Violent Crime driven by income inequality between countries

By Mario COCCIA †

Abstract. The literature has suggested several approaches to explain violent crime, such as the heat hypothesis that more violence is associated to very hot temperature. However, the manifold determinants of violent crime in society are hardly known. This study shows that, controlling the climate, the intentional homicides (per 100,000 people) can be explained by the high level of income inequality, both in hot tropical areas and in temperate regions of the globe. Overall, then, the socioeconomic inequality is one of factors that generates aversive social environments and, as a consequence, a deteriorated human behavior leading to high rates of intentional homicides in society.

Keywords. Temperature, Inequality, Violent crime, Intentional homicides, Heat hypothesis.

JEL. D63, I14, I24, N30, O44, O57.

1. Introduction

One of the scientific problems of violent crime in social psychology is centered around a main issue: what environmental factors cause violent crime and aggressive behavior in society? This paper has two goals. The first is to show that hot temperatures, per se, provide a partial explanation of deteriorated human functioning leading to violent crime in society. The second is to stress the importance of the income inequality that negatively affect the mental health and to provide evidence that the high rates of violent crime at country level can be explained by high economic inequality in society, controlling the factor climate (Coccia, 2017e). This study is important in psychological sciences because The United Nations General Assembly in 2015 adopted the 2030 Agenda for Sustainable Development, addressing the need for violence prevention at an unprecedented scale (United Nations, 2015). In fact, determinants of the environmental violence have become more and more a critical argument in several scientific fields that consider different factors, such as poverty (Hsieh & Pugh, 1993; Lee, 2016), resource scarcity (Cozens, 2008), high population (Christens & Speer, 2005), social factors (Perkins et al., 1993), characteristics of the inhabitants (Jencks, 1992), psychological factors (Kuo & Sullivan, 2001; Perkins et al., 1993; Anderson, 1987), etc. A main research stream in social psychology is based on heat hypothesis: hot temperature can increase aggressive behavior and violence in society (Baron & Bell, 1976; Carlsmith et al., 1979; Anderson, 1989; Anderson & Anderson, 1996). In particular, some scholars argue that hot climate can directly increase feelings of hostility and indirectly increase aggressive thoughts inter- and intra-groups (Anderson, 2001), but Simister & Cooper (2005, pp.7-8, original emphasis) discuss about some cities in Puerto Rico (with hot climate), which appear to be ‘outliers’ in having low crime rates relative to some U.S. cities (cf. also Simister & Van de Vliert, 2005). In general, this heat hypothesis has influenced several research fields of the psychological sciences, neuroscience, behavioral and cognitive sciences of crime (Baron, 1972; Anderson, 1987;
Anderson et al., 1997; DeFronzo, 1984; Simister & Van de Vliert, 2005; Van de Vliert & Smith, 2004). Recently, Van Lange et al., (2016) propose a model that seeks to understand the variation in aggression and violence in terms of differences in climate. These scholars show that lower average temperature and larger variation in seasonal temperature influence individuals and groups to adopt a slower life strategy and a stronger focus on self-control (Van Lange et al., 2016). However, current theoretical frameworks about environmental violence are not comprehensive approaches because it is clear that there are at least some factors about aggressive behavior and violent crime in society that these studies have trouble explaining. In social psychology, several researchers have implicitly assumed that the hot climate is a prime factor of the violence and aggressive behavior. This study here challenges this conventional wisdom by highlighting the critical role of socioeconomic factors on human behavior that can lead to violent crime in society. Although “social psychologists are characteristically less critical of theories than is desirable” (Greenwald & Ronis, 1981, p.136), it would seem useful to explore other environmental factors and related interactions, from socioeconomic studies, that can support and integrate the approaches of social psychology in explaining the high rates of violent crime and aggressive behavior in areas both with hot and with temperate climate. Hence, this study here challenges by arguing that the high socioeconomic inequality, controlling the latitude (a proxy of the climate), can generate aversive environments for human behavior and violent crime in society as a result. The hypothesis of the study here will be substantiated with statistical analysis to develop an integrative theoretical framework to current psychological approaches that can clarify and explain, whenever possible a main relation relationship between human behavior and environmental violence. In order to position the analysis here within the existing literature, this paper begins by reviewing some studies and by discussing the theoretical framework of this study.

2. Theoretical framework and working hypothesis

Understanding where violent crime happens can provide vital information to explaining why it happens (Christens & Speer, 2005; Lee, 2016). It has been discussed in literature that environmental stressors, emanate from less than favourable conditions in built or natural locations, generate various psychological health problems in society (Lepore et al., 1991). Some studies show that the crowding of specific areas has a significant negative influence on social relations and generates a deteriorated human functioning conducive to aggressive behavior (Altman, 1975; Baum & Paulus, 1991). Many studies, as said above, have showed that hot temperature seems to induce environmental violence (Simister & Van de Vliert, 2005). The theoretical framework of these studies is based on the heat hypothesis: hot temperatures can increase (under some conditions) aggressive behavior of humans. In this research field, Anderson & Anderson (1996, p. 748) predict that warmer cities will be positively associated with more violent behavior. Van de Vliert et al., (1999, p.51) claim that: “the highest rates of violence are associated with temperatures about 24°C; whereas Simister & Cooper (2005) consider violence to be more common if temperatures are more than 24°C”. Van de Vliert et al., (1999) endeavour to explain the results with a relation between climate, culture and human behavior. Anderson (2001) confirmed that higher rates of aggression are in hot climate rather than cooler one. Simister & Van de Vliert (2005) argue that other factors of the climate (in addition to the temperature) are also relevant to environmental violence, such as rainfall and humidity. Specific studies, for explaining the high rates of violent crime, focus on ‘cultural masculinity’ of geoeconomic areas (Van de Vliert et al., 1999). Instead, Simister & Cooper (2005, p.52) suggest a biological explanation of the heat hypothesis by considering the adrenaline of the body (“which is secreted into the blood at high temperatures, as part of a thermal control mechanism in humans”, cf. also Duke et al., 2013). Instead, other studies argue that hot weather negatively affects physical factors of geographical areas that reduce economic resources and, as a
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consequence, increase the poverty and violence (e.g., farm output may be reduced by extreme weather, cf., Van de Vliert et al., 2000). Lower levels of democratization of countries can also be another factor related to high rates of violence and crime in society (Simister & Cooper, 2005).

The debate in these topics also concerns the temperature-aggression relationship (Anderson et al., 2000). The literature shows that the relationship between temperature and violence can be linear or a curve with a Negative Affect Escape (called NAE; cf., Bell, 1992; 2005; Anderson, 1989; Anderson & DeNeve, 1992; Anderson et al., 2000; Rotton & Cohn, 2002; Rotton, 1986; 1993). Baron & Ransberger (1978) indicated that the frequency of collective violence and ambient temperature were curvilinearly related. Instead, Bushman et al., (2005), using Minneapolis data, suggest a rectilinear rather than a curvilinear relationship. Although some studies seem to support the curvilinear relationship (cf., Rotton & Cohn, 2000a; Van de Vliert et al., 1999), Anderson and colleagues have claimed that these results are methodologically weak (cf., Anderson, 1989; Anderson et al., 2000). Rotton & Cohn (2004) argued that the curvilinear relationship holds only when escape to cooler temperatures is not readily available, but identifying other such circumstances and their practical and theoretical implications would be a valuable direction for the analysis of the heat–aggression relationship (cf., Bell, 2005, p.72).

In social studies, the inequality is a vital factor to explain some dynamics in society because negatively influences wellbeing and economic growth (Aaberge & Mogstad, 2011; Herzer & Vollmer, 2012; Elbers et al., 2008; cf. also Ferreira et al., 2016). Fajnzylber et al., (2002, 1-7) argue that: “Crime rates and inequality are positively correlated within countries and, particularly, between countries, and this correlation reflects causation from inequality to crime rates, even after controlling for other crime determinants. ...an increase in income inequality has a significant and robust effect of raising crime rates”. Hsieh & Pugh (1993) claim that poverty and income inequality are associated with violent crime. Ouniet (2012) also argues that economic development, inequality and poverty are significant predictors of the homicide rate for all countries. Blau & Blau (1982) argue that economic inequality is at the root of violent crime in the United States and Poveda (2011) finds that inequality has positive impacts on the homicide rates in seven major cities in Colombia. In general, there is a growing consensus that problematic socioeconomic conditions, such as unemployment, income inequality and poverty, are underlying causes of violent crime and homicide. Social studies have two competing theories for explaining the mechanisms through which inequality may foster environmental violence (Coccia, 2017e). The first theoretical framework is by Becker (1968). The crime is a function of an individual's calculations in weighing the expected utility of crime against the utility of using the same time and resources to pursue legal activities. This theory suggests that inequality leads to crime by placing low-income individuals who have low returns from market activity in proximity to high-income individuals who have things that are worth taking (Kelly, 2000). In particular, although poverty remains fixed, a larger income gap between the poor and the rich people would lead to rising criminal behavior because the expected gains of criminal activity are related to the wealth and assets of the potential targets (Enamorado et al., 2016, p.130). The second approach is based on sociological theories of crime by Elgar (1938), who focuses on emotional feelings that lead people to become delinquents. According to this theory, individuals low in the social structure are frustrated by their failure to attain the material attributes of success, and this failure is more galling when they are confronted by the success of those around them (cf., Kelly, 2000). Poor people would be more likely to become violent in a place where inequality is high when compared with a similar individual living in a more egalitarian society (Fajnzylber et al., 2002). In short, both theories strongly suggest that higher levels of inequality boost crime, even after controlling poverty levels.

In general, climate, scarce environmental resources and other socioeconomic factors can generate a “blockage of goal-seeking behavior” (Agnew, 1985; passim) and stimulate aggressive behavior and violence (Mackintosh et al., 1975; Altman, 1975; Baldassare, 1975; Verbrugge & Taylor, 1980; Regoeczi, 2003; Schuurman & Horgan, 2016). In particular, inequality and poverty can produce deteriorated human functioning that leads to crime as a result (Christens & Speer, 2005; Coccia, 2017e). In other words, socioeconomic inequality, combined with high density of population, hot climate and other factors, may generate high levels of psychological stress in society (e.g., frustration and anger) that most likely induce environmental violence (Regoeczi, 2003). However, although various studies about the relation between environmental stressors of human behavior and violence in society have been proposed, convincing and comprehensive arguments of the sources of violent crime in different geoeconomic areas are still hardly known. Specifically, the interaction between climate and income inequality has been largely ignored to explain the sources of frustration, anger and violent crime in society.

Theoretical frameworks just discussed above suggest a general relation between income inequality and violent crime across space and time that can lay the theoretical foundations to posit and explore the following working hypothesis. Suppose that:

a) Countries of the Tropical zone have a warmer climate than countries of Temperate zone, ceteris paribus
b) Intentional homicides are an indicator of violent crime in society
c) Income inequality is a socioeconomic stressor both in rich and in poor countries

This study intends to substantiate the following focal hypothesis:

**Inequality Hypothesis**: Economic inequality negatively influences human functioning and leads to violent crime in society, ceteris paribus (i.e., controlling) the climate.

**Remark**: the hypothesis supposes that the income inequality, rather than hot temperature per se, is a stimulant of violent crime. Hence, the income inequality can be an invariant factor across time and space to explain the rate of violent crime in society, such as rates of intentional homicide.

The purpose of the present study is to see whether statistical evidence supports the hypothesis that the violent crime, measured with intentional homicides (per 100,000 people), can be explained by the high level of income inequality, measured with Gini coefficient, controlling the climate. Therefore, this study here has the goal of clarifying, as far as possible, the relation between socioeconomic inequality and high rates of violent crime in society, controlling (ceteris paribus) the climate factor of countries.

### Table 1. Variables, descriptions and sources of data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Source of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude</td>
<td>An important factor for determining climate of countries.</td>
<td>GeoNames, 2016; Mapszoom, 2016.</td>
</tr>
<tr>
<td>GDP per capita PPP current Int. $ (2006)</td>
<td>Gross domestic product per capita (GDPPC) by purchasing power parity, 2006y. The gross domestic product (GDP) is the value of all goods and services produced minus the value of any goods or services used in their creation.</td>
<td>World Bank (2008); Norris (2015).</td>
</tr>
<tr>
<td>Intentional homicides (per 100,000 people) 2006-2013</td>
<td>Intentional homicides (per 100,000 people) from UN Office on Drugs and Crime's International Homicide Statistics database. Intentional homicides are estimates of unlawful homicides purposely inflicted as a result of domestic disputes, interpersonal violence, violent conflicts over land resources, intergang violence over turf or control, and predatory violence and killing by armed groups. Intentional homicide does not include all intentional killing; the difference is usually in the organization of the killing. Individuals or small groups usually commit homicide, whereas killing in armed</td>
<td>World Development Indicators - The World Bank Group (2014).</td>
</tr>
</tbody>
</table>
conflict is usually committed by fairly cohesive groups of up to several hundred members and is thus usually excluded. Period under study is 2006-2013.

- Income Gini coefficient 2004
  Acronym: GINI2004

- Population ages 0-14 (% of total 2003)
  Acronym: POPY0-14
  Source of data: World Bank (2004); Norris (2015).

3. Methods

The method of condition-seeking of the study here has to purpose to analyse whether under the condition of high socioeconomic inequality, the violent crime increases, even after the climate of countries is controlled (cf. Greenwald et al., 1986). This factor of socioeconomic inequality, within and between countries, can be considered a competitor variable to perform a “destructive testing” of the heat hypothesis (Anderson & Anderson, 1996).

The sample of this study focuses on 191 countries. The approach here is based on aggregate data at country level to calculate the arithmetic mean of variables over time and perform a cross-section analysis. The variables under study are in table 1.

Latitudes are a fairly good measure to detect, in average, the climate of countries (cf., Anderson & Anderson, 1996, p. 744). In particular, this study divides the countries in two geographical zones. Tropics are between 23.5S and 23.5N latitude (countries have average high temperatures).

Countries from 23.5N to 66.5N and between 23.5S and 66.5S are into the temperate zones with clear spring/summer/fall/winter seasons (see, world map of the Köppen-Geiger climate classification; Kottek et al., 2006, p. 260ff).

The violent crime is measured with the Intentional homicides (per 100,000 people) at aggregated level (i.e., country) to suggest inferences about the average violent crime rate across nations. This study does not consider other typologies of aggressive behavior such as rape, assault, etc. because they may be underreported and generate systematic bias in the analysis (cf., Anderson & Anderson, 1996, p.744). The socioeconomic inequality of countries is measured by Income Gini coefficient (Measure of the deviation of the distribution of income among households within a country from a perfectly equal distribution). This variable can be a strong indicator of socioeconomic stress within countries (cf., Fajnzylber et al., 2002). Gross Domestic Product (GDP) per capita by purchasing power parity is the most common indicator in socioeconomic studies to measure the economic activity and wealth of nations. GDP is the control variable in some statistical analyses performed here.

![Diagram](image_url)

**Figure 1.** Invariant relation between climate and socioeconomic inequality for explaining the source of violent crime
The study here assumes that the climate (and related temperature) affects primarily the natural and economic environment of countries and it is this socioeconomic system that in turn influences people and their behavior, rather than to conjecture a linear cause-and-effect linkage from hot temperature to violent crime in society by-passing socioeconomic factors (in fact, between the temperature and human behavior there is the socioeconomic environment; Fig. 1-2). The idea of the study is to explain the high violent crime from a socioeconomic perspective, considering the level of income inequality as principal driver of environmental stress in society, in a comparable geoeconomic area with similar climate.

Figure 1 shows the visual representation of the theoretical interplay between climate and socioeconomic inequality that can lead to violent crime.

Figure 2. Model from high economic and social inequality to environmental stressors that induce deteriorated human functioning and violent crime in society, ceteris paribus the climate.

Evidence of hypothesis is based on following statistical analyses:

Descriptive statistics, bivariate correlation and partial correlation (with control variables Latitude and/or GDP per capita).

Independent Samples $T$ Test (a parametric test) that compares the arithmetic means of Intentional homicides of two independent sets (i.e., Countries with Gini coefficient higher/lower than arithmetic mean, both within and between Tropical and Temperate areas) in order to determine whether there is statistical evidence of significant difference.

In particular, the null hypothesis ($H_0$) and alternative hypothesis ($H_1$) of the independent samples $T$ test are given by:

$$H_0: \mu_1 = \mu_2 \quad H_1: \mu_1 \neq \mu_2$$

with:

$\mu_1 =$ arithmetic mean of Intentional homicides (per 100,000 people) within countries with Gini coefficient lower than average value (in Tropical and Temperate zones).

$\mu_2 =$ arithmetic mean of Intentional homicides (per 100,000 people) within countries with Gini coefficient higher than average value (in Tropical and Temperate zones).
Regression analysis with linear models of simple and multiple regression. The specification of the model of simple regression is:

\[ Y_{i,t} = \lambda_0 + \lambda_1 x_{i,t} + u_{i,t} \quad (\text{country } i = 1, \ldots, n; \text{ } t = \text{time}) \]

where:
- \( Y_{i,t} \) (Dependent variable) = the Intentional homicides (per 100,000 people)
- \( x_{i,t} \) = Gini coefficient of income inequality, which is the explanatory variable
- \( u_{i,t} \) = Error term

The linear model of multiple regression is given by:

\[ Y_{i,t} = \lambda_0 + \lambda_1 x_{i,t} + \lambda_2 k_{i,t} + \epsilon_{i,t} \quad (\text{country } i = 1, \ldots, n; \text{ } t = \text{time}) \]

where:
- \( Y_{i,t} \) (Dependent variable) = the Intentional homicides (per 100,000 people)
- \( x_{i,t} \) = Gini coefficient of income inequality, which is the first explanatory variable
- \( k_{i,t} \) = Latitude, which is the second explanatory variable
- \( \epsilon_{i,t} \) = Error term

The goodness of fit is measured with the coefficient of determination \( R^2 \). These models are estimated with the Ordinary Least Squares (OLS) method. The expectation of these statistical analyses is that, fixed the latitude (climate of countries), high rates of intentional homicide are associated to countries with high income inequality: i.e., the high rates of violent crime can be explained by high values of economic inequality, rather than hot temperature of certain geoeconomic areas per se. Statistical analyses are performed by using the Statistics Software SPSS® version 15.0.

4. Statistical evidence

This study endeavors to explain the violent crime by a socioeconomic cause that negatively affects the human functioning, even after the climate of countries is controlled. The evidence is presented with a general analysis considering all countries and a specific analysis of Tropical vs. Temperate climate countries.

4.1. General analysis of all countries

Table 1A in Appendix A shows descriptive statistics. In particular, the logarithmic transformation of variables shows normal distributions for appropriate statistical (parametric) analyses.

<table>
<thead>
<tr>
<th>Table 2. Bivariate correlation</th>
<th>LN GINI2004y</th>
<th>LN HOM2006-13y</th>
<th>LN GDPPC2006y</th>
</tr>
</thead>
<tbody>
<tr>
<td>LN GINI2004y</td>
<td>Pearson Correlation</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>126</td>
<td>0.63&quot;</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>LN HOM2006-13y</td>
<td>Pearson Correlation</td>
<td>0.01</td>
<td>-0.33&quot;</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>124</td>
<td>183</td>
<td>183</td>
</tr>
<tr>
<td>N</td>
<td>126</td>
<td>183</td>
<td>183</td>
</tr>
<tr>
<td>LN GDPPC2006y</td>
<td>Pearson Correlation</td>
<td>0.01</td>
<td>-0.39&quot;</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>N</td>
<td>126</td>
<td>183</td>
<td>191</td>
</tr>
</tbody>
</table>

**Note:** LN is logarithm; **= Correlation is significant at the 0.01 level (2-tailed). GINI2004y= Income Gini coefficient 2004; HOM2006-13y= Intentional homicides (per 100,000 people) 2006-2013; GDPPC2006y= GDP per capita PPP current Int. $ (2006).

Table 2 shows a very high coefficient of Pearson correlation (63%), which indicates a strong (positive) linear relationship between income inequality and Intentional homicides with 1% of statistical significance (p<0.01). This study also
found a negative linear relationship between Intentional homicides and GDP per capita ($r = -0.39, p<0.01$).

An important result is in table 3 with the partial correlation. This correlation indicates a strong (positive) relationship between income inequality and Intentional homicides, fixed the latitude and GDP per capita of countries ($r = 0.503, p<0.001$). This result is consistent with the hypothesis stated above about the effect of rising socioeconomic inequality on high rates of violent crime, *ceteris paribus climate and income per capita* (GDP per capita PPP current Int. $).
OLS estimation of models of regression analysis is in table 5. These results indicate a reasonably $R^2$ of the estimated models 1 and 2 of 0.30 and 0.39 respectively, which implies that more than 30% of the variation in the Intentional homicides can be attributed (linearly) to Gini coefficient of income inequality. The coefficient of regression $\lambda$, of the model 2 indicates that a 1% higher income inequality, *ceteris paribus the latitude*, increases the expected Intentional homicides (per 100,000 people) by about 2.96% (*cf.*, geometric representation is in Fig. 3).

Figure 3 shows that countries with warm climate are in the North-East corner but these are also countries with a strong association between high socioeconomic inequality and violent crime. *Vice versa* the South-West corner has mainly countries with temperate climate, lower income inequality and violent crime.

**Figure 3. Regression line of Intentional homicide on income Gini coefficient**

4.2. Statistical analyses of Tropical vs. Temperate climate countries

Table 2A in Appendix A shows descriptive statistics of variables understudy for Tropical and Temperate climate zone. Logarithmic transformation shows normal distribution of variables for applying correct statistical analyses (*cf. also* Appendix B). First of all, the Tropical Zone has higher average values of Intentional homicides (per 100,000 people) and of economic inequality.

Table 6 shows a high coefficient of correlation in Tropical zone between income inequality (GINI) and Intentional homicides (HOM). The Pearson correlation is 38% and indicates a good (*positive*) linear relationship between income inequality and Intentional homicides with statistical significance ($p<0.01$).
The statistical analysis of this study also found a positive linear relationship between Intentional homicides and GDP per capita in Tropical zone \((r = 0.28, p < 0.05)\). Temperate climate zone has a very high coefficient of correlation between income inequality and Intentional homicides: it is about 60% and indicates a strong (positive) linear relationship with 1% of statistical significance \((p < 0.01)\). This study also found, in this temperate zone, a negative linear relationship between Intentional homicides and GDP per capita \((r = -0.28, p < 0.05)\). This result can be explained with better institutions and high wellbeing of developed areas that decrease violent crime in comparison to countries of tropical area with poor institutional arrangements (cf., Acemoglu et al., 2001). Partial correlation in table 7 also provides important results. This correlation indicates in Tropical zone a good (positive) relationship between income inequality and Intentional homicides, fixed the latitude and GDP per capita of countries \((r = 0.38, p < 0.01)\). Temperate climate zone confirms this result with a higher coefficient of partial correlation \((r = 0.46, p < 0.01)\).

Table 8 shows that Tropical zone has a higher arithmetic mean of economic inequality measured with GINI coefficient 2004\(y\) (GINI 2004\(y\)=46 in Tropical

**Note:** LN is logarithm; **= Correlation is significant at the 0.01 level; *= Correlation is significant at the 0.05 level (2-tailed); GINI2004y = Income Gini coefficient 2004; HOM2006-13y= Intentional homicides (per 100,000 people) 2006-2013; GDPPC2006y= GDP per capita PPP current Int. $(2006).
zone, whereas GINI 2004y=35 in Temperate climate zone). The hot zone of the globe confirms that the subset of countries with income inequality higher than arithmetic mean (*i.e.*, GINI 2004y≥46) has also a high value of Intentional homicides (per 100,000 people) over 2006-2013y (HOM 2006-13y is 2.39) in comparison to countries having economic inequality lower than mean GINI 2004y<46 (*i.e.*, HOM 2006-13y is 1.73). This regularity is confirmed in temperate climate areas (HOM 2006-13y is 1.22 in countries with economic inequality higher than mean, *i.e.*, GINI 2004y≥35, whereas average intentional homicide is 0.56 in the subset of countries with average economic inequality lower than arithmetic mean GINI 2004y<35, see table 8). Since the T-test for Equality of Means in table 8 has both in Tropical and in Temperate climate zone p<0.05, we can reject the null hypothesis and conclude that the arithmetic mean of these two subsets is significantly different at 5%. In general, countries of the same climate zone with high (average) income inequality have a high (average) value of Intentional homicides (per 100,000 people) over 2006-2013.

**Table 8. Independent Samples Test with Intentional homicides (per 100,000 people) 2006-2013 for Tropical and Temperate climate zone**

<table>
<thead>
<tr>
<th></th>
<th>Tropical Zone (23°27'N-23°27'S)</th>
<th>Temperate climate Zone (&gt;23°27'N and S)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GINI coefficient 2004y</strong></td>
<td>N Mean* Std. Dev. Std. Error Mean</td>
<td>N Mean* Std. Dev. Std. Error Mean</td>
</tr>
<tr>
<td>LN HOM 2006-13y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GINI 2004y≥ 46</td>
<td>28</td>
<td>2.39</td>
</tr>
<tr>
<td>GINI 2004y&lt; 46</td>
<td>29</td>
<td>1.73</td>
</tr>
<tr>
<td><strong>Levene’s Test for Equality of Variances</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal variances assumed</td>
<td>F 0.005  Sig. 0.94  df 1  Sig. (2-tailed)</td>
<td>F 2.206  Sig. 0.14  df 1  Sig. (2-tailed)</td>
</tr>
<tr>
<td>Equal variances not assumed</td>
<td>F 2.35  Sig. 0.54  df 1  Sig. (2-tailed)</td>
<td>F 2.91  Sig. 0.05  df 1  Sig. (2-tailed)</td>
</tr>
</tbody>
</table>

**Note:** LN is logarithm; GINI2004y = Income Gini coefficient 2004; *= HOM2006-13y= Intentional homicides (per 100,000 people) 2006-2013.

OLS estimation for Tropical and Temperate climate zone produces the results in table 9 that shows positive coefficients of regression for linear models. In particular, Tropical zone with hot climate indicates that a 1% higher income inequality, *ceteris paribus* latitude (proxy of climate and temperature), increases the expected violent crime measured with Intentional homicides (per 100,000 people) by about 2.5% (model 2)! Similar results for Temperate climate areas.

**Table 9. Regressions of Intentional homicides (per 100,000 people) equations for Tropical and Temperate climate zone**

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Gini coefficient of income inequality</th>
<th>Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Models for Tropical areas (23°27'N-23°27'S)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F (Sign.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Gini coefficient of income inequality 2004y

-5.73* (2.55) 2.05** (0.67) -- 0.13 9.32

2. Gini coefficient of income inequality 2004y; Latitude

-7.62** (2.66) 2.52*** (0.69) 0.02* (0.01) 0.18 6.96
Overall then, the statistical evidence shows the systematic differences of arithmetic mean of intentional homicides (per 100,000 people) between countries with high and low socioeconomic inequality, fixed (i.e. controlling) the latitude (Climate factor). These results here seem in general to support the hypothesis stated that the high violent crime can be explained with the economic inequality, controlling the climate of countries, both in Tropical and in Temperate climate zone.

5. Discussion

The heat hypothesis in social psychology makes a clear prediction that warmer regions should have higher aggression rates (Anderson & Anderson, 1996, p.745). However, the study here shows that, controlling the climate factor, high violent crime at country level can be explained by high income inequality, which has high values in warmer geoeconomic areas. Why income inequality is higher in countries with hot climate, e.g. Tropical zone? One of contributing factors seems to be the historical developmental paths. Acemoglu et al., (2001) argue that in regions where Europeans faced very high mortality rates, such as Tropical zones with hot temperature and Malaria, they could set up extractive states with the intention of transferring resources rapidly to the metropole. These institutions were detrimental to investment, rule of law and economic progress of these regions and persisted to the present (Acemoglu et al., 2001, p.1395). These determinants of whether Europeans could go and settle in these regions with high mortality and hot temperature, therefore, have had negative effects on historical developmental paths of countries and their institutions today: current low economic growth, democratization, high poverty and socioeconomic inequality have created aversive environments that lead to high criminality in society (cf., Ferreira et al., 2016; Hsieh & Pugh, 1993; Fajnzylber et al., 2002). This argument of detrimental institutions and rule of laws in countries with hot temperature, due to historical developmental paths, can also explain the question by Anderson & Anderson (1996) of how heat may have contributed to the development of a southern culture of violence. In short, the statistical analysis here seems to show that income inequality, ceteris paribus climate, can lead to aversive environments and violent crime as a result. Mutatis mutandis, the socioeconomic inequality can also explain the high crime rate within specific areas of cities with problematic socioeconomic factors (cf., Cahill & Mulligan, 2003). This result is consistent with the socioeconomic literature that high rates of homicide tend to be positively and significantly associated to high levels of inequality in the distribution of income despite an extensive list of conceptually relevant controls (Messner & Rosenfeld, 1997; Lee & Bankston, 1999, Daly et al., 2001; The Equality Trust, 2011). Elgar & Aitken (2010) also confirm that inequality is related to homicide independently of local context.

Now a question is: why and how economic inequality induces to high growth rates of intentional homicide despite controlling factors such as climate? We now move on to discuss and explain the relation between economic inequality, human

<table>
<thead>
<tr>
<th>Models for Temperate climate areas Zone(&gt;23°27’N and S)</th>
<th>Constant $\lambda_0$ (St. Err.)</th>
<th>coefficient $\lambda_1$ (St. Err.)</th>
<th>coefficient $\lambda_2$ (St. Err.)</th>
<th>$R^2$ (St. Err. of the Estimate)</th>
<th>F (Sign.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gini coefficient of income inequality 2004y</td>
<td>$-8.39^{***}$ (1.52)</td>
<td>$2.61^{***}$ (0.43)</td>
<td>--</td>
<td>0.35</td>
<td>37.01</td>
</tr>
<tr>
<td>2. Gini coefficient of income inequality 2004y</td>
<td>$-9.12^{***}$ (2.18)</td>
<td>$2.80^{***}$ (0.58)</td>
<td>0.002</td>
<td>0.35</td>
<td>18.40</td>
</tr>
</tbody>
</table>

Note: ***=Coefficient is significant at $p<0.001$; **=Coefficient is significant at $p<0.01$; *=Coefficient is significant at $p<0.05$. 
behavior and violence, trying, as far as possible, to clarify the problem just mentioned. Socioeconomic inequality tends to increase mainly in regions with a higher population density and a lower level of household income with subsequent increase of residential crime (cf., Cahill & Mulligan, 2003; Christens & Speer, 2005). This positive correlation between higher population density, income inequality and crime can be also explained with the association between high density of people and poverty (Curtis, 1975). In fact, high growth rates of population generate a high number of young population that, in the presence of poverty and high economic inequality, can be unable to achieve valued goals. Data show that Population ages 0-14 (% of total) in 2003 was 37.6 in Tropical zones and 24.3 in Temperate climate zones. The “blockage of goal-seeking behavior” (Agnew, 1985, passim) of young people is a source of frustration and in certain environments that are aversive and painful may stimulate aggressive behavior and violence (Mackintosh et al., 1975; Altman, 1975; Baldassare, 1975; Verbrugge & Taylor, 1980; Agnew, 1985). In other words, high density of population and the unbalanced growth of geoeconomic system in the space (Hirshman, 1969) generate income inequality that negatively influences social relations and leads to deteriorated human functioning and violence (Baum & Paulus, 1991; Regoezzi, 2003, p.457; cf., Altman, 1975; Lepore et al., 1991). The relationship between inequality and crime is also explained with sociological theories on crime, such as the theory of “relative deprivation”: inequality breeds social tensions and the less well-off individuals feel dispossessed when compared with wealthier people (Stack, 1984). Hsieh & Pugh (1993) argue that poverty and income inequality are an indicator of resource deprivation, which is associated to homicide. Arthur (1991) also finds that the homicides can be explained with an individual’s reaction to resource deprivation or material disadvantage that causes subsequent personal frustration and diffuse hostility (cf., Nettler, 1984, p.229). Stolzenberg et al., (2006) confirm that sociological explanations of crime are based on economic deprivation that acts as a motivational factor in the manifestation of crime. In short, economic inequality engenders resentment, hostility, frustration, and is a precipitating factor in the impetus of criminal behavior (Blau & Blau, 1982). Messner & Golden (1992) extend the arguments by Blau & Schwartz (1984) with the thesis of the “relative deprivation’ …the consciousness of the disadvantaged, their realization of their common economic interests, and that the inability of the disadvantaged to get a fair redistribution of resources, or more open access to wealth, generates anger and frustration, which ultimately leads to more crime” (Stolzenberg et al., 2006, p.304, original emphasis). This socio-psychological foundation of relative deprivation due to high income inequality “reduces one's ability to compete for scarce jobs by imposing standards of competition that those individuals cannot realistically be expected to meet, and, therefore, it is directly related to involvement in crime and violence as those individuals adapt to that reality in any way they can” (Kovandzic et al., 1998, p.590). The feeling of disadvantage and unfairness leads the poor people to seek compensation and satisfaction by all means, including committing crimes against both poor and rich individuals (Fajnzylber et al., 2002). In other words, economic inequality generates crime via psychosocial processes based on negative social interactions, human behavior and sense of control over one's life, combined with loneliness, tension, anxiety and depression (cf. Elgar & Aitken, 2010). According to Gillan (2001), the inequality affects personality of people generating disrespect, loss of face and humiliation which are amongst the most common triggers to violence. Daly et al. (2001) confirm that the distribution of wealth, rather than level of wealth, influences rates of murder and manslaughter. In addition, the relationship income inequality and violent crime in specific tropical and temperate zones can also generate a reverse causality because rising crime rates affect inequality by encouraging richer residents to move out of violent locations (Enamorado et al., 2016). Hence, economic inequality and other socioeconomic
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factors, even after the climate is controlled, increase the poverty and cultural deviance that generate high rates of violent crime (Regoezzi, 2003).

6. Concluding observations

On the basis of the argument presented in this paper, we can therefore conclude that one of the sources of violent crime across countries can be also explained by high levels of economic inequality, ceteris paribus latitude (a proxy of climate and temperature). This socioeconomic factor could be a useful competitor variable for a destructive testing of the heat hypothesis to increase the likelihood of a theoretical links in social psychology between high economic inequality and crime rates across countries to explain aggressive behavior of humans. As a matter of fact, the hot climate can be an illusory cause of mental stress and deteriorated human functioning leading to violence, because the hot temperature may not be an environmental stressor per se, whereas a high socioeconomic inequality can lead to aversive environment, frustration, anger and violent crime in problematic geoeconomic areas, ceteris paribus the climate.

To sum up, the contributions of this study are that:

(1) The conceptual framework here assigns a central role to income inequality to explain deteriorated human functioning conducive to violent crime;

(2) The conceptual framework here is able to explain the source of high violent crime by high levels of income inequality both in Tropical and in Temperate climate areas. This socioeconomic stressor of inequality can be generalized, whenever possible, to explain the source of violence between and within countries and cities, controlling the climate factor;

(3) Societies with low socioeconomic inequality, high standard of living, quality of life and multiple opportunities for advancement of young generations are not likely to produce violent crime, ceteris paribus the climate.

(4) One future scenario might be that the increasing economic inequality within and between countries (World Bank, 2013) can feed high rates of violent crime for many years to come.

Programs of economic aid for one or more societies/cities/communities with high economic and social inequality would be appropriate policies to reduce this socioeconomic stressor and, as a consequence, the environmental violence. In fact, a political economy of growth directed to poor societies can increase economic prosperity to lower the economic inequality that set the stage for aversive environments and cultural deviance leading to violent crime over the long run. Fajnzylber et al., (2002) also claim that the growth rate and distribution of income reduce the poverty, and the rate of poverty alleviation has a crime-reducing effect. Some scholars also argue that crime levels are expected to decline in the future because of investment in R&D and research labs, technology transfer, improved enforcement technologies and possible rising economic growth, but these expected results have to be considered together with other factors such as the possible increase of income inequality, population growth, public debt, recessions and economic turmoil, migration flows, global warming, etc.¹.


conclusions of this study are tentative because we know that complex drivers of aggressive behavior in society are often not equal over time and space. The study here to analysis did not permit some intervening variables that may have been useful in providing a deeper and richer explanation of these phenomena of interests. Hence, much work remains if we are to understand in more depth the reasons for and the implications of environmental stressors of human behavior conducive to violent crime. To conclude, there is need for much more detailed research into the relations among geographical, socioeconomic and cultural factors and human behavior to explain the comprehensive drivers of cultural deviance and violence in society.
### Table 1A. Descriptive statistics of all countries

<table>
<thead>
<tr>
<th></th>
<th>Intentional homicides (per 100,000 people) Average 2006-2013y</th>
<th>LN Intentional homicides (per 100,000 people) Average 2006-2013y</th>
<th>GDP per capita PPP 2006y</th>
<th>LN GDP per capita PPP 2006y</th>
<th>GINI coefficient 2004y</th>
<th>LN GINI coefficient 2004y</th>
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<tr>
<td><strong>N</strong></td>
<td>Valid 191 Missing 8</td>
<td>183 Missing 8</td>
<td>191 Valid 0</td>
<td>191 Missing 0</td>
<td>126 Valid 126</td>
<td>126 Valid 126</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>7.62 Missing 1.44</td>
<td>7455.72 Missing 7.82</td>
<td>7.82 Valid 10.14</td>
<td>80.14 Valid 40.14</td>
<td>65 Valid 65</td>
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<tr>
<td><strong>Std. Deviation</strong></td>
<td>10.78 Missing 1.14</td>
<td>10780.67 Missing 1.60</td>
<td>10.36 Valid 0.25</td>
<td>25.00 Valid 0.25</td>
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<tr>
<td><strong>Skewness</strong></td>
<td>3.12 Missing -0.49</td>
<td>2.81 Missing -0.97</td>
<td>0.63 Valid 0.16</td>
<td>16.00 Valid 0.16</td>
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</tr>
<tr>
<td><strong>Kurtosis</strong></td>
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<td>-0.97 Missing -0.75</td>
<td>3.66 Valid -0.75</td>
<td>0.25 Valid -0.75</td>
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</table>

### Table 2A. Descriptive statistics for Tropical and Temperate climate zone

<table>
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<tr>
<th>Tropical Zone</th>
<th>Intentional homicides (per 100,000 people) Average 2006-2013y</th>
<th>LN Intentional homicides (per 100,000 people) Average 2006-2013y</th>
<th>GDP per capita PPP 2006y</th>
<th>LN GDP per capita PPP 2006y</th>
<th>GINI coefficient 2004y</th>
<th>LN GINI coefficient 2004y</th>
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<tr>
<td><strong>Tropical Zone</strong></td>
<td>Intentional homicides (per 100,000 people) Average 2006-2013y</td>
<td>LN Intentional homicides (per 100,000 people) Average 2006-2013y</td>
<td>GDP per capita PPP 2006y</td>
<td>LN GDP per capita PPP 2006y</td>
<td>GINI coefficient 2004y</td>
<td>LN GINI coefficient 2004y</td>
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<tr>
<td>(23°27’N-23°27’S)</td>
<td>103 Missing 98</td>
<td>98 Missing 5</td>
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<td>103 Missing 0</td>
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<td>3343.19 Missing 7.13</td>
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<td>3.18 Missing 0.29</td>
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<td><strong>Temperate climate Zone</strong> (&gt;23°27’N and S)</td>
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<tr>
<td><strong>Std. Deviation</strong></td>
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Appendix B. Box Plot of variables

Figure 1B. Box plot of intentional homicide and Gini coefficient in Tropical zone

Figure 2B. Box plot of intentional homicide and Gini coefficient in Temperate zone

Table 1B. Statistics

<table>
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<td>Tropical Zone (23°27'N-23°27'S)</td>
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<td>103</td>
<td>59</td>
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<td>75</td>
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<td>Non-tropical Zone (5°27'N and S)</td>
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<td>Homicide Average 2006-13</td>
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