J. Benefit Cost Anal. 2019; 10(2):178–205
doi:10.1017/bca.2019.12

Emilio Picasso* and Mariana Conte Grand

The Value of the Risk to Life in the Context of Crime

Abstract: The value of the risk to life is a key element for benefit-cost analysis, enabling more rational public policy decisions in diverse areas as environmental, health, and crime. We value the risk to life in the context of crime using a discrete choice experiment (CE). The method has clear advantages in that it applies to the whole population and does not require vast data from labor markets, for example. Such data are not always available even in developed economies. Combining the stated preference approach with contingent valuation (CV), CE offer advantages yet to be explored in the context of crime. We demonstrate the application in a developing economy, where similar valuations are not available. The best estimate obtained for Argentina is an average of 1.5 million in 2015 US dollars per statistical life with a confidence interval ($1.1–$2.3). This result is consistent with estimates for the developed world, after appropriate transfer. We also analyze demographic factors in the risk to life, finding a positive influence of income, risk aversion, previous victimization experience and family size on the value of a statistical life, as well as a negative impact of individualism.

Keywords: choice experiment; crime valuation; discrete choice model; risk to life; value of statistical life.

JEL classifications: J17; K14; Q51.

1 Introduction

Benefit-cost analysis, an invaluable tool for efficient public policy planning, can be straightforward when the goods involved are traded in competitive markets. However, the existence of externalities tends to complicate the analysis. It is quite clear that environment, health, or safety involves externalities and so require special (nonmarket) valuation methods. Safety issues mainly occur in transport, labor, and

***Corresponding author: Emilio Picasso,** Universidad Católica Argentina, Av Moreau de Justo 1600, (1107), Buenos Aires, Argentina, e-mail: epicasso@uca.edu.ar
Mariana Conte Grand: Universidad del CEMA, Universidad del CEMA, Av Cordoba 374, (1054), Buenos Aires, Argentina

crime contexts. Crime represents a pervasive problem in all countries, which indicates the relevance of valuing its impact.

Specifically for the risk to life, the available literature distinguishes several techniques to estimate its value. Schelling (1968) introduced the idea that valuing risk to life requires capturing individuals' willingness to pay for life-risk reductions [usually referred as the value of a statistical life or value of a statistical life (VSL)].[1] The concept of subjective value of the risk to life is defined as the marginal rate of substitution between risk and consumption: how much consumption the individual is willing to give up to reduce his or her risk of dying. It is quite different from the human capital measure (i.e., the present value of lost income from premature death to normal life expectancy), since the latter neglects the value of leisure time and important subjective aspects, and focuses only on pecuniary impacts of death.[2]

Two categories of methods are typically employed for the VSL: indirect methods (based on revealed preferences) and direct methods (based on stated preferences). The former generally deal with hedonic estimations, relating wages to labor risks or property prices to environment, health, and crime risk rates (see the conceptual framework in Rosen, 1974, 1983; and the review of empirical results in Viscusi & Aldy, 2003). Historically, the VSL was assessed using this type of technique for the labor market (Viscusi, 1978; Blomquist, 2004).[3] The latter methods expose the individuals to hypothetical scenarios of varying risk and cost in which they have to make choices. The idea of capturing the value of life based on directly approaching individuals appeared previously in the work of Mishan (1971). The most usual techniques are contingent valuation (CV) and choice experiments (CE). As is the case for hedonic pricing, CV has been extensively applied to environmental, health and transport problems and has been employed incipiently in the context of crime (Cropper et al., 2011). CE has been used to capture the VSL in transportation but not yet in the crime context.[4] Even when there are nonmarket methods to assess the VSL, they involve detailed data and sophisticated techniques, which require resources and knowledge. This may explain why there are relatively few estimates of VSL

1 There is a significant controversy about the widely used term "Value of a Statistical Life" (VSL). As a consequence, Cameron (2010) proposes to replace it by the more accurate: "willingness to swap alternative goods and services for a microrisk reduction in the chance of sudden death". We acknowledge that fact, but we use the traditional VSL to stay in line with the literature.

2 See Fein (1958) and Mushkin and Collings (1959) for the human capital approach.

3 Studies on risk averting behavior based on demand of consumer-safety products (e.g., seat belts) have also been used to estimate VSL (Blomquist, 2004).

4 For example, Rizzi and Ortuzar (2003) apply choice experiments in the traffic context to measure the VSL in Chile obtaining $0.4 million (US dollars as of 2002). This value is low compared to the developed world but it is approximately ten times higher than the local actuarial value. Hensher et al. (2009) enhance the methodology to apply it in Australia, finding a VSL of $3 million (US dollars as of 2008), an intermediate figure between Chile and US/UK.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

for low- and middle-income countries, as it is widely acknowledged in the literature (see Robinson, 2017, among others).

This paper contributes in several aspects to the state of the art. We make the first valuation of the risk to life in the context of crime by means of a CE and nonlinear discrete choice modeling. We extend the validity of existing VSL measures because our method represents a wider population: all adults are exposed to crime risk, whereas previous studies are limited to people exposed to labor or traffic risks. We also contribute beyond crime by providing one of the few VSL figures in developing countries, useful for general project evaluation. We also analyze the demographic determinants of VSL.

The present article is structured as follows. Section 2 presents the literature review, covering VSL empirical results with a special focus on willingness to pay for life reductions in the context of crime. Section 3 describes the empirical strategy and the data gathered for the estimation. The results follow in Section 4, including an analysis of the robustness of the model and discussion, and we conclude in Section 5.

2 Literature review

Viscusi and Aldy (2003) make a thorough review of empirical valuation in the labor and traffic contexts for studies in the USA, the UK, and Canada, and conclude that the VSL for those countries ranges between $5 and $12 million (US dollars as of 2000), with a median of $7 million. The numbers they find are more disperse in Asia, with $9.7 million for Japan and $0.8 million for Korea. Most of these studies have employed indirect valuation methods (hedonic price models applied to the labor market). There are some recent reviews of VSL studies that have been undertaken. OECD (2012) collected the estimates of VSL stated preferences within OECD countries and, based on its comparison, recommended the use of a VSL in the range of $1.45 to $4.35 million US 2005 dollars with a base value of $2.9 million. Narain and Sall (2016) broaden that search to middle-income countries, and their results are inputs to World Bank and IHME (2016). Based on a meta-analysis, they report a mean for the VSL of $1.48 million (measured in 2011 $ PPP) for the whole sample, $3.83 million for OECD countries, and $0.18 million for middle-income countries. Viscusi and Masterman (2017) examine 953 VSL hedonic pricing estimates in 68 studies undertaken in 14 countries (of which, only two are low- to middle-income countries), but predominantly in the USA (80 % of the estimates). Based on that information, they calculate VSL to income elasticities that are used to transfer the US VSL (current $9.631 million). Finally, adjusting by income, they calculate VSL for 189 countries, which go from US $0.45 to $18.3 million.

This difference in estimates among the different reviews has several origins. As pointed out by Robinson (2017), one is the difference in the criteria for inclusion of

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

studies and another is the empirical technique employed for the comparison among them (usually meta-analysis). But, it also has to do with the methods used to assess the VSL in each of the base studies (stated or revealed preferences) and with local socioeconomic conditions (Hammitt, 2017). This evidence fosters the need to undertake studies in the developing world to avoid relying solely on benefit transfer from developed countries when benefit-cost (or cost-effectiveness) analyses have to be carried out (Robinson, 2017). This is particularly the case in the VSL for crime, since there are very few estimates for that risk to transfer from, even in high-income nations.

2.1 Valuation of risk to life in the context of crime

Calculating the benefits of reducing crime is challenging. It can be made from different perspectives: the government (the costs in anticipation of crime—as police—and in the consequences of crime—courts and prison systems) or the victim. And the issue is even wider, extending to the society as a whole over the nonvictims, as well as to varying mechanisms like undesired avoidance behavior, weakening community cohesiveness caused by fear, overdeterrence (i.e., activities avoided by innocent people for fear of being accused of criminal activity), the load imposed on the offenders and their families, and the undue cost of justice (i.e., punishing innocents and exonerating guilty). Monetizing the cost of crime (the benefits of reducing it) requires information on several types of costs involved (i.e., tangible costs that include direct costs as those incurred to repair material or health consequences of crime and indirect costs as productivity losses, as well as intangible costs such as pain and suffering). Atkinson et al. (2005) estimate the intangibles at more than half of the value of crime.

Early valuations of crime were based on "bottom-up" calculations that added all possible direct and indirect costs in an accounting manner (analogous to the human capital approach), and measured intangibles by comparison to civil court compensation decisions (see McCollister et al., 2010). In particular, Cohen (1988) studies the cost of crime from the standpoint of the victim, making an effort to measure the intangibles like subsequent suffering and loss of quality of life by examining jury awards from cases in which victims sued perpetrators.

The excessive burden of the bottom-up method and the difficulties estimating intangibles led the scientists to find another way (Cohen, 2010). The "top-down" approach encompasses all these elements by acting on a single source, usually through hedonic pricing and CV.[5] Thaler (1978) uses the hedonic price method to

5 A third method has been developed recently (Di Tella and MacCulloch, 2006), that derives crime valuation from income (revealed) and life satisfaction (stated). It seems promising though it is still early to assess its accuracy.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

isolate the impact of the crime rate on property prices. Pope and Pope (2012) also relate decreases of violent crime rates to property value increases. In their work, violent crime rates include homicides and also other violent crimes because, as explained by the authors, "although homicides are a good national barometer of crime, they are rare enough at a localized level that it is difficult to use homicides as a crime indicator on its own." Even if there were enough data by type of crime, different crimes are likely collinear (neighborhoods with a high murder rate are also high in all sorts of crimes) and it is not easy to control for all potential determinants of property prices. Beyond other empirical difficulties lying behind the hedonic pricing methodology (see Haab & McConnell, 2002; Freeman, 2003), data limitations substantially contribute to explain why direct methods began to be applied in crime valuation research studies.[6]

Zarkin et al. (2000) utilize CV to assign a value to the use of drugs by making its drawbacks for society (one of which is crime) explicit. The change proposed is that a certain number of addicts undergo a recovery treatment. The cost is a voluntary contribution. Ludwig and Cook (2001) make a CV study of a weapon reduction program. The proposed change is a 30 % reduction in injuries produced by firearms, and the cost is a local tax. The valuation obtained is $1.2 million (US dollars as of 1998) per gun injury, not necessarily implying death. Cohen et al. (2004) value the risk of different types of crimes in the USA: burglary, assault, armed robbery, rape, and murder. The change proposed for the latter is a 10 % reduction. The valuation obtained for murder is $9.7 million (US dollars as of 2000), which is an order of magnitude higher than the bottom-up valuation.

Atkinson et al. (2005) perform a CV of crime in the UK. They deal with three categories of crime: serious wounding, other wounding, and common assault (no injuries). The authors discover a large heterogeneity in the willingness to pay to reduce crime, depending on some personality traits, the belief of control of the situation, the fear of crime, security perception, etc. Nagin et al. (2006) address youth crime proposing two alternative programs: longer prison and rehabilitation. The value of the latter is somehow higher despite having a similar efficacy level. This study opens up the issue of policy: should the risk reduction or the policy be valued? On the one hand, it can be argued that the result is what counts. On the other hand, collateral effects of different policies may affect the valuation to the extent of a less effective policy being preferred by the society.[7]

6 Linden and Rockoff (2008) claim that they overcome data limitations because they focus on a sufficiently large database with locations of sex offenders, and estimate values of nearby properties' value.

7 Another line of research has also developed related to the valuation of specific nonviolent crimes: identity theft (Piquero et al., 2010, through a bottom-up approach for four states in the US) and white-collar and corporate offenses (Cohen, 2015, using contingent valuation for the US).

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

Among direct methods, the CV technique is the most frequent approach for assessing the VSL (Freeman, 2003), and the only one used to date within the context of crime. However, CV presents the respondent with an improved scenario having a cost for the individual to choose versus the status quo, whereas CE consists of several scenarios characterized by a number of attributes, including the aspects of risk (for instance fatality, permanent injury, or temporary injury), the cost, and even policies. Both allow observation of decisions in hypothetical scenarios presented in controlled experiments, but CE permits overcoming the package effect (Saelensminde, 2003) present in CV.[8] This means that when the proposed improvement covers a singular risk, e.g., a reduction in the rate of death, the respondent attaches to it an improvement in all sorts of related risks and policies. Hence, CE can avoid the package effect by presenting several dimensions, including simultaneously different risks and policies. The use of CE for valuing policing policies was proposed in Carson and Louviere (2017). To our knowledge, Picasso and Cohen (2019) is the only academic publication that values policies to fight against crime, and this is the only article that employs the CE method to value VSL in the context of crime. It is worth mentioning that direct methods go beyond active value (lower risk for the individual or her friends and family) as they are capable of measuring the passive value (altruistic idea of a better society regardless of a personal impact).

In summary, the valuation of crime is generally restricted to a few developed countries,[9] and the efforts in top-down valuation done to date employ the CV method and, with the exception of Cohen et al. (2004), they cover a variety of crimes, whereas the value of life is not directly addressed. The objective of the present study is to measure the VSL in the crime context via a CE in a developing country (Argentina). CE has not been used in the crime context before, to the best of our knowledge. The crime context is not only relevant by itself, but it also expands the scope of validity of existing estimates of the VSL since the labor context limits the scope to the population of workers, and the traffic context to the population of drivers, whereas the crime context addresses the whole population of adults.

2.2 Demographic determinants of the value of the risk to life

As it is recognized in the literature (Hammitt, 2017), the VSL depends on the mortality risk involved in terms of both the type and the amount of the risk

8 This author uses the term "embedding effect", which should not be confused with the same term applied in environmental valuation.

9 For example, in the review of the cost of crime of adult offenders by Wickramasekera et al. (2015) that goes from 1996 to 2013, the 21 studies included were from only six developed countries: Australia, Canada, the US, the UK, Poland, and New Zealand.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

(Hoffmann et al., 2017), income levels, the context of death, risk aversion, cultural and religious beliefs, life expectancies and health, family network, etc. Hence, the value of a statistical life is not a universal constant to be determined, but a value depending on the individual and the context.

The demographic determinants of the VSL have been empirically explored mainly in the labor and transportation context.[10] Viscusi (1978) shows that safety is a normal good, i.e., it has positive income elasticity; and continued developing this same idea in Kniesner et al. (2010), by estimating the income elasticity of the VSL between 1.23 and 2.24, with a median of 1.44, using a quantile regression.[11]

The context of death also adds or deducts utility. As shown in Cameron and De Shazo (2013), the value of health risk reductions depends on their attributes. This explains why people may tend to dismiss the high probability risk caused by unhealthy food, whereas they are horrified by extremely rare diseases when they are long and painful. That could explain why Alberini and Scasny (2013) find that the VSL is different for cancer and traffic accidents.

The demographic determinants of the VSL have been empirically explored mainly in the labor context; however, Viscusi and Aldy (2003) find that risk takers (as identified by the habits of smoking or not using the safety belt) tend to have a lower VSL, suggesting that risk aversion can be a fundamental characteristic showing up in different contexts. In the same line, Hoffmann et al. (2017) show that people who buy commercial insurance (a proxy for their risk aversion) have lower VSL.

Another factor that might mitigate the VSL is the perception of control. Rizzi and Ortuzar (2003) find evidence supporting that the VSL is lower when the individual thinks he can control the situation. The individual perceives that the probability of death is lower for him despite the general risk prevalence reported. This could explain a higher perceived risk for flying compared with road travel. Family composition is another factor to take into account. Hojman et al. (2005) find that having small children correlates with higher VSL.[12]

As a result of the review of the literature, we organize the exploration of the demographic factors in several hypotheses. First, we expect VSL to increase with income. Second, impatience is hypothesized to erode the VSL, as predicted by the life

10 We use the term "demographic" in its wide sense, according to the etymologic origin: "demos" = "people", "graphos" = "description".

11 The hedonic prices method is not useful to address the income elasticity because income is the response variable (wage). Viscusi and Aldy (2003) try a meta-analysis of hedonic price studies, obtaining an elasticity between 0.5 and 0.6; however, this result is biased due to the inability to represent people heterogeneity. Quantile regression solves these problems.

12 The influence of the age has been explored both from the theoretical and empirical points of view. Notably, Aldy and Viscusi (2008) find that the VSL grows with age, peaking between 40 and 50 years old, to decline thereafter. We have studied this relation finding similar results, which were not included to avoid unduly extending the article.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

cycle theory, through increased subjective discount rate affecting the future benefits derived from life. General risk aversion is expected to induce higher VSL, as found empirically. The subjective perception of the probability of death is hypothesized to influence the VSL. The belief of control of the crime situation is expected to decrease the VSL. The VSL is hypothesized to increase with family size, as a projection of the own life onto dependents. Individualism (the personality trait) is expected to negatively influence VSL. The rationale behind this, not established in the literature yet, is that an individualistic person would disregard the passive value[13], focusing mainly on the active value, and then tolerate more risk to avoid funding collective efforts.

3 Empirical methodology

In this study, the empirical methodology is a CE to value VSL. The CE (Louviere et al., 2000) consists of presenting to the individuals a series of hypothetical situations involving crime risks, policies, and costs for them to make choices.

We select for this study the population of adults residing in the metropolitan area of Buenos Aires (Argentina).[14] Despite having an average rate of homicides in global terms, crime is a highly relevant social issue in Argentina (Moreno & Salvia, 2012), probably due to the fact that the prevailing rate of violent crime is the highest in Latin America (UNDP, 2013, p. 57).

The survey was administrated online via an Internet panel during May–June, 2014. The e-panel company hired for this study adheres to the best practices established by European Society for Opinion and Marketing Research (ESOMAR), and it is frequently used for scientific and market research. Panelists are proactively recruited following a double opt-in process, and receive periodic requests to fill out a Web-based survey in exchange for a chance to receive prizes that are randomly awarded to participants. The demographic profile is monitored to represent the local online population. The online penetration in Argentina (70 %) is high enough to represent all significant demographic profiles. The instrument was distributed to a random sample of adult panelists living in Buenos Aires, obtaining 269 complete interviews, with 91 % response rate among valid candidates. Each interview contains 10 effective choice tasks (plus 2 practice trials), making a total sample size of approximately 2690 units of analysis for the discrete choice model (DCM). As shown in Table 1, the demographic profile of the sample resembles the population fairly well. The gender is

13 Active value is derived from the lower risk for the individual and her relatives and friends, whereas passive value is derived from the altruistic or conceptual idea of a better social condition.

14 The metropolitan area of Buenos Aires includes the city, or federal district, having around 3 million habitants, and the suburbs having over 10 million habitants. The metropolitan area is divided into 25 districts, each one has an average population of 0.5 million habitants.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

Table 1 Frequencies of demographic variables in the sample and the population.

Variables	Sample (%)	Population (%)	Variables	Sample (%)	Population (%)
Gender			Education		
Female	64	53	University	47	20
Male	36	47	Secondary school	42	40
Age			Primary school	10	28
18–34 years old	22	38	Less	1	13
35–44 years old	32	18	Income segment		
45–54 years old	21	16	ABC1	31	13
55+ years old	25	28	C2	30	25
Place of residence			C3	23	28
City	62	21	DE	16	34
Suburbs	38	79			

Note: Income was measured via the socioeconomic level metric developed by SAIMO (2015).

quite balanced, slightly favoring female (64 %). In terms of age, it is slightly more likely to find people in the 34–54 range in the sample than in the population, whereas it is worth mentioning that older people were almost as likely to be found in the sample as in the population (25 % of the sample is aged 55+ versus 28 % in the population). The sample achieves a granular geographic representation of the city, covering 42 out of the 48 neighborhoods, and it becomes sparser in the suburbs (where 38 % of people in the sample live). All education levels are present in the sample, with a slight overrepresentation of secondary and high school instruction. All socioeconomic levels are present in the sample (except the marginal bottom 3 %), with a balanced representation of the mid-high (30 vs 25 % in the population) and mid-low (23 vs 28 % in the population) classes, more intense participation of the high class (31 vs 13 % in the population), and consequently attenuated share of the low class (16 vs 34 % in the population). This distribution of education and income was expected due to the unequal internet penetration in the different social classes. While the e-panel-based sample is not probabilistic, the key source of bias is neutralized via income adjustment.[15]

3.1 The choice experiment

The measurement instrument, distributed online, has four sections. The first one contains a filter to select the relevant population. Students living with their parents are

15 The underrepresentation of low income class is neutralized by performing an income adjustment. This might be incomplete as lower-class people might be more exposed to crime, as pointed out by a reviewer. However, if this were the case, our valuation would be conservative.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

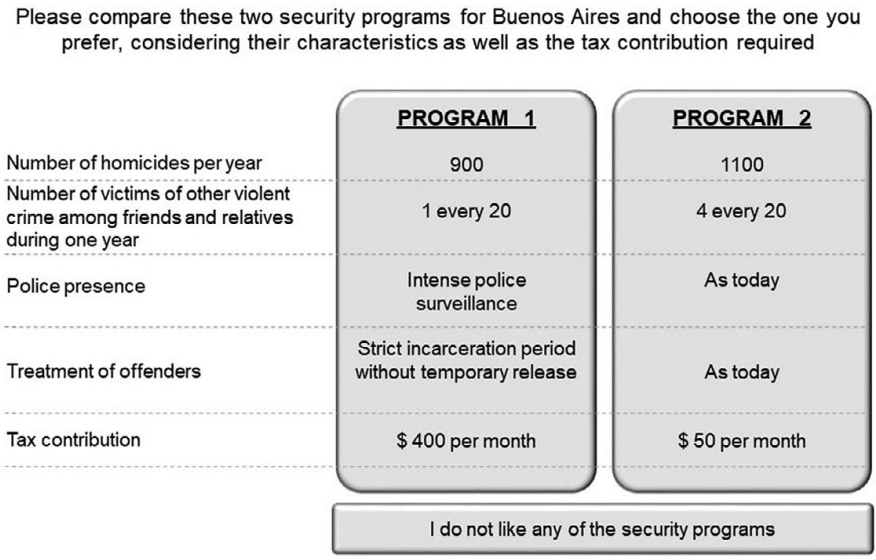

Figure 1 Example of choice task.

considered mostly economically dependent and excluded from the sample. It also includes a preliminary measure of the socioeconomic level via the value of the main car in the household, which is used to determine the cost level for the valuation question. The second section holds the CE itself, to be described below. The third one contains a series of questions related to beliefs and perceptions about security issues, experience as a crime victim, impatience and risk aversion, as well as credibility (to assess the validity of the responses to the CE). The last (fourth) section is devoted to demographics, including gender, place of residence, education, and socioeconomic level.[16]

The CE consists of 10 tasks (as well as 2 previous practice tasks) like the example in figure 1. Each choice task presents two alternative security programs, characterized by risk, policy, and cost. The individual was able to choose one of the programs or a third alternative representing the status quo. The choice tasks differ in the values of the variables following a predesigned experimental plan. Choice tasks seem random to the individual; nevertheless, they are carefully planned with the objective of maximizing the data richness by presenting alternatives forcing trade-off among the variables, as explained below.

16 A translated version of the full survey is available in an online Appendix. See supplementary material section for more information.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

The security programs are characterized by five variables. The first two variables are homicide and other violent crime risk.[17] Our approach, like in Cohen et al. (2004), is to learn the value the public assigns to perceived risks. In order to work with current perceptions, we avoided exposing the respondents to descriptions of the process or the consequences of different kinds of crime. We assume the urban population is sufficiently informed about victimization given the high local relevance of crime and the enhanced intensity of social communication prevailing in modern societies. Both risks are varied independently in the experiment, enabling specific valuation and avoiding the package effect.

The metrics for the risk variables deserve consideration. As shown by Kahneman and Tversky (1979) and Tversky and Kahneman (1986), people find it difficult to make sense of very low probabilities like the one of being murdered. We avoid this problem by defining the metric as the absolute number of homicides per year in the area. On the other hand, the probability of being a victim of a violent crime is rather high in Argentina. Then the metric was defined as the number of households out of 100 where any of the members faces a violent crime (not death) during one year.

Two policies entered the experiment: extended police presence and the strict fulfillment of court sentences. The former was characterized by frequent police surveillance in the streets, video surveillance cameras in all dangerous places, and empowering the police with pre-emptive rights to arrest suspects. The latter was defined by strict respect for the prison term,[18] criminal responsibility since 16 years of age instead of 18, housing dangerous convicted persons far from urban centers,[19] and prison improvement to ensure dignity. Respondents were exposed to a detailed description of the policies before starting the experiment, and it was kept available throughout the process in a help screen.

The CE requires creating a hypothetical market where the "trade" of risks and policies is performed by means of a monetary vehicle. In this case, we have created a hypothetical local tax to serve as payment. This tax would be earmarked to fund a local police force, operating at a district level. As is well known, the monetary vehicle is a critical element in the design of experiments. Given the failure of crime control policies implemented in the past, the population has become fairly skeptical about the ability of the government to control crime. This leads some people to reject additional taxes collected by the discredited high-level institutions like the national or provincial government, surrounded by a cloud of corruption (Moreno & Salvia, 2012).

17 Homicide involves premeditation and malice including the case where original intention would not be killing, and excludes involuntary manslaughter, war and terrorism. Violent crime is defined as any situation where the victim is assaulted by a criminal and forced to act against her will, generally by means of a weapon, including robbery and rape, and excluding burglary.

18 Current law in Argentina allows the reduction of the period of sentence in case of good behavior. There is also an extended program of temporary release for inmates.

19 Current law in Argentina establishes that convicted must be housed near their home address.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

People rely on private security, but this would be an imperfect vehicle with limited reach to the proposed policies. The payment vehicle was designed to resemble private security in terms of closeness to the local people, but having a wider reach: A tax to create, equip, and instruct a local police force dependent on the district authority. Despite the careful design, we anticipated that a certain number of extreme skeptical individuals would persist. The metric defined for the cost is Ar$[20] per household-month, so that people can easily relate it to their income and expenditures.

The CE involves setting each variable at specific points to describe each security program. These points are defined in relation to base values. The decisions are grounded on the differences in the values of the variables between alternative programs, so the base values do not enter the model directly. However, realistic values contribute to the external validity of the experiment. The base values for the security risks were set at the actual levels: 1100 homicides per year,[21] and 20 % of households having been a victim of violent crime per year.[22] The points used in the experiment were set downward, reflecting improvements to the current situation. Five points were set for the rate of homicides: 1100, 900, 700, 500, and 300. Four points were set for violent crime: 20, 15, 10, and 5 households affected out of each 100. The zero level was not included in either case in order to avoid the certainty effect identified by Kahneman and Tversky (1979) and Tversky and Kahneman (1986). The base value for the policies is the current situation, as perceived by the individual. The base value for the cost was set at a level compatible with the resources required to implement the policies. Specifically, the cost of the local police organization of the Federal District as stated in the Budget of the Government of the City, was extrapolated to the whole metropolitan area, representing 544 Ar$/household/month. Given the heterogeneity of income, this level could be irrelevant to a large part of the population. Then, we used the preliminary socioeconomic level assessment to classify the respondents into three levels, and dynamically assigned different base values for the cost: 300, 500, and 1000 Ar$/month. Five points were set around the base value: BV − 60 %, BV − 30 %, BV, BV + 30 %, and BV+60 % (Table 2).

20 Ar$ denotes Argentine peso.

21 The statistics of the National Ministry of Justice record 82 homicides per million habitants per year. The rate is smaller for the city district: 46 hom/Mhab/Y, according to the crime statistics of the Buenos Aires city. The victimization rate for the suburbs is 5 % higher than the country average (Schargrodsky & Di Tella, 2013), yielding a rate at 86 hom/Mhab/Y. A weighted average of both rates results in 1051 hom/Y for the whole metropolitan area, which is rounded to 1100.

22 Other violent crime includes robbery, aggravated assault, and rape. The main item is assault (86 %), involving injuries in 16 % of the cases. Crime against freedom follows (12 %). Rape represents 1 %. Property crime and involuntary manslaughter are excluded. The information is affected by sub-declaration to the police, measured by Di Tella et al. (2006). Applying this adjustment to the statistics of the Buenos Aires city we obtain the probability that any member of a household is a victim of a violent crime at 17 %, rounded to 20 % due to the fact that the household size in the suburbs is larger and the probability should not be lower.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

Table 2 Experimental plan.

Variable	Levels				
Risk of homicide (# homicides per year in the area)	300	500	700	900	1100
Risk of violent crime (# of households out of 100, where any member faced at least a violent crime, during one year)	5	10	15	20	
Cost[a]	BV − 60 %	BV − 30 %	BV	BV + 30 %	BV + 60 %
Police presence	Current	Extended			
Court sentences	Current	Strict			

[a] BV is the base value, which is determined by an approximation of each individual's income.

A set of $5 \times 4 \times 5 \times 2 \times 2 = 400$ combinations is available for each security program, making a total of 400^2 possible choice tasks. In order to bring this number down to a manageable level for each respondent we performed an optimal experimental plan. An experimental design having 200 tasks was created out of the full factorial, by means of the Federov (1972) algorithm. The tasks were arranged into blocks of 10 by means of the Meyer and Nachtsheim (1995) algorithm.[23] In this way, we created blocks of 10 tasks for 20 respondents, planned to maximize the information content. Two practice tasks were added at the beginning of each block to account for learning effects. These 20 blocks of 12 tasks were assigned at random to respondents, repeating as necessary to complete the sample.

Several demographic variables were measured in the survey. Standard questions were used for gender, age, residence, education, and family composition. Income was measured by the socioeconomic level methodology developed by the local society of market research (SAIMO, 2015), primarily based on education and job position.[24] The habits of smoking and safety belt usage were measured to represent risk aversion. A trade-off instrument was created to measure impatience via subjective discount rate: the respondent was prompted to choose between receiving a certain amount in two weeks or 20 % more 8 weeks later, followed up with another question to determine the point of indifference. The perception of the crime risk exposure was captured by a specific question besides victimization experience. The perception of

23 The R package "DoE" was employed for both algorithms´ calculations. The models we describe below were calibrated with the R package "mlogit."

24 We have employed the socioeconomic level method developed by SAIMO (Sociedad Argentina de Investigadores de Mercado y Opinión: local association of market researchers), due to the difficulty to measure income directly within the local culture. The method is based on a series of questions about the head of the household: maximum level of education attained, occupation, other source of income, and health and insurance. This information together with the number of persons living in the household and the number of income earners, has proven predictive of the level of income (SAIMO, 2015).

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

control was assessed with the question: "How do you think you would behave in a violent assault situation? Drive the criminal away/negotiate to neutralize the risk/don't know/ask for help/follow the criminal instructions/be paralyzed". Individualism, as a personality trait, was measured with a stylized version of Triandis and Gelfand (1998) scale.[25,26]

The instrument was programmed in Lime Survey language, combined with an *ad hoc* application for the CE. A pilot test was implemented with supervised respondents, and understanding issues were solved before actual fieldwork.

3.2 The discrete choice model

CEs are appropriately represented by DCM based on random utility theory (Mc Fadden, 1975). The DCM represents the decision patterns of the individuals via utility functions. Each alternative is assumed to generate a certain utility level to the individual depicted by a deterministic term (U), and an idiosyncratic random term (ε):

$$\begin{cases} \tilde{U}_{1it} = U_{1it}(H_{1it}, V_{1it}, S_{1it}, P_{1it}, C_{1it}) + \varepsilon_{1it} \\ \tilde{U}_{2it} = U_{2it}(H_{2it}, V_{2it}, S_{2it}, P_{2it}, C_{2it}) + \varepsilon_{2it} \\ \tilde{U}_{3it} = U_{3it}(H_{3it}, V_{3it}) + \varepsilon_{3it} \end{cases} \quad (1)$$

The following explanatory variables enter the utility functions of the main model: H is the rate of homicides (thousands/year), V is the rate of violent crimes (% of households victimized/year), S is the strictness of the execution of court sentences (0 for current, 1 for strict), P is the police force presence (0 for current, 1 for extended), and C is the cost (Ar $/Month). The random term accounts for model limitations and deviations from pure rationality that may occur in human behavior. The characteristics of the alternatives vary for different tasks and different individuals, being the reason for the subscripts t and i, respectively. Note that the third alternative, the status quo, does not have strict execution of sentences nor extended police presence nor cost, but only prevailing risks.

The alternative with the highest utility is selected in each choice task. A number of parameters govern the sensitivity of the utility to each of the variables. Hence, the calibration of the model consists of finding the value of the parameters that best

25 The scale is composed of four direct items: "I'd rather depend on myself than others", "I often do my own thing", "It is important to do my job better than others", and "Competition is the law of nature"; and four opposite items: "If a coworker gets a prize, I would feel proud", "To me, pleasure is spending time with others", "It is my duty to take care of my family, even when I have to sacrifice what I want", and "It is important to me to respect the decisions made by my group".

26 Further detail about the measurement of demographics is available upon request to the authors.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

reproduce the decisions made via utility calculation. The basic DCM, the Multinomial Logit, assumes that the random terms follow independent Gumbel Maximum laws (Train, 2009). This assumption produces a simple expression for the probability of choice of each alternative that can be used for calibration purposes. The alternatives of our CE are not all alike. The two security programs are hypothetical, whereas the status quo is a well-known situation. Following Adamowicz et al. (1998), we employ a Nested Logit DCM to take this into account. The decision is represented in two stages. The individual decides first to engage in a security program or to stay in the status quo, and then, if the former is chosen, s/he selects among the security programs. A multinomial logit model is employed at each level, producing a higher correlation among the programs compared to the status quo. That correlation is empirically tested by the so-called inclusive value (IV) coefficient. The calibration of the model is done via maximum likelihood by means of the "mlogit" package in the R software.

The utility functions in (1) are usually established as linear. However, they could well take alternative forms. Hence, we performed a quadratic Box and Cox (1964) estimation that includes the linear specification as a special case. Quadratic Box-Cox implies to include level, square and cross terms for each of the independent variables. A second model was built to explore the influence of the demographic factors, by including these variables in the utility functions. Demographic variables (D) enter the model in a specific way: by interacting with the risk of homicides ($H´$), the cost ($C´$), and their interaction ($H´C´$).[27] Several demographics are included in the model simultaneously, provided they are not collinear. Then, models are compared via Akaike's Information Criteria (AIC) and likelihood-ratio (LR) tests.

Finally, the VSL is calculated according to the definition:

$$VSL = -\frac{\partial U/\partial H}{\partial U/\partial C} \tag{2}$$

The VSL is the ratio of the utility gain from avoiding a life-risk as is a homicide and the reduction in utility that the cost of this less risky alternative implies.

4 Results and discussion

4.1 Results

As expected, a significant part of the sample (41 %) showed signs of skepticism about the effectiveness of the government to fight crime. It was necessary to remove

27 Otherwise, they would be unidentified constants added in the utility function of all alternatives.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

this part of the sample, not for lack of interest in their preferences, but for the impossibility to elicit them. In order to project the results of the study to the whole population we compared the profile of the skeptical with the rest of the sample across 30 variables. No statistically significant demographic differences were found for age, gender, family size, or socioeconomic levels.[28] The skeptical prefer a higher police presence in the streets and longer sentences for criminals, whereas they show lower interest in their reintegration to the society. Among attitudes and behavior, only a higher fear for death was detected. This analysis shows that, if there is any difference between skeptical people and believers, this is the fear for crime. This means that the valuation based on the believers is conservative. The remaining sample size, after removing the skeptical and a few lexicographic responses, 1475 data units, is adequate for DCM calibration according to Hensher (2004, 2006) and Caussade et al. (2005).

Several modeling alternatives were considered for robustness checks. The results shown in Table 3 are for the main model and the general quadratic Box-Cox estimation as well as simpler versions of it. All DCM considered have the nested logit structure to properly represent the status quo alternative. First, we have considered a model with linear utility functions in the main explanatory variables (homicide risk, violent crime risk, extended police presence, strictness of sentences, and cost). Its performance is very good (all parameters have the expected sign and are statistically significant); however, it was surpassed by other more elaborate models. Specifically, AIC is 2696.6 compared with 2688.4 for the main model, and the likelihood ratio test shows supremacy at $p < 1$ %. We also explore curvature by means of quadratic and rectangular terms for all variables. The quadratic terms were not significant, and the significant rectangular terms are the interactions retained in the main model: homicide risk with cost, and severity of sentences with cost. The likelihood ratio test proves the advantage of this model compared to the linear one ($p = 2$ %), whereas it is below the main model, with AIC at 2696.4. We have also explored the Box-Cox transformation on the three metric variables: the two risks (homicides and violent crimes) and cost. The model shows all statistically significant parameters having the expected sign. Then a Box-Cox model with all quadratic and rectangular terms was calibrated. The large number of parameters, many of them nonsignificant, cause deterioration in the AIC indicator. By retaining the significant parameters, we find the best structure for the main model ("Box-Cox Simplified" in Table 3). The parameters eliminated are not globally significant according to the Likelihood ratio test ($p = 66$ %).

28 Detail in the Appendix.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

Table 3 Main discrete choice model.

	Linear model (1)	Quadratic model (2)	Linear Box-Cox (3)	Quadratic Box-Cox (4)	Box-Cox simplified (5)
Homicide rate (H)	−2.250***	−2.792***	−2.269***	−3.482***	−3.528***
Violent crimes rate (V)	−0.047***	−0.032*	−0.011***	−0.002	−0.003***
Police (P)	1.305***	1.258***	1.314***	1.171***	1.308***
Strictness (S)	1.743***	1.717***	1.751***	1.672***	1.487***
Costs (C)	−1.011***	−0.818**	−0.594***	−0.765	−1.111***
H^2		−0.465		−0.666	
V^2		−0.001		0.000	
C^2		0.632		0.499	
HV		−0.045		−0.001	
HP		0.365		0.330	
HS		0.333		0.320	
HC		−2.025*		−1.615*	−1.645*
VP		−0.007		0.000	
VS		−0.015		0.000	
VC		0.010		0.000	
PS		0.088		0.090	
PC		−0.443		−0.431	
SC		−0.563*		−0.536*	−0.473*
Constant U_2	0.016	0.036	0.020	0.037	0.027
Constant U_3	2.694***	1.571***	0.507	1.120**	0.476
n (tasks)	1475	1475	1475	1475	1475
IV	0.57***	0.58***	0.58***	0.58***	0.56***
Log likelihood	−1340.3	−1327.2	−1336.9	−1326.9	−1331.2
AIC	2696.6	2696.4	2695.8	2701.8	2688.4
VSL	10.7	8.4	4.3	3.7	3.2

Note: *, ** and *** denotes significance at 10, 5 and 1 %, respectively. The VSL is in 2014 million US dollars.

Hence, the main model specification is as follows:[29]

$$\begin{cases} \tilde{U}_1 = \beta_H H_1^{'} + \beta_V V_1^{'} + \beta_S S_1 + \beta_P P_1 + \beta_C C_1^{'} + \beta_{HC} H_1^{'} C_1^{'} + \beta_{SC} S_1 C_1^{'} + \varepsilon_1 \\ \tilde{U}_2 = \beta_2 + \beta_H H_2^{'} + \beta_V V_2^{'} + \beta_S S_2 + \beta_P P_2 + \beta_C C_2^{'} + \beta_{HC} H_2^{'} C_2^{'} + \beta_{SC} S_2 C_2^{'} + \varepsilon_2 \\ \tilde{U}_3 = \beta_3 + \beta_H H_3^{'} + \beta_V V_3^{'} + \varepsilon_3 \end{cases} \tag{3}$$

The parameters measure the change in utility due to each characteristic of the alternatives: β_H to the rate of homicides, β_V to the rate of violent crime, etc. The parameters for the main effects are highly statistically significant ($p < 0.01$) and have

29 We drop here the subscripts *i* and *t* for the sake of clarity.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

Table 4 Interest for security policies by socioeconomic level.

	C3/D	A/B/C1	Difference
Longer court sentences	33 %	26 %	−7 %*
Suppress temporary release for convicts	46 %	20 %	−25 %***
Social reinsertion of convicts	25 %	33 %	8 %**

Note: The socioeconomic levels A and B represent the high income class and they are numerically minimal, adding to less than 1 % of the population. The middle class covers about half of the population and it is divided into C1 (mid-high), C2, and C3 (mid-low). The D level forms practically the other half of the population, the low income class. *, ** and *** denotes significance at 10, 5 and 1 %, respectively.

the expected sign. Both risks (homicide and violent crimes) have negative influence on utility, corresponding to rational behavior. The security policies (police in the streets and strictness of punishment) have positive effect on utility, meaning they are appreciated by the people. The cost effect on utility is negative, as expected according to economic theory.

There are two interactions showing statistical significance in most models. The intense interaction between the homicide risk and the cost (HC) means that the effects of these variables on utility are non-additive, but rather reinforce each other. The rationale for this is that the burden of the cost is psychologically more intense when it is ineffective, as shown by a concurrent high homicide risk. There is also a negative sign on the interaction between the strict execution of court sentences and the cost. This may reflect the lower interest for such a policy among the more affluent individuals, measured in an independent question, whose results are shown in Table 4. The difference between mid-high class and mid-low class is statistically significant. As the former faced higher costs in the experiment, this difference explains the interaction.

The second program constant (β_2) measures its preference beyond its characteristics. As it is not statistically significant we conclude that respondents do not exhibit any stimulus position bias. The status quo constant (β_3) has a similar role. Rational behavior does not require it to be null because the status quo may have perceived characteristics beyond the ones explicit in the experiment. However, being not statistically significant adds notable strength to the results of the experiment, meaning that reality has been fully represented by the selected variables.

The inclusive value (IV) coefficient measures the complement of the correlation between programs. It validates for all our results the hierarchical decision making process represented in the Nested Logit model because the correlation between both programs is approximately 0.4 (1–0.6).

The coefficient of the Box-Cox transformation (not shown in the tables for length reasons) for homicides is $\lambda_H = 1.2$, slightly departing from linearity. The coefficient

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

for violent crime, $\lambda_V = 2.0$, implies that its marginal disutility grows with the risk. This pattern might be related to the high risk prevalence in Argentina (UNDP, 2013, p. 57). The coefficient for the cost, $\lambda_C = 0.4$, implies declining marginal dis-utility. This is consistent with the Prospect Theory proposed by Kahneman and Tversky (1979) and Tversky and Kahneman (1986), considering that the contribution represents a loss with respect of the status quo frame.

Valuation is performed according to the definition:

$$\mathrm{VSL} = -\frac{\partial U/\partial H}{\partial U/\partial C} = \frac{\left[\beta_H + \beta_{HC}\frac{C^{\lambda_C}-1}{\lambda_C}\right] H^{\lambda_H - 1}}{\left[\beta_C + \beta_{HC}\frac{H^{\lambda_H}-1}{\lambda_H} + \beta_{SC}S\right] C^{\lambda_C - 1}} \tag{4}$$

The VSL calculated results in $3.2 million (US dollars). This figure is adjusted to reflect the population income in Argentina. The average income of the sample indexes 1.66 versus the population, and the income elasticity estimated by Kniesner, Viscusi et al. (2010) is 1.44. The income adjusted VSL is then $1.5 million per statistical life.[30]

This estimate is consistent with results obtained in the literature[31]. Viscusi and Masterman (2017) recommend to consider the VSL estimates for the US as the basis of transference for all other countries. For that purpose, they select the VSL figure determined by the US CFOI: $9.6 million. The US value transferred to Argentina is between $1.5 and $2.8 million. Robinson (2017) estimates the average VSL for OECD countries at $4.0 million. The OEDC value transferred to Argentina is between $1.1 and $1.7 million. Then, we conclude that our results are in the same order of magnitude as the values determined for other regions.

The VSL is sensitive to respondent income, consistently with economic theory. Another model sensitivity, also described more thoroughly below, shows that respondents having recent victimization experience have higher VSL. These two elements, as well as other demographic exploration performed below, contribute to demonstrate the sensitivity of scope of the model. Our model also shows adequate sensitive to scope. This validation is not as critical as for CV, as CE involve comparative evaluation that is more accurate than monadic evaluation (Carson, 1997), however it can be considered relevant to stated preference methods in general.

30 The adjustment by income, as it is usual, considers the VSL in the sample (VSL_s), the income ratio between the sample and the population (I_s/I_p) and the income elasticity (η) as:$\mathrm{VSL}_p = \left(I_p/I_s\right)^{\eta} \cdot \mathrm{VSL}_s. = (1/1.66)^{1.44} \cdot 3.2$

31 A transfer is made via income adjustment for comparison, as it is usual in the literature. Income is the GNI per capita, Atlas method, obtained from the World Development Indicators database from the World Bank. Income elasticity recommended in the literature varies depending on the level of income (Viscusi and Masterman, 2017). We report the range between 0.8 and 1.2 as most representative elasticity to transfer values from high-income economies. Figures are in 2014 US dollars.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

Choice experiments have a built-in scope sensitivity test as they involve different levels of the risks (Hanley et al. 1998). This test has been considered internal, but it is also external in this case as respondents face different starting risk levels. The Cochran-Mantel-Haenzel test was performed on raw experimental data revealing statistically significant decay of security program choice with homicide risk ($p < 0.01$), stratified by income level and cost. Desvousgues et al. (2012) go beyond this standard validation pointing out that the difference should also be economically adequate in magnitude to achieve sensitivity to scope. Our model satisfies this more stringent criterion as demonstrated by the elasticity of VSL to risk amounting to 0.75.

The model is also employed to measure the value of violent crime risk reduction in a similar way, resulting $4.1 thousand (US dollars) per statistical crime. Violence implies the victim being forced against her will, whereas injuries may occur only occasionally, and homicide is excluded. The value is significantly lower as expected. (The reader is referred to Picasso and Cohen (2019) for criminology discussion.)

The main model is then expanded for demographic exploration. Demographics enter the model by interacting with alternative specific variables,[32] specifically with the risk of homicides, the cost, and their interaction, by adding the following terms to the utility of each alternative j:

$$+\beta_{HD} DH_j + \beta_{CD} DC_j + \beta_{HCD} DH_j C_j \tag{5}$$

The service level variables do not contribute to collinearity by construction[33], however the demographics should be evaluated in this aspect. Most of the correlations among demographics are low, except between variables measuring the same concept, like family size and number of children under 18 years old. These substitutes do not enter the model simultaneously. Setting redundancy aside, the determinant of the demographics correlation matrix is 0.18, dismissing any serious collinearity problem.

Table 5 shows the results of the model including demographic variables. The valuation expression (4) is modified appropriately by taking into account the new terms in expression (5) for the derivatives. We do not reproduce here the entire formula for length reasons.

There are several sociodemographic variables, which have the expected sign and are significant. First, the VSL is positively and significantly associated with Income, confirming the results in Viscusi and Aldy (2003) and Kniesner et al. (2010). The model was also estimated on subsamples of high (low) income individuals producing +63 % (−41 %) variation in the VSL.

32 Otherwise, there would be unidentified constants added in the utility functions of all alternatives.

33 A small degree of collinearity was tolerated among the service level variables, because individuals were assigned to three groups according to their income level, and each group had a different base cost. Perfect orthogonality was sacrificed in the interest of external validity.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

Table 5 Model with demographic variables.

	Main model (5)	Demographic model (6)		Main model (5)	Demographic model (6)
Homicide (H)	−3.528***	−3.606***	Victim H		0.336
Violent crime (V)	−0.003***	−0.003***	Victim C		0.354**
Police (P)	1.308***	1.328***	Victim H C		0.123
Strictness (S)	1.487***	1.576***	Perc.Risk H		0.844**
Costs (C)	−1.111***	−1.293***	Perc.Risk C		0.125
H C	−1.645*	−1.704***	Perc.Ctrl H		0.048
S C	−0.473*	−0.390	Perc.Ctrl C		−0.045
Income (I) H		−0.813*	Child H		0.086
I C		0.139	Child C		0.271**
I H C		−1.418***	Indiv H		0.468
Impatience H		0.026	Indiv C		−0.282
Impatience C		−0.161	Constant U_2	0.027	0.056
Impatience H C		−0.349	Constant U_3	0.476	0.577
Smokes H		0.057	n (tasks)	1475	1475
Smokes C		−0.216*	IV	0.56***	0.64***
Smokes H C		0.110	Log Likelihood	−1331.2	−1259.7
			AIC	2688.4	2617.4

Note: The asterisks correspond to individual parameter significance (Wald test). The two parameters related to the Indiv variable are collectively significant (Likelihood ratio test) in spite of the fact that they are individually not significant.

Second, general risk aversion is positively associated with VSL. We have used smoking habit as a measure of (lack of) risk aversion, as in previous research ("Smokes" in Table 5). The VSL results $0.1 million lower among smokers. Considering the strong official communication campaign on the negative consequences of smoking, could assume that the population knows about its risk to life. This result is in agreement with other research reviewed in Viscusi and Aldy (2003) across various life risk contexts.

Third, the VSL we estimate is associated with victimization experience since it is higher by $0.7 million for recent victims compared to non-victims ("Victim" in Table 5). This suggests that more involved people can perceive the probability in a different way. On the other hand, the individuals perceiving higher crime risk exposure in their environment show lower VSL ("Perc.Risk" in Table 5). The perception of risk exposure is probably built through long term experience, providing the time to take protective measures, like private security. This may explain why people perceiving higher risk show lower VSL. On the other hand, recent victimization, volatile by definition, would not provide the time for defensive actions.

The VSL increases with the family size by $0.2 million per child ("Child" in Table 5). The VSL is negatively associated with individualism. The corresponding

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

parameters ("Indiv" in Table 5), despite lacking individual significance (Wald tests), are collectively statistically significant (likelihood ratio test).

On the other side, the impact of other demographic variables is not statistically significant. The VSL is negatively associated with Impatience, measured by the inter-temporal discount rate, as predicted by the life cycle theory. Individuals demanding 1 % higher rate appear to have $21 thousand lower VSL. This result is directional as the specific coefficients involved in the valuation ("Impatience" in Table 5) are not statistically significant. The VSL is also found negatively correlated with the belief of control of the crime situation ("Perc.Ctrl" in Table 5). Such belief was measured by means of a direct question. The result is also directional as the corresponding coefficients are not statistically significant.

4.2 Discussion

This study shows that risk to life in the context of crime is severely undervalued if foregone earnings techniques are employed. In Argentina, and likely in most developing countries where subjective individual willingness-to-pay measures are unavailable, the VSL is over 10 times higher than the human capital estimate.[34] This finding has wide implications. As the VSL represents the amount the population is willing to pay to reduce the risk, it provides the right figure for ex-ante economic evaluation. New and more effective crime control policies would be viable in benefit-cost terms by employing the subjective value of risk to life in the analysis. This type of valuation could also be used for ex-post compensation. As the VSL is subjective it properly represents the damage caused to the victim. This value would be useful in case of a crime derived from negligence of public or private authority.

There are implications beyond crime control policy as well. Assuming that our crime related VSL determination could be used as a proxy for other contexts, at least in the absence of specific research, it should be employed in the economic evaluation of local projects having risk to life implications. Many environmental improvement programs would encounter economic validation by using the VSL rather than the human capital value. For instance, the project for improving a 100 km route on the basis of traffic accidents would only be economically validated over 33 fatalities per year under the latter, whereas 2 fatalities per year would suffice under the VSL

34 Estimated between $0.05 and $0.1 million (US dollars) as discounted cash flow of lost income, with the following inputs: survival probability and average income from the National Bureau of Statistics, mean age in the sample: 44 years old, social discount rate: 3 %.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

criterion. On the other hand, noisy social discussions about environmentally concerning projects may find an objective decision criterion in the VSL determined in this study.

Our experiment seems to corroborate the erosion in VSL produced by impatience proposed by the life cycle theory, albeit only directionally. The argument that an impatient individual would recklessly take higher risks paying less attention to the value of the asset at risk is intuitively appealing. However, we must admit that further research is required in this matter. Firstly, we have measured financial impatience whereas other dimensions might exist. The measurement instrument should be further refined and tested for concurrent validity with other approaches. Secondly, we are focusing on the context of crime risk, and impatience might have different influence vis-a-vis other assets. A refined instrument would probably be more conclusive about this hypothesis.

Our work seems to confirm the fundamental nature of risk aversion, linking smoking habit, a well-known indicator of low risk aversion, with the VSL determined in the context of crime. This correlation was also observed across other contexts like labor and traffic risks. These findings support the universality of risk aversion, which is itself a very interesting psychological subject for further research.

Our results support the idea that recent victimization impacts the way people perceive crime risk. This is aligned with the theory of availability bias, and provides an explanation to the empirical observation that the willingness-to-pay for risk reduction is higher wherever the risk is higher and more readily available, as explained above.

The result showing a higher VSL for larger families seems to confirm that children provide value to their parents' life. One potential rationale is that the children create a sense of responsibility in their parents. Another explanation is the intergenerational altruistic effect proposed by Birchenall and Soares (2009).

The result about a lower VSL for individualistic persons is not established in the literature yet, to our knowledge. We think that the individualistic would disregard the passive value, focusing mainly on the active value, and then tolerate more risk to avoid funding collective efforts. The model corroborates this hypothesis.

5 Conclusions

The main contribution of this paper is a new approach for measuring the value of the risk to life in the context of crime. A choice experiment is employed to elicit the preferences of the population, where individuals choose among different scenarios with varying crime risk, policies and cost. Accurate representation of these decisions is achieved through discrete choice modeling, enabling the valuation of the risk to life and causal analysis. The method is more accurate than other direct

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

methods like CV, and less demanding in terms of data than indirect methods. The methodological decision to set the crime context enhances the representation as it involves the whole population whereas current studies based on the hedonic wage function are limited to the labor population.

The value of a statistical life determined for Argentina (an upper-middle income country) is $1.5 million (US dollars), with 90 % confidence interval ($1.1 to $2.3).[35] This result is consistent with valuations performed in the USA and other countries after VSL-income elasticity adjustment. The VSL is found to increase with income, to decrease with impatience, to grow with generic risk aversion, to be influenced by the risk perception, to fall with the belief of control of the situation, and to increase with family size. In this way, we confirm statements made at theoretical or empirical level by other authors, as discussed in the results section. A new finding is that the VSL is lower for individualistic people.

We acknowledge that our study is still exploratory and that a larger database would allow researchers to obtain stronger results. Fine tuning the methodology to better reach the skeptical population in the study would be valuable to understand if they influence the measured VSL. In addition, an interesting path for further research would be to geographically extend the application of the methodology presented in this study, particularly to developed nations, where other valuations have been undertaken. The comparison with other methodologies would let us understand the strengths and weaknesses of each one, along with increasing the accuracy of the VSL figures employed in practise. There is another area for further research with regard to crime control policy. That is, extending the scope of the experiment to other policies would provide better understanding of the preferences of the population about them and thus contribute to improve crime control policies' decisions.

Acknowledgments: We are grateful to the Universidad Católica Argentina for funding the present research project.

Supplementary material

To view supplementary material for this article, please visit
https://doi.org/10.1017/bca.2019.12

35 The confidence interval is derived through an approximate Monte Carlo approach, because the theory for this model is not tractable. The relevant parameters were randomly simulated around their estimates, and the VSL was calculated. The confidence interval was calculated as the middle portion of the 1000 values.

References

Adamowicz, Wiktor, Jordan Louviere, and Joffre Swait. 1998. *Introduction to Attribute-Based Stated Choice Methods*. Report Submitted to the Resource Valuation Branch, Damage Assessment Center, NOAA (National Oceanic and Atmospheric Administration), US Department of Commerce, January.

Alberini, Anna, and Milan Scasny. 2013. "Exploring Heterogeneity in the Value of a Statistical Life: Cause of Death v. Risk Perceptions." *Ecological Economics*, 94: 143–155.

Aldy, Joseph E., and W. K. Viscusi, 2008. "Adjusting the Value of a Statistical Life for Age and Cohort Effects." *The Review of Economics and Statistics*, 90(3): 573–581.

Atkinson, Giles, Andrew Healey, and Susana Mourato. 2005. "Valuing the Costs of Violent Crime: A Stated Preference Approach." *Oxford aEconomic Papers*, 57: 559–585.

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

Blomquist, Glenn C. 2004. "Self-Protection and Averting Behavior, Values of Statistical Lives, and Benefit Cost Analysis of Environmental Policy." *Review of Economics of the Household*, 2(1): 89–110.

Box, George E.P., and David R. Cox. 1964. "An Analysis of Transformations." *Journal Royal Statistical Society B*, 26(2): 21–252.

Cameron, Trudy A.. 2010. "Euthanizing the Value of a Statistical Life." *Review of Environmental Economics and Policy*, 4(2): 161–178.

Cameron, Trudy A., and J. R. De Shazo, 2013. "Demand for Health Risk Reductions." *Journal of Environmental Economics and Management*, 65(1): 87–109.

Carson, Richard T. 1997. "Contingent Valuation Surveys and Tests of Insensitivity to Scope". In *Determining the Value of Non-Marketed Goods*, edited by Raymond J. Kopp, Werner W. Pommerehne, and Norbert Schwarz, 127–163. Netherlands: Springer.

Carson, Richard T. and Jordan Louviere, 2017. "Estimation of Broad-Scale Tradeoffs in Community Policing Policies." *Journal of Benefit-Cost Analysis*, 8(3): 385–398.

Caussade, Sebastián, Juan de Dios Ortúzar, Luis I. Rizzi, and David A. Hensher. 2005. "Assessing the Influence of Design Dimensions on Stated Choice Experiment Estimates." *Transportation Research Part B*, 39: 621–640.

Cohen, Mark A. 1988. "Pain, Suffering and Jury Awards: A Study of the Cost of Crime to Victims." *Law and Society Review*, 22: 537–555.

Cohen, Mark A. 2010. "Valuing Crime Control Benefits using Stated Preference Approaches" In *Cost-Benefit Analysis and Crime Control*, edited by Roman, John K., John Dunworth, and Kevin Marsh, 73–117, Washington, D.C.: Urban Institute Press.

Cohen, Mark A. 2015. "Willingness to Pay to Reduce White-Collar and Corporate Crime." *Journal of Benefit-Cost Analysis*, 6(02): 305–324.

Cohen, Mark A., Ronald T. Rust, Sara Steen, and Simon T. Tidd. 2004. "Willingness-to-pay for Crime Control Programs." *Criminology*, 42(1): 89–110.

Cropper, Maureen L., James K. Hammitt, and Lisa K. Robinson. 2011. "Valuing Mortality Risk Reductions: Progress and Challenges." *Annual Review of Resource Economics*, 3: 313–336.

Desvousgues, William, Kristi Mathews, and Kenneth Train. 2012. "Adequate Responsiveness to Scope in Contingent Valuation." *Ecological Economics*, 84: 121–128.

Di Tella, Rafael, Sebastián Galiani and Ernesto Schargrodsky. 2006. *Crime Distribution and Victim Behavior During a Crime Wave*. William Davidson Institute Working Papers Series No. wp849.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press

Di Tella, Rafael and Robert MacCulloch. 2006. "Some uses of Happiness Data in Economics." *Journal of Economic Perspectives*, 20: 25–46.
Federov, Valeriĭ Vadimovich. 1972. *Theory of Experiments*, translated and edited by Studden, William J. and Klimko M. Eugene. New York, NY: Academic Press.
Fein, Rashi. 1958. *Economics of Mental Illness*. New York, NY: Basic Books.
Freeman, A. Myrick. 2003. *The Measurement of Environmental and Resource Values*. 2nd ed. Washington, D.C.: Resources for the Future.
Haab, Timothy, and Kenneth McConnell. 2002. *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*. United Kingdom: Edward Elgar Publishing.
Hammitt, James K. 2017. "Extrapolating the Value per Statistical Life Between Populations: Theoretical Implications." *Journal of Benefit-Cost Analysis*, 8(2): 215–225.
Hanley, Nick, Robert E. Wright, and Wiktor Adamowicz. 1998. "Using Choice Experiments to Value the Environment." *Environmental and Resource Economics* 11(3–4): 413–428.
Hensher, David A. 2004. "Identifying the Influence of Stated Choice Design Dimensionality on Willingness to Pay for Travel Time Savings." *Journal of Transport Economics and Policy*, 38(3): 425–46.
Hensher, David A.. 2006. "Revealing Differences in Willingness to Pay Due to the Dimensionality of Stated Choice Designs: An Initial Assessment." *Environmental and Resource Economics*, 34(1): 7–44.
Hensher, David A., John M. Rose, Juan de Dios Ortuzar, and Luis I. Rizzi. 2009. "Estimating the Willingness to Pay and Value of Risk Reduction for Car Occupants in the Road Environment." *Transportation Research Part A*, 43: 692–707.
Hoffmann, Sandra, Alan Krupnick, and Ping Qin. 2017. "Building a Set of Internationally Comparable VSL Studies: Estimates of Chinese Willingness to Pay to Reduce Mortality Risk." *Journal of Benefit-Cost Analysis*, 8(2): 251–289.
Hojman, Pablo, Juan de Dios Ortúzar, and Luis I. Rizzi. 2005. "On the Joint Valuation of Averting Fatal and Severe Injuries in Highway Accidents." *Journal of Safety Research*, 36: 377–386.
Kahneman, Daniel, and Amos Tversky. 1979. "Prospect Theory: An Analysis of Decision under Risk." *Econometrica*, 47(2): 263–291.
Kniesner, Thomas J., Kip W. Viscusi, and James P. Ziliak. 2010. "Policy Relevant Heterogeneity in the Value of Statistical Life: New Evidence from Panel Data Quantile Regressions." *Journal of Risk and Uncertainty*, 40: 15–31.
Linden, Leigh, and Jonah E. Rockoff. 2008. "Estimates of the Impact of Crime Risk on Property Values from Megan's Laws." *American Economic Review*, 98(3): 1103–1127.
Louviere, Jordan, David A. Hensher, and Joffre Swait. 2000. *Stated Choice Methods: Analysis and Applications*. New York, NY: Cambridge Univiversity Press.
Ludwig, Jens, and Philip J. Cook. 2001. "The Benefits of Reducing Gun Violence: Evidence from Contingent Valuation Survey Data." *Journal of Risk and Uncertainty*, 22: 207–226.
McCollister, Kathryn E., Michael T. French, and Hai Fang. 2010. "The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation." *Drug and Alcohol Dependence*, 108(1–2): 98–109.
Mc Fadden, Daniel. 1975. *The Measurement of Urban Travel Demand*. University of California, Berkeley, CA.
Meyer, Ruth K., and Christopher J. Nachtsheim. 1995. "The Coordinate-Exchange Algorithm for Constructing Exact Optimal Experimental Designs." *Technometrics*, 37: 60–69.
Mishan, Edward J. 1971. *Cost–Benefit Analysis. An Introduction*. New York, NY: Praeger.

Moreno, Carolina, and Agustín Salvia, 2012. *Vulnerabilidad al delito y sentimiento de inseguridad en las grandes áreas urbanas de la Argentina.* Universidad Católica Argentina. Available at: http://wadmin.uca.edu.ar/public/20180427/1524854330_Boletin_inseguridad_2012_21-12.pdf (accessed April 1, 2019).

Mushkin, Selma J., and Francis d'A. Collings, 1959. "Economic Costs of Disease and Injury." *Public Health Reports* 74: 795–809.

Nagin, Daniel S., Alex R. Piquero, Elizabeth S. Scott, and Laurence Steinberg. 2006. "Public Preferences for Rehabilitation Versus Incarceration of Juvenile Offenders: Evidence from a Contingent Valuation Survey." *Criminology and Public Policy*, 5: 301−326.

Narain, Urvashi, and Chris Sall. 2016. *Methodology for Valuing the Health Impacts of Air Pollution: Discussion of Challenges and Proposed Solutions.* Washington, D.C.: World Bank Group.

OECD, 2012. *Mortality Risk Valuation in Environment, Health and Transport Policies*. Paris: OECD Publishing.

Picasso, Emilio, and Mark A. Cohen. 2019. "Valuing the Public's Demand for Crime Prevention Programs: A Discrete Choice Experiment." *Journal of Experimental Criminology*. forthcoming.

Piquero, Nicole Leeper, Mark A. Cohen, and Alex R. Piquero. 2010. "How Much is the Public Willing to Pay to be Protected from Identity Theft?." *Justice Quarterly*, 28(3): 437–458.

Pope, Devin G., and Jaren C. Pope. 2012. "Crime and Property Values: Evidence from the 1990s Crime Drop." *Regional Science and Urban Economics*, 42(1–2): 177–188.

Rizzi, Luis I., and Juan de Dios Ortuzar. 2003. "Stated Preference in the Valuation of Interurban Road Safety." *Accident Analysis and Prevention*, 35: 9–22.

Robinson, Lisa. A.. 2017. "Estimating the Values of Mortality Risk Reductions in Low- and Middle-Income Countries." *Journal of Benefit-Cost Analysis*, 8(2): 205–214.

Rosen, Sherwin. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy*, 82(1): 34–55.

Rosen, Sherwin. 1983. *The Equilibrium Approach to Labor Markets*. National Bureau of Economic Research, NBER Working Paper No. 1165.

Saelensminde, Kjartan. 2003. "Embedding Effects in Valuation of Non-market Goods." *Transport Policy*, 10: 59–72.

SAIMO. 2015. *Sociedad Argentina de Investigadores de Marketing y Opinión. El nivel socioeconómico en Argentina.* Available at: http://www.saimo.org.ar/observatorios/observatorio-social (accessed April 1, 2019).

Schargrodsky, Ernesto, and Rafael Di Tella. 2013. "Informe del Laboratorio de investigaciones sobre crimen, instituciones y políticas." Report by Laboratorio de investigaciones sobre crimen, instituciones y politicas, Universidad Torcuato Di Tella, Buenos Aires, Argentina.

Schelling, Thomas C. 1968. "The Life You Save May Be Your Own." *Problems in Public Expenditure Analysis*, 127: 129–130.

Thaler, Richard. 1978. "A Note on the Value of Crime Control: Evidence from the Property Market." *Journal of Urban Economics*, 5(1): 137–145.

Train, Kenneth. 2009. *Discrete Choice Methods with Simulation*. New York: Cambridge University Press.

Triandis, Harry, and Michele Gelfand. 1998. "Converging Measurement of Horizontal and Vertical Individualism and Collectivism." *Journal of Personality and Social Psychology*, 74: 118–128.

Tversky, Amos, and Daniel Kahneman. 1986. "Rational Choice and the Framing of Decisions." *Journal of Business*, 59(4.2): S251–S278.

United Nations Development Program. 2013. Informe regional de desarrollo humano. Seguridad ciudadana. Available at: https://www.undp.org/content/dam/rblac/img/IDH/IDH-AL Informe completo.pdf.

Viscusi, W. Kip. 1978. "Labor Market Valuations of Life and Limb: Empirical Evidence and Policy Implications." *Public Policy*, 26(3): 359–386.

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

Viscusi, W. Kip, and Clayton J. Masterman. 2017. "Income Elasticities and Global Values of a Statistical Life." *Journal of Benefit-Cost Analysis*, 8(2): 226–250.

Wickramasekera, Nyantara, Judy Wright, Helen Elsey, Jenni Murray, and Sandy Tubeuf. 2015. "Cost of Crime: A Systematic Review." *Journal of Criminal Justice*, 43(3): 218–228.

World Bank and IHME (Institute for Health Metrics and Evaluation). 2016. *The Cost of Air Pollution: Strengthening the Economic Case for Action*. Washington, D.C.: World Bank.

Zarkin, Gary A., Sheryl C. Cates, and Mohan V. Bala. 2000. "Estimating the Willingness to Pay for Drug Abuse Treatment: A Pilot Study." *Journal of Substance Abuse Treatment*, 18: 149–159.

https://doi.org/10.1017/bca.2019.12 Published online by Cambridge University Press