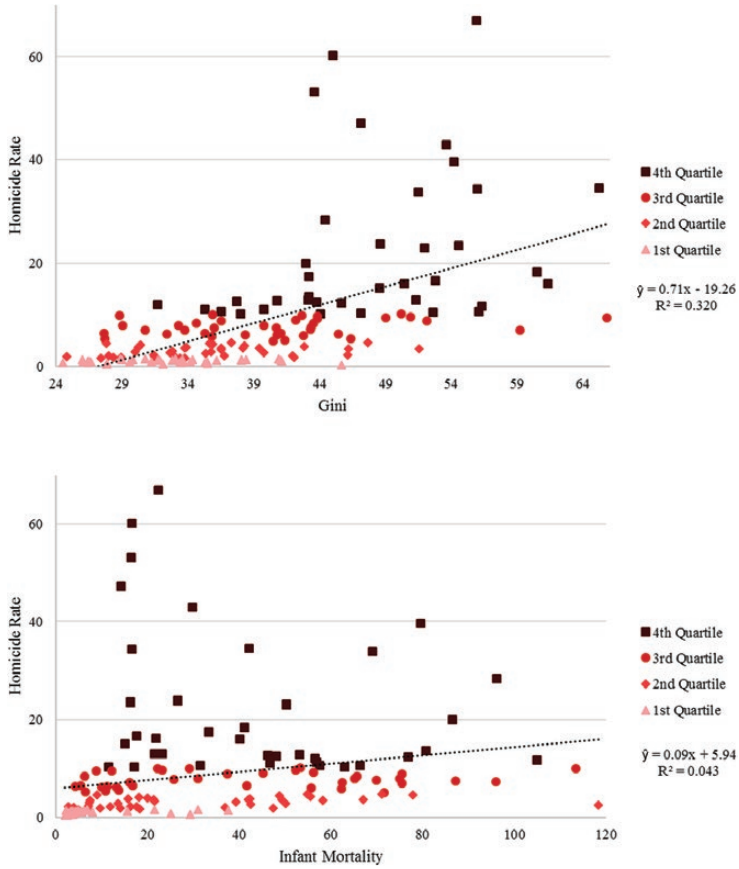

FIG. 3. Scatterplot of economic deprivation variables by homicide rate with bivariate OLS equation line

[7]While the relationship between infant mortality and homicide in the highest quartile appears to be counterintuitive, a further analysis highlights the reasons underlying this pattern. Specifically, these findings are explained in part by differences in the association between infant mortality and homicide in African and Latin American countries. The 15 counties in the highest homicide quartile from Latin American have a mean homicide rate of 30.26 per 100,000 persons and a mean infant mortality rate of 20.6 per 1,000 births (range 14.3–33.3), which is below the sample mean infant mortality rate (30). For instance, Honduras has the highest homicide rate of the sample at 67, but has a below average rate of infant mortality (22.4). However, the 20 countries in the highest homicide quartile located in the sub-Saharan Africa have an mean homicide rate of 17.8 and a mean infant mortality rate of 63.1(range 40.1–104.9), which is twice as large as the infant mortality rate sample mean. This pattern might reflect differences in levels of hunger and food security between the two regions, as well as differences in levels of democratization, both of which have been shown to influence the prevalence of infant mortality (Pelletier *et al.* 1993; Gerring *et al.* 2012).

The quantile regression model also indicates that the relationship between several of the control variables and homicide is variable across the homicide distribution. First, the association of the urban population ratio appears to be U-shaped with the strongest positive relationship at the tail ends of the homicide distribution and small negative association in the middle quantiles. For instance, the urban population ratio at the 10th percentile has a positive association with homicide ($\beta = 0.180$), yet becomes negative at the 25th percentile ($\beta = -0.116$) and the median ($\beta = -0.058$). The relationship then becomes positive at the 75th percentile ($\beta = 0.018$) with its strongest overall association at the 90th percentile ($\beta = 0.275$). Still, the overall impact at any point of the distribution is quite small which is consistent with previous research (Nivette 2011).

In regards to the age distribution of the population, we find that the ratio of young persons to other ages in the population has a small and non-significant association in the OLS regression ($\beta = 0.853$), and the quantile regression model at the 10th ($\beta = -0.179$) and 25th percentiles ($\beta = 0.277$). However, the ratio of young persons in the population becomes a substantially stronger predictor of homicide rates with increasing levels of homicide. At the 75th percentile, the estimated coefficient rises to 1.856 and at the 90th percentile the estimated coefficient indicates that a one per cent increase in the young population increases the homicide rate by approximately 3 per cent. This relationship is further illustrated in Figure 4, which shows that countries with the highest levels of homicide rates often have the greatest ratio of young persons in their population.

The sex ratio of the population also demonstrates a varying association with homicide across the homicide distribution. While the ratio of males to females in the population has a negative relationship throughout the entire distribution, the strongest association occurs at the 10th ($\beta = -5.755$) and 25th percentiles ($\beta = -4.734$). However, all coefficients are consistently negative, indicating that a smaller number of males in a population corresponds to higher levels of homicide. The results for gender, while surprising given males higher proneness to violence than females, are consistent with prior research which finds a negative relationship between sex ratio and homicide rate (Nivette 2011; Pridemore 2011; Rogers and Pridemore 2013). One explanation for this pattern is that low sex ratios (i.e. few males to females) hinder family formation and

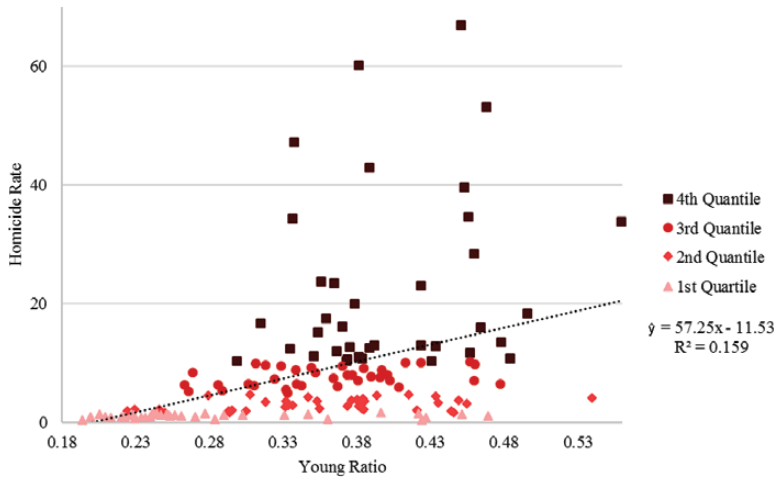

Fig. 4. Scatterplot of young ratio by homicide rate with bivariate OLS equation line

increase marital instability. Consequently, higher levels of family disruption may be criminogenic by reducing informal social control (Messner and Sampson 1991).

Finally, the relationship between the education index and homicide is inconsistent across the homicide distribution. The results of the OLS model indicate a positive and non-significant relationship with homicide rates ($\beta = 0.251$), which is consistent with the results of the quantile regression model at the 10th ($\beta = 1.010$), 25th ($\beta = 0.226$) and 50th percentiles ($\beta = 0.325$). However, the coefficient for the education index becomes negative at the higher end of the distribution. Since there were potential multicollinearity problems with the education index, a sensitivity analysis was performed by estimating a model without this index. The coefficients of this model were very similar to those discussed above (results not shown).[8]

Discussion

The current study applied quantile regression to explore whether and to what extent the relationship between economic deprivation and homicide differs according to national levels of homicide. Drawing from macro-level strain theory, we hypothesized that the relationship between economic deprivation and homicide would vary conditional on the homicide rate. Specifically, the current study tested the proposition that the association between absolute deprivation and homicide would be strongest in the safest countries and weakest in the most violent countries. In addition, we propose competing theoretical perspectives suggesting that relative deprivation could be associated with homicide in the most violent countries, as well as in relatively safer countries.

The results from this study yielded several interesting insights. First, while both inequality and poverty are significantly related to the conditional mean of homicide, only inequality exhibits a consistently positive and significant association across the entire homicide distribution. This relationship between economic inequality and homicide is consistent with most prior cross-national homicide research (LaFree 1999; Messner *et al.* 2002; Wilkinson, 2004; Nivette 2011; Ouimet 2012). However, the inconsistent relationship between absolute deprivation and homicide across the homicide distribution stands in contrast to recent work which finds a positive, significant association between absolute deprivation and homicide while controlling for relative deprivation which was unrelated to homicide (Pridemore 2008; 2011).

One possible explanation for the difference in findings is the use of a larger and more diverse sample of countries. For instance, Pridemore's (2008) work used a sample of 46 western countries and found that when both poverty and inequality were included in the same model, poverty retained a significant positive association with homicide whereas inequality did not.[9] In contrast, our findings are in line with other research that

[8]While the main results utilized averages across the years 2005–2012, a subsequent analysis was performed using an unbalanced panel of 749 country-year observations. These results were substantively similar to our main findings. These models are available upon request.

[9]We ran additional quantile regression models restricting our analysis to the 46 countries used by Pridemore (2008). We find that in this sample that infant mortality retains a positive significant association at all quantiles of the homicide distribution, whereas inequality retains a significant positive association at the 10th and 50th percentile and a non-significant positive association at all other points (results available upon request). We believe these findings further underscore our point that the selection of countries included in cross-national homicide research has important implications for the empirical findings.

uses a larger and more heterogeneous sample of countries and finds limited support for the association between infant mortality and homicide rates (Cole and Gramajo 2009; Pare and Felson 2014). Whereas Pridemore's (2008) study sample included only 46 countries, most of which were developed democracies, the current study includes 148 countries. Moreover, Pridemore's (2008) sample of countries was more homogeneous with respect to their economic indicators, including inequality, thus resulting in much smaller variation of the Gini index and homicide rates. Indeed, Stamatel (2006) notes a limitation of prior cross-national homicide research is that samples are typically biased towards highly developed countries. Our results demonstrate that studies that omit developing countries may overstate the impact of absolute deprivation relative to those studies that include both developed and developing countries. This also suggests that the results of much of the existing cross-national research on homicide may not generalize to countries outside of Western democracies.

Next, the results indicate a large degree of variability in the relationship between deprivation and homicide rates across the homicide distribution. On a theoretical level, the results of the quantile regression suggest that key economic variables used to explain homicide cross-nationally have neither a stable nor universal effect. Rather, the importance of absolute deprivation appears most salient among the safest countries. One possible explanation is that in these countries, the infant mortality rate may capture a key segment of the population that may be most impacted by strain and interpersonal violence. As Messner *et al.* (2010: 530) suggest, infant mortality reflects 'the social conditions of the socially excluded and marginalized', whereas measures such as the GDP per capita are likely to reflect only the average wealth of a society, thus obfuscating the actual prevalence of material deprivation. Accordingly, infant mortality captures the prevalence of a marginalized and excluded portion of the population that may explain the difference in homicide between the safe, and the safest countries in the world. Moreover, we proposed that the presence of a marginalized group in safer and more stable countries is a manifestation of relative deprivation. In other words, when wealthy and safe countries have a portion of the population severely deprived, the economic differences between this group and others in their country is likely to result in even greater strain and frustration than might be felt by severely deprived individuals living in more violent countries. Our results provide empirical support for this proposition (Table 1).

The results also indicated that inequality retained a positive and significant association throughout the homicide distribution. Although the relationship between inequality and homicide was consistent, we find that inequality was most strongly related to homicide at the 75th percentile and had the smallest impact at the 10th percentile. These findings suggest that inequality corresponds to increased homicide across all countries, although this relationship is strongest in countries with higher homicide rates. Moreover, the finding of a positive relationship between inequality and homicide is consistent with prior work which suggests that inequality is an important contributor to social problems, including homicide, on a global level (Wilkinson and Pickett 2011). This finding supports both the role of macro level variables as a homicide predictor, and the relevance of explanations that emphasize the unequal distribution of resources and opportunities across the social structure. Relative deprivation dictates that individual's perceptions about their social condition are not

absolute, but relative to the social condition of others within the same social structure. This means that strain and frustration is greater not necessarily where opportunities to achieve valued goals are absent for all, but where such opportunities are most unevenly distributed (Merton 1938).

These findings have key implications for criminological theory and future research. First, the results are supportive of theories that emphasize economic inequality as a primary component in explaining differences in homicide rates between countries. The results also provide support for a limited role of absolute deprivation as measured by the infant mortality rate. Although the results provide only limited support for the association between absolute deprivation and homicide at the cross-national level, it is important for future research to continue to explore the relationship between poverty and national homicide rates particularly in developing countries. Indeed, the results suggest that poverty may have less explanatory power in samples that include developing countries (Cole and Gramjo 2009; Pare and Felson 2014).

Moreover, this study responds to Pridemore's (2008) challenge for researchers to more carefully consider the interdependence of absolute and relative deprivation in their influence of cross-national homicide rates. Our study has attempted to fulfill this task. In doing so we used propositions from strain theory to generate a more nuanced explanation of economic deprivation and homicide in a cross-national context. We proposed that the relationship between poverty and inequality would be strongest in the safest countries, where absolute deprivation would be more frustrating and therefore manifest into relative deprivation. The findings of the current study demonstrate that poverty and inequality are most strongly associated with homicide in countries where homicide rates are lowest. Moreover, the infant mortality rate is significantly related to homicide at the lower end of the homicide distribution but yields a non-statistically significant association above the median of the homicide distribution. Overall, these findings suggest that the relationship between absolute and relative deprivation and homicide is complex and may depend on homicide itself. Future research should continue to investigate the relationship between economic deprivation and homicide in order to advance our understanding of how economic deprivation and other macro level variables influence homicide rates.

This study also has implications for methodological approaches used in cross-national criminological research. While the traditional approach of prior research is to rely on ordinary least squares with small convenience samples, our findings suggest that much can be learned through the use of both larger, more globally representative samples as well as alternative methods such as quantile regression. Beyerlein (2014; 331) suggests 'sometimes only the pattern of regression coefficients over the whole range of quantiles can reveal the true underlying associations'. While quantile regression may not be appropriate for all research questions posed by criminologists, we believe there is much to be gained from an analytic approach that moves the focus beyond average differences. This is especially true for criminological research, which often deals with skewed distributions (Britt 2009). Since distributions often differ in their means, as well as the lower and upper tails, modelling only the mean can miss important associations between the outcome and a given predictor (Beyerlein 2014). In light of those considerations we believe this study offers a productive example of the application of quantile regression for the study of crime.

This study contains limitations that future research can expand upon. First, the current study left out several potential control variables such as the degree of democracy (LaFree and Tseloni 2006) and ethno-linguistic diversity (Cole and Gramajo 2009). However, the inclusion of additional control variables comes at the cost of a reduced sample size due to missing data. In addition, the large explained variance of the model substantially minimizes the risk of omitted variable bias. An additional limitation is in regards to the strength of our economic deprivation measures. While Pridemore (2008) argues that infant mortality serves as a strong proxy for poverty, other research suggests that infant mortality is associated more strongly with relative poverty rather than absolute poverty (Messner *et al.* 2010). Although there is a lack of reliable data on poverty cross-nationally (Pridemore 2008), future research that more fully examines the relationship between infant mortality and absolute deprivation would be worthwhile. An additional consideration for future research is to consider whether other variables reliably measure inequality at the cross-national level. While the Gini index is one of the most commonly used measures of economic inequality, it captures only one dimension of relative deprivation. Other measures of inequality that may be relevant for homicide include land inequality and political inequality (Deaton 2003; Yang *et al.* 2012).

Variation in the quality of homicide data between countries is another potential limitation. It is possible that some countries have less accurate statistics, due to mistakes in the classification and recording of data, or for politically motivated reasons. However, the WHO data are consistently considered among the highest quality measures of international causes of mortality and international organizations are generally aware of the possibility of differential validity across countries. As such, the WHO makes attempts to quantify and minimize these potential errors by investigating inconsistencies in data over time and across countries, and by comparing estimates across sources (WHO 2014*b*). As illustrated by Figure 1, the geographical distribution of homicide rates across the world is unsurprising, and reflects the reliability of the data.

We end with a comment about the implications of the current study for interventions and efforts to reduce homicide. From a public policy perspective, the results suggest that approaches to homicide reduction through economic initiatives may differ according to the level of homicide within a country. Efforts to reduce economic inequality may be most effective in reducing homicide in countries characterized by high levels of homicide, while countries characterized by low levels of homicide may benefit more from economic initiatives designed to reduce inequality, as well as improving the quality of life for the most impoverished and marginalized in society.

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Appendix A

Countries of the World by Homicide Rate and Quartile (148 Countries)

1st quartile		2nd quartile		3rd quartile		4th quartile	
Country	Homicide	Country	Homicide	Country	Homicide	Country	Homicide
Singapore	0.4	Canada	1.6	Mauritania*	5.0	Togo*	10.3
Japan	0.4	Slovak Republic	1.7	United States	5.2	Russian Federation	10.3
Iceland	0.5	Jordan	1.7	Ukraine	5.4	Peru	10.4
Indonesia*	0.6	Romania	1.9	Argentina	5.5	Zimbabwe*	10.6
Austria	0.7	Macedonia, FYR	1.9	Lao PDR*	5.9	Zambia*	10.7
Switzerland	0.7	Belgium	1.9	Ghana*	6.1	Mongolia	10.7
Slovenia	0.8	Tajikistan	2.0	Thailand	6.2	Madagascar*	11.1
Algeria*	0.8	Azerbaijan	2.0	Sri Lanka	6.2	Sudan*	11.2
Denmark	0.8	Israel	2.1	Uruguay	6.4	Central Afr. Rep.*	11.8
Norway	0.9	Bulgaria	2.2	Estonia	6.4	Ethiopia*	12.0
Germany	0.9	Finland	2.2	Belarus	6.5	Mozambique	12.4
Korea, Rep.	0.9	Tunisia*	2.2	Georgia	6.5	Congo, Rep.	12.5
Netherlands	0.9	Armenia	2.3	Cambodia	6.5	Tanzania*	12.7
Sweden	0.9	Malaysia*	2.4	Pakistan	7.1	Turkmenistan*	12.8
Spain	1.0	Sierra Leone*	2.5	Haiti*	7.1	Nicaragua	13.0
Italy	1.0	Bangladesh	2.7	Moldova	7.1	Paraguay	13.0
Czech Republic	1.1	Senegal*	2.8	Chad*	7.3	Cote d'Ivoire*	13.6
Malta	1.1	Mauritius	2.9	Mali*	7.5	Mexico	15.2
Qatar*	1.1	Montenegro*	3.0	Cameroon*	7.6	Namibia	16.1
New Zealand	1.2	Nepal	3.1	Philippines*	7.7	Ecuador	16.2
Australia	1.2	Vietnam*	3.3	Iraq*	8.0	Panama	16.7
China	1.2	Malawi	3.5	Burkina Faso*	8.0	Guyana	17.5
France	1.3	Chile	3.5	Burundi*	8.0	Botswana	18.4
United Kingdom	1.3	India	3.6	Lithuania	8.4	Nigeria*	20.0
Poland	1.3	Turkey	3.6	Benin*	8.4	Rwanda*	23.1
Ireland	1.3	Liberia*	3.6	Bolivia	8.9	Brazil	23.5
Portugal	1.3	Uzbekistan*	3.7	Guinea*	8.9	Dominican Rep.	23.8
Cyprus	1.3	Albania*	3.8	Gabon*	9.1	Congo, Dem. Rep.*	28.3
Greece	1.3	S.Tomé & Príncipe	3.8	Uganda	9.3	Swaziland	33.8
Croatia	1.4	Fiji*	4.0	Seychelles	9.5	Colombia	34.3
Bhutan	1.4	Iran*	4.1	Costa Rica	9.6	South Africa	34.5
Luxembourg	1.4	Timor-Leste*	4.2	Papua New Guinea	9.6	Lesotho*	39.6
Serbia	1.5	Yemen, Rep.	4.4	Cabo Verde*	9.7	Guatemala	42.9
Hungary	1.5	Afghanistan*	4.6	Angola*	10.0	Venezuela, RB	47.2
Egypt*	1.5	Latvia	4.6	Kazakhstan	10.0	Jamaica	53.1
Bosnia & Herzegovina*	1.5	Niger*	4.7	Kyrgyz Republic	10.1	El Salvador	60.2
Morocco	1.6	Kenya	4.7	Gambia, The	10.2	Honduras	67.0

*Denotes the 51 countries with homicides rates that are obtained via statistical estimation.

Appendix B

Formula for Quantile Regression

Traditional OLS defines the equation solution through an optimization strategy which minimizes the sum of squared residuals from the estimated regression function:

$$\min_{\propto \in \Re} \sum_{i=1}^{n} \left(y_i - \mu\right)^2$$

The median regression also utilizes an optimization strategy, but it defines the solution to the problem by minimizing the sum of asymmetrically weighted absolute residuals:

$$\min_{\xi \in \Re} \sum \rho_\tau \left(y_i - \xi\right)$$

where $\rho_\tau(\cdot)$ specifies the absolute value function of the τth sample quantile, y_i specifies the observed value of the dependent variable, and ξ represents the predicted value of the dependent variable.

The conditional quantile is obtained by replacing ξ with the parametric function $\xi\,(x, \beta)$ and specifying one value for τ (i.e. 0.5 for the median). Estimations of functions conditional on other quantiles simply require the change of the value of τ. The optimization strategy remains the same:

$$\min_{\mu \in \Re} \sum_{i=1}^{n} \rho_\tau \left(y_i - \xi(x, \beta)\right)$$

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