November 2003

# The Welfare Cost of Violence*

**Abstract**

This paper estimates the welfare loss caused by the homicide rates observed in 73 countries of the world during the nineties. A homicide rate, and its distribution across age groups, determines a loss in life expectancy that can be valued using the marginal willingness to pay approach. Together with the age distribution of the population, the willingness to pay can be used to estimate the social value of violence reductions. The results show that homicide rates reduce life expectancy at birth, on average, by one year. This represents a reduction in welfare corresponding to, on average, 24% of the 1995 GDP. In Colombia, homicide rates reduce life expectancy at birth by 3 years; in the US, by 0.8 year. The welfare cost of violence corresponds to, respectively, 20 and 113% of the American and Colombian aggregate GDP's in 1995. Generally, one additional year of life lost to violence is associated with 26% of the GDP in the social willingness to pay for violence reductions.

*Rodrigo R. Soares*
Department of Economics, University of Maryland, 3105 Tydings Hall, College Park, MD 20742
e-mail: soares@econ.umd.edu

*This paper benefited from comments from Roger Betancourt, Shawn Bushway, Ana María Díaz, Peter Reuter, Carlos Eduardo Vélez-Echavarria, and seminar participants at LACEA 2003 (Puebla, Mexico). The usual disclaimer applies.

# 1 Introduction

In the course of more than ten years of direct involvement of the United States in the Vietnamese conflict, roughly 58,000 American lives were lost. During the decade of the nineties, an average of more than 27,000 American lives were lost every year due to homicides, injuries purposely inflicted, and other forms of violence. Colombia, with a population more than seven times smaller than the American, lost to violence, on average, more than 28,000 lives in each year of that same decade.

It is difficult to imagine that such impressive numbers do not represent significant welfare losses, that go above and beyond the simple material costs and inefficiencies associated with crime. Material costs of crime and violence – including both direct costs and expenditures on criminal justice and crime prevention – have indeed been estimated to add up to a significant fraction of production across different regions of the world. This number is thought to be around 2.1% of the GDP for the US, and 3.6% for Latin America (see, for example, Bourguignon, 2000 and Londoño and Guerrero, 1999). Yet, introspection suggests that a large part of the welfare loss entailed by violence is related to the feeling of insecurity, or the exposure to the risk of victimization itself.

This paper draws on the "value of life" literature to estimate the non-monetary costs associated with the homicide rates observed in 73 countries of the world during the nineties. A given homicide rate, and its distribution across different age groups, determines a loss in life expectancy that can be valued using the marginal willingness to pay approach suggested by Usher (1973), and developed in detail by Rosen (1988). Together with the age distribution of the population, the willingness to pay can be used to estimate the social value of violence reductions for any given country. The policy appeal of a number like this is obvious: it gives the sum of resources that a society is willing to spend in order to eliminate violence or, more generally, to reduce violence to some predetermined level.

The criminology literature has made numerous efforts to estimate different dimensions of the costs of crime and violence in the United States. The most common approach has been to try to infer costs of crime by looking at byproducts of differences in crime rates across different locations. This is the case of the strand of literature

inaugurated by Thaler (1978), and with a recent example in Lynch and Rasmussen (2001), which uses differences in house prices across neighborhoods with different crime rates to infer the welfare costs of crime. In an analogous way, Hamermesh (1999) uses the differences in timing of work across different metropolitan areas to infer the inefficiencies and the social welfare loss generated by violence. Also, Cullen and Levitt (1999) hint at the social cost of crime when discussing the effect of crime on urban flight, but they do not estimate welfare loss or willingness to pay values. Most of these studies suggest that non-material costs of crime are probably of the same order of magnitude of material costs, and, therefore, are an important and often neglected dimension of the problem.

Other literature, exemplified by Cohen (1990), Miller et al (1993), and Cook and Ludwig (2000) tries to estimate direct (material, medical, etc) and welfare costs of violence by bringing together several different sources. Material and medical costs are usually calculated using National Crime Survey and Bureau of Justice Statistics estimates. Welfare losses from exposure to the risk of victimization are obtained either by multiplying the probability of death by the "value of a statistical life," or by using jury awards, determined for accidents with consequences similar to crimes (see Cohen, 1990).

From an international perspective, virtually no work has been done in the area. To our knowledge, the only exceptions are the work of Bourguignon (2000) and Londoño and Guerrero (1999). Bourguignon (2000) is mainly interested in the effects of crime and violence on development and inequality. While analyzing the effect of crime on welfare inequality, he presents raw estimates of the monetary costs of violence for the United States and Latin America as a whole. Additionally, he also estimates non-monetary costs related to the pain from victimization (from jury awards) and the loss of human capital. Nevertheless, in reality, several of the statistics presented for Latin America are indirectly obtained via extrapolation of US numbers (using an income-proportionality assumption). The author acknowledges the limitation of his numbers, and stresses the tentative nature of the analysis. Londoño and Guerrero (1999) also present estimates for Latin America as a whole and some statistics for selected countries (Brazil, Colombia, El Salvador, Mexico, Peru, and Venezuela). But these authors do not explain their methodology, and claim that the numbers are obtained from case studies, even though there are no explicit

references to them in the paper. So it is difficult to know exactly what their results mean and how reliable they are.

This paper presents the first set of cross-country estimates of non-monetary costs of crime. Methodologically, it also represents the first serious attempt to use the "value of life" methodology in order to estimate the social value of violence reductions.

We use age and cause specific number of deaths in 1995 to simulate the age specific mortality rates that would be observed in a given country in the absence of violence. This does not reflect the optimal reduction in violence, and it does not even imply that eradication of violence is possible. It just reflects the loss in well being from existing violence levels. These mortality rates correspond to hypothetical survival probabilities that add up to a life expectancy higher than the one actually observed in 1995. The "value of life" approach allows us to estimate how much individuals at different ages would be willing to pay for the change in survival probabilities determined from the reduction in violence. With the age distribution of the population, we can aggregate the willingness to pay to obtain the social value of violence eradication, or, in other words, the welfare cost of violence.

Our results show that, in the extreme case of Colombia, homicide rates determine a reduction of 3 years in life expectancy at birth. For the US, violence reduces life expectancy at birth by 0.82 year, while for Western Europe the average reduction is 0.5 year. The value of such changes in life expectancy is quite significant, and even more so once one realizes the social aspect of violence. If we assume that all the population of each country can enjoy the ensuing mortality reductions, the social value of eliminating violence corresponds to 20% of the American GDP in 1995, and 113% of the Colombian GDP in that same year. In Western Europe, the average value of homicide eradication corresponds to 9% of the 1995 GDP. Generally, a one-unit increase in the years of life lost to violence is associated with an increase of 26% of the GDP in the social willingness to pay for violence reductions. These results support the belief that non-monetary costs of violence and crime are at least as important as material costs.

The remainder of the paper is structured as follows. Section 2 develops the theoretical framework used in the valuation of reductions in mortality rates, and discusses the parameterization of the model. Section 3 discusses the data used, and the construction

of the counterfactual survival probabilities that would be observed in the absence of violence. Section 4 presents and discusses the results. Section 5 illustrates, with the case of Brazil, the potential implications of incorporating inequalities in income and victimization into the analysis. Section 6 summarizes the main results of the paper, and points out its limitations and policy implications.

## 2 The Valuation of Reductions in Violence

Violence, as reflected in homicide rates, has effects on mortality across different age groups of a given society. Mortality due to violence reduces survival probabilities throughout the survival distribution, and has a final cumulative effect that is reflected on a reduced life expectancy at birth. In section 3, we discuss how we simulate the survival probabilities that would be observed in the absence of violence. Now, we develop the tools that will be used to value a given change in survival probabilities.

Define $S(t,a)$ as the probability of survival to age $t$ of an individual currently at age $a$. Assume that some exogenous factor $v$ (as in violence) affects the survival function, so that we can write $S(t,a;v)$. Exogenous changes in $v$ shift the survival function according to $\partial S(t,a;v)/\partial v$. To save on notation, we define $S_v(t,a) = \partial S(t,a;v)/\partial v$. Our goal is to give monetary values to $S_v(t,a)$.

### 2.1 Theory

Following Rosen (1988), consider an individual at age $a$ facing survival probabilities up to age $t$ given by the survival function $S(t,a)$. Lifetime discounted utility at age $a$ can be written as:

$$U(a) = \int_a^{\infty} e^{-\rho(t-a)} S(t,a) u(c(t)) dt, \qquad (1)$$

where $c(t)$ is consumption at $t$, and $\rho$ is the rate of time preference. This formulation implicitly assumes that utility on the "death state" is normalized to zero (for a detailed

discussion, see Rosen, 1988). Assume a complete contingent claims market, such that the individual's budget constraint is given by

$$\int_a^{\infty} e^{-r(t-a)} S(t,a) y(t) dt = \int_a^{\infty} e^{-r(t-a)} S(t,a) c(t) dt, \tag{2}$$

where *y(t)* is income at age *t*, and *r* is the interest rate. Rather than realism, this assumption appeals to the tractability of the problem.

First order conditions for the agent's optimum imply that

$$e^{-\rho(t-a)} u'(c(t)) = \lambda_a e^{-r(t-a)}, \tag{3}$$

for every *t*, where $\lambda_a$ is the Lagrangian multiplier on the constraint for an individual at age *a*.

Using the envelope theorem, the marginal willingness to pay for changes in *S(t,a)*, brought about by changes in *v*, is defined as:

$$MWP_a = \frac{\partial V(a)}{\partial v} \frac{1}{\lambda_a} = \frac{\int_a^{\infty} e^{-\rho(t-a)} u(c(t)) S_v(t,a) dt}{\lambda_a} + \int_a^{\infty} e^{-r(t-a)} (y(t) - c(t)) S_v(t,a) dt.$$

Rearranging terms and using the first order conditions:

$$MWP_a = \int_a^{\infty} e^{-r(t-a)} \left[ \frac{u(c(t))}{u'(c(t))} + y(t) - c(t) \right] S_v(t,a) dt. \tag{4}$$

Defining $\varepsilon(c(t))$ as the elasticity of the instantaneous utility function *u(.)* in relation to its argument (evaluated at *c(t)*), we can rewrite this expression as:

$$MWP_a = \int_a^{\infty} e^{-r(t-a)} \left[ \frac{c(t)}{\varepsilon(c(t))} + y(t) - c(t) \right] S_v(t,a) dt. \quad (5)$$

As we are interested in cross-country analysis of welfare, we abstract from life cycle considerations by assuming that $r = \rho$ and $y(t)$ is constant ($y(t) = y$). In addition, this allows the calculation of the value of reductions in violence using only national income figures widely available (GDP per capita as $y$). With these assumptions, first order conditions imply that $c(t)$ is also constant, such that we can write $c(t) = c = y$, and $MWP_a$ can be expressed as

$$MWP_a = \frac{y}{\varepsilon(y)} \int_a^{\infty} e^{-r(t-a)} S_v(t,a) dt. \quad (6)$$

The interpretation of $MWP_a$ in this context is straightforward. For a given country at a point in time, it tells us how much an individual at age $a$, earning the average income of the country in every period of life, would be willing to pay for the changes in survival probabilities summarized by $S_v(t,a)$.

In the simple case where individuals live for a deterministic amount of time ($\tau$), and all life expectancy gains are concentrated in the last period of life, this expression takes on a very simple form:

$$MWP_a = \frac{y}{\varepsilon(y)} e^{-r(\tau-a)} d\tau = \frac{u(y)}{u'(y)} e^{-r(\tau-a)} d\tau. \quad (6')$$

Though we will not make use of this simple version of the model in our analysis, it illustrates the two main determinants of the value of reductions in mortality: the value of income throughout life (fraction term), and the size and moment of the reductions in mortality (term multiplying the fraction). Countries with higher income attach more value to given longevity gains, since marginal extensions in life expectancy are more valuable the higher is consumption in this extended lifetime, or, in other words, the higher is income. This is so because, with a time separable utility function, longevity and income

are complements in the indirect utility function (in terms of the cross derivatives of the marginal utilities). Additionally, the moment of mortality reductions is important because competing risks vary along the lifecycle and mortality reductions far off in the future are discounted at higher rates (on competing risks, see Dow, Philipson, and Sala-i-Martin, 1999).

Expression (6) will be used to evaluate the welfare gains from reductions in violent deaths for an individual at age *a*. With this expression in hand, the social value can be obtained by integrating $MWP_a$ through all ages, weighting the value at each age by the respective population.

Assume that the population *P* of a country is distributed across ages according to the density function *f(.)*. The social value of changes in survival probabilities, brought about by changes in *v*, is given by:

$$Social\ MWP = P\int_0^{\infty} MWP_a f(a)da. \qquad (7)$$

This is simply the sum of the willingness to pay of all current members of society. Incorporating future generations into the analysis would unambiguously lead to a higher social cost of violence.

**2.2 Parameterization and Calibration**

In the specification of the functional form for the instantaneous utility function *u(.)* and the calibration of the model, we follow closely the strategy of Becker, Philipson, and Soares (2003).

There are two dimensions of the instantaneous utility function *u()* that are relevant for the analysis of changes in survival probabilities: the substitutability of consumption in different periods of life (inter-temporal elasticity of substitution), and the value of being alive relative to being dead. Rosen (1988, p.287) stresses the importance of this last factor as a consequence of the normalization of utility in the death state to zero.

Unless one is willing to take first order linear approximations of the utility function, this means that the inter-temporal elasticity of substitution cannot possibly contain enough information to calibrate all the relevant dimensions of choice involved in the problem. In our case, since we are dealing with extremely large differences in income across countries, a first order linear approximation does not seem adequate. Therefore, we follow Becker, Philipson, and Soares (2003) and assume the following functional form for the instantaneous utility function:

$$u(c) = \frac{c^{1-1/\gamma}}{1-1/\gamma} + \alpha, \qquad (8)$$

where $\alpha$ is the parameter that arises from the normalization of utility in the death state to zero, and $\gamma$ is the inter-temporal elasticity of substitution. Note that, contrary to the superficial intuition, it is not true that $\alpha$ is necessarily positive. Strictly, $\alpha$ is the parameter determining the level of annual consumption at which the individual would be indifferent between being alive or dead. If we think that there is such a level of consumption, $\gamma$ larger than one necessarily means $\alpha$ smaller than zero.

We assume that preferences towards consumption and survival rates are the same across different cultures, so that $\alpha$ and $\gamma$ are underlying parameters shared by all the economies in our sample. So we can calibrate the value of $\alpha$ and $\gamma$ using data from one country, and use them to value changes in survival rates in other countries.

Two pieces of information, available in the literature for the US, are enough to fully calibrate the instantaneous utility function: the inter-temporal elasticity of substitution and the consumption elasticity of the instantaneous utility function. Define $\varepsilon$ as the consumption elasticity of the utility function. We have that:

$$\varepsilon = \frac{u'(c)c}{u(c)} = \frac{c^{1-1/\gamma}}{\frac{c^{1-1/\gamma}}{1-1/\gamma} + \alpha}, \tag{9}$$

and, from this expression, $\alpha = c^{1-1/\gamma}\left(\frac{1}{\varepsilon} - \frac{1}{1-1/\gamma}\right)$.

The value of $\varepsilon$ can be estimated from compensating differentials for occupational mortality risks. Murphy and Topel (2003), using numbers from the literature on occupational risks, estimate $\varepsilon$ to be 0.35. As noted by Cohen (1990), the risk of a violent death is not much different from the probability of death in a work-related accident. Therefore, it seems reasonable to assume that these estimates refer to the same parameter that we would want when evaluating changes in mortality due to violence reductions.

In relation to the inter-temporal elasticity of substitution, a wide range of values is available in the empirical literature. Browning, Hansen, and Heckman (1999, p.614), after exhaustively reviewing the estimates, suggest that the inter-temporal elasticity of substitution for non-durables is probably slightly above 1.

We use $\gamma$ = 1.25, $\varepsilon$ = 0.346 and $c$ = 26,365 to calibrate the value of $\alpha$. The value of consumption is the value of US per capita income in 1990 in the Penn World Tables version 6.1 (PWT 6.1) dataset. We use this value because Murphy and Topel (2003) estimate $\varepsilon$ using US data for 1990, and our income data comes from the PWT 6.1. Our calculations give a value of $\alpha$ equal to –16.16. Together with the value of $\gamma$, this implies that an individual with annual income equal to 353 would be indifferent between being alive or dead.[1]

Notice that the functional form adopted is flexible enough to accommodate an income-elasticity of the marginal willingness to pay that actually changes with income. So the calibration using US data is not limiting in the sense of imposing an income-elasticity that does not belong to the less-developed countries we want to analyze. For average levels of income per capita, around $10,000, our calibrated parameters imply an

[1] The lowest value of the GDP per capita in our sample is 1153 (Tajikistan). In the entire PWT 6.1 dataset, the only values of the RGDPTT variable (GDP adjusted for terms of trade) below 353 are the ones for the Democratic Republic of Congo between 1994 and 1997.

income-elasticity of the marginal willingness to pay ($(\partial MWP/\partial y)/(MWP/y)$) around 1.2. But our specification allows this elasticity to vary with the income level, so that it reaches very high values for low income per capita. For example, it reaches 1.9 and 3.8 for, respectively, $1,000 and $500 of income per capita. Therefore, the functional form adopted is flexible enough to identify underlying preference parameters that, in principle, can be used irrespectively of the income level.

Viscusi and Aldi (2003) make an extensive review of estimates of the "value of a statistical life" around the world. For the countries that are included both in our sample and in their review – Australia, Austria, Canada, Japan, Hong Kong, UK, and US – our parameterization implies "values of a statistical life" between $1.6 and $2.6 million. These are typically in the lower range of estimates discussed in Viscusi and Aldi (2003). If anything, our parameterization will tend to underestimate the value of reductions in mortality and, therefore, the welfare cost of violence.

With the values of $\alpha$ and $\gamma$ in hand, we can use equation (6) to value the mortality reductions that would be observed if homicide rates were reduced to zero. This does not imply that the goal of public policy should be to reduce homicide rates to zero. It does not even require that such goal be actually feasible. The meaning of the exercise is just that, in order to calculate the welfare cost of violence, one should compare the situation observed in the presence of violence with what would be observed in its absence. These will determine the potential benefits from violence reductions or, alternatively, the welfare cost of the observed violence levels. What is feasible or not constitutes the other side of the equation, and will depend on the technology available and on the implementation costs of specific policies.

With the assumptions made up to now, expression (6) can be rewritten in terms of the parameters discussed here as:[2]

$$MWP_a = \left( \frac{y}{1-1/\gamma} + \alpha y^{1/\gamma} \right) \int_0^{\infty} e^{-r(t-a)} S_v(t,a) dt \,. \qquad (10)$$

[2] The formula used in the calculations is a discrete time version of (10).

We set interest rates equal to 3% per year in the calculations. Notice that the actual discount applied to the individual problem will be higher than that, since it takes into account also the survival probabilities. Once expression (10) is used to calculate the marginal willingness to pay for individuals at each age *a* in a given country, we can use the age distribution of the population and equation (7) to calculate the social value of violence reductions.

## 3 Data and Empirical Implementation

Age specific population and number of deaths are available from the World Health Organization Mortality Database.[3] We define violent deaths as deaths caused by "homicide and injury purposely inflicted by other persons, and other violence," which correspond to the aggregate causes of death B55 and B56 in the International Code of Diseases 9 (ICD-9).[4] The income variable used is real GDP per capita adjusted for terms of trade, in 1996 international prices. This is the RDPTT variable from the PWT 6.1 database. All variables for 1995 are calculated as averages for the period between 1990 and 1999 (or years available in this interval). All countries for which mortality data disaggregated by cause of death and age are available are included in the sample. This gives us 73 countries, listed in the Appendix.

We calculate the changes in survival probabilities brought about by reductions in violence in the following way. By definition, the survival probability between ages *t* and *t + 1* can be calculated as[5]

$$S(t+1,t) = 1 - \frac{N(t+1,t)}{P(t+1,t)}, \tag{11}$$

[3] The WHO database contains data for each five-year age interval. To calculate life expectancy and survival probabilities, we assume constant mortality rates within these five-year intervals.

[4] The problem of underreporting of number of deaths is potentially serious. But the evidence discussed in Soares (2002) suggests that homicide rates behave in similar ways to crime rates obtained from victimization surveys. Therefore, reporting errors are likely to be random. At any rate, the worst case scenario – with high underreporting, correlated with income – would tend to diminish the value of violence reduction, and even more so for less developed countries. So, if anything, our main results will be conservative estimates of the true value of violence reductions.

[5] We switch to a discrete setting for ease of exposition.

where *N(t+1,t)* is the number of deaths between ages *t* and *t+1*, and *P(t+1,t)* is the population between ages *t* and *t+1*. The counterfactual survival probabilities in the absence of violence are simulated as:

$$SNV(t+1,t) = 1 - \frac{N(t+1,t) - NV(t+1,t)}{P(t+1,t)}, \tag{12}$$

where *NV(t+1,t)* is the number of deaths caused by violence between ages *t* and *t+1* (aggregate causes B55 and B56 in ICD-9), and *SNV(t+1,t)* is the "no-violence" survival rate between ages *t* and *t+1*. This rate gives the survival probability that would be observed between ages *t* and *t + 1* if no deaths caused by violence were registered. This formulation assumes that an individual dying because of violence in a given year would not have died from any other cause otherwise.

These single-period survival probabilities can be immediately transformed into cumulative survival probabilities. By definition, $S(t,a) = \prod_{a}^{t-1} S(i+1,i)$ and $SNV(t,a) = \prod_{a}^{t-1} SNV(i+1,i)$. Also by definition, life expectancy at birth is $L = \sum_{t=1}^{\infty} S(t,0)$, and the life expectancy at birth that would be observed in the absence of violence is $LNV = \sum_{t=1}^{\infty} SNV(t,0)$ . With the cumulative survival probabilities in hand, the counterfactual changes in survival probabilities that would be brought about by the elimination of violence are simulated as

$$S_v(t,a) = SNV(t,a) - S(t,a). \tag{13}$$

Finally, $S_v(t,a)$ allows us to calculate an interesting descriptive statistic, which will be discussed in the next section: the expected years of life lost to violence. Since life expectancy at birth is simply the integral of *S(t,0)* from zero to infinity, expected years of life lost to violence can be defined as:

$$L_v = \sum_{t=1}^{\infty} S_v(t,0) = \sum_{t=1}^{\infty} SNV(t,0) - \sum_{t=1}^{\infty} S(t,0) = LNV - L\,, \tag{14}$$

which is simply the difference that arises when life expectancy is calculated using, respectively, the *SNV(t,0)* and the *S(t,0)* survival functions. It is the reduction in life expectancy caused by violence.

$S_v(t,a)$ is used, together with equations (6) and (7), to estimate the individual willingness to pay and the aggregate social value of violence reductions in the 73 countries included in the sample. Next section presents and discusses the results.

## 4 Results

Tables 1 and 2 present the results of our exercise. The value of violence reductions is presented as the marginal willingness to pay of a newborn individual (age zero), and as the aggregate social value (both in level and percentage of GDP). Additionally, both tables present some statistics that will be helpful in our discussion: life expectancy at birth, homicide rate (per 100,000 inhabitants), GDP per capita, the life expectancy that would be observed in the absence of violence, and the expected years of life lost to violence. Table 1 presents the results for the World Health Organization regions (some of them divided into sub-regions): Latin America and the Caribbean, North America, Western Europe, Former Communist Europe, and Western Pacific.[6] Table 2 presents the results for each individual country.

From a descriptive perspective, Tables 1 and 2 contain some interesting numbers. First, the expected years of life lost to violence highlights a point that is already clear from the homicide rates. But this counterfactual variable is particularly interesting because it materializes the content of homicide rates in a more concrete way. Our calculations show that, in 1995, individuals born in Latin America and Former Communist Europe had life expectancies, respectively, 1.6 and 1.3 years lower because of violence. These numbers are more than two times higher than the loss in life

[6] Regional numbers are non-weighted country averages. Due to data availability, the only African country included in the sample is Mauritius, and the only Eastern Mediterranean country is Kuwait. Therefore, these regions are not included in the regional table. Values for these two countries are contained in Table 2.

expectancy for any other region. Among the countries analyzed, violence is a much more serious mortality issue in Latin America and Eastern Europe. This problem reaches its peak in Colombia, where 3.1 expected years of life are lost because of violence. Following, we have Tajikistan, Turkmenistan, El Salvador, Brazil, and Venezuela, all of which have more than 2 years of life expectancy lost to violence.

But our main interest here is the value of potential reductions in violence levels and, as discussed in section 2, mortality is not the only relevant dimension. Income will also play a major role. In this matter, the first thing to come out of Table 1 is that, no matter how you look at it, the value of violence reduction is very high. For a newborn individual ($MWP_0$), the marginal willingness to pay for bringing homicide rates down to zero picks at 14,317 for North America, followed by 8,148 for Latin America. These two cases illustrate the forces at work in determining willingness to pay: income and mortality. North America has the highest income per capita in the sample and homicide rates that, though not too high, are above the ones observed in other developed countries. As a result of the dominance of the income effect, the willingness to pay is the highest among all regions. The case of Latin America is the mirror image of this: though income per capita is the second lowest in the sample, homicide rates are so high that the willingness to pay for violence reduction is the second highest among all regions.

The role of income in determining the marginal willingness to pay is illustrated in Figure 1. This figure plots the cross-sectional relation between the natural logarithm of income per capita and the marginal willingness to pay at age zero ($MWP_0$), and fits a regression line to this relation. Income and $MWP_0$ are significantly related, with an $R^2$ of 0.37. Note that this simple regression confounds the effect of income with the changing violence rate across countries. Since expected years of life lost are negatively related to income in our sample, Figure 1 illustrates the strong positive effect of increases in income on the willingness to pay.[7]

[7] In our sample, the regression of expected years of life lost on income per capita generates a negative and statistically significant coefficient (p-value = 0.00). In a multivariate setting, the negative relation between income and homicide rates has been found not to be very robust. In this direction, there is no accepted knowledge on the relation between income and crime rates in the literature, though recent evidence seems to suggest that it is either mildly negative or nonexistent (see Fajnzylber et al, 2002a and 2002b, and Soares, 2002). Nevertheless, our argument is purely a descriptive one, and does not require the general stability of the relation.

This is clearer in a multivariate context. Table 3 presents the results of a linear regression of $MWP_0$ on the natural logarithm of income and years of life lost to violence. The estimated coefficients imply that a 100% increase in income per capita is associated with a \$6,613 increase in $MWP_0$, while one additional year of life expectancy lost to violence increases $MWP_0$ by \$5,128.

To analyze the social aspect of welfare gains, it is interesting to look at the social value of violence reduction as a share of national output (aggregate GDP). This gives an idea of the relative importance of reductions in violence, when compared to material conditions. From this perspective, Latin American countries are on the front of the line. The value of reducing homicide rates to zero for Latin American countries amounts to, on average, 43% of the 1995 GDP. This value is more than 65% higher than the second highest regional value (26% for Former Communist Europe). Figure 2 shows the social value of violence reduction as a share of GDP for all countries in the sample, ordered from highest to lowest. The four frontrunners are Latin American: Colombia, with an astounding 113%, followed by El Salvador (73%), Brazil (58%), and Venezuela (58%). From the 10 highest values, 6 are Latin American, 3 are Eastern European (Kazakhstan, Turkmenistan, and Russia), and the remaining one is the Philippines. In the other extreme of the distribution, 7 out of the 10 lowest values are from Western Europe, with the remaining three being Slovenia, Korea and Japan.

When analyzing the values as shares of income, the dominant dimension is mortality. Figure 3 plots the expected years of life lost against the social value of violence reduction (as a percentage of GDP), and fits a regression line to the relation. The close relation between the two variables is clear: the coefficient on years of life lost is positive and statistically significant, and the $R^2$ is 0.81.[8] The estimated coefficient implies that one

[8] Note that this regression does not have a perfect fit only because of the non-linear relation between marginal willingness to pay and income, and the fact that, in the calculation of years of life lost, future gains in survival rates are not discounted at rate $r$. If we ignored the constant $\alpha$ and assumed a constant elasticity form for the instantaneous utility function, the marginal willingness to pay would be linear on income: $MWP_a = \frac{y}{1-1/\gamma}\int_0^\infty e^{-r(t-a)} S_v(t,a)dt$. In this case, the $R^2$ from the estimated regression would be even closer to one, with all the deviation coming from the differences between $\int_0^\infty e^{-rt} S_v(t,0)dt$ and $\int_0^\infty S_v(t,0)dt$. We could arrive at a concept similar to the one captured by this regression analytically, by

additional year of life lost to violence increases the social willingness to pay for violence reduction by 28% of the GDP. In this dimension, the relation between income and willingness to pay (as % of GDP) is indeed negative, due to the negative correlation between income and years lost to violence (see Figure 4).

Another interesting dimension of the analysis is the age profile of the willingness to pay within a given country. Figures 5 (a) to (d) plot this profile between ages zero and 70 for selected countries.

A common feature of the age profile of willingness to pay in all different regions is the initially increasing portion – up to age 5 – followed by a sharply declining interval – between ages 5 and 10 – that later on tends to slope upward again, with the intensity of this last inflexion varying from country to country. By age 70, the willingness to pay is quite small in all cases.

The overall age profile of the willingness to pay is determined by two factors. First, higher life expectancy conditional on survival increases the willingness to pay, and more so if consumption in the extended lifetime is higher. Therefore, everything else constant, younger individuals have a larger willingness to pay than older individuals, and this differential is increasing in the income level.[9] Second, future gains are discounted at the rate of interest, and gains past the individual's age have no value whatsoever. Therefore, everything else constant, the willingness to pay tends to rise just before large changes in mortality, and drop suddenly after that. The interaction of these two dimensions, together with the age distribution of violent deaths, determines the age profile of the willingness to pay for different countries.

Reductions in mortality at early ages are very valuable because the number of years to be enjoyed conditional on survival is very high. In addition, the value attached to these added years increases with income. This is the reason why initial willingness to pay

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taking the derivative of the $MWP_0$ and evaluating it at some convenient point. But there is no one to one relation between the expected years of life lost and the discounted change in the survival function, which appears in the marginal willingness to pay expression. Therefore, the exercise would be more complicated and less intuitively appealing. A similar comment applies to the results presented in Table 3. The regression does not have a perfect fit only because the relation between the two independent variables and the dependent variable in equation (10) is not linear. These linear regressions should be seen as descriptive tools.

[9] We are not taking into account life cycle issues, which might change this result depending on the periods when individuals accumulate or deplete wealth.

tends to be higher on the first years of life, and even more so for rich countries (in relative terms). As ages subject to significant mortality due to violence are surpassed, both the reduced horizon, and the fact that part of the mortality is already past the individual's age, work towards reducing the willingness to pay. The top five countries in terms of $MWP_0$ in the sample are all relatively rich: Bahamas, United States, Kuwait, Argentina, and Luxembourg.

The dimension of violence most connected to the economic aspect of crime – as it relates to inequality, urbanization, etc – reveals itself at later ages. Violent deaths between ages 15 and 50 are the ones thought to be related to common crimes and generalized violence. When we move in the age distribution to young adulthood, we see that homicide rates indeed take over the income effect, and become relatively more important in determining the willingness to pay. For example, already by age 18, the highest willingness to pay for violence reductions in the sample is observed in Colombia (even in absolute values). In Figure 5a, we see that Argentina and Brazil start at age zero with a higher willingness to pay than Colombia, but by age 10 the situation is reversed. Colombia's willingness to pay for violence reduction remains the highest among the three up to age 60, even though Colombia's income per capita is the lowest one.

Figure 5b shows a similar pattern among Russia, Kazakhstan and Turkmenistan: Russia – the highest homicide rate among the three – starts at age zero with the lowest willingness to pay for violence reductions; by age 7, the situation is reversed, and remains so up to age 70. But note that Russia's per capita income is the highest among the three, so that the pattern here does not arise purely because of the differences in homicide rates.

Finally, Figures 5c and 5d illustrate a striking point: for every single age, the welfare cost of violence in the United States is much higher than in any other developed country. This arises from the fact the US is the second richest country in the sample and, among the developed countries, the one with the second highest homicide rate (behind Portugal). As should be clear by now, the interaction of these two factors generates a very large willingness to pay for reductions in violence.

## 5 Inequalities in Income and Exposure to Risk

The main limitation of the methodology used here is the implicit assumption that both income and victimization are equally distributed across a country's population. This would not be a serious problem if victimization were uncorrelated with income, in which case our estimates would have a zero mean error. But evidence shows that this is not the case. Victimization rates of different crimes are typically correlated with income, sometimes positively and sometimes negatively (for example, see Levitt, 1999 for a discussion on the US, and Gaviria and Vélez, 2002 for a discussion on Colombia).

In order to overcome this problem, we would need homicide rates by age and income groups for all the countries included in our sample. This data is very difficult to obtain, and an effort to collect all the required information is beyond the scope of this paper. Nevertheless, to assess the extent of the problem, we analyze one extreme case, in which the positive bias in our estimates is likely to be the largest one. In this section, as an exploratory effort, we look at the case of Brazil. Our goal is to evaluate the effect of inequalities in income and risk exposure on the estimation of the welfare cost of violence.[10]

Brazil has one of the highest levels of income inequality in the world, with the 20% richest fraction of the population earning more than 30 times the income of the 20% poorest fraction (World Development Indicators). At the same time, Brazilian homicides rates are above 30 per 100,000 inhabitants, being also among the highest in the world.

Though there is no data on number of deaths by income groups, the Brazilian Ministry of Health does release statistics on number of violent deaths by educational level (same cause of death groups as in the World Health Organization database). In almost 50% of these deaths, the educational level is not reported. Nevertheless, within the universe of deaths with reported education, we can have some idea of the distribution of violent deaths according to educational groups.[11]

[10] The same concern should be present whenever the "value of life" methodology is used to evaluate the welfare impact of reductions in mortality rates due to other causes of death, as long as the reductions are correlated with income.

[11] The dataset is the DATASUS, from the Brazilian Ministry of Health. It is obvious that the high degree of non-reporting of education is likely to be non-random. Nevertheless, it is not clear what the direction of the bias is likely to be. In addition, there is nothing we can do in this respect.

There are four educational levels contained in the data, corresponding to four different stages of the Brazilian educational system (see Blom, Holm-Nielsen, and Verner, 2000). We translate them into the American system according to the following classification: "No Education" (0 years of schooling), "Some Elementary" education (between 1 and 8 years of schooling), "Some High-School" (between 9 and 11 years of schooling), and "Some College" (more than 11 years of schooling).[12]

Income per capita within each educational group is calculated by using average wage differentials across educational groups, and the distribution of the population is simulated according to the distribution of the Brazilian labor force. Menezes-Filho (2001) presents wage differentials and the educational distribution of the labor force for Brazil in 1997. We use the distribution of the labor force, rather than population, because we want a picture of the distribution of completed years of schooling, and how it relates to average income levels in the population.

Table 4 presents descriptive statistics for the different educational groups in Brazil, once the assumptions discussed above are used to construct homicide rates, incomes, and population shares. Homicide victimization is largely concentrated among the less educated/poorer population. Homicide rates within the group with "Some Elementary" education are more than 8 times higher than homicide rates among people with "Some College." At the same time, people with "Some College" earn, on average, 5 times more than people with "Some Elementary" education. Since the elasticity of $MWP_0$ in relation to income is above unit, these systematic differences may have a significant impact on the social willingness to pay for violence reductions.

We apply the same methodology outlined before to the four different educational groups in Brazil. By doing that, we obtain the social cost of violence for each educational group and, aggregating the total value, we obtain the social cost of violence in Brazil, once income and victimization inequalities are taken into account. For the exercise to be feasible, we assume that mortality by the other underlying causes of death is the same across the different educational groups, and only mortality caused by violence differs. Therefore, life expectancy in the no-violence scenario will be the same across the

[12] The three educational categories following "No Education" correspond to "Ensino Fundamental," "Ensino Secundário" and "Ensino Superior" in the Brazilian system.

different educational groups (and the same as it was in our previous calculations, 69.8), but life expectancy in the presence of violence will be different.

With these assumptions, and data from Table 4, we obtain the results presented in Table 5. Most of the burden of violence falls on the population with "Some Elementary" education. This fraction represents 35% of the Brazilian population and is likely to contain most of the urban poor. They loose 4.7 years of life expectancy at birth due to violent deaths, and their willingness to pay for violence reduction corresponds to 22.5% of the Brazilian GDP.

The "No Education" group has very low income and, therefore, its willingness to pay is quantitatively very small, even though its population is exposed to very high homicide rates. In the other extreme, the groups with "Some High School" and "Some College" have higher income, but are exposed to lower violence levels and are smaller in size. Therefore, their aggregate willingness to pay is also quantitatively modest.

The age specific willingness to pay for the different educational groups is presented in Figure 6. Though willingness to pay at earlier ages is higher for the groups subject to more violence, by age 23 the income effect already dominates and the group with "Some College" becomes the one with the highest values. This is also due to the fact that violence levels at earlier ages are much higher for the low education groups.

But the most important information contained in Table 5 is the aggregate social cost of violence estimated for Brazil, once inequalities in income and victimization are taken into account. In this case, the social cost of violence is estimated to be 33% of the 1995 GDP, as opposed to 58% estimated before. The estimated social cost is reduced by roughly 40% of its initial value.

This arises because of the negative correlation between income and victimization present in the Brazilian data, and the high elasticity of the willingness to pay in relation to income. As compared to the estimations assuming a homogenous population, victimization rates are "redistributed" towards the fractions of the population with lowest willingness to pay, and this diminishes the aggregate value of violence reductions. The extent of the reduction is explained by the extreme degree of inequality observed in Brazilian society.

Though the exercise indicates that inequalities in income and risk exposure may have significant effects on the social willingness to pay for violence reductions, there are two points worth mentioning here. First, the order of magnitude of the estimates is not changed. After accounting for inequality, the welfare cost of violence still seems to be at least as important as the material costs. Second, the effect of inequality is likely to be the highest in the case of Brazil, because of the extremely high degree of income inequality and the high levels of violence. In this sense, the 40% bias estimated in this section is likely to be an upper bound to what can happen in other countries. Even discounting for that, the estimated welfare cost of violence is still very large.

## 6 Concluding Remarks

This paper presents the first comprehensive cross-country assessment of the importance of non-monetary costs of violence. Our results show that, for the 73 countries included in the sample, reducing homicide rates to zero would imply an average increase of one year in life expectancy at birth, and would have a value corresponding to, on average, 24% of the 1995 GDP. For Colombia and the United States, violence reduces life expectancy at birth by, respectively, 3.1 and 0.8 years. These declines in life expectancy represent a social welfare loss of the order of 20% of the 1995 GDP for the US, and 113% for Colombia. Generally, a one-unit increase in years of life lost to violence is associated with an increase of 26% of the GDP in the social willingness to pay for violence reductions.

These numbers should be compared to the present discounted value of the annual flow of material costs of crime. Material costs of the order of 2.1% of the GDP for the US correspond to a present value of 62% of the GDP. Material costs of the order of 3.6% of the GDP for Latin America correspond to a present discounted value of roughly 100% of the GDP.[13]

Though the material costs are higher, the order of magnitude is the same. In addition, these estimated material costs include expenditures, among others, on police force, penitentiaries, and judicial system, all of which are in place in order to reduce the

[13] The discount rate applied here also accounts for survival probabilities.

risk of victimization of the general population. If public policy is efficiently designed, the welfare benefits from having such institutions in place should be at least as large as these observed costs.

Alternatively, our estimates give potential benefits from further reductions in violence. These do not mean that additional expenditures on public safety should necessarily be undertaken. Whether these additional expenditures are worthwhile depends on the public safety technology available, and on its implementation costs. Or, in other words, it depends on whether further reductions in violence can be achieved at a cost lower than the social willingness to pay.

It is also important to stress precisely what our estimates measure. The identification of the underlying parameters that allows the valuation of changes in survival probabilities comes from the value of life literature, via compensating differentials for occupational mortality risks. As long as mortality rates and the probability of injuries are correlated across different occupations, the estimation of the relevant parameters may partially capture the willingness to pay for reductions in the probability of injuries. Therefore, by using these parameters, we are probably also valuing, to some extent, certain reductions in "injury rates" that may accompany reductions in homicides (assuming a correlation between homicides and injuries similar to the correlation between occupational mortality risks and probability of work-related injuries). Nevertheless, there is a large share of non-monetary costs due to injuries and other aspects of violence – sexual violence, for example – that is clearly not captured by the correlation between death and injury implicit in the estimation from occupational risks. From this perspective, if anything, our results probably underestimate the true social value of violence reductions.

Also, we do not discuss the indirect economic effects of the violence-induced reduction in life expectancy. These may include decreased investments in human capital and health, reduced savings and investments in physical capital (higher discount rates), and, therefore, reduced long-run growth.

Even so, the estimated social value of investments in security and policies aimed at reducing violence is huge. We do not think that these non-monetary costs of violence

and crime are taken seriously enough into account in the discussion and formulation of public policies. Our results suggest that they should be.

# Appendix

## A.1 Countries Included in the Sample

Albania; Argentina; Armenia; Australia; Austria; Azerbaijan; Bahamas; Barbados; Belarus; Belgium; Belize; brazil; Bulgaria; Canada; Chile; Colombia; Costa Rica; Croatia; Cuba; Czech Republic; Ecuador; El Salvador; Estonia; Finland; France; Georgia; Germany; Greece; Grenada; Hong Kong; Hungary; Iceland; Ireland; Israel; Italy; Japan; kazaks tan; Kuwait; Kyrgyzstan; Latvia; Lithuania; Luxembourg; Macedonia; Malta; Mauritius; Mexico; Netherlands; new Zealand; Norway; Philippines; Poland; Portugal; Puerto rice; republic of Korea; republic of Moldova; Romania; Russian federation; saint kits and Nevis; Singapore; Slovak Republic; Slovenia; Spain; Suriname; Sweden; Tajikistan; Trinidad and Tobago; Turkmenistan; Ukraine; united kingdom; United States; Uruguay; Uzbekistan; Venezuela.

## A.2 Variables

*Income per capita*: RGDPTT from the Penn World Tables version 6.1. Real GDP per capita adjusted for terms of trade, in 1996 international prices. The value for 1995 is the average for all years available between 1990 and 1999.

*Homicide Rates*, *Survival Probabilities*, and *Counterfactual Survival Probabilities*: Calculated from the World Health Organization Mortality Database, using number of deaths, number of deaths caused by "homicide and injury purposely inflicted by other persons, and other violence" (aggregate causes of death B55 and B56 in the ICD-9), and population, all by age group. The value for 1995 is the average for all years available between 1990 and 1999.

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**Table 1: Value of Violence Reduction and Descriptive Statistics, WHO Regions*, 1995**

| WHO Region | Life Expectancy | Homicide Rate (per 100,000) | GDP per capita | Life Expectancy with No Violence | Expected Years of Life Lost | Marg Will to Pay of a Newborn | Social Value (billions) | Social Value as % of Agg GDP |
|---|---|---|---|---|---|---|---|---|
| Latin America & Caribbean | 70.4 | 21.8 | 7,708 | 72.0 | 1.6 | 8,148 | 67.78 | 43% |
| North America | 75.6 | 6.5 | 25,672 | 76.3 | 0.6 | 14,317 | 752.02 | 14% |
| Western Europe | 75.8 | 4.0 | 19,532 | 76.3 | 0.5 | 7,750 | 31.50 | 9% |
| Former Communist Europe | 67.9 | 17.2 | 6,009 | 69.2 | 1.3 | 4,247 | 36.34 | 26% |
| Western Pacific | 75.7 | 7.8 | 17,839 | 76.3 | 0.6 | 5,640 | 48.83 | 14% |

Notes: * Regional numbers are unweighted country averages. Due to data availability, the only African country included in the sample is Mauritius, and the only Eastern Mediterranean country is Kuwait. Therefore, these regions are not included in this table. Values for these two countries are contained in Table 2.

**Table 2: Value of Violence Reduction and Descriptive Statistics, Countries, 1995**

| Country | Life Expectancy | Homicide Rate (per 100,000) | GDP per capita | Life Expectancy with No Violence | Expected Years of Life Lost | Marg Will to Pay of a Newborn | Social Value (billions) | Social Value as % of Agg. GDP |
|---|---|---|---|---|---|---|---|---|
| ALBANIA | 72.3 | 14.2 | 2,573 | 74.0 | 1.69 | 2,157 | 2.27 | 27% |
| ARGENTINA | 70.5 | 15.8 | 9,938 | 72.3 | 1.83 | 13,776 | 132.58 | 39% |
| ARMENIA | 71.3 | 13.8 | 2,486 | 72.3 | 1.06 | 1,244 | 1.69 | 18% |
| AUSTRALIA | 77.0 | 2.6 | 22,047 | 77.5 | 0.46 | 8,713 | 31.05 | 8% |
| AUSTRIA | 75.7 | 1.9 | 21,099 | 76.1 | 0.40 | 7,461 | 9.14 | 5% |
| AZERBAIJAN | 68.0 | 22.2 | 2,288 | 69.7 | 1.70 | 1,843 | 5.17 | 30% |
| BAHAMAS | 69.5 | 24.7 | 16,527 | 71.0 | 1.57 | 20,241 | 2.20 | 49% |
| BARBADOS | 72.4 | 9.9 | 14,339 | 73.4 | 1.05 | 12,084 | 0.80 | 22% |
| BELARUS | 67.9 | 22.5 | 6,870 | 68.8 | 0.87 | 3,648 | 17.10 | 24% |
| BELGIUM | 75.1 | 4.5 | 21,025 | 75.7 | 0.58 | 10,482 | 20.62 | 10% |
| BELIZE | 72.9 | 8.6 | 6,131 | 74.1 | 1.16 | 4,682 | 0.36 | 30% |
| BRAZIL* | 67.5 | 34.4 | 6,591 | 69.8 | 2.25 | 9,822 | 370.77 | 58% |
| BULGARIA | 69.6 | 6.2 | 6,263 | 70.3 | 0.76 | 3,361 | 5.20 | 10% |
| CANADA | 76.7 | 2.8 | 22,827 | 77.2 | 0.44 | 8,719 | 50.31 | 8% |
| CHILE | 72.3 | 33.5 | 8,116 | 74.1 | 1.83 | 9,327 | 61.01 | 55% |
| COLOMBIA | 70.4 | 83.2 | 5,249 | 73.5 | 3.06 | 8,253 | 201.70 | 113% |
| COSTA RICA | 73.8 | 7.8 | 5,247 | 74.9 | 1.10 | 3,657 | 4.07 | 24% |
| CROATIA | 70.7 | 31.4 | 7,838 | 72.0 | 1.26 | 6,032 | 12.27 | 33% |
| CUBA | 73.5 | 10.6 | 5,498 | 74.2 | 0.75 | 2,511 | 8.96 | 15% |
| CZECH REPUBLIC | 70.9 | 6.5 | 12,876 | 71.6 | 0.68 | 7,113 | 14.71 | 11% |
| ECUADOR | 69.8 | 15.5 | 3,691 | 71.7 | 1.83 | 3,807 | 15.63 | 40% |
| EL SALVADOR | 68.8 | 42.3 | 3,959 | 71.4 | 2.52 | 5,267 | 15.54 | 73% |
| ESTONIA | 67.5 | 26.4 | 7,771 | 68.6 | 1.05 | 5,195 | 3.34 | 29% |
| FINLAND | 75.0 | 7.2 | 19,423 | 75.5 | 0.46 | 6,847 | 11.26 | 11% |
| FRANCE | 76.9 | 5.2 | 20,299 | 77.4 | 0.51 | 8,391 | 116.23 | 10% |
| GEORGIA | 68.1 | 12.8 | 4,776 | 69.3 | 1.24 | 3,774 | 3.96 | 20% |
| GERMANY | 75.3 | 3.6 | 20,848 | 75.7 | 0.39 | 6,926 | 110.00 | 6% |

**Table 2: Value of Violence Reduction and Descriptive Statistics, Countries, 1995**

| Country | Life Expectancy | Homicide Rate (per 100,000) | GDP per capita | Life Expectancy with No Violence | Expected Years of Life Lost | Marg Will to Pay of a Newborn | Social Value (billions) | Social Value as % of Agg. GDP |
|---|---|---|---|---|---|---|---|---|
| GREECE | 76.3 | 1.4 | 12,583 | 76.8 | 0.46 | 4,721 | 6.44 | 5% |
| GRENADA | 67.2 | 10.3 | 4,984 | 68.0 | 0.84 | 2,718 | 0.10 | 22% |
| HONG KONG | 77.6 | 3.3 | 24,556 | 77.9 | 0.32 | 6,419 | 10.18 | 7% |
| HUNGARY | 67.8 | 4.5 | 8,941 | 68.6 | 0.81 | 5,780 | 9.29 | 10% |
| ICELAND | 77.3 | 2.0 | 21,728 | 77.7 | 0.40 | 7,469 | 0.45 | 8% |
| IRELAND | 74.3 | 1.5 | 17,692 | 74.6 | 0.37 | 5,643 | 3.86 | 6% |
| ISRAEL | 75.9 | 6.5 | 15,534 | 76.6 | 0.69 | 8,451 | 13.96 | 17% |
| ITALY | 76.7 | 2.8 | 20,216 | 77.1 | 0.46 | 7,995 | 72.28 | 6% |
| JAPAN | 79.4 | 2.9 | 23,406 | 79.7 | 0.30 | 5,719 | 150.57 | 5% |
| KAZAKSTAN | 64.3 | 38.6 | 6,052 | 66.2 | 1.93 | 7,428 | 54.71 | 56% |
| KUWAIT | 74.1 | 3.3 | 23,386 | 75.0 | 0.89 | 18,731 | 7.89 | 19% |
| KYRGYZSTAN | 64.8 | 17.6 | 2,836 | 66.8 | 1.94 | 2,953 | 5.09 | 40% |
| LATVIA | 65.9 | 34.6 | 7,323 | 67.1 | 1.21 | 5,491 | 6.47 | 35% |
| LITHUANIA | 68.9 | 16.0 | 6,920 | 69.7 | 0.90 | 4,023 | 5.29 | 21% |
| LUXEMBOURG | 75.4 | 3.2 | 33,969 | 75.9 | 0.45 | 13,972 | 1.12 | 8% |
| MACEDONIA | 70.0 | 3.4 | 4,559 | 71.3 | 1.32 | 4,039 | 1.37 | 15% |
| MALTA | 75.4 | 2.7 | 13,101 | 76.1 | 0.65 | 6,892 | 0.46 | 10% |
| MAURITIUS | 68.0 | 2.5 | 11,145 | 69.3 | 1.26 | 11,937 | 2.44 | 20% |
| MEXICO | 69.8 | 20.8 | 7,630 | 71.8 | 1.99 | 10,369 | 370.13 | 55% |
| NETHERLANDS | 76.3 | 1.6 | 21,122 | 76.7 | 0.44 | 8,205 | 19.24 | 6% |
| NEW ZEALAND | 75.4 | 2.5 | 16,807 | 75.9 | 0.53 | 7,537 | 5.23 | 9% |

**Table 2: Value of Violence Reduction and Descriptive Statistics, Countries, 1995**

| Country | Life Expectancy | Homicide Rate (per 100,000) | GDP per capita | Life Expectancy with No Violence | Expected Years of Life Lost | Marg Will to Pay of a Newborn | Social Value (billions) | Social Value as % of Agg. GDP |
|---|---|---|---|---|---|---|---|---|
| NORWAY | 76.1 | 1.6 | 23,515 | 76.5 | 0.41 | 8,665 | 6.28 | 6% |
| PHILIPPINES | 69.7 | 33.2 | 3,086 | 71.6 | 1.89 | 2,789 | 106.67 | 50% |
| POLAND | 70.1 | 8.3 | 7,277 | 71.0 | 0.84 | 4,341 | 41.29 | 15% |
| PORTUGAL | 73.4 | 13.3 | 13,434 | 74.1 | 0.70 | 6,899 | 22.12 | 17% |
| PUERTO RICO | 71.2 | 28.5 | 9,974 | 72.7 | 1.49 | 10,102 | 15.19 | 43% |
| REPUBLIC OF KOREA | 74.9 | 3.7 | 12,706 | 75.0 | 0.13 | 942 | 29.65 | 5% |
| REPUBLIC OF MOLDOVA | 64.8 | 25.1 | 2,251 | 66.2 | 1.38 | 1,464 | 2.25 | 24% |
| ROMANIA | 67.7 | 4.6 | 4,629 | 68.7 | 0.99 | 3,099 | 11.78 | 11% |
| RUSSIAN FEDERATION | 65.2 | 49.9 | 7,918 | 66.7 | 1.50 | 7,172 | 573.09 | 49% |
| SAINT KITTS AND NEVIS | 67.7 | 11.6 | 10,567 | 69.1 | 1.42 | 11,251 | 0.20 | 43% |
| SINGAPORE | 75.9 | 6.6 | 22,265 | 76.3 | 0.43 | 7,357 | 8.45 | 13% |
| SLOVAK REPUBLIC | 70.6 | 5.4 | 10,443 | 71.4 | 0.72 | 5,967 | 6.73 | 12% |
| SLOVENIA | 73.1 | 3.2 | 12,823 | 73.5 | 0.40 | 4,090 | 1.58 | 6% |
| SPAIN | 76.6 | 1.3 | 15,541 | 76.9 | 0.34 | 4,462 | 24.86 | 4% |
| SURINAME | 70.3 | 15.9 | 2,948 | 71.6 | 1.32 | 1,978 | 0.34 | 28% |
| SWEDEN | 77.2 | 6.6 | 20,788 | 77.7 | 0.48 | 7,750 | 20.81 | 11% |
| TAJIKISTAN | 63.7 | 15.9 | 1,153 | 66.8 | 3.02 | 1,183 | 2.57 | 40% |
| TRINIDAD AND TOBAGO | 69.2 | 12.3 | 9,514 | 70.0 | 0.76 | 5,086 | 2.75 | 23% |
| TURKMENISTAN | 62.0 | 8.8 | 4,533 | 64.7 | 2.63 | 8,180 | 10.65 | 56% |
| UKRAINE | 67.1 | 29.9 | 6,223 | 68.1 | 1.04 | 3,850 | 90.51 | 28% |
| UNITED KINGDOM | 75.4 | 4.6 | 19,650 | 75.9 | 0.51 | 8,273 | 107.85 | 9% |
| UNITED STATES | 74.5 | 10.2 | 28,517 | 75.3 | 0.82 | 19,916 | 1,453.72 | 20% |
| URUGUAY | 70.5 | 4.4 | 8,810 | 71.9 | 1.45 | 9,937 | 5.79 | 21% |
| UZBEKISTAN | 65.8 | 7.8 | 2,595 | 67.7 | 1.94 | 2,742 | 20.09 | 35% |
| VENEZUELA | 69.8 | 23.6 | 6,746 | 71.9 | 2.18 | 9,950 | 79.78 | 58% |

Notes: * The mortality data for Brazil refers only to the South, Southeast, and Central-West regions. GDP per capita figures used are for the whole country, and aggregate GDP is calculated by using the GDP per capita figure and the region specific populations.

**Table 3: Effect of Income and Years of Life Lost to Violence on the Willingness to Pay of a Newborn ($MWP_0$)**

| | Coeff | Std Error | t | p-value |
|---|---|---|---|---|
| ln(GDP) | 6,613 | 472 | 14.00 | 0.00 |
| $L_v$ | 5,128 | 522 | 9.83 | 0.00 |
| const | -59,096 | 4742 | -12.46 | 0.00 |
| $R^2$ | 0.74 | | N Obs | 73 |

Note: Dependent variable is Willingness to Pay of a Newborn for Violence Reductions; independent variables are natural logarithm of per capita GDP (RTTGDP from PWT 6.1) and Expected Years of Life Lost to Violence.

**Table 4: Descriptive Statistics for Educational Groups, Brazil, 1995**

| Educational Group | Income per Capita | Homicide Rate | Population Share |
|---|---|---|---|
| No Education | 2,706 | 35.4 | 13% |
| Some Elementary | 4,006 | 68.5 | 35% |
| Some High School | 6,689 | 4.8 | 43% |
| Some College | 20,469 | 8.1 | 10% |

Note: Income per capita is GDP in 1996 international prices adjusted for terms of trade, calculated using average educational wage differentials. Population shares are calculated using shares of the labor force.

**Table 5: Value of Violence Reduction by Educational Group, Brazil, 1995**

| Educational Group | Life Expectancy | Expected Years of Life Lost | Marg Will to Pay of a Newborn | Social Value (billions) | Social Value as % of National GDP |
|---|---|---|---|---|---|
| No Education | 65.9 | 3.9 | 5,547 | 21.4 | 3.3% |
| Some Elementary | 65.1 | 4.7 | 10,882 | 144.7 | 22.5% |
| Some High School | 69.7 | 0.1 | 454 | 17.4 | 2.7% |
| Some College | 69.6 | 0.2 | 2,287 | 28.2 | 4.4% |
| Aggregate Social Cost of Violence = | | | | 211.7 | 32.9% |

**Figure 1: Income and the Marginal Willingness to Pay of a Newborn, 1995**

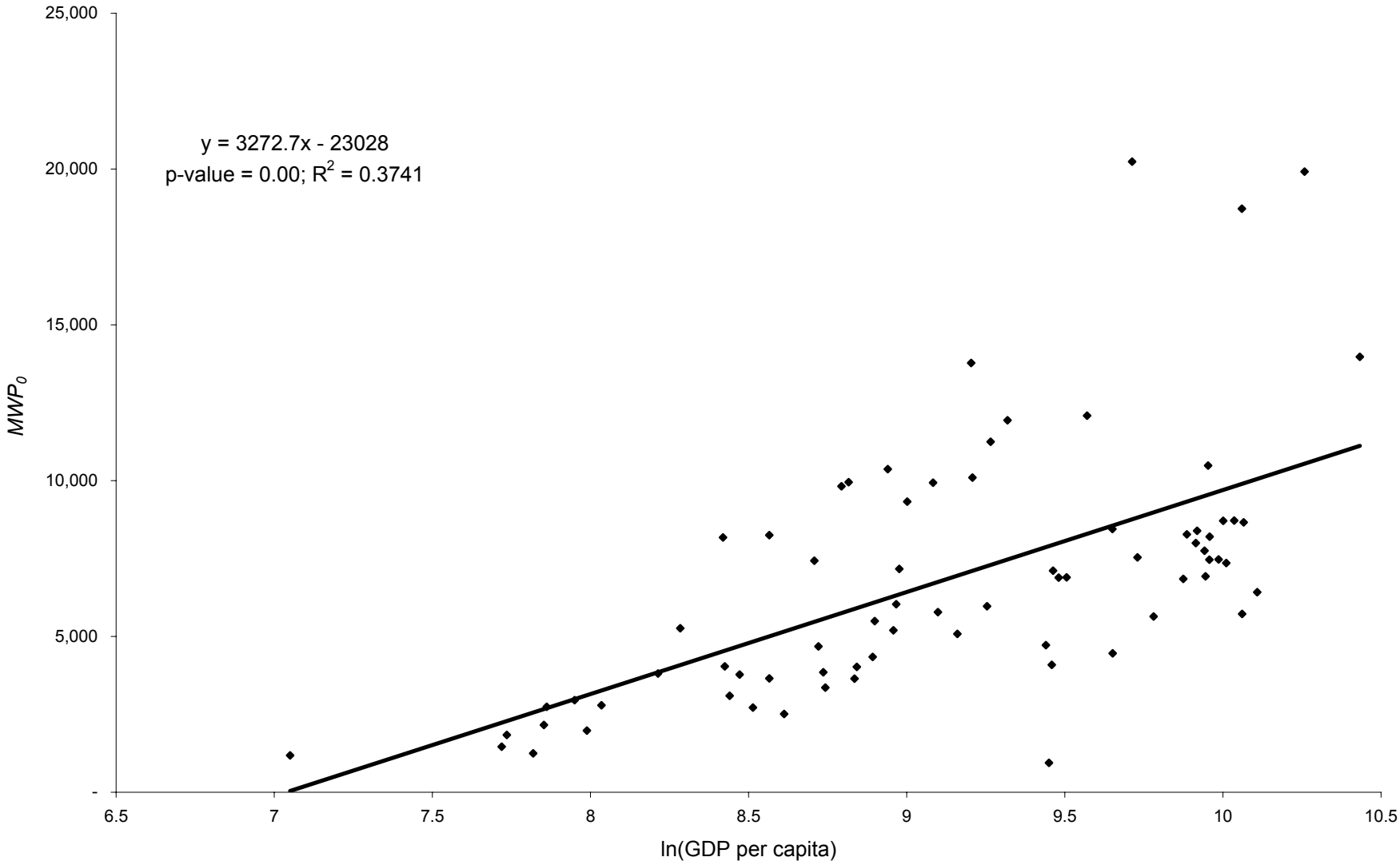


**Figure 2: Social Value of Violence Reduction (% of GDP), 1995**

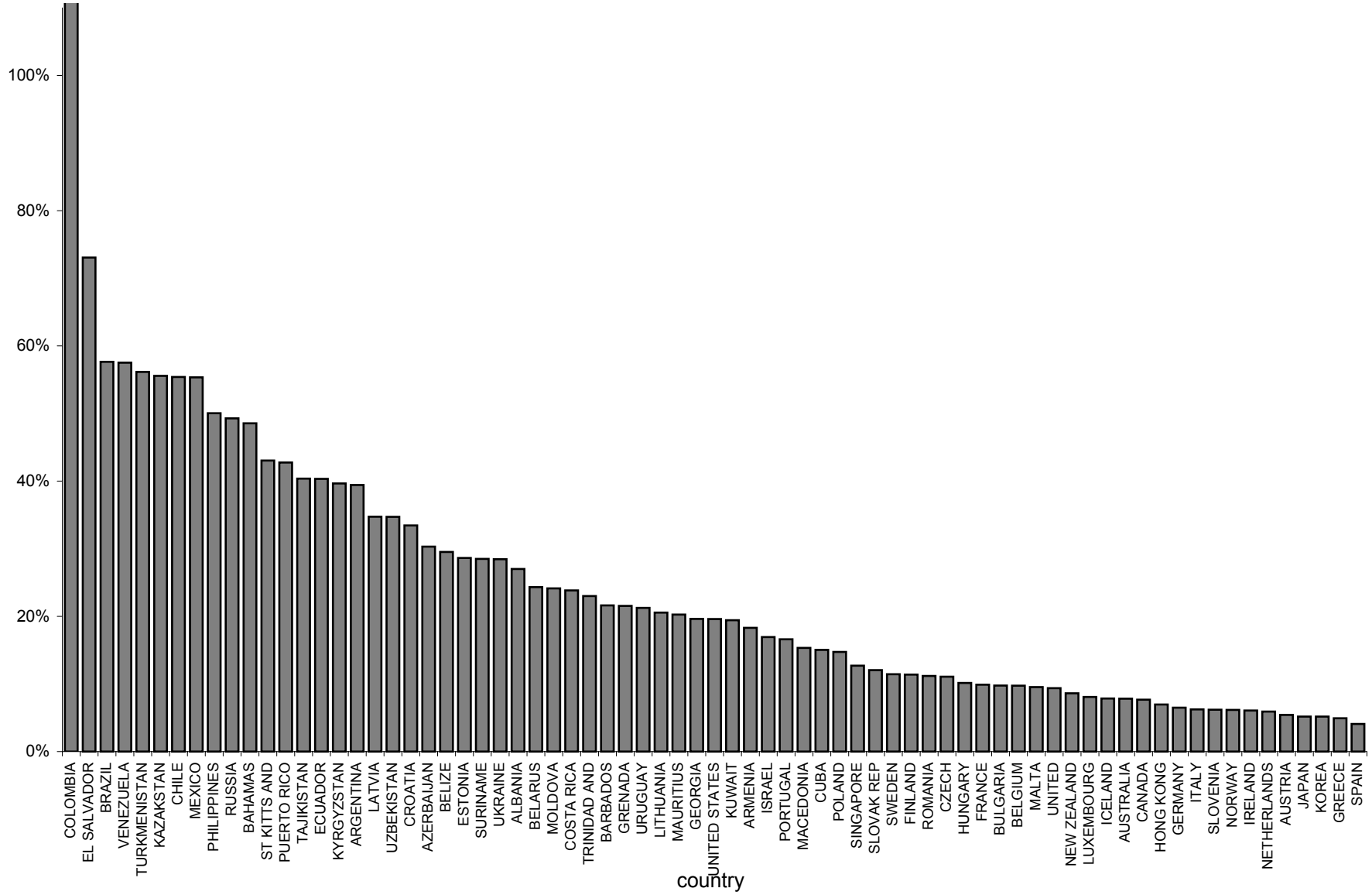


**Figure 3: Expected Years of Life Lost and Social Value of Violence Reduction (% of GDP), 1995**

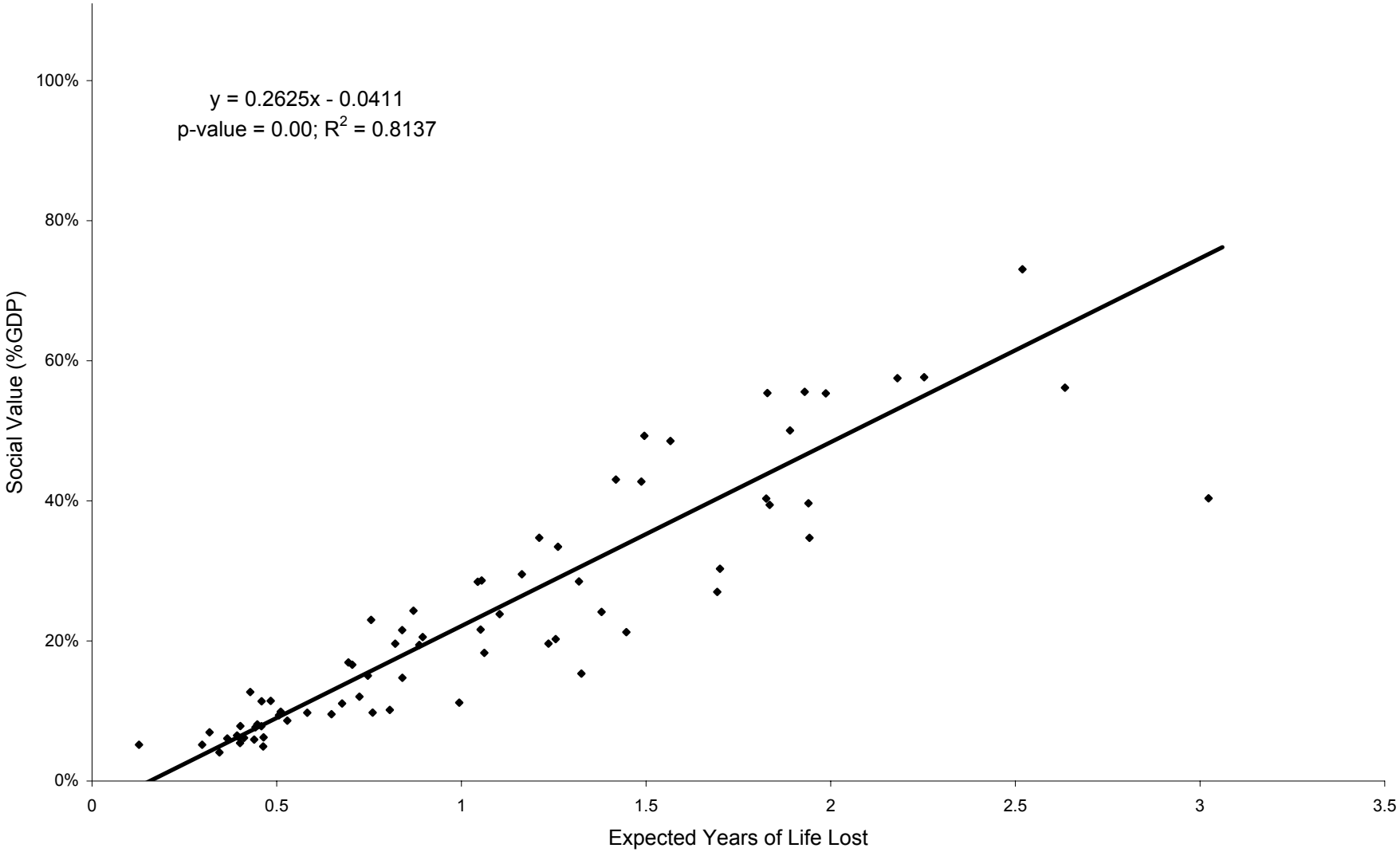
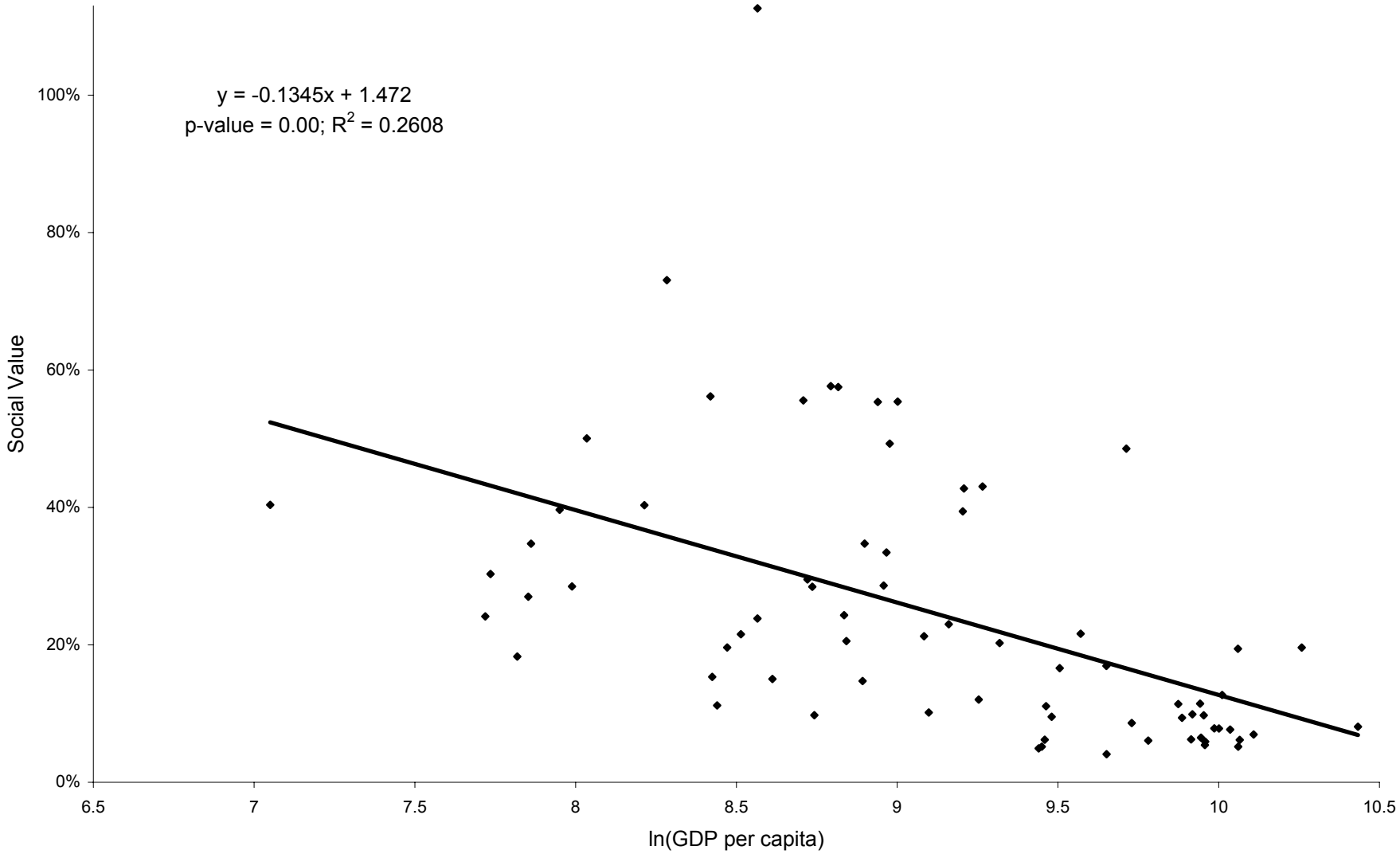


**Figure 4: Income per capita and Social Value of Violence Reduction (% GDP), 1995**



## Figure 5: Age Profile of the Willingness to Pay for Violence Reductions, Selected Countries, 1995

**Figure 5a: Selected Latin American Countries; 1995**

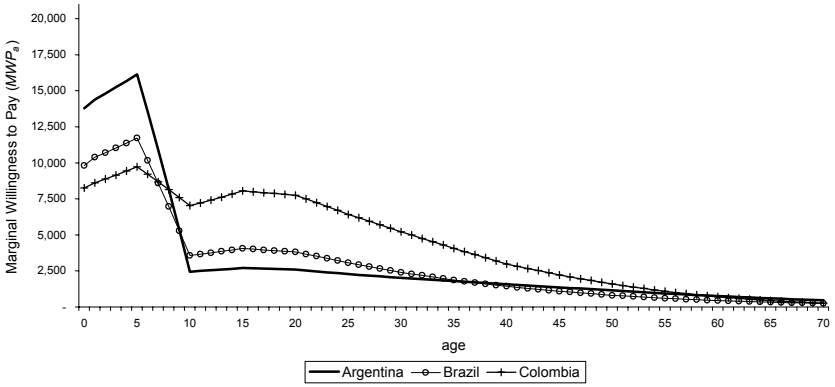



**Figure 5b: Selected Former Communist Countries; 1995**

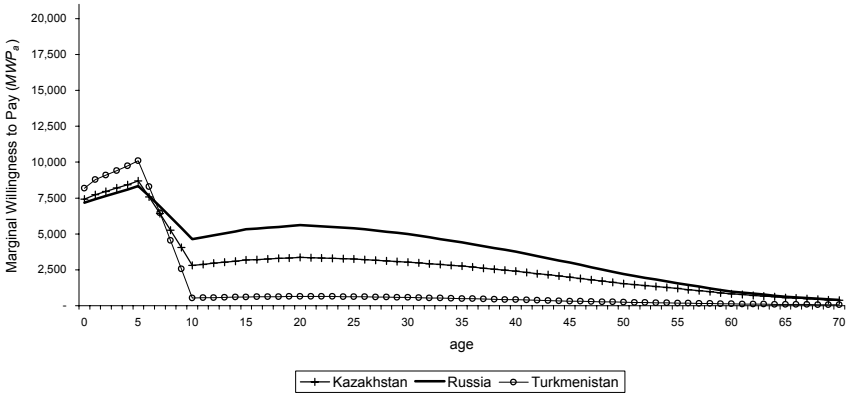



**Figure 5c: North America and Mexico; 1995**

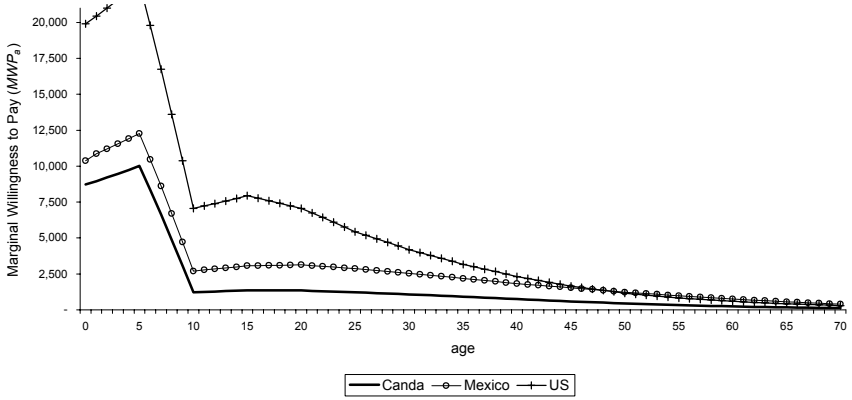



**Figure 5d: Selected Western European and Asian Countries; 1995**

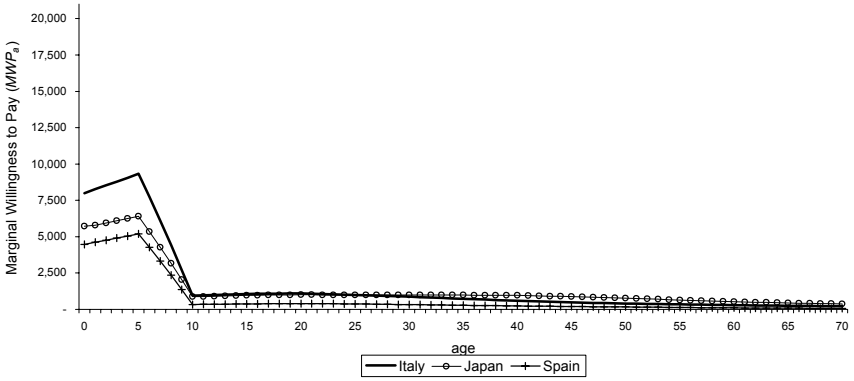


**Figure 6: Willingness to Pay for Violence Reductions by Age, Brazil, Different Educational Groups**