TEXTO PARA DISCUSSÃO

No. 600

The Welfare Cost of Homicides in Brazil: Accounting for Heterogeneity in the Willingness to Pay for Mortality Reductions

Daniel R. C. Cerqueira
Rodrigo R. Soares

PUC RIO

DEPARTAMENTO DE ECONOMIA
www.econ.puc-rio.br

The Welfare Cost of Homicides in Brazil: Accounting for Heterogeneity in the Willingness to Pay for Mortality Reductions*

Daniel R. C. Cerqueira†

and

Rodrigo R. Soares‡

June 2012

Abstract

This paper estimates the health dimension of the welfare cost of homicides in Brazil incorporating age, gender, educational, and regional heterogeneities. We use the marginal willingness to pay approach from the "value of life" literature to assign monetary values to the welfare cost of increased mortality due to violence. The results indicate that the present discounted value of the welfare cost of homicides in Brazil corresponds to roughly 78% of the GDP or, measured in terms of yearly flow, 2.3%. The analysis also indicates that reliance on aggregate data to perform such calculations, without taking into account the relevant dimensions of heterogeneity, can lead to biases of the order of 20% in the estimated social cost of violence.

Keywords: marginal willingness to pay, welfare, cost, violence, value of life, Brazil
JEL Codes: I18, J17, K42, O57

---

* This paper benefited from comments from João M. P. De Mello, Claudio Ferraz, Leandro Piquet, Leonardo Rezende, Fernando Veloso, and seminar participants at IPEA-Rio, PUC-Rio, and the 2011 Meeting of the Brazilian Econometrics Society.
† Institute of Applied Economic Research (IPEA), Brazil; contact info: *daniel.cerqueira* at *ipea.gov.br*
‡ Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Brazil, and IZA; contact info: *soares* at *econ.puc-rio.br*

1. Introduction

The so-called value of life literature has experienced a major renewal in recent decades. After seminal theoretical contributions by Schelling (1968), Usher (1973), Arthur (1981), and Rosen (1988), it was eventually translated into an empirically usable framework that was applied to a broad set of questions concerning welfare gains from mortality reductions. These questions encompassed issues such as welfare gains from medical innovations, overall welfare inequality across and within countries, the value of health improvements for future generations, markets for organ transplants, and the welfare cost of violence, among various others (see, for example, Becker and Elías, 2007, Becker, Philipson, and Soares, 2005, Bergstrom, 1982 and 2006, Cropper and Sussman, 1988, Garrett, 2001, Jones-Lee, 1992, Murphy and Topel, 2003 and 2006, Nordhaus, 2003, and Soares, 2006 and 2007). Its basic logic advocates the use of economic models calibrated with information from value of statistical life estimates to calculate the willingness to pay of a certain population for observed or hypothetical changes in mortality rates.

An important issue often overlooked in the majority of this body of work is the potential effect of heterogeneity on estimates of willingness to pay for mortality reductions. Willingness to pay numbers for a certain good can be interpreted as marginal rates of substitution between money and the respective good. Therefore, with longevity as a normal good, the willingness to pay for a given reduction in mortality rates increases with income levels. Apart from the philosophical questions raised by this relationship, it constitutes a problem for empirical applications. First, mortality rates for specific conditions are not uniformly distributed across age groups, genders, educational levels, or regions of residence. For a given cause of death, along some of these dimensions there may be a negative relationship between income and mortality, while along others there may be a positive one. In addition, willingness to pay is typically not linear on income, so that, even for uniformly distributed mortality rates, redistributions of income across groups may change aggregate willingness to pay numbers. Therefore, in principle, it is difficult to draw general conclusions on how the incorporation of heterogeneity would affect estimates of the willingness to pay for health improvements.

Heterogeneities in mortality are particularly salient for the case of violence in a country like Brazil. In this context, death rates due to violence are orders of magnitude larger for males than for females, for young adults than for children or the elderly, and for the uneducated than for the educated (numbers presented in the next sections). Because of the typical income profiles observed, heterogeneities along some of these dimensions (educational levels) tend to reduce aggregate willingness to pay for violence reductions, while heterogeneities along others (genders, age groups) tend to increase it. On top of it, Brazil has one of the highest levels of income inequality in the world (Gini coefficient of 54.7 in 2009 according to the World Bank's World Development Indicators), so that ignoring income heterogeneity by itself may lead to biased estimates of the willingness to pay for violence reductions.

In this paper, we estimate the welfare cost of homicides in Brazil based on the marginal willingness to pay of individuals to avoid the risk of premature death by murder. The analysis developed in the paper follows the same line of research proposed by Soares (2006), who estimates the welfare cost of violence for a large number of countries using the value of life methodology. But in order to be able to provide estimates for a large number of countries, Soares (2006) abstracts almost entirely from within country heterogeneities in the incidence of mortality by violence. Here, instead, we focus on a single country and account for all dimensions of heterogeneity of income and mortality that can be inferred from the data: age, gender, educational level, and geographic region.

Using information from household surveys, we calibrate lifetime profiles of income for different genders, educational levels, and regions. Then, using death registration records to compute mortality rates by violence and overall mortality for these same groups, we estimate the aggregate willingness to pay for reductions in mortality due to violence. Our results suggest a significant loss of welfare due to the reduction in life expectancy caused by deadly violence, equivalent to 78% of the GDP in terms of discounted present value, or 2.3% in terms of yearly flow. Because of the sizeable differences in the prevalence of homicides across ages, regions of residence, genders, and educational levels, this estimated value changes substantially depending on whether such characteristics are accounted for. Ignoring heterogeneities in gender, education, and state of residence can lead to biases of up to 23% in the estimated welfare cost of violence.

There are three main approaches in the estimation of the welfare cost of violence: accounting, contingent valuation, and hedonic pricing. In the accounting methodology, expenditures and other costs associated with crime and the public security system are added together to generate numbers on the total observed costs of violence. There is a vast number of studies that use this strategy, such as Anderson (1999), Brand and Price (2000), and Mayhew (2003), who estimate the economic and social costs of crime in the US, England and Wales, and Australia, respectively. Similar exercises were undertaken by Londoño and Guerrero (2000) for Latin America, and Cerqueira et al (2007) for Brazil. Alternatively, in the contingent valuation method, individuals are asked directly to reveal their willingness to pay to avoid risks of victimization. Examples of studies using the contingent valuation strategy include Cook and

Ludwig (2000), Ludwig and Cook (2001), Cohen et al (2004), and Atkinson et al (2005), who estimate the value of preventing gun violence and violent crime. Finally, in the hedonic pricing strategy, the valuation of individuals with respect to exposure to violence is estimated based on market behavior, typically from the effect of violence in an area on real estate prices and rental rates. The first work to adopt this methodology was Thaler (1978), who analyzed the case of Rochester, NY. Several authors, such as Hellman and Naroff (1979), Clark and Cosgrove (1990), Lynch and Rasmussen (2001), and Besley and Mueller (2012), follow this same original idea.

Our approach is based on the value of life methodology, which is a marginal willingness to pay strategy stemming from the health economics literature. It uses hedonic pricing from labor market estimates of compensating differentials for mortality risks (see a review in Viscusi and Aldy, 2003) to calibrate the parameters of an economic model. The advantage of this strategy is that, once calibrated, the model can then be used to generate counterfactual marginal willingness to pay numbers for any change in mortality rates. In particular, it can be used to generate estimates of the gain in welfare that would be achieved with the elimination of violent deaths, or, in other words, an assessment of the mortality dimension of the welfare cost of violence. This approach was first applied to calculate the welfare cost of violence by Soares (2006), in an initial study that covered 73 countries but abstracted from most of the within country heterogeneities in mortality and income.

We believe that the current paper contributes to the literature in two ways. First, it provides, for the case of Brazil, a much more precise estimate of the mortality dimension of the welfare cost of violence. For that matter, the exercise proposed is likely the most careful application of the value of life strategy to the welfare cost of violence currently available, irrespective of the country in question. It can, therefore, be seen as a guideline for the future use of the methodology in this context. Second, it discusses in detail an example of the potential consequences of heterogeneities in estimates of the willingness to pay for mortality reductions. So our exercise can also be seen as a cautionary tale on the potential implications of ignoring heterogeneities in mortality and income for value of life calculations.

The remainder of the paper is structured as follows. In Section 2, we present the theoretical model used to produce our willingness to pay numbers. In Section 3, we describe the data used and our calibration strategy. In Section 4, we present and analyze the results. Finally, section 5 concludes the paper.

2. Theoretical Model

The model presented here follows closely the approach developed by Rosen (1988), Murphy and Topel (2003), and Soares (2006). One fundamental difference with respect to Soares (2006) is that we assume that homicides affect differently the various population subgroups, having therefore heterogeneous effects on life expectancy at birth. We define the conditional survival function as $S(t \mid a, g, e, s, v)$, indicating the probability that an individual of age *a*, gender *g*, educational level *e*, residing in state *s*, lives until age *t*. Furthermore, we assume that each individual of a population subgroup is subject to a certain rate of victimization *v*, which affects the probability of future survival.

The individual's life-cycle utility is the discounted value of the instantaneous utility from consumption in each period of life (*u(c)*), as described in equation (1) below. In this context, instantaneous utility is discounted by the intertemporal discount rate (β) and by the probability of survival $S(t \mid a, g, e, s, v)$. Assuming discrete time, the lifetime utility can be written as[1]

$$U(a) = \sum_{t=a}^{\infty} \beta^{(t-a)} S(t \mid a,g,e,s,v) u(c_{t,a,g,e,s}). \tag{1}$$

For tractability, we follow the literature and assume the existence of a complete contingent claims market, so that individuals have access to a fair insurance. Defining A_a as the accumulated wealth of an individual at age *a* and $y_{t,a,g,e,s}$ as the earnings of an individual with initial characteristics *(a,g,e,s)* at age *t*, the budget constraint can be written as

$$A_a + \sum_{t=a}^{\infty} \left(\frac{1}{1+r} \right)^{(t-a)} S(t \mid a,g,e,s,v) y_{t,a,g,e,s} = \sum_{t=a}^{\infty} \left(\frac{1}{1+r} \right)^{(t-a)} S(t \mid a,g,e,s,v) c_{t,a,g,e,s}. \tag{2}$$

Optimal choices for instant *t* imply the first-order condition described in equation (3) below,[2] where $\lambda_{a,g,e,s}$ is the Lagrangian multiplier for an individual with initial age *a*, gender *g*, educational level *e*, living in state *s*:

$$\beta^{(t-a)} u'(c_{t,a,g,e,s}) = \lambda_{a,g,e,s} \left(\frac{1}{1+r} \right)^{(t-a)}. \tag{3}$$

---

[1] The model assumes implicitly that the utility of death is normalized to zero, as discussed by Rosen (1988).

[2] The solution of the program should make it clear that we take the level of violence as a given, ignoring general equilibrium effects and other welfare considerations associated with changing consumption patterns and inefficient allocation of resources for violence prevention.

Defining *V(a,g,e,s)* as the value function for the problem of an individual with characteristics described by the vector *(a,g,e,s)*, the willingness to pay for a change in the survival function due to reduced violence is given by

$$MWP_{a,g,e,s} = \frac{\partial V(a,g,e,s)}{\partial S}\frac{\partial S}{\partial v}\frac{1}{\lambda_{a,g,e,s}}$$

From the envelope theorem, this expression can be rewritten as

$$MWP_{a,g,e,s} = \frac{\sum_{t=a}^{\infty}\beta^{(t-a)}u(c_{t,a,g,e,s})S(t\,|\,a,g,e,s,v)}{\lambda_{a,g,e,s}} + \sum_{t=a}^{\infty}\left(\frac{1}{1+r}\right)^{(t-a)}[\,y_{t,a,g,e,s} - c_{t,a,g,e,s}\,]S_v(t\,|\,a,g,e,s,v).$$

where $S_v(t\,|\,a,g,e,s,v)$ represents the impact of reduced violence on the survival function. Defining *ε(c)* as the consumption elasticity of the instantaneous utility function and using the first order conditions, it follows that

$$MWP_{a,g,e,s} = \sum_{t=a}^{\infty}\left(\frac{1}{1+r}\right)^{(t-a)}\left[\frac{c_{t,a,g,e,s}}{\varepsilon(c_{t,a,g,e,s})} + y_{t,a,g,e,s} - c_{t,a,g,e,s}\right]S_v(t\,|\,a,g,e,s,v). \tag{4}$$

It is important to understand what this expression means in terms of the determinants of *MWP*: (i) the closer the individual is to the moment of a given mortality reduction, the higher his *MWP*, since the future is discounted at a positive rate; and (ii) the higher the consumption and savings at the time when reductions in mortality occur, the higher the *MWP*, since higher income is used to generate instantaneous welfare and to “finance” consumption in other periods of life. Therefore, one can think of the value of a given pattern of reductions in mortality as being determined by three factors: the reduction in mortality itself, the welfare level in the moment of survival gains, and the “excess” income (savings) in that same moment.

Given the typical age profile of homicides, with a high concentration among young adults (see, for example, Legge, 2008, and Hunnicutt, 2004), $MWP_{a,g,e,s}$ should start at a low value when the individual is born and increase with age. This would occur not only because the individual approaches the moment when victimization is most likely, but also because individual income — and savings — increases with age until late adulthood. After the age at which homicides are most prevalent, smaller increments in survival would tend to be compensated, at least during some years, by higher savings. Finally, at some point, both prospective gains in life expectancy from violence reduction and future income would be lower, leading to a smaller

$MWP_{a,g,e,s}$. By a similar logic, we should expect $MWP_{a,g,e,s}$ to be higher for males than for females, since men have typically higher earnings and higher probabilities of victimization.

From equation (4), one can compute the social marginal willingness to pay to reduce violence (*SMWP*). This is defined simply as the aggregate value of violence reduction for the population currently alive plus the discounted value for future cohorts:

$$SMWP = \sum_{s=1}^{n_s}\sum_{g=1}^{n_g}\sum_{e=0}^{n_e}\sum_{a=0}^{\infty} MWP_{a,g,e,s} P_0(a,g,e,s) + \sum_{s=1}^{n_s}\sum_{g=1}^{n_g}\sum_{e=0}^{n_e}\sum_{\tau=1}^{\infty} MWP_{0,g,e,s}\left(\frac{1}{1+r}\right)^{\tau} P_\tau(0,g,e,s), \tag{5}$$

where $P_0(a,g,e,s)$ corresponds to the population with characteristics (a,g,e,s) at the present moment, i.e., $\tau = 0$, and n_i refers to the number of groups considered in attribute i.

The second term on the right hand side captures the gains, discounted at interest rate r, that future generations will enjoy from reductions in homicide rates. The term $P_\tau(0,g,e,s)$ refers to the population with characteristics (g,e,s) to be born in each future year $(\tau > 0)$. The expression above is analogous to that used to characterize the optimal provision of public goods in the traditional public finance literature once future generations are accounted for. Though there are more complicated alternatives to incorporate future populations in value of life calculations (see, for example, Birchenal and Soares, 2009), the strategy adopted here has been the dominant one in empirical applications in the area (see Murphy and Topel, 2003 and 2006, and Soares, 2006). Our specific assumptions in order to calibrate the expressions above are explained in detail in the next section.

3. Empirical Strategy and Calibration

3.1 Data

To estimate the social value of reductions in homicides in Brazil, we use data from various sources. The information on mortality for 2007 was obtained from the Brazilian Ministry of Health's *Sistema de Informações de Mortalidade* (SIM/DATASUS), which follows the 10th revision of the International Classification of Diseases. For each death, we identified the cause that generated the first morbid process (i.e., aggression),[3] place of residence, gender and educational group.[4] The populations for each subgroup of categories (state, gender and

[3] Subcategories X850 to Y09.

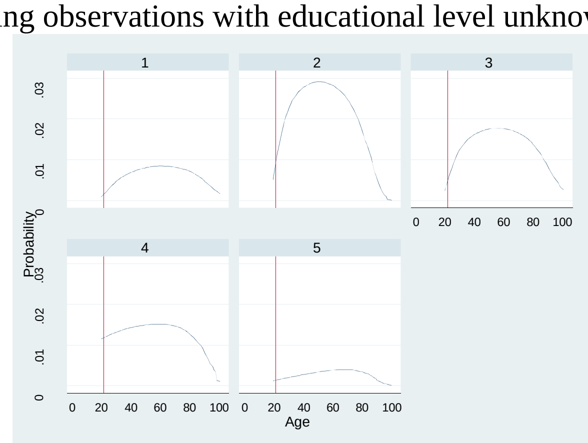
[4] Educational groups in the mortality database are defined as follows: 1 = 0 years of education; 2 = 1 to 3 years of education; 3 = 4 to 7 years of education; 4 = 8 to 11 years of education; and 5 = more than 11 years of education.

education) were obtained from the 2007 Brazilian household survey (PNAD).[5] The earnings for each subgroup of the population were estimated based on the household surveys for the years 2006, 2007, and 2008. The specific procedure adopted to estimate these earnings is outlined in detail in the following pages. Additionally, to account for future populations, we used the population projections through year 2050 from the Brazilian Census Bureau (IBGE).

Regarding the mortality data, a central question concerns information on the educational level of the victim. For homicides that occurred in 2007, educational level of the victim was unreported or unknown in 35.6% of cases. In principle, two procedures could be adopted to address this problem: (i) some imputation for missing data, based on the joint distribution of other characteristics of the population in the data; and (ii) setting education of these individuals to zero. On the assumption that those with unreported educational levels in their death certificates are, conditional on observables, more likely to be of lower socioeconomic strata, both these procedures would lead to biased estimates of the true educational distribution: the first would tend to overestimate the true educational level of victims, while the second would tend to underestimate it.

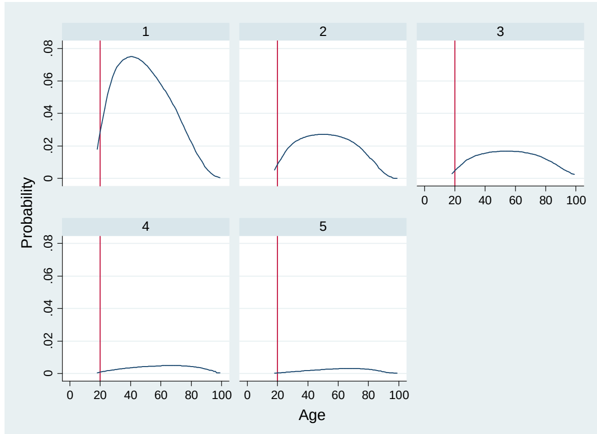
This fact is made clear in Figures 1 and 2, where we present the counterfactual numbers on survival probabilities when homicide rates are set to zero throughout the life cycle for each educational group. The difference between the two figures is that, in the first, we simply ignore individuals with unknown educational level, while, in the second, we assign these individuals to the lowest educational level.

Figure 1: Impact of the elimination of violence on the probability of survival by age and education group – Ignoring observations with educational level unknown – Brazil, 2007



[5] Subpopulations for each demographic group from the PNAD 2007 are proportionally adjusted according to aggregate numbers from the Brazilian census bureau (IBGE), in order to render the aggregate numbers from our estimates consistent with the aggregate official projections from IBGE.

Figure 2: Impact of the elimination of violence on the probability of survival by age and education – Setting educational level unknown to 0 years of schooling – Brazil, 2007



Note that, apart from the lowest educational level,[6] the impact of violence on the probability of survival in Figure 1 decreases with education. However, in the first figure, the smallest impact of violence appears precisely for those individuals without education. This seems odd, since individuals with no education are precisely those who have the least means to protect themselves or to move away from an environment where violence is prevalent. In Brazil, it has been widely documented that individuals from lower socioeconomic strata are the ones most exposed to violence (see, for example, Soares, 2007).

In the second figure, when we assign those with unknown education to the lowest educational level, the odd non-monotonic pattern from Figure 1 disappears. Given this pattern, and in order to obtain a conservative lower bound for the welfare cost of homicides in Brazil, we adopted this second strategy.

To estimate individual income by gender, age, educational level, and state of residence, we use a local regression method known as LOWESS (locally weighted scatter-plot smoothing). The advantage of this method is that there is no need to impose a parametric structure defined a priori, which could generate discrepancies in income when certain values of independent variables are combined.

Based on the 2006, 2007 and 2008 household surveys (PNAD), we calculate the income of individuals[7] measured in January 2010 prices. Then, we divide the database into 54 sub-samples for each of 27 states and 2 genders. For each of these sub-samples, we apply a LOWESS

[6] 1 = 0 years of education; 2 = 1 to 3 years of education; 3 = 4 to 7 years of education; 4 = 8 to 11 years of education; and 5 = more than 11 years of education.
[7] The variable used was V4720

algorithm[8] in order to obtain the predicted income for each combination of education and age. In the model, we assume that income is a function of a vector x of independent variables, which include age, years of study, and a random error ε_i, as in: $y_i = g(x_i) + \varepsilon_i$. The idea is that the value of y_i can be approximated locally by a regression that fits the data in a neighborhood of point x_0. The method of weighted least squares is used to fit linear or quadratic functions of the predictors at the center of the neighborhood of point x_0. One issue is the choice of the smoothing parameter that relates the size of the radius that encompasses a percentage of the data in the neighborhood of the point. The fitted values depend crucially on this smoothing factor. When this parameter is too low, the predicted value interpolates the data, albeit at the expense of a high variance. On the other hand, the variance can be decreased by increasing the value associated with the smoothing parameter. In LOWESS, the trade-off between variance and predictive power with acceptable goodness of fit is solved by choosing an optimal smoothing parameter. This is achieved using the Akaike information criterion, where this parameter is selected to minimize a function that depends on the log-variance as well as a term that penalizes excessive smoothing.

From these estimations, we generate predicted incomes for each population subgroup, which will be used to compute equation (4). Namely, we obtain lifetime earnings profiles by gender, educational level, and state of residence. One important point is that the mortality data provide only five levels of education, while the household data provide wages by years of schooling. In order to exploit the more detailed information available from the household survey, we assume that the likelihood of survival is the same for individuals within the same broad educational category, even though incomes differ, given different years of schooling within the same broad educational category.

3.2 The Survival Function

The change in the survival function $S_v(t|a,g,e,s,v)$ measures the increased probability of survival up to age t, for an individual of initial age a, gender g, educational level e, and resident of state s. This can be expressed as the difference between the probability of survival in a counterfactual survival function where violent deaths are set to zero and the actual survival function:

$$S_v(t\,|\,a,g,e,s,v) = SNV(t\,|\,a,g,e,s,0) - S(t\,|\,a,g,e,s,v). \tag{6}$$

Note that, by definition, either of the two terms on the right side of equation (6) represent the joint likelihood that the individual survives from: age a to a+1, age a+1 to a+2, and so on,

[8] Within SAS, the method implemented is PROC LOESS. For further details see Cohen (1999) [httpp://support.sas.com/rnd/app/papers/loesssugi.pdf].

until age t. That is, considering the year-to-year probabilities of survival, it follows that *SNV(.)* and *S(.)* can be written as:[9]

$$S(t,a) = \prod_{i=a}^{t-1} S(i+1,i) \qquad \text{and} \qquad SNV(t,a) = \prod_{i=a}^{t-1} SNV(i+1,i) \tag{7}$$

The likelihoods of survival from one age to the next can be obtained based on mortality and demographic data as:

$$S(i+1,i) = 1 - \frac{N(i+1,i)}{P(i+1,i)}, \quad \text{and} \tag{8}$$

$$SNV(i+1,i) = 1 - \frac{N(i+1,i) - NV(i+1,i)}{P(i+1,i)}, \tag{9}$$

where *N(i+1,i)* stands for the number of deaths between ages i and $i+1$, *P(i,i+1)* for the population, and *NV(i,i+1)* for the number of deaths not attributable to homicides.

To compute the survival function, we first estimate the probabilities described in (8) and (9) for a given set of characteristics, i.e., gender, education, and state of residence. Following, based on (7), we calculate the probability that individuals at age $a = 0, 1, 2, ... t–1$ survive up to age t under the violence and no-violence scenarios. Finally, from (6), we calculate the counterfactual change in the survival function that would be attributable to the elimination of homicides.

Our innovation in relation to Soares (2006) is to compute the survival function taking into account regional, gender, and educational heterogeneities throughout the life cycle. As will be clear later on, homicides in Brazil affect predominantly individuals who are young, male, and uneducated. It is precisely the correlation between the prevalence of violence and income that is the source of potential biases in marginal willingness to pay calculations that abstract from heterogeneities.

However, the introduction of these heterogeneities imposes additional challenges, due to the fact that some individual characteristics may change over the lifecycle. The issue of education, in particular, is crucial, since homicides affect to a large extent young people, who perhaps have not yet completed their education. In other words, the relevant marginal willingness to pay is not that of an 11 year-old individual with primary education, but that of an individual who would attain a certain level of education when adult (or, alternatively, an individual who belongs to a social group expected to attain a certain level of education when reaching maturity).

[9] To save on notation, we omit the variables that identify population subgroups.

To address this question, we assume that the final distribution of education among the young population, when they reach adulthood, will reproduce the distribution of education of the cohort of young adults observed in 2007. This is yet another conservative assumption, since in recent decades Brazil has experienced a consistent increase in years of schooling. So it is likely that current youth will reach adulthood with higher educational levels than those observed among current adults. Specifically, we assume that the distribution of education among young people (below 25) will be the same as that of individuals currently aged 25. The choice is based on the fact that, by age 25, educational investments for the vast majority of the population have already been completed.

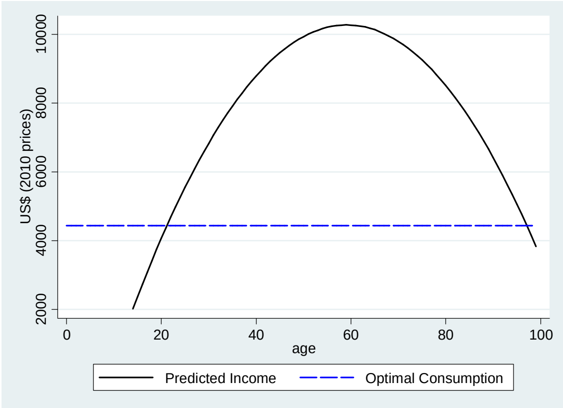
3.3 Calibration

To compute the *MWP*, we must take into account the individual life cycle decision regarding consumption and savings. Following Soares (2006) and other papers in this literature, we assume that $\beta = \frac{1}{1+r}$, so that, from the first order condition described in (3), we have $c_t = u'(\lambda_a)$. Setting $A_0 = 0$ and using the individual budget constraint, one can then calculate the optimal consumption throughout life for an individual with characteristics *(g,e,s)*, as determined by the optimal solution to the individual's problem at birth:

$$c_{t,0,g,e,s} = \bar{c}_{g,e,s} = \frac{\sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t S(t\,|\,0,g,e,s,v)\, y_{t,0,g,e,s}}{\sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t S(t\,|\,0,g,e,s,v)}. \qquad (10)$$

In order to illustrate this point, Figure 3 plots estimated average earnings in Brazil throughout the lifecycle and the corresponding level of yearly consumption derived from the model (abstracting from other dimensions of heterogeneity).

Figure 3: Lifecycle Earnings and Consumption in the Model



To calculate the *MWP* as indicated in equation (4), we follow Becker et al (2005) and Soares (2006) and assume that the instantaneous utility takes the form

$$u(c) = \frac{c^{1-1/\gamma}}{1-1/\gamma} + \alpha,$$

with α = –16.16 and γ = 1.25.[10] The interest rate is set to 3% per year in the calculations.

In the next section, we present the results obtained when we apply our strategy to the data. We start by ignoring heterogeneities in gender, educational group, and region of residence, and looking only at lifecycle considerations. We then follow on to incorporate sequentially the three additional dimensions of heterogeneity, each one separately at a time. In a final exercise, we incorporate the three dimensions of heterogeneity simultaneously.

4. Results

4.1 Accounting for Lifecycle Earnings and Mortality without Other Heterogeneities

In 2007, the homicide rate per 100,000 inhabitants in Brazil was 25.9. Violence that year was responsible for a loss in life expectancy at birth of 0.7 year. As made clear in Figure 4, homicides were heterogeneously distributed across the population, with the victimization of young adults – between ages 16 and 35 – being disproportionately high. Figure 4 also plots the age profile of the marginal willingness to pay for the elimination of violence (*MWP*), which reaches a maximum value of US$ 5,837 for individuals at age 37.[11] The homicide rate peaks in the early 20's, but *MWP* keeps growing after that due to increased income during prime ages. After age 37, income gains and victimization rates are much smaller, so that the *MWP* gradually falls.

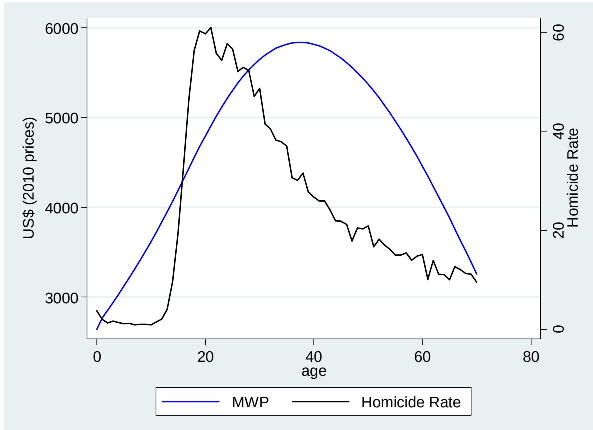
In this scenario, the social marginal willingness to pay (*SMWP*) of the current generation to avoid violence is around US$ 870 billion. Added to the value for future generations (US$ 205 billion), it results in a present discounted cost of homicides to society as a whole of the order of US$ 1,075 trillion, equivalent to 60.2% of the 2007 GDP. This indicator, however, represents the ratio of a stock (*SMWP*) to a flow (*GDP*). Calculating the equivalent flow value associated with

[10] As discussed in Becker et al (2005), two pieces of information are necessary to calibrate this instantaneous utility function: the inter-temporal elasticity of substitution and the consumption elasticity ($\varepsilon = u'(c)c/c$). The value of ε can be inferred from compensating differentials for occupational mortality risks, and Murphy and Topel (2003) estimate it to be 0.35. In relation to the inter-temporal elasticity of substitution, Browning et al (1999) suggest that it is probably slightly above 1. Becker et al (2005) use γ = 1.25, ε = 0.346 and c = 26,365 (data for the US) to calibrate the value of α.

[11] All monetary values are measured in January 2010 prices.

an annuity gives an yearly social cost of 1.8% of the GDP. The results from this subsection constitute the initial numbers used as reference in the remainder of the discussion in the paper.

Figure 4: Homicide Rates and Willingness to Pay over the Lifecycle – Brazil, 2007 – No Heterogeneity Scenario



4.2 Incorporating State Heterogeneity

When we conduct the same analysis allowing for state level heterogeneity in income and mortality due to violence, the total cost of homicides is lowered by 3.4 percentage points of the GDP, thereby corresponding to 56.8% of the 2007 GDP. Though there is not a strong correlation between income and victimization across states, this result arises from the unequal effects of the redistributions along these two dimensions once heterogeneity is accounted for.

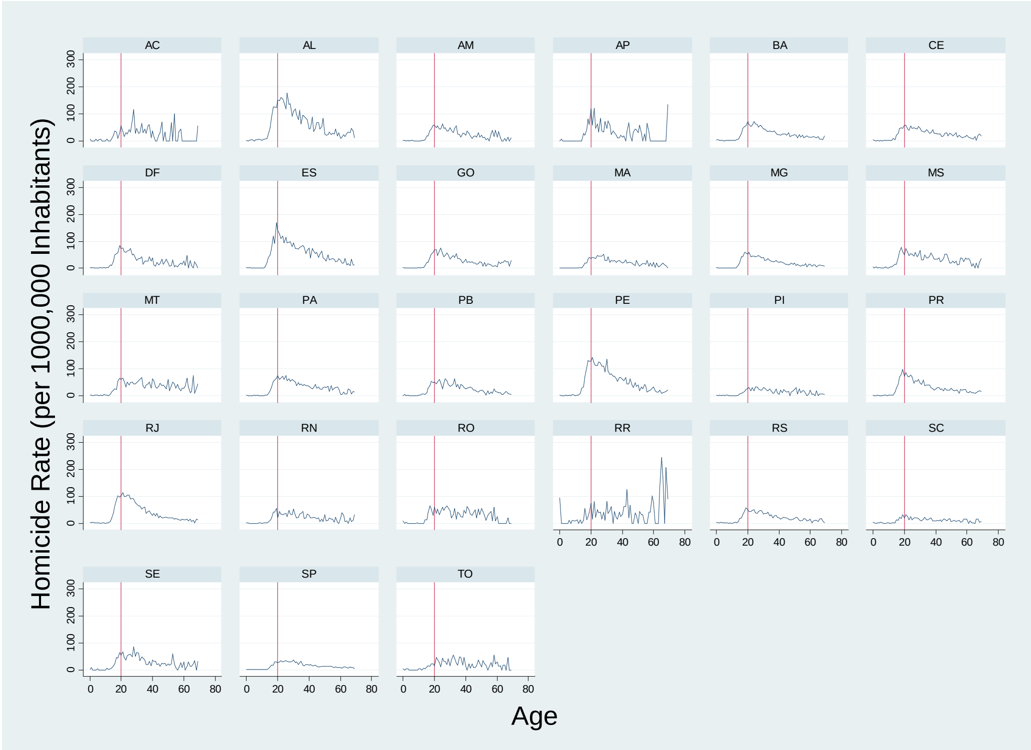
As shown in Table 1, there is great heterogeneity in the prevalence of violence across Brazilian states, with the mortality rate per 100,000 ranging from 11.6 in Santa Catarina (SC) to 61.4 in Alagoas (AL). These correspond to reductions in life expectancy at birth due to violence of, respectively, 0.31 and 1.67 year. The *MWP* at age 18, for example, ranges from US$ 1,666 in Piauí (PI), a state with low homicide rate and low income per capita, to US$ 10,980 in Distrito Federal (DF), a state with high homicide rate and high income per capita. A common thread in the profile of violence across Brazilian states, made explicit in Figure 5,[12] is the overwhelming concentration of mortality due to violence among young people, aged around 20. Considering the overall results, and taking the demographic structure into account, the largest and wealthiest states lead in terms of aggregate numbers. The social willingness to pay for violence elimination ranges from US$ 2.43 billion in Roraima to US$ 148.80 billion in São Paulo.

[12] Some states display mortality rates with a lot of variance over the lifecycle. This is mainly due to small populations. Exactly for the same reasons, these cases bear very little weight on the final aggregate numbers presented in the paper.

Table 1: Mortality due to Violence and Cost of Violence across Brazilian States – Brazil, 2007

State	Hom Rate	Life Exp	Life Exp without Violence	Life Years Lost to Violence	MWP at age 18 (US$)	SMWP of Current Generations (US$ billion)	SMWP of Future Generations (US$ billion)	Total SMWP (US$ billion)
SP	15.6	73.4	73.8	0.41	2,893.48	124.47	24.33	148.80
RJ	39.0	71.6	72.7	1.08	8,004.78	123.34	20.58	143.91
MG	22.0	73.6	74.2	0.61	3,667.93	72.75	15.74	88.50
PE	54.6	71.3	72.7	1.42	7,931.96	67.64	17.51	85.14
PR	31.0	72.2	73.1	0.83	6,286.28	64.79	14.49	79.29
BA	26.5	74.9	75.6	0.74	3,586.86	51.61	13.47	65.08
RS	21.3	73.2	73.8	0.59	3,992.33	44.33	8.98	53.31
PA	30.3	75.0	75.8	0.87	4,078.26	30.18	10.80	40.98
ES	54.8	72.4	73.8	1.46	8,627.48	30.98	7.05	38.02
DF	29.1	73.7	74.5	0.76	10,979.83	26.37	7.90	34.27
GO	26.9	73.4	74.2	0.71	4,458.93	26.60	6.76	33.36
CE	24.1	75.5	76.2	0.70	2,888.65	24.78	6.42	31.20
AL	61.4	71.6	73.3	1.67	7,628.95	23.76	6.25	30.01
MT	31.1	72.2	73.1	0.83	4,643.27	14.49	4.12	18.61
MA	18.5	77.0	77.6	0.58	2,060.90	13.41	4.17	17.59
MS	31.2	72.2	73.0	0.83	5,423.80	13.07	2.72	15.80
PB	24.4	73.6	74.3	0.67	3,385.94	12.45	3.18	15.63
AM	21.6	73.5	74.1	0.62	3,161.05	10.69	3.70	14.39
SC	11.6	72.9	73.2	0.31	1,960.88	12.11	2.18	14.28
RN	19.6	75.0	75.5	0.54	2,589.34	8.24	2.30	10.54
SE	26.5	72.4	73.1	0.70	3,092.72	6.42	1.87	8.29
RO	27.7	75.4	76.2	0.80	3,571.67	5.97	1.78	7.75
PI	13.5	74.9	75.3	0.38	1,666.24	5.44	1.48	6.92
TO	17.4	75.8	76.4	0.54	2,308.08	3.39	0.81	4.21
AP	27.1	76.6	77.5	0.83	3,888.54	2.48	0.99	3.47
AC	20.8	71.6	72.2	0.62	3,205.40	2.17	0.82	3.00
RR	28.7	76.2	77.2	1.01	4,136.76	1.86	0.57	2.43
Aggregate Value for Brazil						823.81	190.97	1,014.78

Figure 5: Mortality due to Violence over the Lifecycle, by State – Brazil, 2007



4.3 Incorporating Gender Heterogeneity

When we incorporate gender into our original calculations from section 4.1, the estimated social cost of violence increases by 16% reaching 69.7% of the 2007 GDP. In monetary terms, this is equivalent to US$ 1.24 trillion, of which US$ 1.00 trillion derive from gains accrued by the population currently alive and US$ 246 billion come from the gains of future generations. Such an increase is due to the strong positive correlation between victimization and income across genders. Men have typically higher income and higher mortality rate due to violence, and this redistribution of mortality rates and income toward the same group tends to increase the aggregate willingness to pay for violence reductions. Figure 6 portrays the mortality rate due to violence by age for males and females separately, highlighting the major difference across genders. For men, it peaks at 120 per 100,000 around age 20, whereas, for women, it barely reaches 10 per 100,000.

Overall, due to lifestyle and biological reasons, women have higher life expectancy at birth than men (77.3 and 69.7, respectively). On top of that, homicides imply a much higher loss in life expectancy for males (1.2 year) than for females (0.13 year). In addition, male earnings are substantially higher than female earnings throughout the lifecycle. The combination of these factors lead to the result that the *MWP* for violence elimination for men is approximately 10 to

16 times greater than that for women (at all ages). Figure 7 displays these profiles, showing that while the *MWP* of men reaches a maximum of US$ 12,940 at age 37, the same number for women reaches a maximum of US$ 811 at age 41.

Figure 6: Mortality due to Violence over the Lifecycle, by Gender – Brazil, 2007

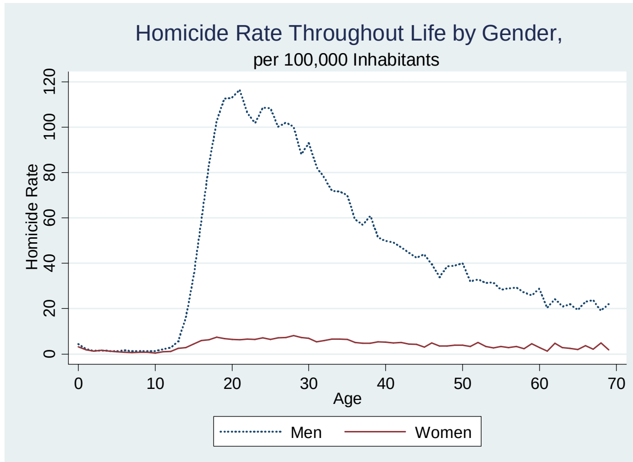
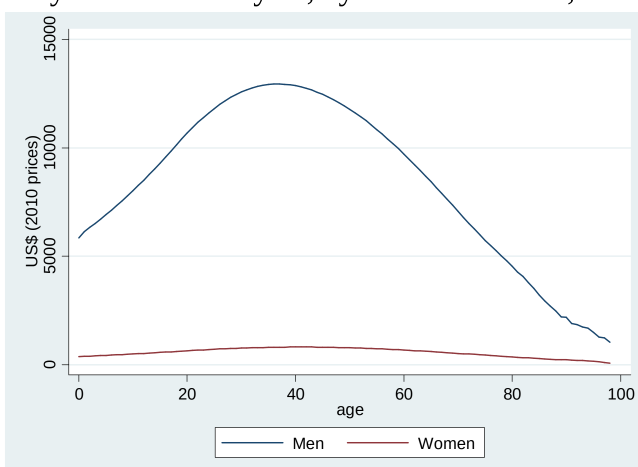


Figure 7: Willingness to Pay over the Lifecycle, by Gender – Brazil, 2007



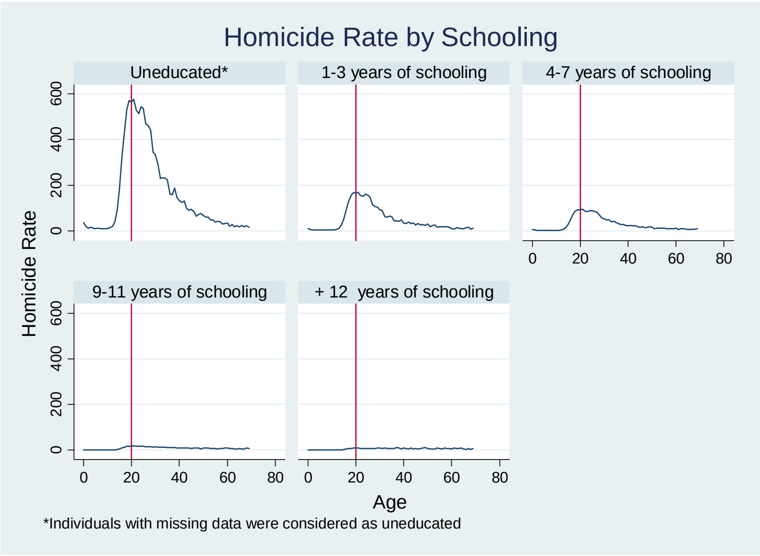
Taking into account the demographic structure, the *SMWP* leads to a welfare cost of homicides of US$ 1.17 trillion for men and US$ 76 billion for women.

4.4 Incorporating Educational Heterogeneity

In Brazil, the main victims of homicides are young people, with low education, from poor families. This negative correlation between probability of victimization and income means that there should be a reduction in the estimated willingness to pay for violence elimination once educational heterogeneities are accounted for.

Figure 8 depicts the mortality rate due to violence over the lifecycle by educational level. As explained in the methodological section, we attribute to cohorts below age 25 the distribution of education in the population currently aged 25. Two points are of particular interest in the figure: (i) independently of education, young people are always disproportionally victimized; and (ii) individuals with higher schooling experience substantially lower probabilities of being victimized.

Figure 8: Mortality due to Violence over the Lifecycle, by Educational Level – Brazil, 2007

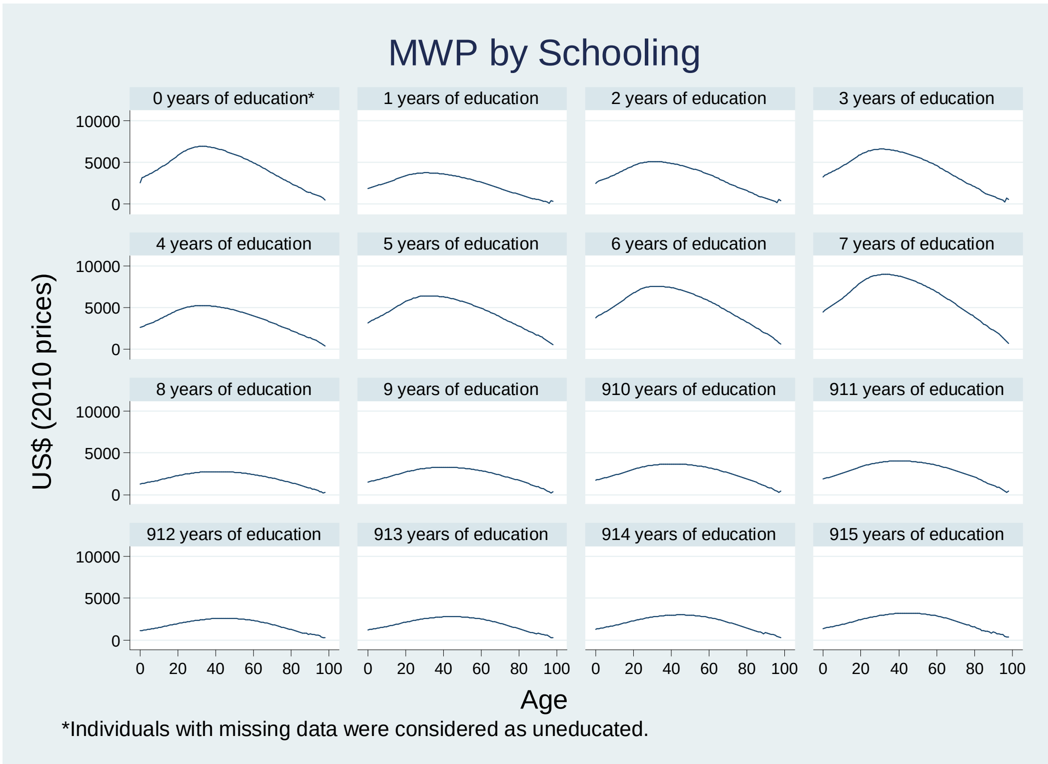


In fact, our calculations indicate that the reduction in life expectancy due to homicides decreases monotonically, from 2.8 years for individuals with no education, to 0.1 year for individuals with at least some college. This heterogeneity is striking and highlights the perverse regressive nature of the impact of violence on welfare in the Brazilian population.

Figure 9 presents the *MWP* for violence elimination for different years of schooling. From 1 to 7 years of schooling, *MWP* increases, mainly as a function of increased income across groups. However, given the much higher level of victimization in the group with zero years of schooling, its willingness to pay is the highest, despite the very low income levels. Analogously, but in the opposite direction, *MWP* declines for the population above 11 years of schooling, despite the increase in income, due to the much lower victimization rates.

Finally, in terms of aggregate losses, the *SMWP* of the population currently alive adds up to US$ 676 billion, while the *SMWP* for future generations reaches US$ 155 billion. Together, these correspond to US$ 831 billion, or 46.5% of the 2007 GDP. This number is much lower than those obtained in the previous calculations. This pattern is explained by the high concentration of victimization in Brazil among low income groups, highlighting the ethical issues that marginal willingness to pay approaches rise when considering heterogeneities in mortality that are correlated with income.

Figure 9: Willingness to Pay over the Lifecycle, by Educational Level – Brazil, 2007



4.5 Incorporating All Dimension of Heterogeneity Simultaneously

We start this section by summing up our previous results, when we considered each dimension of heterogeneity separately. We found that death due to violence and income had a high positive correlation across genders, leading to a higher social marginal willingness to pay when compared to the initial calculation. The opposite occurred when we broke down the analysis by regions and, more extremely so, when we incorporated educational heterogeneities. Therefore, it is not clear what would be the result of incorporating all dimensions of heterogeneity simultaneously. The pattern that arises from the interaction of all heterogeneities hinges on the joint distribution of income and mortality due to violence across states, genders, educational levels, and ages (the latter was already incorporated in our initial lifecycle calculation).

When all sources of heterogeneity are considered simultaneously, there is a positive correlation between victimization and income that is higher than the one that was present when gender heterogeneity was considered alone. This ends up driving the *SMWP* also even higher. Table 2 presents the social willingness to pay to eliminate violence, accounting for state of residence, gender, and educational heterogeneities. In this calculation, the social welfare cost of homicides in Brazil amounts to US$ 1.39 trillion, which represents 78% of the 2007 GDP, or an yearly cost measured in terms of flow of about 2.34% of GDP.

Comparing this table with Table 1, where only regional differences were considered, one notices that the *SMWP* for each state increases, but that this increase is not evenly distributed. The state of Paraná (PR), for example, which ranked 5th in the previous table, now ranks 3rd.

Table 2: Cost of Violence across Brazilian States, Accounting for Heterogeneities – Brazil, 2007

State	SMWP of Current Generations (US$ billion)	SMWP of Future Generations (US$ billion)	Total SMWP (US$ billion)
SP	190.41	27.57	217.97
RJ	171.08	23.87	194.95
PR	131.86	23.64	155.51
MG	103.44	20.18	123.62
BA	81.85	22.56	104.41
PE	73.32	17.62	90.94
PA	43.65	14.72	58.37
DF	42.69	9.38	52.06
RS	42.06	5.10	47.16
GO	37.29	6.02	43.31
CE	28.87	6.25	35.13
MT	27.45	7.62	35.07
MS	28.76	1.57	30.33
MA	22.17	6.14	28.31
AM	19.27	6.14	25.41
AL	22.28	2.26	24.54
ES	21.77	2.77	24.54
SC	14.55	1.71	16.26
RN	11.71	2.65	14.36
PB	11.42	2.03	13.46
PI	9.89	3.18	13.07
SE	9.66	2.93	12.59
RO	7.39	1.47	8.86
AP	7.33	0.56	7.89
TO	6.25	1.45	7.70
AC	2.80	1.11	3.91
RR	2.71	0.98	3.69
Aggregate Value for Brazil	1171.93	221.49	1393.42

These results are somewhat surprising and illustrate the importance of taking into account the various dimensions of heterogeneity simultaneously in value of life calculations. The result that takes into account the various heterogeneities leads to numbers substantially higher than those discussed in previous sections. This happens due to fact that income across states is strongly correlated with the homicide rate of young men with 4-7 years of schooling, which is the subpopulation with some of the highest *MWP* numbers throughout the country.

Table 3 presents the cross-state correlation between the discounted present value of income for individuals aged 18 with 4-7 years of schooling and homicide rates for different groups. Note that there is little correlation between income and average homicide rates (0.11), and also little correlation for most of the groups considered in the table. But there is a high correlation between income and homicides for men with 4 to 7 years of education (0.34) and an even higher correlation for men 18 to 20 years old with 4 to 7 years of education (0.45). These were some of the groups with highest *MWP* numbers in Figure 9.

Table 3: Cross-State Correlation Between the Discounted Present Value of Income of Young Males and Homicide Rates, by Educational Groups – Brazil, 2007

	Discounted present value of income of men 18 years old with 4-7 years of education
Homicide rate	0.11
Homicide rate of men	0.12
Homicide rate of men with no schooling	0.07
Homicide rate of men with 1-3 years of education	0.05
Homicide rate of men with 4-7 years of education	0.34
Homicide rate of men with 8-11 years of education	0.05
Homicide rate of men with more than 11 years of education	-0.43
Homicide rate of men 18 to 20 years old with 4-7 years of education	0.45

Table 4 summarizes our main results. As mentioned before, when considering regional, gender, and educational heterogeneities, the social cost of homicides in Brazil adds up to US$ 1.39 trillion, corresponding to 78% of the GDP. Without considering these socioeconomic differences, the social cost reaches US$ 1.07 trillion (60.2% of GDP), implying a downward bias of 22.9% in the calculation that does not incorporate heterogeneities.

In Brazil, the main victims of homicides are young males with low levels of schooling. It should therefore be expected that, once educational differences are incorporated, the negative correlation between victimization and education would lead to a reduction in the estimated welfare cost of violence (in relation to the no-heterogeneity scenario). Indeed, once we account for educational differences, the *SMWP* of homicides amounts to US$ 831 billion, or 46.5% of the 2007 GDP. On the other hand, when gender is incorporated, the estimated *SMWP* increases substantially, reaching US$ 1.24 trillion, or 69.7% of the 2007 GDP (given the strong positive correlation between income and victimization by gender). Regarding state heterogeneities, it is interesting to note that despite the great variation in the prevalence of homicides among Brazilian states, results change relatively little when regional differences are accounted for.

Table 4: Summary of the Main Results on Social Cost of Violence – Brazil, 2007

Calculation	Current SMWP (US$ billion)	Future SMWP (US$ billion)	Total SMWP (R$ billion)	% GDP: Stock	% GDP: Annuity	% Diff.to Benchmark
No Heterog.	870	205	1,075	60.2%	1.8%	-22.9%
Heterog. by:						
Gender	1,000	246	1,245	69.7%	2.1%	-10.6%
State	824	191	1,015	56.8%	1.7%	-27.2%
Schooling	676	155	831	46.5%	1.4%	-40.4%
Gender+ State+ Schooling	1,172	221	1,393	78.0%	2.3%	Benchmark

Taking as reference point the calculation that considers all dimensions of heterogeneity simultaneously, we have the following results: (i) considering differences in education alone leads to a downward bias of 40.4%; (ii) considering differences in state of residence alone leads to a bias of 27.25%; and (iii) considering differences in gender alone leads to a downward bias of 10.6%. Thus, the analysis of the social willingness to pay for violence reductions based on aggregate numbers may lead to significant biases. Though there are still other dimensions of heterogeneity not incorporated here, we believe that the characteristics considered encompass the most relevant dimensions of the joint variation in income and mortality due to violence, therefore going a long way in terms of accounting for the most relevant potential biases.

Cerqueira et al (2007) estimate that other dimensions of the yearly cost of violence in Brazil – expenditures on public security systems, incarceration, etc – add up to 3.74% of the GDP. Putting this number together with the result from our analysis, we obtain an estimate of the total welfare cost of violence in Brazil, measured as an yearly flow, of the order of 6.08% of the GDP.

6. Conclusions

This paper has two main objectives: (i) to estimate the welfare cost of homicides in Brazil, and (ii) to examine the potential bias in marginal willingness to pay calculations that ignore relevant dimensions of heterogeneity. The analysis developed here uses as theoretical benchmark the theory of marginal willingness to pay for reductions in mortality developed by Rosen (1988) and applied to the case of violence by Soares (2006). We build upon Soares (2006) by incorporating various dimensions of heterogeneity: lifecycle, gender, education, and state of residence.

From a broader perspective, our results should be interpreted as lower bounds to the welfare cost of mortality due to homicides. Several methodological decisions taken had the explicit objective to deliver conservative estimates and, in addition, other dimensions that constitute relevant costs to society were not considered. The dimensions of cost ignored include morbidity conditions generated as outcomes of violent acts, intangible costs associated with fear of victimization, and changes in habits to avoid crime. So, if anything, the numbers provided here should be seen as lower bounds to the true social cost of violence.

Our results indicate that the incorporation of heterogeneities may have important effects on the estimated welfare cost of mortality due to violence. Ignoring heterogeneities in gender, education, and state of residence lead to estimates that are 23% lower than those obtained accounting for all of these dimensions simultaneously.

References

Anderson, David A. (1999). The Aggregate Burden of Crime. *Journal of Law and Economics*, XLII (2), October 1999.

Atkinson, Giles, Andrew Healey, and Susana Mourato (2005). Valuing the costs of violent crime: A stated preference approach. *Oxford Economic Papers* 57:559-585.

Becker, Gary S. (1991). *A Treatise on the Family*. Cambridge, Harvard Univesrity Press.

Arthur, W. Brian (1981). The Economics of Risks of Life. *American Economic Review*, 71(1), 54-64.

Becker, Gary S. and Julio Elías (2007). Introducing Incentives in the Market for Live and Cadaveric Organ Donations. *Journal of Economic Perspectives*, 21(3), 3-24.

Becker, Gary S., Tomas J. Philipson, and Rodrigo R. Soares (2005). The Quantity and Quality of Life and the Evolution of World Inequality. *American Economic Review*, 95(1), 277-291.

Bergstrom, Theodore (1982). When Is a Man's Life Worth More Than His Human Capital? In: M. W. Jones-Lee (ed). *The Value of Life and Safety*. Amsterdam, North-Holland, 3-26.

Bergstrom, Theodore (2006). Benefit-cost in a Benevolent Society. *American Economic Review*, 96(1), 339-351.

Besley, Timothy and Hannes Muellers (2012). Estimating the Peace Dividend: The Impact of Violence on House Prices in Northern Ireland. *American Economic Review*, 102(2), 810–33.

Birchenall, Javier A. and Rodrigo R. Soares (2009). Altruism, Fertility, and the Value of Children: Health Policy Evaluation and Intergenerational Welfare. *Journal of Public Economics*, 93(1-2), 280-295.

Brand, Sam and Richard Price (2000). The Economic and Social Costs of Crime. Home Office Research Study 217. London.

Carvalho, Alexandre, Daniel Cerqueira, Rute I. Rodrigues, and Waldir Lobão (2008). Custos das Mortes por Causas Externas no Brasil. *Revista Brasileira de Biometria*, 26(3), 23-47.

Cerqueira, Daniel, Alexandre Carvalho, Rute I. Rodrigues, and Waldir Lobão. (2007). Análise dos Custos e Consequências da Violência no Brasil. IPEA, Texto para Discussão N 1284. Brasília.

Clark, David E. and James C. Cosgrove (1990). Hedonic Demand, Identification, and The Demand for Public Safety. *Journal of Regional Science*, 30, 105-21.

Cohen, Mark A., Roland T. Rust, Sara Steen, and Simon T. Tidd (2004). Willingness-to-pay for crime control programs. *Criminology* 42:89-110.

Cook, Phillip J. and Jens Ludwig (2000). *Gun Violence: The Real Costs*. Oxford University Press, Oxford and New York, 242p.

Cropper, Maureen L. and Frances G. Sussman (1988). Families and the Economics of Risks to Life. *American Economic Review*, 78(1), 255-260.

Garrett, Allison M. (2001). Health Improvements and the National Income and Product Accounts: 1880 to 1940. Ph.D. Dissertation, University of Chicago.

Hellman, Daryl A. and Joel L. Naroff (1979). The Impact of Crime on Urban Residential Property Values. *Urban Studies*, 16, 105-12.

Hunnicutt, Gwen (2004). Dross-National Homicide Victimization: Age and Gender Specific Risk Factors. University of North Carolina at Greensboro (mimeo).

Jones-Lee, M. W. (1992). Paternalistic Altruism and the Value of a Statistical Life. *Economic Journal*, 102(January), 80-90.

Legge, Sandra (2008). Youth and Violence: Phenomena and International Data. *New Directions for Youth Development*, No 119, Fall 2008. Wiley Periodicals, Inc.

Lynch, Allen K. and David W. Rasmussen (2001).Measuring The Impact of Crime on House Prices. *Applied Economics*, 33, 1981-1989.

Londoño, Juan Luis and Rodrigo Guerrero (2000). Violencia en América Latina: Epidemiología y Costos, in Asalto al Desarrollo: Violencia en América Latina.

Ludwig, Jens and Philip Cook (2001). The benefits of reducing gun violence: Evidence from contingent-valuation survey data. *Journal of Risk and Uncertainty*, 22(3), 207-26.

Mayhew, Pat (2003). Counting the Costs of Crime in Australia: Trends and Issues in Crime and Criminal Justice N 247. Australian Institute of Criminology. Canberra. Australia.

Murphy, Kevin M. and Robert Topel (2003). The Economic Value of Medical Research. In: Kevin M. Murphy and Robert Topel (eds). *Measuring the Gains from Medical Research: An Economic Approach*. Chicago, University of Chicago Press, 41-73.

Murphy, Kevin M. and Robert Topel (2006). The Value of Health and Longevity. *Journal of Political Economy*, 114(5), 871-904.

Naguin, Daniel S. and Alex R. Piquero (2006). Public Preferences for Rehabilitation versus Incarceration of Juvenile Offenders: Evidence from a Contingent Valuation Survey. University of Virginia Law School. The John M. Olin Program in Law and Economics Working Paper Series 28.

Nordhaus, William D. (2003). The Health of Nations: The Contribution of Improved Health to Living Standards. In: Kevin M. Murphy and Robert Topel (eds). *Measuring the Gains from Medical Research: An Economic Approach*. Chicago, University of Chicago Press, 9-40.

Rodrigues, Rute I., Daniel Cerqueira, Alexandre Carvalho, and Waldir Lobão (2009). Os Custos da Violência para o Sistema Público de Saúde no Brasil. *Cadernos de Saúde Pública*. 25 N 1, 29-36.

Rosen, Sherwin (1988). The Value of Changes in Life Expectancy. *Journal of Risk and Uncertainty*, 1(3), 285-304.

Rosen, Sherwin (1994). The Quantity and Quality of Life: A Conceptual Framework. In: George Tolley, Donald Kendel, and Robert Fabian (eds). *Valuating Health for Policy: An Economic Approach*. Chicago, University of Chicago Press, 221-248.

Schelling, Thomas C. (1968). The Life You Save May Be Your Own. In: Samuel B. Chase, Jr. (ed). *Problems in Public Expenditure Analysis*. Brookings Institution, Washington, D.C., 127-161.

Soares, Rodrigo R. (2006). The Welfare Cost of Violence Across Countries. *Journal of Health Economics*, 25(5), 821-846.

Soares, Rodrigo R. (2007). Health and the Evolution of Welfare across Brazilian Municipalities. *Journal of Development Economics*, 84(2), 590–608.

Soares, Sergei D. S. (2007). Educação: Um Escudo Contra o Homicídio? Texto para Discussão Nº 1298. Ipea. Brasília, Brasil.

Thaler, Richard (1978). A note on the value of crime control: evidence from the property market. *Journal of Urban Economics*, 5, 137-45.

Usher, Dan (1973). An Imputation of the Measure of Economic Growth for Changes in Life Expectancy. In: Milton Moss (ed). *The Measurement of Economic and Social Performance, Studies in Income and Wealth*, Vol. 38. Conference on Research in Income and Wealth. New York, National Bureau of Economic Research and Columbia University Press, 193-225.

Viscusi, W. Kip and Aldy, Joseph E. (2003). The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World. *Journal of Risk and Uncertainty*, 27(1), 5-76.

Zarkin, Gary A., Sheryl C. Cates, and Mohan V. Bala (2000) Estimating the willingness to pay for drug abuse treatment. *Journal of Substantive Abuse Treatment* 18:149-159.

Departamento de Economia PUC-Rio
Pontifícia Universidade Católica do Rio de Janeiro
Rua Marques de Sâo Vicente 225 - Rio de Janeiro 22453-900, RJ
Tel.(21) 35271078 Fax (21) 35271084
www.econ.puc-rio.br
flavia@econ.puc-rio.br