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The Welfare Cost of Violence*

Abstract

This paper estimates the welfare loss caused by the violent deaths registered in 73 countries of the world during the nineties. A violence 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 violence reduces life expectancy at birth, on average, by one-third of a year. This represents a reduction in lifetime welfare corresponding to, on average, 15% of the 1995 GDP. In Colombia, homicide rates reduce life expectancy at birth by 2.2 years; in the US, by 0.3 year. The lifetime welfare cost of violence corresponds to 13 and 100% of, respectively, the American and Colombian aggregate GDP's in 1995. Generally, one additional year of life lost to violence is associated with an increase of 44% of the GDP in the social willingness to pay for violence reductions.

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1 Introduction

This paper estimates the welfare loss caused by the violent deaths registered in 73 countries of the world during the nineties. We use data on number of deaths by age group and cause of death from the World Health Organization to calculate the age-specific reduction in survival probabilities due to violence. We then apply the marginal willingness to pay approach suggested by the "value of life" literature, in order to estimate the monetary value of the reductions in survival probabilities for individuals at any given age. Together with the age distribution of the population, this willingness to pay can be used to estimate the social value of violence reductions, or the welfare cost of violence. Our results show that the reduction in life expectancy due to violence represents a substantial welfare loss, comparable in magnitude to the direct material costs of crime.

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 per year 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 violence observed in different countries of the world. A given violence 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 Schelling (1968), and developed in detail by Usher (1973) and 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, taking into account only its effects on mortality.

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) and Miller et al (1993) 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).

More recently, a promising literature, which uses the "contingent-valuation" approach suggested originally for the evaluation of environmental policies, has emerged. Cook and Ludwig (2000), Ludwig and Cook (2001), and Cohen et al (2004) are examples of this line of research. The contingent-valuation method is based on surveys asking individuals' about their choices over alternative policies. The answers to these surveys

are then used to estimate the individual and social willingness to pay for policies targeted at a specific type of crime or violence.

Though there is a vast literature in all these areas, it is almost exclusively restricted to the US case. From an international perspective, virtually no work has been done on the non-monetary costs of crime and violence. 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 based on case studies (Brazil, Colombia, El Salvador, Mexico, Peru, and Venezuela).

This paper presents the first set of comprehensive cross-country estimates of non-monetary costs of crime. Methodologically, it also represents the first attempt to use the "value of life" methodology in this context 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, violence determines a reduction of 2.2 years in life expectancy at birth. For the US, violence reduces life expectancy at birth by 0.3 year, while for Western Europe the average reduction is 0.1 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 present lifetime social value of eliminating violence corresponds to 13% of the American GDP in 1995, and 100% of the Colombian GDP in that same year. In Western Europe, the average present lifetime social value of violence eradication corresponds to 5% of the 1995 GDP. Generally, a one-unit increase in the years of life lost to violence is associated with an increase of 44% of the GDP in the lifetime social willingness to pay for violence reductions.

These results give the welfare loss determined by the increased mortality rates induced by violence. There are several other costs of violence that are not incorporated into the analysis, and that should be added to the numbers we obtain. Material costs, such as the ones discussed in the first paragraphs of the introduction, and inefficiencies associated to changes in behavior induced by crime and violence, are not addressed in the paper (on the latter, see studies discussed in Merlo, 2004). Nevertheless, we do provide estimates for a large number of countries on the cost of violence on one very important welfare dimension, namely, mortality. The evidence supports the belief that non-monetary costs of violence and crime are 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 death 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:

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

where $c(t)$ is consumption at t, and ρ 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 λ_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:

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

This expression summarizes the main determinants of the willingness to pay for changes in survival probabilities. Discounting of the future implies that individuals will be willing to pay more for given mortality reductions the closer they are to the moment

where the largest changes in survival probabilities take place. From a social perspective, the population distribution will be important because it will determine the weight attributed to mortality reductions at each given age, according to the size of the population that is immediately affected by it.

In addition, income and consumption throughout life will also determine the value of changes in survival probabilities. The higher consumption is at a point in time, the higher the direct utility gain ($c(t)/\varepsilon(c(t))$) from increasing the probability of survival up to that moment. Similarly, the higher the income surplus from a given period that can be used to "subsidize" consumption in other periods is ($y(t) - c(t)$), the higher the value of increasing the probability of survival up to that moment. In short, the value of surviving up to a given moment is determined by the utility directly enjoyed in that moment and by the income surplus generated in that moment that can be used to increase utility in other periods. These are the two factors inside brackets in expression (5).

Expression (5) can be used to evaluate the welfare gains from given reductions in mortality rates for an individual at any age a. With this expression, the social value is obtained by integrating MWP_a through all ages, weighting the value at each age by the population in the respective age group. If 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[1]

$$Social\,MWP = P\int_0^{\infty} MWP_a f(a)da. \qquad (6)$$

This is the sum of the willingness to pay of every individual in society. Equation (6) is analogous to the one that characterizes the optimal provision of a continuous public good in the traditional public finance literature.

In this general formulation, the calculation of the marginal willingness to pay for changes in survival probabilities requires data on income and consumption at every point in time. In a cross-country context, these data are not available for the vast majority of

[1] This formula does not incorporate the value to future generations of the reductions in violence. Therefore, also from this perspective, our numbers should be seen as conservative estimates of the social lifetime present value of the welfare costs of violence.

cases. When the main goal is the comparison of lifetime welfare levels and changes, a feasible alternative is to abstract from lifecycle considerations by assuming that $\rho = r$ and $y(t)$ is constant ($y(t) = y$). This allows the calculation of values of changes in mortality rates 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

$$MWP_a = \frac{y}{\varepsilon(y)} \int_a^{\infty} e^{-r(t-a)} S_v(t,a) dt. \qquad (7)$$

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 $S_v(t,a)$. We come back to the limitations imposed by this assumption in Section 5.

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

$$MWP_a = \frac{y}{\varepsilon(y)} e^{-r(\tau-a)} d\tau = \frac{u(y)}{u'(y)} e^{-r(\tau-a)} d\tau. \qquad (7')$$

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. 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 (7) 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, according to equation (6).

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 (2004).

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 (2004) 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 α is the parameter that arises from the normalization of utility in the death state to zero, and γ is the inter-temporal elasticity of substitution. Note that, contrary to the superficial intuition, it is not true that α is necessarily positive. Strictly, α is the

parameter determining the level of annual consumption at which the individual would be indifferent between being dead or alive. If we think that there is such a level of consumption, γ larger than one necessarily means α smaller than zero.

We assume that preferences towards consumption and survival rates are the same across different cultures, so that α and γ are underlying parameters shared by all the economies in our sample. So we can calibrate the values of α and γ 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 ε 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 ε can be estimated from compensating differentials for occupational mortality risks. Murphy and Topel (2003), using numbers from the literature on occupational risks, estimate ε 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 γ = 1.25, ε = 0.346 and c = 26,365 to calibrate the value of α. 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 ε using US data for 1990, and our income data comes from the PWT 6.1. Our calculations give a value of α equal to –16.16. Together with the value of γ, this implies that an individual with annual income equal to 353 would be indifferent between being alive or dead.[2]

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 $10,000, our calibrated parameters imply an income-elasticity of the marginal willingness to pay ($(\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 α and γ in hand, we can use equation (7) to value the mortality reductions that would be observed if violent deaths were reduced to zero. This does not imply that the goal of public policy should be to reduce violence 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

[2] 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.

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 (7) can be rewritten in terms of the parameters discussed as:[3]

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

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 (6) 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.[4] 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).[5] 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. In order to increase the number of countries in the sample, all variables for

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

[4] 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.

[5] The problem of underreporting of number of deaths is potentially serious. But the evidence discussed in Soares (2004) 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. If anything, our main results will be conservative estimates of the true value of violence reductions.

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[6]

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

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.[7]

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

[7] This corresponds to assuming that deaths by violence are realized in the end of each period, after deaths from other causes were already realized. Alternatively, one could assume that deaths by violence are realized in the beginning of the period, before mortality from other causes is realized. In this case, the counterfactual scenario would have to take into account that the deaths that did not happen due to violence should be subject to the observed mortality rates from other causes. Since most of the violent deaths take place at ages when mortality from other causes is very low (prime-age), the difference between the two alternative hypotheses should be small.

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 lifetime 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 an 18 year-old individual,

and as the lifetime 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.[8] 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 highlight a point that is already clear from the homicide rates. But this counterfactual variable is particularly interesting because it materializes the content of violence 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, 0.6 and 0.4 year lower because of violence. These numbers are at least two times higher than the loss in life 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 2.2 expected years of life are lost because of violence. Following, we have El Salvador, the Philippines, the Russian Federation and Chile, all of which have more than 0.9 year of life expectancy lost to violence.

But our main interest here is on 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 reductions is quite high. For an 18 year-old individual (MWP_{18}), the marginal willingness to pay for eliminating violent deaths picks at values above $7,000, for Colombia, the Bahamas, and the US. These three cases illustrate the forces at work in determining willingness to pay: income and mortality. In terms of regions, North America has the highest value for MWP_{18} ($4,389), due to the highest income per capita in the sample and homicide rates that, though not too high, are

[8] 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.

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, with MWP_{18} equal to \$2,941, 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 and life expectancy lost to violence in determining the marginal willingness to pay is illustrated Table 3.[9] This table presents the results of a linear regression of MWP_{18} 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 \$1,393 increase in MWP_{18}, while one additional year of life expectancy lost to violence increases MWP_{18} by \$4,637.

To analyze the social aspect of welfare gains, it is interesting to look at the lifetime social value of violence reduction as a share of national output (aggregate GDP). This gives an idea of the relative importance of the effects of violence on lifetime welfare, when compared to the annual value of production. From this perspective, Latin American countries are on the front of the line. The value of reducing violence rates to zero for Latin American countries amounts to, on average, 27% of the 1995 GDP. This value is almost two times higher than the second highest regional value (15% for Former Communist Europe). Figure 1 shows the social value of violence reduction as a share of GDP for all countries in the sample, ordered from highest to lowest. The 6 frontrunners are either Latin American or Former Communist countries: Colombia, with an astounding 100%, followed by El Salvador (53%), Russian Federation (44%), Chile (42%), Kazakhstan (40%), and Brazil (38%). Among the 10 highest values, 7 are from Latin American or the Caribbean, 2 are from Eastern Europe, and the remaining one is the Philippines. In the other extreme of the distribution, the 6 lowest values are from Western Europe.[10]

[9] 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, 2004).

[10] The US constitutes an interesting case to check the consistency of our results, given the abounding evidence related to the welfare cost of violence from a series of different sources. In particular, our results are consistent with the evidence from the recent contingent-valuation literature. For example, Ludwig and Cook (2001) estimate that the social gain from reducing all types of gun violence (including non-lethal) by 30% would be of the order US\$24.5 billion per year. A back of the envelope calculation gives that the total

When analyzing the values as shares of income, the dominant dimension is mortality. Figure 2 plots the expected years of life lost to violence 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 0.98.[11] When the willingness to pay is divided by income, the cost of violence has an almost linear relation with the loss in life expectancy. The estimated coefficient implies that one additional year of life lost to violence increases the social willingness to pay for violence eradication by 44% of the GDP. The close relationship portrayed in Figure 2 suggests a very simple rule of thumb: *x* years of life expectancy lost to violence increase the lifetime social cost of violence by *x**44% of yearly production.

Another interesting dimension of the analysis is the age profile of the willingness to pay within a given country. Figures 3 (a) to (d) plot this profile between ages zero and 70 for selected countries. Since we abstracted from income variations through the

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welfare loss of gun related violence corresponds to US$81.7 billion per year. Discounted at the interest and mortality rates used here, this gives a lifetime present value equal to 25% of the 2000 aggregate GDP. This percentage is almost two times higher than the one that we obtain for the US (13%), but this should be no surprise, since the contingent-valuation methodology implicitly estimates all direct and indirect costs of violence, and also the costs of non-fatal injuries. Cohen et al (2004), using a similar methodology, estimate the costs of all types of crimes in the US – burglary, armed robbery, serious assault, rape and sexual assault, and murder – to correspond to US$625 billion per year. This gives a lifetime discounted value one order of magnitude higher than before (189% of the 2000 aggregate). Mainly due to availability of international data, our analysis is restricted to violence resulting in death, and it does not incorporate the direct material costs of crime. Nevertheless, these numbers suggest that, if anything, we are probably underestimating the welfare cost of violence.

[11] 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 α 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 taking the derivative of the MWP_{18} 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 simply as descriptive tools.

lifecycle, this reflects only the distribution of violence and overall mortality across the different ages (the latter is important because it affects the horizon of the individual problem, and also because competing risks affect the value of mortality reductions at any given age).

A common feature of the age profile of willingness to pay in all different regions is the initially increasing portion – up to some age between 15 and 20 – followed by a constantly declining trend until the end of life. 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.[12] 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 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 tends to be relatively high on the first years of life, and even more so for rich countries. Additionally, as ages subject to significant mortality due to violence (prime-ages) approach, the willingness to pay tends to rise, since the gains become more immediate. As these ages are surpassed, both the reduced horizon, and the fact that part of the mortality reductions are already past the individual's age, work towards reducing the willingness to pay.

The top five countries in terms of the willingness to pay at age zero (MWP_0) are Bahamas, United States, Colombia, Puerto Rico, and the Russian Federation. But the

[12] Lifecycle issues might change this result depending on the periods when individuals accumulate or deplete wealth.

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 violence 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 3(a), we see that Argentina and Brazil start at age zero with a willingness to pay smaller than the Colombian, and that this gap is amplified until age 20. 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 3(b) shows a similar pattern among Russia, Kazakhstan and Turkmenistan: Russia – the highest homicide rate among the three – starts at age zero with the highest willingness to pay for violence reductions, and this difference is amplified until the early 20's; Russia remains with the highest values for MWP_a 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 violence rates.

Finally, Figures 3(c) and 3(d) illustrate a striking point: for every single age up to the 60's, 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 only). As should be clear by now, the interaction of these two factors generates a very large willingness to pay for reductions in violence. Figure 3(d) also highlights the fact that Western European and East Asian countries have very low violence levels. The magnitudes of the willingness to pay in Italy, Japan and Spain are not only much lower than the ones observed in the other graphs in Figure 3, but also their age profile is much less pronounced.

5 Inequalities in Income and Exposure to Risk

The main limitation of the methodology applied 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).

There are several different dimensions over which this takes place. Usually, income and victimization rates are higher for men than for women and for adults than for children or older individuals. Alternatively, in terms of violent deaths, victimization is typically higher for individuals of lower socioeconomic status, which have lower income. To some extent, this same criticism applies whenever the "value of life" methodology is used in other contexts to evaluate the welfare impact of reductions in mortality, as long as the reductions are correlated with income.[13]

In order to fully address this issue, we would need, for every country in the sample, income and death rates by age and cause of death, for every group that might be relevant for the analysis (men and women, black and white, rich and poor, etc). These data are very difficult to obtain, and an effort to collect all the required information is beyond the scope of this paper. Nevertheless, in order to assess the impact of our homogeneity assumptions, we concentrate in the dimension that is most serious for our analysis and use one specific example to evaluate the potential extent of the induced bias.

Whenever income and victimization are positively correlated in the population, our estimates of the willingness to pay for violence reductions will be biased downwards. This is true simply because the willingness to pay increases with income. So, if we incorporated considerations about the lifecycle profile of income or about gender differences in income and victimization, our estimates would be increased. Therefore, in

[13] For example, when using the "value of life" methodology to analyze the economic value of medical research, Murphy and Topel (2003) incorporate mortality and income differences between men and women, and also differences across the lifecycle. But they do not consider the correlations between mortality and income across different socioeconomic groups.

this dimension, our results are conservative estimates of the true mortality costs of violence. And since our main point is that these results are already quite expressive as they are, this is not much of a concern.

But there is one specific dimension of heterogeneity in which our numbers are probably biased upwards. In respect to socioeconomic status, homicide victimization is typically concentrated in the lower strata of the population. In this case, by incorporating heterogeneity in income and victimization, we would probably obtain numbers smaller than the ones portrayed in Tables 1 and 2. As an exploratory effort, we look at the case of Brazil to asses how serious this bias may be. Our goal is to evaluate the effect of inequalities in income and risk exposure across different socioeconomic strata on the estimation of the welfare cost of violence.

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. At the same time, Brazilian homicide 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; the database is the DATASUS, from the Brazilian Ministry of Health). 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 use these educational levels as proxies for different socioeconomic strata, and 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).[14]

[14] The three educational categories following "No Education" correspond to "Ensino Fundamental," "Ensino Secundário" and "Ensino Superior" in the Brazilian system. This is far from the ideal dataset, for a number of reasons. First, in almost 50% of the deaths, the educational level is not reported. Second, even if the reporting rate was higher, the information contained is not exactly what we need, since the educational level reported is the one of the victim herself. So, for example, the death of a 10 year-old individual will never be reported as belonging to the "Some College" group, even if the individual belonged to the highest socioeconomic group. This is a limitation imposed by the fact that we are using individual educational level to match socioeconomic status. It is not clear what the final effect of these biases will be. In any case, there

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 the average income levels of the different socioeconomic groups.

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* 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 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 1.8 years of life expectancy at birth due to

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is nothing we can do in this respect. As a positive note, the victimization profile described in Table 4 seems to be in line with the available evidence for Brazil.

violent deaths, and their willingness to pay for violence reduction corresponds to 14.6% of the aggregate Brazilian GDP in 1995.

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 4. Though willingness to pay at earlier ages is highest for the group subject to the highest violence levels, by age 25 the income effect already dominates and individuals from the group with "Some College" become the ones with the highest values. This also reflects the fact that violence levels tend to peak at earlier ages for the group with "Some Elementary" education, as compared to the group with "Some College." This may be due to the bias discussed in the last footnote and requires further investigation. But it may also indicate that part of the victimization of the low income group ("Some Elementary") is related to the early involvement of some of its members in criminal activities, while the victimization of the high income group ("Some College") is related to the fact that it is an attractive target for criminals.

But the most important information contained in Table 5 is the aggregate social cost of violence, once inequalities in income and victimization are taken into account. In this case, the social cost of violence is estimated to be 24% of the 1995 GDP, as opposed to the 38% estimated before. The estimated social cost is reduced by 37% of its initial value once inequalities are taken into account.

This arises because of the negative correlation between income and victimization present in the Brazilian data, and the 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 is still very high. Second, the effect of inequality is likely to be among 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 37% 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 violence rates to zero would imply an average increase of 1/3 of a year in life expectancy at birth, and would have a lifetime value corresponding to, on average, 15% of the 1995 GDP. For Colombia and the United States, violence reduces life expectancy at birth by, respectively, 2.2 and 0.3 years. These declines in life expectancy represent social welfare losses of the order of 13% of the 1995 GDP for the US, and 100% for Colombia. Generally, a one-unit increase in years of life lost to violence is associated with an increase of 44% 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 per year for the US correspond to a lifetime present value of 62% of the GDP. Material costs of the order of 3.6% of the GDP per year for Latin America correspond to a present discounted value of roughly 100% of the GDP.[15] Our results would increase the current estimates of the costs of crime and violence by roughly 25%. 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 risk of victimization of the

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

general population. If public policy is efficiently designed, the welfare benefits from having such institutions in place should be at least as large as the 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, or the other inefficiencies associated with crime. These may include loss in utility from changed behavior, 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 quite large. 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 an 18 Year-old	Social Value (billions)	Social Value as % of Agg GDP
Latin America & Caribbean	71.4	21.8	7,708	72.0	0.6	2,941	43.07	27%
North America	76.1	6.5	25,672	76.3	0.2	4,389	496.61	8%
Western Europe	76.2	4.0	19,532	76.3	0.1	1,383	17.62	5%
Former Communist Europe	68.9	17.2	6,009	69.2	0.4	1,435	29.16	15%
Western Pacific	76.0	7.8	17,839	76.3	0.2	1,368	32.95	9%

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 an 18 Year-old	Social Value (billions)	Social Value as % of Agg. GDP
ALBANIA	73.6	14.2	2,573	74.0	0.40	527	1.07	13%
ARGENTINA	71.9	15.8	9,938	72.3	0.41	2,633	61.66	18%
ARMENIA	72.0	13.8	2,486	72.3	0.34	409	1.08	12%
AUSTRALIA	77.4	2.6	22,047	77.5	0.08	1,284	13.35	3%
AUSTRIA	76.0	1.9	21,099	76.1	0.05	717	3.57	2%
AZERBAIJAN	69.2	22.2	2,288	69.7	0.59	683	3.04	18%
BAHAMAS	70.4	24.7	16,527	71.0	0.63	7,836	1.52	33%
BARBADOS	73.2	9.9	14,339	73.4	0.26	2,833	0.44	12%
BELARUS	68.4	22.5	6,870	68.8	0.45	2,099	14.28	20%
BELGIUM	75.6	4.5	21,025	75.7	0.11	1,702	10.66	5%
BELIZE	73.8	8.6	6,131	74.1	0.29	929	0.15	12%
BRAZIL*	69.0	34.4	6,591	69.8	0.83	3,912	241.36	38%
BULGARIA	70.2	6.2	6,263	70.3	0.13	534	2.65	5%
CANADA	77.1	2.8	22,827	77.2	0.08	1,353	23.68	4%
CHILE	73.2	33.5	8,116	74.1	0.91	4,375	46.07	42%
COLOMBIA	71.2	83.2	5,249	73.5	2.23	7,872	178.86	100%
COSTA RICA	74.7	7.8	5,247	74.9	0.23	708	1.76	10%
CROATIA	71.2	31.4	7,838	72.0	0.80	4,930	10.77	29%
CUBA	74.0	10.6	5,498	74.2	0.26	901	6.13	10%
CZECH REPUBLIC	71.5	6.5	12,876	71.6	0.14	1,166	8.03	6%
ECUADOR	71.2	15.5	3,691	71.7	0.46	985	7.60	20%
EL SALVADOR	70.1	42.3	3,959	71.4	1.22	2,983	11.22	53%
ESTONIA	68.0	26.4	7,771	68.6	0.56	3,187	2.79	24%
FINLAND	75.3	7.2	19,423	75.5	0.18	2,631	8.40	8%
FRANCE	77.3	5.2	20,299	77.4	0.13	1,854	71.85	6%
GEORGIA	69.0	12.8	4,776	69.3	0.28	761	2.18	11%
GERMANY	75.6	3.6	20,848	75.7	0.08	1,287	64.45	4%

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 an 18 Year-old	Social Value (billions)	Social Value as % of Agg. GDP
GREECE	76.7	1.4	12,583	76.8	0.04	331	2.04	2%
GRENADA	67.8	10.3	4,984	68.0	0.26	748	0.05	12%
HONG KONG	77.8	3.3	24,556	77.9	0.09	1,452	6.64	5%
HUNGARY	68.5	4.5	8,941	68.6	0.09	511	3.51	4%
ICELAND	77.6	2.0	21,728	77.7	0.06	995	0.18	3%
IRELAND	74.6	1.5	17,692	74.6	0.04	553	1.26	2%
ISRAEL	76.4	6.5	15,534	76.6	0.17	1,843	7.13	9%
ITALY	77.1	2.8	20,216	77.1	0.07	1,082	36.04	3%
JAPAN	79.6	2.9	23,406	79.7	0.07	988	97.07	3%
KAZAKSTAN	65.4	38.6	6,052	66.2	0.83	3,291	39.32	40%
KUWAIT	74.9	3.3	23,386	75.0	0.10	1,743	2.25	6%
KYRGYZSTAN	66.3	17.6	2,836	66.8	0.44	649	2.35	18%
LATVIA	66.5	34.6	7,323	67.1	0.63	3,204	5.45	29%
LITHUANIA	69.4	16.0	6,920	69.7	0.35	1,597	3.90	15%
LUXEMBOURG	75.8	3.2	33,969	75.9	0.08	2,331	0.54	4%
MACEDONIA	71.2	3.4	4,559	71.3	0.08	198	0.27	3%
MALTA	76.0	2.7	13,101	76.1	0.07	787	0.16	3%
MAURITIUS	69.2	2.5	11,145	69.3	0.06	465	0.37	3%
MEXICO	71.2	20.8	7,630	71.8	0.59	3,103	204.13	31%
NETHERLANDS	76.7	1.6	21,122	76.7	0.05	724	6.18	2%
NEW ZEALAND	75.8	2.5	16,807	75.9	0.07	864	1.81	3%

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 an 18 Year-old	Social Value (billions)	Social Value as % of Agg. GDP
NORWAY	76.5	1.6	23,515	76.5	0.04	803	2.10	2%
PHILIPPINES	70.6	33.2	3,086	71.6	0.95	1,465	77.86	37%
POLAND	70.8	8.3	7,277	71.0	0.17	813	22.77	8%
PORTUGAL	73.8	13.3	13,434	74.1	0.29	2,472	17.28	13%
PUERTO RICO	71.9	28.5	9,974	72.7	0.76	5,922	11.77	33%
REPUBLIC OF KOREA	74.9	3.7	12,706	75.0	0.10	827	27.72	5%
REPUBLIC OF MOLDOVA	65.7	25.1	2,251	66.2	0.52	587	1.56	17%
ROMANIA	68.6	4.6	4,629	68.7	0.10	261	3.95	4%
RUSSIAN FEDERATION	65.8	49.9	7,918	66.7	0.94	5,488	510.72	44%
SAINT KITTS AND NEVIS	68.7	11.6	10,567	69.1	0.41	3,519	0.11	23%
SINGAPORE	76.2	6.6	22,265	76.3	0.17	2,694	6.20	9%
SLOVAK REPUBLIC	71.2	5.4	10,443	71.4	0.12	849	3.17	6%
SLOVENIA	73.5	3.2	12,823	73.5	0.08	660	0.87	3%
SPAIN	76.9	1.3	15,541	76.9	0.03	393	9.53	2%
SURINAME	71.2	15.9	2,948	71.6	0.44	658	0.20	17%
SWEDEN	77.5	6.6	20,788	77.7	0.16	2,534	14.74	8%
TAJIKISTAN	66.3	15.9	1,153	66.8	0.48	190	0.79	12%
TRINIDAD AND TOBAGO	69.6	12.3	9,514	70.0	0.31	2,176	1.87	16%
TURKMENISTAN	64.5	8.8	4,533	64.7	0.22	632	2.02	11%
UKRAINE	67.5	29.9	6,223	68.1	0.57	2,360	77.33	24%
UNITED KINGDOM	75.8	4.6	19,650	75.9	0.12	1,862	61.00	5%
UNITED STATES	75.0	10.2	28,517	75.3	0.31	7,426	969.53	13%
URUGUAY	71.8	4.4	8,810	71.9	0.11	657	1.32	5%
UZBEKISTAN	67.5	7.8	2,595	67.7	0.22	280	5.02	9%
VENEZUELA	71.3	23.6	6,746	71.9	0.66	3,128	42.14	30%

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_{18})

	Coeff	Std Error	t	p-value
ln(GDP)	1,393	164	8.48	0.00
L_v	4,637	349	13.27	0.00
const	-12,397	1560	-7.95	0.00
R^2	0.72		N Obs	73

Note: Dependent variable is Willingness to Pay of an 18 Year-old 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	12%
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 an 18 Year-old	Social Value (billions)	Social Value as % of Aggregate National GDP
No Education	68.7	1.1	1,341	11.6	1.8%
Some Elementary	68.0	1.8	4,498	94.2	14.6%
Some High School	69.7	0.1	673	17.8	2.8%
Some College	69.6	0.2	4,025	28.8	4.5%
Aggregate Social Cost of Violence =				152.4	23.7%

Figure 1: Social Value of Violence Reduction (% of GDP), 1995

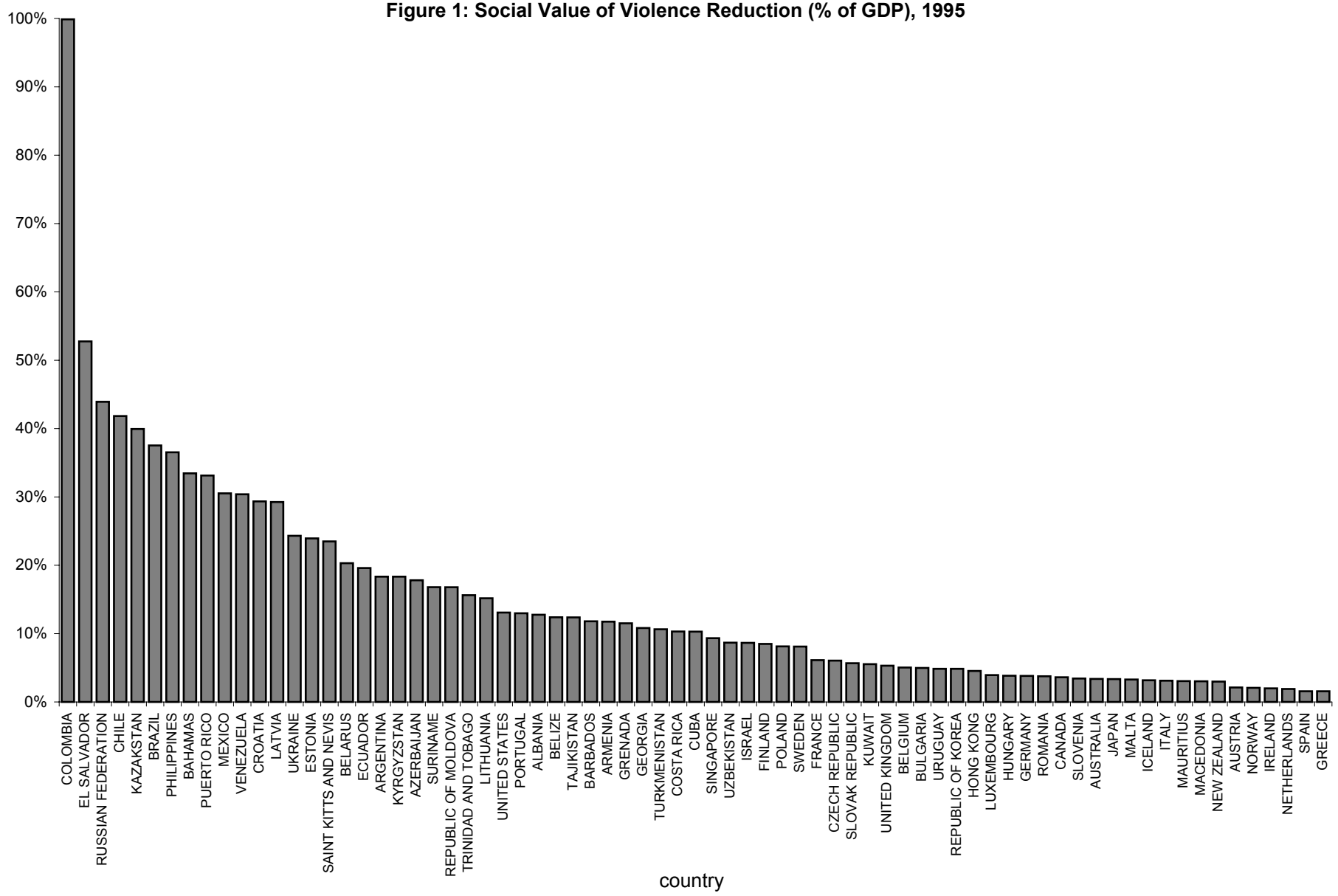

Figure 2: Expected Years of Life Lost and Social Value of Violence Reduction (% of GDP), 1995

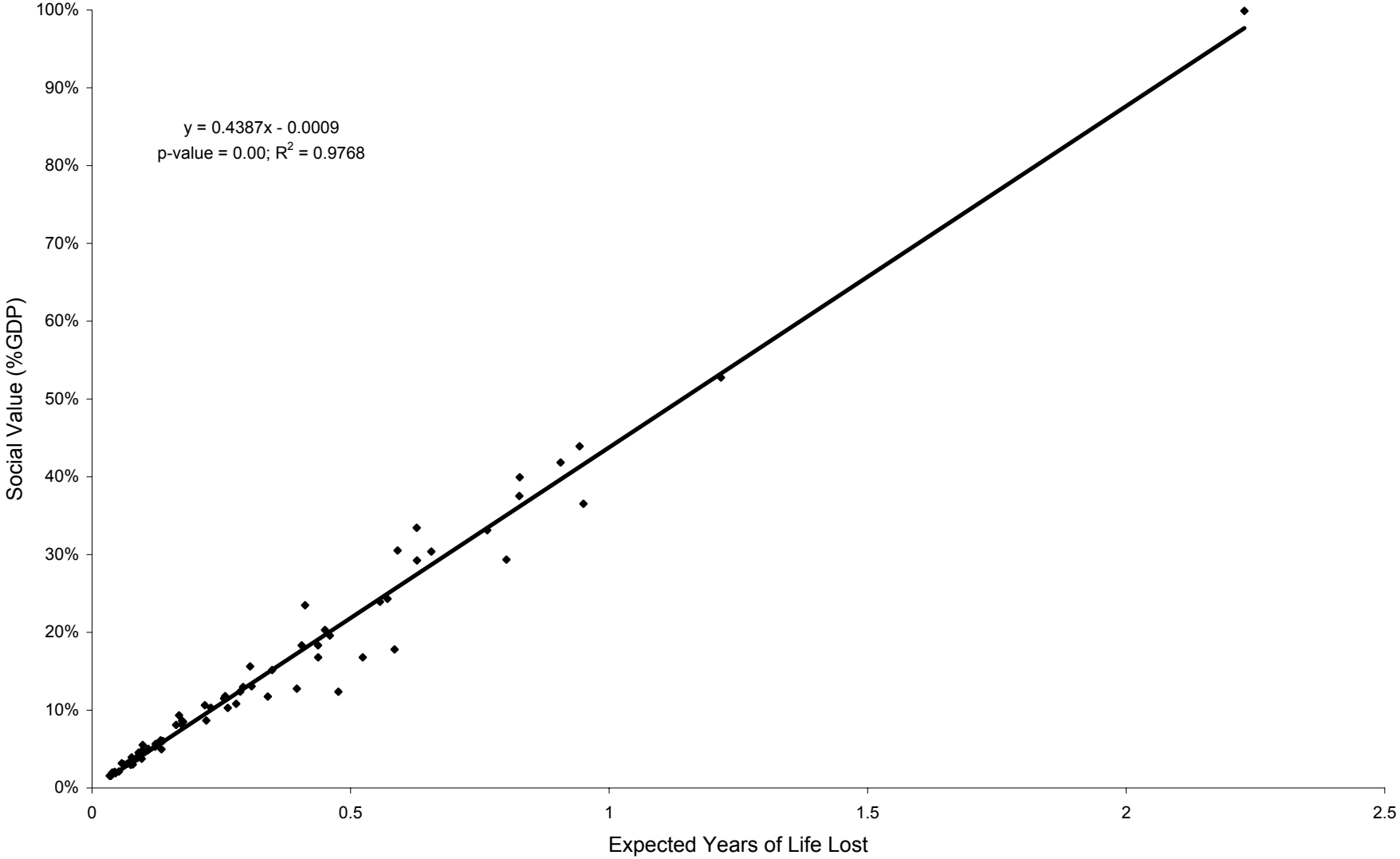

Figure 3: Age Profile of the Willingness to Pay for Violence Reductions, Selected Countries, 1995

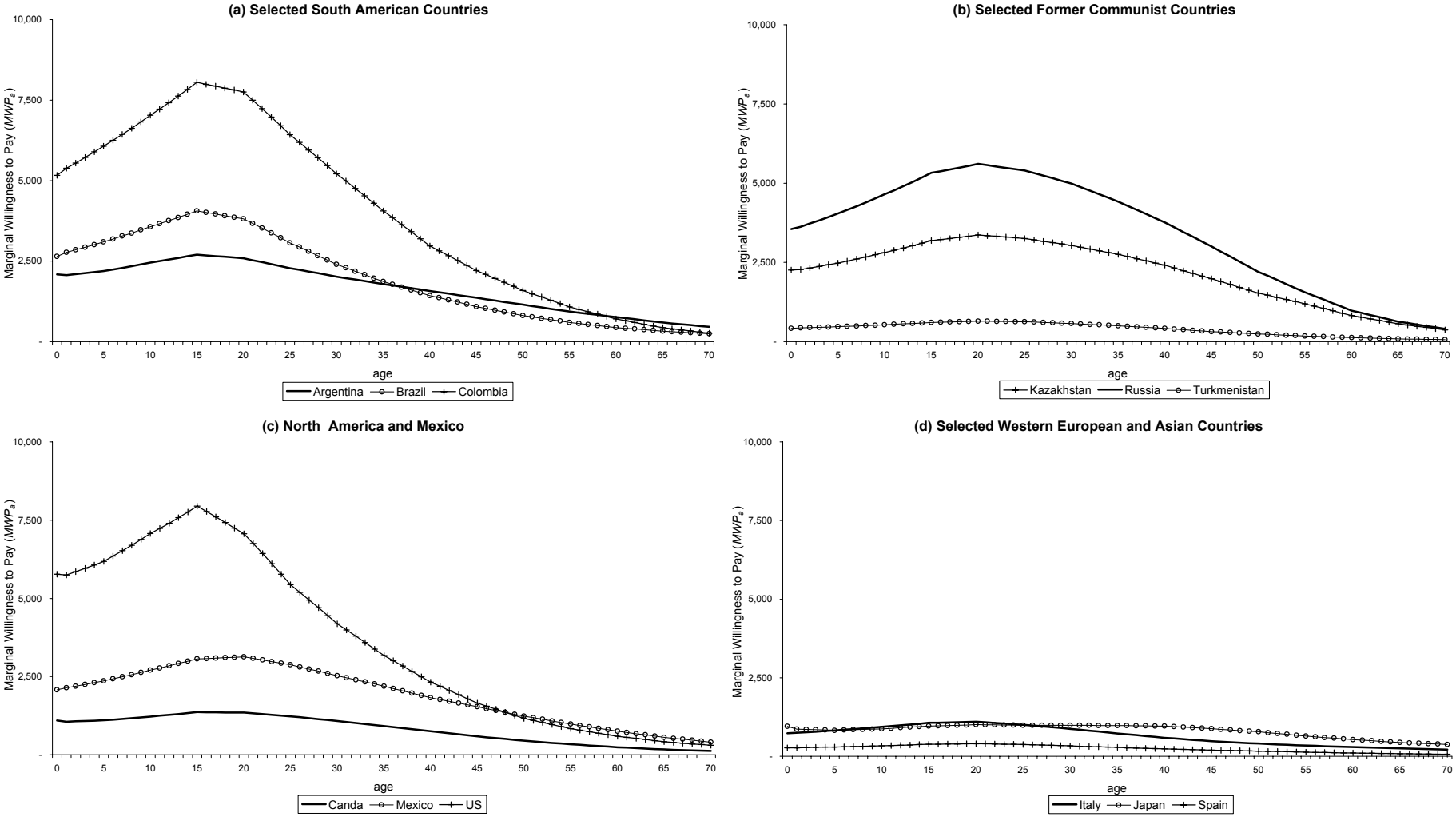

Figure 4: Willingness to Pay for Violence Reductions by Age and Educational Groups, Brazil