The Value of Longevity in Mexico

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Abstract: This paper evaluates the gains in longevity based on individuals' willingness to pay, and measures the social values of these gains. We apply the Murphy and Topel (2003, 2006) model for Mexico for the first time, which allows us to estimate the value of a life year and the value of remaining years of life at each age. We also apply the estimates to three cases to exemplify how these calculations can be used in decisions concerning public policy: value of gains in mortality rates, cost of deaths associated with obesity, and a cost-benefit analysis of lives saved through treatment for children with leukemia.
Keywords: longevity, willingness to pay, Mexico.

El valor de la longevidad en México

Resumen: Evaluamos las ganancias en longevidad con base en la disposición a pagar de los individuos, y calculamos el valor social de estas ganacias. Aplicamos el modelo de Murphy y Topel (2003, 2006) por primera vez para México, y así estimamos el valor de un año de vida y el valor de la vida restante a cada edad. Además, usamos los estimados en tres casos para ejemplificar cómo pueden usarse para decisiones de política pública: valoración de las ganancias en las tasas de mortalidad, costo de muertes por obesidad y análisis costo-beneficio de vidas salvadas por medio de tratamiento para niños con leucemia.
Palabras clave: longevidad, disposición a pagar, México.

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Introduction

Life expectancy at birth in Mexico has increased significantly during the last few decades (Gómez de León and Rabell, 2001), and the

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health status of the overall population has improved. Moreover, in recent years the Mexican government has spent a significant amount of public resources to finance *Seguro Popular (SP)*, a health insurance program created primarily for the poor, who were previously excluded from formal social insurance. But how much are the gains in longevity and improved health worth? Has *SP* yielded positive results in terms of benefits and costs?

Estimating the value of health and longevity is key to understand the benefits of increased spending and evaluating polices that aim to devote additional public resources to health. Assessing whether *SP* has resulted in positive net outcomes is not only needed to justify the continuation of the program in Mexico, but also to inform decisions about implementation of similar programs in other countries.

In the analysis we present here we apply the framework developed by Murphy and Topel (2003, 2006) to calculate willingness to pay (WTP) for improvements in health and longevity to the case of Mexico. We calculate the value of longevity during the period 1930-2010. We provide evidence on the value of longevity associated to avoiding obesity-related deaths, and we exemplify how cost benefit analysis can be performed to a subsidized health program, such as *SP*. As a byproduct of the model, we estimate the value of remaining years of life (VRL). We find that gains in longevity in Mexico during the period 1930-2010 have been very high, amounting to around 15 trillion dollars,[1] which is equivalent to 17 times the country's 2010 gross domestic product (GDP). We also estimate that the annual value of avoiding obesity-related deaths, specifically deaths resulting from four diseases for which obesity is listed as a risk factor, equals 22 billion dollars. Finally, we demonstrate that gains resulting from decreased mortality associated with Acute Lymphoblastic Leukemia (ALL) in children exceed the amount that *SP* spends to treat the disease.

This paper is organized as follows: in section I we describe the model and explain how it was calibrated; in section II we apply the model to calculate the social value of gains in longevity from 1930 until 2010, of avoiding obesity-related deaths, as well as to establish thresholds for the SP program in terms of cost-benefit analysis for the specific case of ALL; section III concludes.

[1] Throughout the paper all values are in US dollars unless otherwise specified.

I. The Framework

I.1. Valuing Changes in Longevity

Murphy and Topel's model measures the value of health and longevity by the amount a person is willing to pay to avoid death or to maintain their health. Under this model, a rational agent will maximize their expected remaining utility function subject to a budget constraint. The utility and constraint of an individual age a are shown in equations (1) and (2), respectively. Utility is a function of consumption, work effort, health status and a discount factor, with the last two variables being exogenous to the representative individual. $H(t)$ measures health status, $c(t)$ measures consumption in goods other than healthcare, $l(t)$ measures leisure, and $S(t, a)$ is the probability that an individual age a survives from age a to age t. The budget constraint equation shows that the expected value of the difference between income and consumption plus an exogenous wealth value equals zero.[2] The value of utility after death is normalized to zero; $A(a)$ is the value of assets at age a, and $y(t)$ measures income.

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

Subject to

$$A(a) + \int_a^\infty [y(t) - c(t)]\, S(t, a) e^{-r(t-a)}\, dt = 0 \tag{2}$$

Equation (1) assumes that health improves the quality of life through a multiplicative effect in the utility function (the health status effect), and that utility can also be improved by an increase in the probability of survival (the mortality effect). Income in each period, $y(t)$, is endogenously determined by the choice of leisure since $y(t) = w(t)\,[1 - l(t)] + b(t)$, where $w(t)$ is the wage rate and $b(t)$ is life-contingent non-wage income, such as defined benefit pension receipts, which is exogenous to the individual. The maximum amount of non-market time is normalized at unity. Optimality conditions are shown in equation (3), where μ is the multiplier associated with the constraint.

[2] We do not deal with issues of savings and bequests because we believe they are secondary to this problem. The driving force in the analysis is exogenous change in S, and while there is likely significant co-variation between S and H within each cohort due to wealth, wages and other social variables, for an aggregate analysis the co-variation is not relevant.

$$H(t)u_c'(c(t), l(t)) = \mu e^{-(r-\rho)(t-a)}$$
$$H(t)u_l'(c(t), l(t)) = w(t)\mu e^{-(r-\rho)(t-a)} \tag{3}$$

The optimal values that result from this system can be used to write the indirect function in equation (4), and the VRL at age a can be calculated as the marginal rate of substitution between changes in factors that affect survival probabilities and assets. It is important to note that wages equal the marginal rate of substitution between leisure and non-health consumption ($w = u_l / u_c$).

$$VRL(a) = \int_a^{\infty} v(t)e^{-r(t-a)} S(t, a)dt \tag{4}$$

Where:

$$v(t) = \frac{u(c(t), l(t))}{u_c} - c(t) + y(t) \tag{5}$$

The VRL is the present value of a life year ($v(t)$) in future periods adjusted for the survival probability and the discount factor. The indirect function $v(t)$ measures the monetary value of the utility plus net savings, which enter the value of a life year because they are used to finance future consumption.

Using this framework we can analyze the impact of an exogenous medical improvement, α, that increases the probability of surviving from age a onward. In this exercise we exclude improvements in health through $H(t)$. Equation (6) shows the willingness to pay (WTP) for this medical improvement at age a.

$$WTP(a) = \int_a^{\infty} v(t)e^{-r(t-a)} S(t,a)\Gamma_\alpha(t,a)\, dt \tag{6}$$

where $S(t,a)\Gamma_\alpha(t,a) = \frac{\partial S(t,a)}{\partial \alpha}$. The authors restrict the utility function to be homothetic. Thus, $u(c, l) = u(z(c, l))$, and z is a composite commodity, homogenous of degree 1, that aggregates consumption and non-market time ($z = z_c c + z_l l$). With these assumptions, indirect utility equals full income (y^F) plus consumer surplus multiplied by full consumption (c^F), as seen in equation (7).

$$v = y + \frac{u(z_c c + z_l l)}{z_c u'(z)} - c = y^F + c^F \left[\frac{u(z)}{zu'(z)} - 1 \right] \quad (7)$$

Full consumption and full income include the value of non-market time: $c^F = c + lz_l / z_c = z_c^{-1} z$ and $y^F = y + lz_l / z_c = z_c^{-1} z$, where z_l / z_c is the relative price of non-market time and consumption (w for the labor force participants). The term in brackets measures the consumer surplus per unit of consumption of z. Based on the following equation $\Phi(z) = [u(z) / zu'(z) - 1]$, the value of a life year is given by equation (8).

$$v = y^F + c^F \, \Phi(z) \quad (8)$$

The next section uses equations (6) and (8) to estimate the value of longevity, which enables us to analyze the value of variations in survival probabilities.

I.2. Calibrating the Model for the Case of Mexico

The empirical analogue of equation (6) can be written as

$$WTP(a) = \sum_{t=a}^{\infty} R^{t-a} v_t \Delta S_{a,t} = \lambda \sum_{t=a}^{\infty} R^{t-a} v_t \frac{S_t^1}{S_a^1} = \lambda W_a \quad (9)$$

where S_t measures the probability of surviving from birth to age t, $S_{a,t} = \frac{S_t}{S_a}$.

$$\Delta S_{a,t} = \frac{S_t^2}{S_a^1} - \frac{S_t^1}{S_a^1}, \lambda = \frac{S_t^2 - S_t^1}{S_t^1} \text{ and } R = \frac{1}{1+r}$$

Thus, λ measures small changes in the probability of death that affects homogenously through all periods, and W_a is interpreted as the value of a statistical life (VSL, Kniesner, Viscusi and Ziliak, 2006). One of the key advantages of the framework developed by Murphy and Topel is that estimates of the VSL can be used to calibrate $\Phi(z)$.

We begin our analysis by looking at income and consumption over the life cycle. We base hourly wages and spending figures on estimates obtained by Mejía (2008), who has calculated income and consumption over the life cycle for the case of Mexico using household surveys and national accounts from 2004 as part of the National Transfer Accounts project.[3] We further disaggregate spending so that we can observe private and public health spending, and eliminate health spending from calculations of consumption in our model. The real discount rate is set at 3 per cent, which is the average return over the period 2000-2010 on short-term government bonds. The survivor function was calculated using the probabilities of death at each age from Partida (2008).

There are not straightforward ways to assign a value to leisure. Three interrelated decisions should be made (Boarini, Johansson and Mira d'Ercole, 2006). First, whether to include the value of leisure for workers only or for all the population. Second, to determine how much amount of time is to be assigned to leisure, it is all not working time or not working time deducting time for non market work, activities that persons will be willing to pay other persons to do them on their behalf (cleaning, grocery shopping, etc.). Third, to determine the value of leisure proper. In his seminal paper, Becker (1965) valued leisure as the opportunity cost of work time and thus at the wage rate for workers. In the economic literature this is very common, and indeed it is the approach used by Murphy and Topel (2003, 2006), and by the replications of the model in Japan by Kawagoe (2009), and in Chile by Cerda and Torche (2006).

Feather and Shaw (1999) argue that there are another two commonly used methodologies to value leisure, besides the wage rate; and propose even a fourth methodology. On one hand, to value leisure is estimated as a fraction of the wage rate, calculated using empirical analysis of reveled preference models. On the other, there are models that calculate the value of leisure using hedonic models. Finally the authors propose to estimate the value of leisure using the Heckman (1974) methodology. Results of the empirical evidence indicate that on average the value of leisure is slightly lower than the wage rate and lower than the models that use hedonic equations. Bearing this in mind, in general the value of leisure is approximated using a fraction of the wage rate, say at ¼ or ½ (Larson, Shaikh, and Layton, 2004).

Other works consider that a better approximation of the value of leisure is the value of household production. Therefore, in this case, it is important to value the non market work. Three possibilities have been used:

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[3] See http://www.ntaccounts.org/. All values are expressed in 2004 dollars.

a) the replacement cost, i.e. the cost of hiring individuals to do each activity performed in household work; *b)* the opportunity cost, i.e., the foregone market wage of a person for the time spent doing household production activities; and *c)* the housekeeper cost; *i.e.*, the cost of hiring a housekeeper to do all the non market work (Stephenson, 2006). The three methods require different information. The first one requires prices for each of the activities considered as non market work, information that we do not observe in Mexico. The second one only requires information on wages; whereas the third one requires information on housekeepers remuneration. All methods require information on the time spent on each activity in household production. It can be observed anyway that in any three methods the overall upper bound of the price of the household production would be the market wage of the person doing the non market work.

In this paper, we perform two estimations regarding the value of leisure. First, we take the value of leisure as the wage rate.[4] Second, in the absence of specific information on prices of non market activities, we value leisure as ¼ of the market wage. The first one can be though of the upper bound; the second scenario the lower bound. We assume a person works 2 000 hours per year (assuming a person works 8 hours a day, 5 days a week, 50 weeks a year) and spends another 2 000 hours on leisure activities, according to the Murphy and Topel model and consistent with the information of the *Encuesta Nacional de Uso del Tiempo*.[5]

The VSL is the final number needed to calibrate the model. However, estimates of this value are scarce and vary significantly. Miller (2000), in a survey of studies across the globe, concludes that the VSL for prime-age individuals is approximately 120 times the per capita GDP. This bulk number implies a VSL for Mexico of around $812 000 in 2004 dollars. For countries with similar income per capita as Mexico, Ortiz, Markandya and Hunt (2009) in a study for São Paulo in Brazil calculate a VSL ranging from $770 000 to $1 300 000 2003 dollars. For Chile Bowland and Beghin (1998) using their estimates of a meta analysis for developed economies predict-

[4] The value of leisure as the wage rate is defined structurally in the model (we assume an internal solution); see equation (3). According to the *Encuesta Nacional de Uso del Tiempo*, out of the 8 736 hours in a year, 2000 are market work, 2 380 are leisure and 4 356 are non market work. We use 2 000 in the estimation to have a comparison to the results from Murphy and Topel (2006).

[5] Since Mejía's estimates stop at age 90, income is set at 0 for ages 90 to 110. Consumption decreases 2 per cent annually from ages 90 to 110. Consumption over the life cycle is adjusted in such a way that nowadays value consumption equals income.

Table 1. Value of remaining life (VRL) under different assumptions

Φ(z)	*Source of data*	*VRL at 23 (in US dollars)*
0.0	VSL from Hammitt and Ibarrarán (2006)	\$254 789
2.0	$\Phi(z)$ from Murphy and Topel (2006)	\$671 152
2.9	VSL from international evidence Miller (2000) and Bowland and Beghin (1998)	\$868 448

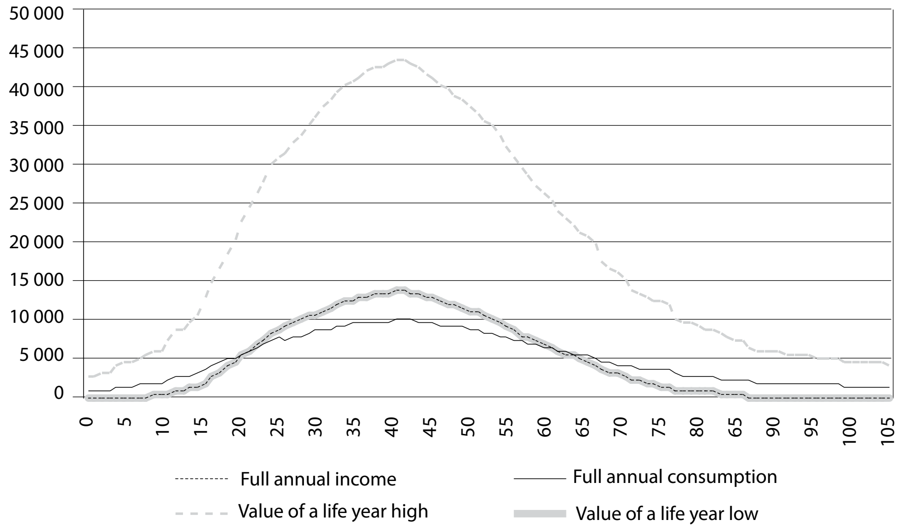
Source: Authors' own elaboration.

ed a value ranging from \$804 000 to \$1 046 000 in 2004 dollars. Also in Chile, but in the area of transportation safety, Jara-Díaz, Gálvez and Vergara (2000) have estimated a VSL ranging from \$2 200 000 to \$6 300 000 in 2000 dollars depending on the model used by the authors, while Rizzi and Ortúzar (2003) calculate a VSL in the range of \$350 000 to \$1 300 000 in 2000 dollars depending on different models and assumptions about people behavior; and Hojman, Ortúzar and Rizzi (2005) calculate the equivalent of \$300 000 dollars. Finally, Hammitt and Ibarrarán (2006) estimate a VSL between \$235 000 and \$325 000 (in 2002 dollars) based on a survey of 600 Mexican workers 18 and older who were 80 per cent male, 33-year-olds on average, and earned an average monthly wage of \$350. The wide range given by the authors for the VSL is explained by the covariates included in their hedonic econometric model.

The high variability in estimates of the VSL is common in the literature on many countries (Viscusi and Aldy 2003). Different VSL are associated with different values of $\Phi(z)$ as can be seen in table 1; consumer surplus must equal zero for the VSL to equal the estimates by Hammitt and Ibarrarán (2006). This result assumes that the average and the marginal utilities of consumption are equal. For VSL values estimated using international experiences $\Phi(z)$ is around 2.9. The $\Phi(z)$ used in Murphy and Topel, equal to 2.0, is associated with a VSL of \$671 151 in 2004 dollars. In what follows, we present estimations using two values for the VSL, the lower and upper limit associated with $\Phi(z)$ equal to zero and equal to 2.9.

Once we have calibrated the model (after estimating the value of $\Phi(z)$ by pinning down equation (9) to a prime-age worker) we can get estimates of the life cycle fluctuations of full income, full consumption, the value of a life-year, and the VRL for the two scenarios of the value of leisure. As figure 1a shows, under the scenario of the value of leisure priced at the market

Figure 1a. Estimates of full annual income and consumption and value of a life-year under two scenarios, 2004 USD (leisure valued at wage rate)



Source: Authors' own elaboration with estimations from the model. *Note:* high means a $\Phi(z) = 2.9$ and low a $\Phi(z) = 0$.

wage, the first three variables peak at around age 45. In the high value scenario, the value of a life-year goes from \$3 000 in early childhood to more than \$40 000 at age 45, and decreases steadily until stabilizing at around \$4 000 in old age. In the low value scenario, the value of a life-year starts at zero (since full income is zero), increases to \$15 000 at age 45, and then decreases steadily to zero (since full income is zero for very elderly people). The second scenario, the one in which the value of leisure is priced at ¼ of the market wage mimics the first scenario but is adjusted downwards approximately 10 per cent. For this reason, and to simplify the paper, in what follows we only report results based on the scenario in which the value of leisure is priced at the market wage.

Figure 2 shows our estimate of the VRL at all ages under each scenario. As we can see, in the high value scenario, the VRL for young children is within the range of \$550 000, then it reaches approximately \$860 000 in a person's 20s, and decreases steadily until reaching zero. In the low value scenario VRL starts at \$148 000, then it reaches \$255 000 during a person's 20s, and decreases until reaching zero towards the end of life.

Figure 1b. Estimates of full annual income and consumption and value of a life-year under two scenarios, 2004 USD (leisure valued at ¼ the wage rate)

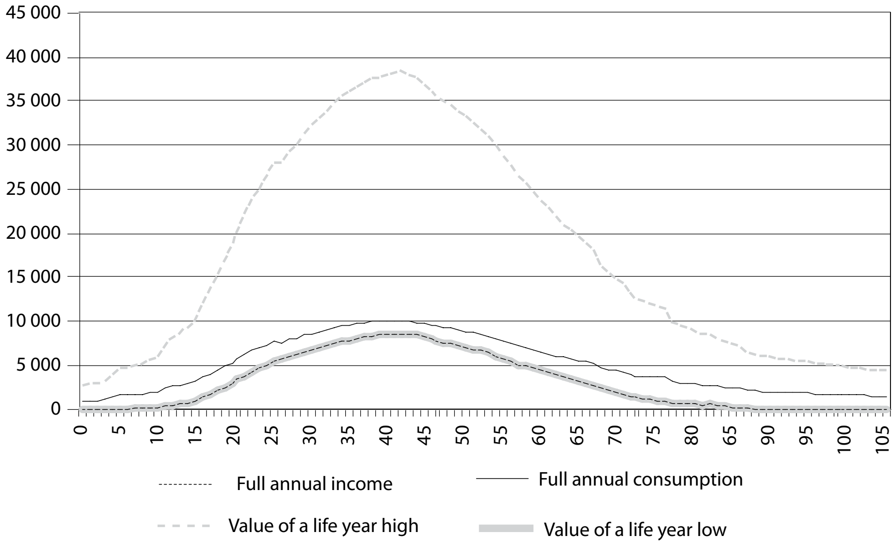
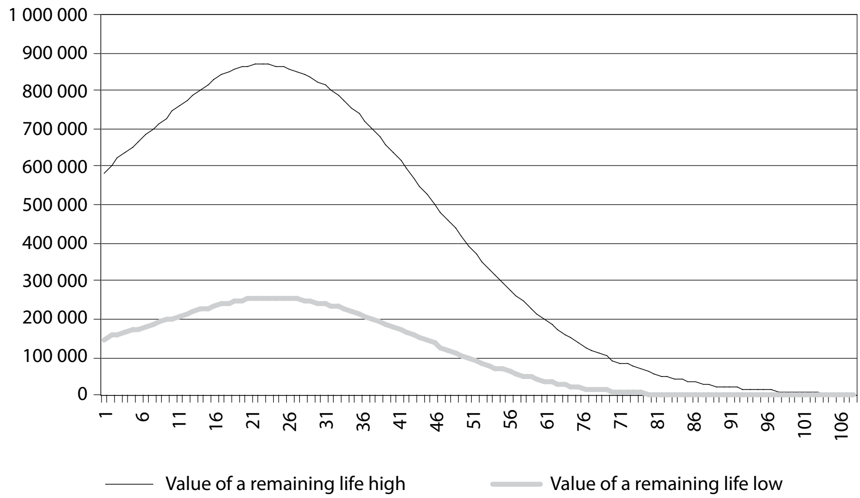


Figure 2. Value of remaining life under two scenarios, 2004 USD



Source: Authors' own elaboration with estimations from the model. *Note:* high means a $\Phi(z) = 2.9$ and low a $\Phi(z) = 0$. Leisure priced at the wage rate.

II. Applying the Model

The model can be applied to evaluate social gains of almost any intervention that improves health. Calculations are straightforward once we have the VRL at each age. In the following subsections we apply the model to three interesting cases. First, similar to Murphy and Topel's analysis, we evaluate the social gains from reducing mortality over a long period, from 1930 to 2010. We also present the social gains from reducing mortality related to obesity, a topic that is of growing concern around the world. Finally, although a smaller intervention compared to previous examples, we employ the model to illustrate benchmarks that a social insurance program such as *Seguro Popular* needs to achieve positive net gains in a cost-benefit analysis. Social insurance programs are proliferating in many countries, and rigorous analyses are needed to justify their implementation.

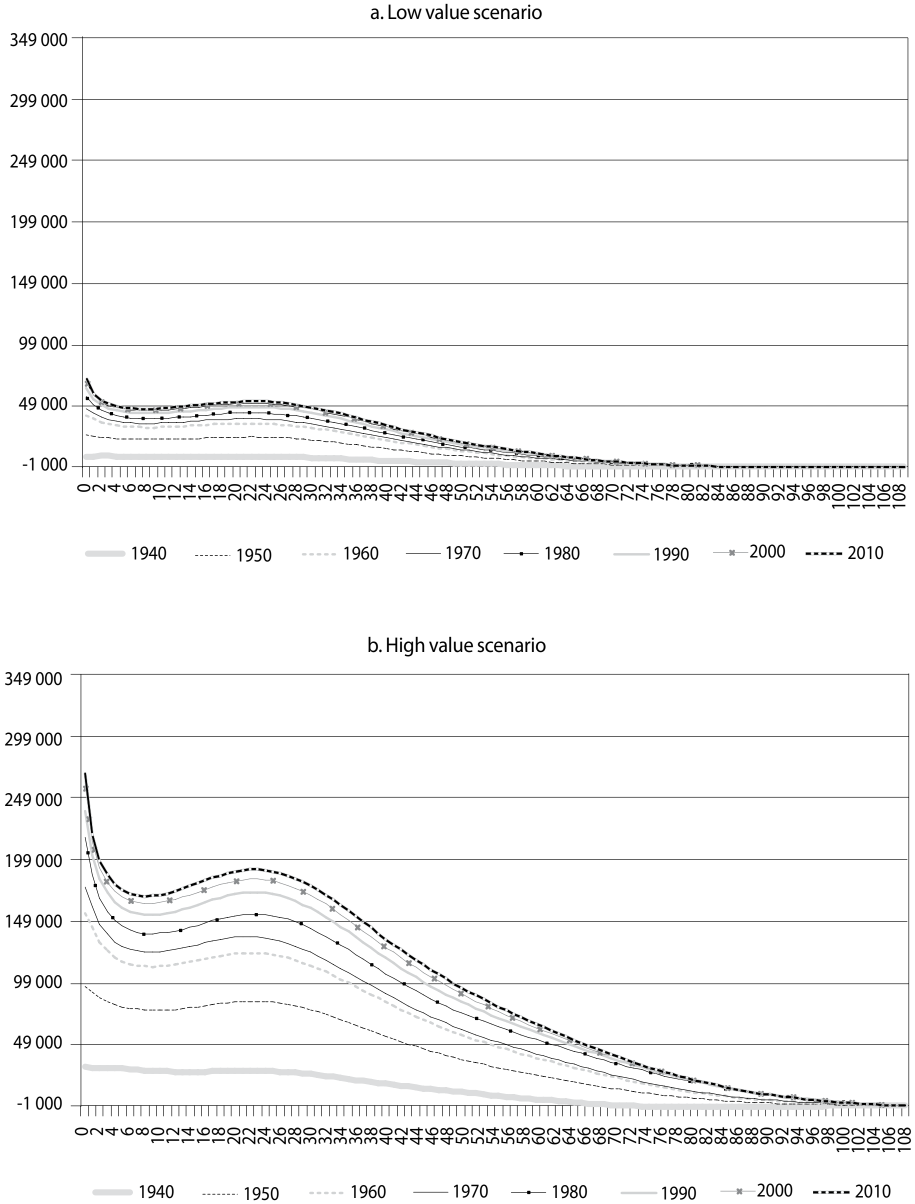
II.1. Valuing the Gains During the Period 1930-2010

Mortality rates in Mexico have decreased substantially from 1930 to 2010. Given the WTP observed in 2004, how much is this reduction worth? Using data from figure 1 on the value of a life-year and the probabilities of death since 1930, we can calculate how today's individuals value the lower probabilities of death (at 2004 prices). Figure 3 shows cumulative gains from 1930 to 1940, from 1930 to 1950 and so on for individuals at each age (with 1930 being the base year for differences in the VRL) under the two scenarios.

In both scenarios the largest gains across the life cycle are observed at birth and are associated with significant decreases in infant mortality rates. The value of this improvement is worth approximately $250 000 per child (at age 0) in the high value scenario, and $71 000 per child in the low value scenario. Health improvements since 1930 have almost doubled the VRL at birth. Gains are also substantial for other age groups. Population between ages 18 and 30 has experienced a cumulative gain over the study period of near $200 000 in the high value scenario and $50 000 in the low value scenario. Cumulative gains continue to be high until age 80 in the high value scenario, with gains of around $40 000, but are zero in the low value scenario.

Over the decades, we observe that the most important gains occurred during the 1940s, 50s and 60s for all age groups. The 80s and 90s were

Figure 3. Individual cumulative value of longevity gains since 1930 (leisure priced at the wage rate) (2004 USD)



Source: Authors' own elaboration with estimations from the model.

also good decades, but since 1990 gains have been negligible. This may be due to the fact that we hold the "quality of life" variable H constant, and perhaps much of the gain in health since the 1990s is less related to reductions in communicable diseases and more related to higher values of H.

We can calculate social gains from the reduction of mortality rates during the period 1930-2010. Moving from private gains to social gains requires the recognition that[6]

$$\text{Social gains} = \sum_{a=0}^{110} n_a WTP_a \tag{10}$$

where n_a is the number of persons in 2010 in each age group and WTP captures the fact that survival rates have changed for each group from 1930 to 2010 (see equation 9). In the high value scenario, social gains in longevity from 1930 to 2010 amount to 15 trillion dollars, roughly 187 billion dollars per year, which equals approximately one-fifth of Mexico's current GDP. In the low value scenario, gains in longevity over the same period amount to 4.3 trillion dollars, or 53 billion dollars per year, which is roughly 6 per cent of the GDP. It is important to note that these calculations underestimate gains for older cohorts, since only those that survived to 2010 are included in the analysis; and we are not accounting for the benefits that future cohorts (those born after 2010) would enjoy from the medical advances up to 2010 (Murphy and Topel, 2006). Equivalently, cumulative gains in the period are worth 150 000 dollars per person; which compares to 1.2 million dollars calculated by Murphy and Topel (2006). The differences in value consistently reflect the tenfold difference in the VSL.

II.2. Valuing Reductions in Mortality Related to Obesity

High incidence of obesity in Mexico and elsewhere has raised concerns regarding diminished quality of life and rising healthcare costs associated with obesity-related diseases. In an internal study for the Mexican Minis-

[6] The approach of the *willingness to pay* method can be considered a partial equilibrium approach since it does not incorporate the effects of extending life across all cohorts, for example, via intergenerational transfers within defined benefits of the social security system (Arthur, 1981).

try of Heath, Guajardo and Gutiérrez (2010a) estimate that the annual total cost of treatment for four obesity-related diseases amounts to 3.2 billion dollars, which is equivalent to 33.2 per cent of the Mexican public healthcare budget for 2008. The authors of this report call for public interventions that diminish the prevalence of obesity. But what is the social value of a reduction in obesity-related mortality?

The following estimates show the value of reducing mortality for four obesity-related diseases. We begin with the estimates by López *et al.* (2006) of the share of total deaths due to obesity for each of the following diseases: colorectal malignant tumors, malignant breast tumors, diabetes mellitus, and cardiovascular disease. These four diseases are among the most prevalent in the Mexican population.[7] In another internal study, Guajardo and Gutiérrez (2010b) use the estimates by López to obtain the number of premature deaths due to obesity for the individuals aged 30-69 in 2008; they also produce an estimate of the income loss as a result of these deaths.[8] We multiply these numbers by the average VRL of people ages 30-69 to obtain an estimate of the value of reducing obesity. For 2008, the gain of avoiding all premature obesity-related deaths accounts to 22 billion dollars in the high value scenario and 5 billion dollars in the low value scenario (at 2004 values). Most of the gains come from avoiding death due to diabetes mellitus, a disease that determines 67 per cent of the overall gain. The estimated gain in the high value scenario is approximately ten times the cost of healthcare services for these diseases calculated by Guajardo and Gutiérrez (2010a) and the income loss calculated by Guajardo and Gutiérrez (2010b). If the reduction of deaths comes from medical advances (not from self efforts to reduce weight) that can apply to future cohorts, we are underestimating the gains.

II.3. Social Value of Saving Lives Through Seguro Popular

We now turn to estimating the value of lives saved as a result of the *Seguro Popular* (SP) program. SP is a public health insurance program

[7] According to administrative information from the Mexican Institute for Statistics (INEGI), 17.2 per cent of total deaths in Mexico are related to heart diseases (64% of these are linked to ischemic heart disease). The second leading cause of death in Mexico is diabetes mellitus, responsible for 14 per cent of total deaths, and finally malign tumors account for almost 13 per cent.

[8] The income loss calculated by the authors is simply the number of premature deaths multiplied by the average wage in each age category.

launched in 2004 that is expected to enroll the total uninsured population in Mexico by 2012. SP covers program beneficiaries for a standard package of interventions (see Knaul and Frenk, 2005 for details of the program). Among the interventions included in the package there is treatment for acute lymphoblastic leukemia (ALL) —for high risk cases and low risk cases— for individuals under the age of 18. ALL is the second leading cause of death in children in Mexico, but if treatment is administered early, the probability of survival can reach 80 per cent. In the analysis that follows, we seek to answer the question: what is the required change in survival probabilities that equates the resources invested in curing the disease with the gains in WTP? The specific measurement is defined by:

$$WTP\ net_a = WTP_a - \Delta\ \text{health spending}_a \tag{11}$$

According to official data, in 2010 SP financed treatment for 946 children with ALL (624 high-risk and 322 low-risk). Children ranged in age from 0 to 18 and were more or less evenly distributed across age groups. SP paid the peso equivalent of $27 400 per child for high-risk cases and $15 600 per child for low-risk cases. This money was used to pay for all direct cost of treatment (medicines, specific test and interventions) and does not cover indirect costs, such as use of public hospitals and doctors wages. Thus these figures do not account for the full social costs of providing care through SP. According to our estimates, if treated children are 12 per cent more likely to survive in a low-value scenario and 3 per cent more likely to survive in a high-value scenario, the benefits of the treatment equal the costs. Official reports state that before the SP intervention, 7 out of 10 children with leukemia died, whereas today 7 out of 10 children live. Indeed, if an ill child that is 4 years old survives three additional years it is still worth financing the treatment (in the high value scenario).[9]

III. Conclusions

Our goal was to estimate the value of improvements in longevity in Mexico. We made use of information previously available for the country, such as estimates of income and spending across the life cycle and built on the

[9] In this example we do not take into account the benefits in future generations because we are not evaluating a new medical treatment that could apply to current and future generations. We are only evaluating the event that SP is now providing drugs and treatment to children that otherwise would not be treated.

work of Murphy and Topel (2003, 2006). First, we presented values of a statistical life over the course of a person's life cycle. We then applied the model to evaluate the gains in longevity from 1930 to 2010, and found that the gains calculated on a yearly basis are equal to one-fifth of Mexico's GDP in the high value scenario. We also find that reducing premature deaths due to obesity would bring an estimated social gain of 22 billion dollars annually. Finally, we use the model to set benchmarks for *Seguro Popular*, and find that program spending on treatment for children with ALL is justified.

These findings indicate that investing in health can have a high rate of return, especially if the investment is made early in life. The variation in our analysis is restricted to a given quality of life at each age (the variable *H* has not changed throughout the paper), so all gains come from improved probabilities of survival. Many life-saving technologies also improve the quality of life, which means that our estimates could be below target. On the other hand, when the extension of life is associated with disabilities and pain, and consumes a large part of the wealth available for non-health consumption, the value of additional years of life may be over estimated. It is also important to recognize that we are conducting a partial cost-benefit analysis of a single program and are evaluating *Seguro Popular* based on its ability to improve survival chances for consumers. Our analysis does not provide insight into whether alternative institutional solutions could provide a more effective means to deliver public subsidies.

Systematic measurement of the social gains from life and health improvements has many applications and should be routinely used in public policies. The value of life can be used to perform analysis that compensate for a life lost, cost-benefit analysis of different competing projects, and redistributive analysis.

For example, now much of the regulation that covers a life lost (including work risk insurance and other legal compensation for life) follows the human capital approach, *i.e.*, compensating by the earning foregone, but we believe mortality risk should instead be measured using a willingness to pay approach. In this regard, the cost-benefit analysis for the decision to invest on road safety improvement should take into account the value of lives saved.

More importantly, with many social and health policies competing for public resources, the statistical value of life across the life cycle can be used to discriminate among different options. For example, should the public institutions promote policies for the elderly or children?; which type of benefits should be prioritized by schemes, cancer, HIV, diabetes?; which vaccines should be provided by the government in the national plan of vaccination? The example we provide of the *Seguro Popular* shows how this approach can be used right away.

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