Suicide: An Economic Approach

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1. Introduction

This paper is about the choices made by very unhappy or miserable individuals. There are many options, including joining a gang, taking drugs, starting or resuming smoking, drinking heavily, gambling heavily, committing crimes, taking highly risky jobs, engaging in very risky sports, marrying in haste, divorcing, joining a church, visiting a psychiatrist, committing suicide, and still others.

No fully reliable statistics give the numbers of miserable persons during any year or other time period, but various indirect measures indicate that it is substantial. Surveys suggest that in the US there are 20.5 millions users of crack and other heavy drugs, some 15.9 millions of individuals are classified as heavy drinkers (more than 5 drinks per day), the number of seriously depressed persons is estimated at 9.9 millions, crimes of violence amount to more than 7.26 per 100,000 population, almost half of all first marriages end in divorce, with many divorce proceedings being quite bitter. In happiness surveys, about 10% percent of persons report themselves as not happy.

Death rates from volitional activities are more objective measures of their importance. Suicide is the eighth leading cause of death in the US, and the third among teenagers. The combined number of deaths from drug use, heavy drinking, murder by a relative or a gang member, and car accidents when drinking are many times as frequent as suicides.

Suicide attracts greater attention than warranted simply by its numerical importance among all deaths. This is true of the suicide of a depressed author, a terminally ill elderly man, a corporate leader revealed to have betrayed the interests of his shareholders, and surely of mass suicide to avoid surrender to an enemy. There is an heroic aura to someone who commits suicide to help others, or to protest against oppression, and there is a tragic side to suicides by persons who appear to "have everything to live for."

We will pay primary attention to suicide, although not because we consider that to be the main outlet for very unhappy individuals. Suicides have interest beyond their numerical significance because they provide information about the most desperate among the much broader class of very unhappy persons. Moreover, starting with Durkheim's classic study (Suicide, 1897), there is extensive quantitative evidence on the personal, social, and economic conditions associated with suicide.

The modern approach to suicide stresses its immorality on the one hand and its connection to mental illness on the other hand. But the Greeks and Romans, as well as Asian cultures – especially the Japanese and Indian – considered suicide to be a rational response to illness, disgrace, and other pain and suffering.

Both Hume and Schopenhauer in brief essays looked upon suicide as a perfectly reasonable response to bad circumstances. In an essay not published until his death (for fear of offending the Church), Hume stated,

> That suicide may often be consistent with interest and with our duty to ourselves, no one can question, who allows, that age, sickness, or misfortune may render life a burden, and make it worse than annihilation. I believe that no man ever threw away life, while it was worth having. For such is our natural horror of death… (Essays on Suicide and the Immorality of the Soul, by the late David Hume, page 588).

Schopenhauer added,

> It will generally be found that, as soon as the terrors of life reach the point at which they outweigh the terrors of death, a man will put an end to his life. But the terrors of death offer considerable resistance . . . (Parerga and Paralipomena, Vol. 2, page 156).

Consequently, there is considerable precedent for the approach in this paper that treats suicide as a purposive action that compares the benefits of continued living with the "benefits" and "terror" of death. However, we will show that with uncertainty about future utility, Hume's and Schopenhauer's claim that many people continue to live when their lives are miserable does not have to depend on fear of death, or even on moral scruples about suicide.

Our purposive choice approach to the behavior of unhappy people assumes they maximize their utility in a forward-looking fashion, taking account of the uncertainty of future events, and the consequences of their actions. Rather than imposing a tight fitting strait jacket on the analysis, the view that even very unhappy individuals compare the

benefits and costs of different actions before deciding on the best, or least worst, steps provides a flexible and fruitful framework. We incorporate some of the insights of sociologists, psychiatrists, and philosophers about the factors that determine suicides and other actions of miserable persons.

Depressed persons are quite miserable. They often have trouble getting pleasure out of lives that would not be considered especially difficulty by others. Patients in mental hospitals do have particularly high suicide rates, especially those with depressive disorders (see Dublin [1963, p. 171]). And many other suicides might be judged to be by mentally disturbed individuals. This inability to get pleasure out of circumstances that most people would not find oppressive may define a mental disorder. Although depressed individuals are quite unhappy much of the time, this does not mean that their suicides are not maximizing responses to their circumstances. They may become willing to end their misery and face the terrors of death. Still, suicide seems to offer a strong challenge to explanations based on maximizing behavior.

We believe the approach in this paper is consistent up to a point with an emphasis on a link between mental disorders and suicide. Yet there is obviously much more to suicide than mental disturbance or an inability to enjoy life. Suicide rates respond to illness, economic circumstances – such as bankruptcy and unemployment – divorce, widowhood, family responsibilities, disgrace, disappointment, fear of punishment, aging, and other variables that affect the utility from living. A utility-maximizing approach to suicide does rather well in explaining these and other regularities in suicide rates.

Psychiatrists not only link suicide to mental illness, but also believe that many so-called "accidental" and "natural" deaths have a suicide component. This observation, too, is consistent with our analysis of suicide. For we will show in section 3 that persons who are "prone" to suicide are tempted to accept gambles and lotteries with their life – at work, using drugs, in suicide "attempts" and in other ways. They may become unwilling to continue to exert the effort and energy required to continue living when faced with illness. They may simply "give up" and die what appear to be natural deaths.

In this way, our analysis provides a link between suicide and other desperate actions. For some desperate acts provide a chance to escape from misery - otherwise why take them?

– but by definition of desperate they presumably also have high probabilities of failing. And failure can mean death, serious injury, and other sources of perhaps even greater misery. Desperate actions include joining a violent gang, taking cocaine and other drugs that may have serious side effects, drinking heavily, participating in crime, driving recklessly, engaging in daredevil stunts, remarrying quickly after rejection by a lover or a spouse, attempting to murder that lover or spouse, attempting suicide, taking jobs that entail relatively high risks of serious injury or death, spending a lot on lottery tickets and other gambles, and many other steps. As indicated earlier, the links between suicide and various risky actions are developed in section 3.

For some miserable individuals the best policy is to do nothing desperate and wait for the situation to get better. Section 4 considers the effects of the rate of discount on the future, the degree of uncertainty about future events, and other variables on this "option" value of waiting.

Hamermesh and Soss (1974) is a pioneering study three decades ago that uses a utility maximizing approach to suicide. This paper is based on, and extends, several other papers, including two that were written more than a decade ago (Becker, 1991 in references, and Becker and Kilburn, 1993), as well as the more recent, Becker and Posner.

Cutler, Glaeser and Norberg (2001) published an important paper that in several dimensions takes a similar approach to ours, although their main purpose is to explain the rise in youth suicide rates in the United States. As in this paper, they also assume that suicide is contemplated when utility drops below a fixed level (0) that utility is maximized sequentially over time, and that there is an option value from delaying suicide if times may get better.

There are however, also important differences. Cutler, Glaeser and Norberg do not draw out the risk-taking implications of this approach to suicide, including how attempted-suicides fit into a risk approach. They do not fully extract the implications of the option value of remaining alive, do not rely on the special form of preferences with habits and social interactions that seems consistent with the evidence on suicide and other behavior, have a different interpretation of the ratio of suicide attempts to "successes", and do not

discuss suicide bombers and the cost of suicide. On the other hand, they provide an innovative analysis of the contagious social aspects of suicide, and link this analysis to data mainly on young persons suicides – when social interactions are important. They also link youth suicides to the deterioration in families, and to the search for sympathy and emotional support.

2. Suicide over the Life Cycle Under Certainty

The dominant characteristic of suicide is its finality – there is no second chance. Hence any purposive model must treat suicide as an irreversible act of a major magnitude. Suicides reflect a belief that it is not worthwhile to continue to live. We interpret "not worthwhile" to mean that the maximum utility from living falls below the point at which a person feels he is just as well off being dead (this is the view also taken in Hamermesh and Soss (1974), and Cutler, Glaeser and Norberg (2001). This utility level equals zero with the utility functions we will be using.

To start out simply, let utility at age t, $u(t)$, be known with certainty for all ages. Life is not worth living at age t alone if $u(t) < 0$, but since suicide is irreversible, this condition does not mean that suicide is rational at t since utility may greatly improve after t. Suicide is rational at age t under perfect certainty if the discounted value at t of current and future utilities is negative when taken over all segments of life into the future beginning at t. That is, it is rational under certainty to commit suicide at t if

$$\sum_{i=t}^{A} \beta^{i-t} u(i) \leq 0, \text{ for all } A = t, t+1, ..., T, \qquad (2.1)$$

where T is the known length of life without suicide.

If life is not worthwhile during every present and future year ($u(A) \leq 0$, $A \geq t$), it is not worthwhile to continue to live. But that strong condition is not necessary, for good years could be outweighed by bad years. Hence suicide could be rational now even when some future years would be very good.

Although to have a rational suicide at t it is necessary that the discounted value of utility over the whole remaining life be negative ($A = T$ in Equation (2.1)), that condition is not sufficient (Hamermesh and Soss (1974) erroneously give this as a necessary and

sufficient condition). For if year t is a good year ($u(t) > 0$), it is obviously worth living at least a little longer to pick up the additional utility. Negative discounted lifetime utility is a sufficient condition for suicide to be optimal at some age, although not necessarily at year t since it may be worth postponing the act to a later age. The full necessary and sufficient condition for suicide at t requires all the inequalities in Equation (2.1) to hold.

Equation (2.1) clearly implies that a necessary condition for suicide at t is that utility be negative then:

$$u(t) \leq 0 \tag{2.2}$$

Indeed, utility could even not be too high in the near future, for if it were, suicide should be postponed until a later age (see appendix for a necessary condition in continuous time). In particular, equation (2.1) implies that if suicide is "optimal" at t,

$$u(t+1) \leq -\frac{u(t)}{\beta} \tag{2.3}$$

If the discount rate is not high, not only must this year be rather bad if it is optimal to commit suicide then, but the next few years after that cannot be very good either.

We assume that people compare the (expected) utility from living with the (expected) utility from death. The amount of utility is, of course, dependent on the utility function used. Even the class of expected utility functions is determined only up to an origin and unit of measure. If a linear transformation of the utility function U gives the new function $U^* = a + bU$, $U > 0$, then the same transformation must be used in evaluating expected utility from death. Only then does a linear transformation leave invariant the point at which the utility from living equals the utility from death.

Christianity, Islam, and to a lesser extent, Judaism all encourage a favorable view of life after death for deserving souls. Since this raises the expected utility from death, it also raises the range over which death appears preferable to continued living. The effect of this would be to increase the effective suicide rate. Possibly to counteract this implication, most religions, especially Catholicism, strongly condemn suicide. We return to this issue in section 6.

The expected utility loss or gain from committing suicide depends on whether a person is concerned about the effect on a spouse, children, or others. He might be discouraged from suicide solely because he is concerned, and they would be especially unhappy if he died by taking his own life. The role of such mutual interdependence in preferences implies that single persons, childless couples, and those without close friends are more likely to take their own lives.

But for people who do not weight heavily the effect of their suicide on the utility of family members and others, their suicides would impose an "externality" on these others. In this case, Pareto-optimality considerations would provide a defense of laws and norms against suicide that goes beyond the motivation to offset the attractions of an afterlife. These considerations also help explain what Durkheim calls "altruistic" suicides: those who kill themselves to help others, as when a soldier sacrifices his life to save comrades, or a husband and father kills himself so his family can inherit his life insurance. The expected utility from suicide compared to continued living could be high if persons he cared about would profit from his death.

Even if suicide will occur at some age because lifetime utility is negative, it could occur either later or earlier depending on the time sequence of utilities. If utilities are negative initially and perhaps positive later on – perhaps because of a major reversal of fortune at an early age – suicide would occur earlier. Conversely, if utilities decline monotonically with age from positive values initially – say because of declining health – suicide would occur when utilities first became negative. Thus Hamermesh and Soss (1974) are mistaken in their claim that rational behavior under certainty generally implies a rising propensity to commit suicide with age (also see Cutler, Glaeser, and Norberg (2001) for a correct analysis).

This conclusion is even more problematic after incorporating heterogeneity among people. Those people with the worst prospects tend to commit suicide earlier, while those with better ones survive to older ages and may never want to commit suicide. As is usual in such situations, like divorce, heterogeneity implies a declining relation of suicide to age: at later ages, only the happiest people would be surviving.

Only a small fraction of any cohort commits suicide; about 0.01% of the US population committed suicide in year 2001. This implies that those with utilities less than zero are located in the extreme left-hand tail – several standard deviations from the mean – in the distribution of utilities among people of the same age, etc. Therefore, even a modest shift in the mean utility – with the variability held constant – would have a very large effect on the fraction of persons whose utilities fall below zero since the extreme tails of most distributions are very sensitive to changes in the mean. For example, even a 10 percent difference in the man I.Q. of two groups implies enormous differences in the fraction of "geniuses" and "retards".

We believe that this sensitivity of the tails helps explains (along with mean reversion in utilities) why suicides have been quite responsive to moderate business cycle changes in economic circumstances (see Hamermesh and Soss (1974). This does not necessarily imply utility is so sensitive to changes in income, but that even moderate changes in income push relatively many more people below the suicide threshold (although the data on happiness do suggest rather large responses in happiness to unemployment). This also explains why the suicide rate for young people doubled in the United States from the late 1950s to the present: the decline in the emotional and other circumstances of children due in part to the deterioration in family stability had an especially large effect on the small fraction of young people thrown below the suicide threshold (Cutler, Glaeser, and Norberg, 2001, give a fuller analysis of the effects of changes in family structure and other variables on suicide rates of youths when there is social interactions).

People who are chronically depressed even though their circumstances are not particularly bad have "inefficient" utility machines. They may try to improve their efficiency by seeking psychiatric counseling, involvement in a religion, using antidepressant drugs, an extensive exercise program, or other ways. Suppose the net effect of a successful psychotherapy or other intervention would be to make a person happier – say it would raise utility linearly for people with non-negative utility to $U^* = a + bU$, $a, b > 0$. For persons who get positive utility from living, this increase may be enough to justify the cost of the therapy. But for a potential suicide – someone with negative utility – the gain may not be sufficient since her utility may still be negative

($U^* < 0$ if $U < -\frac{a}{b}$). Potential suicides require an unusually successful intervention before they no longer want to commit suicide. This makes it obvious why psychoanalysis and other therapies are more successful at treating mild depressions than deep and possible suicidal depressions.

Some might question whether it is legitimate to call "rational" those people who are depressed and are highly inefficient at extracting utility from their situations. Perhaps from some points of view it is not (see section 7), but we use the word rational only to imply maximizing forward-looking behavior. A person who is rational in this sense will take account of her depressed state and other frailties in choosing her optimal actions. Frailties and other imperfections may reduce utility, but they do not necessarily prevent utility-maximizing strategies that can include suicide.

3. Suicide and Risk-Taking

a. Why would-be Suicides take Risks

Unhappy people often take risky actions that appear to be acts of desperation and even irrationality. An unhappy ghetto teen-ager may join a gang that significantly raises the chance that he will end up in jail or murdered. A person rejected by a spouse or lover may on the "rebound" quickly get involved in another relationship that is likely also to be unsuccessful: "marry in haste, repent at leisure". A businessman who goes bankrupt may commit suicide even though he remains wealthy by most persons standards.

These and other examples suggest that misery often leads to actions that may be bad risks from an actuarial viewpoint. Our analysis of suicide can explain why this is so without assuming that these are irrational impulsive actions induced by desperation. They **are** induced by desperation, but they appear to be consistent with maximization of utility with uncertainty about consequences.

Consider a one period example, where the indirect utility function over income is

$$\left.\begin{array}{lll} & u = u(I), u' > 0, u'' < 0 & \\ \textit{and where} & u = 0 \quad \textit{for} \;\; I = I_d & \\ \textit{and} & u < 0 \quad \textit{for} \;\; I < I_d & \end{array}\right\} \tag{3.1}$$

Suppose a person has an income $I_0 < I_d$. If he had to remain with I_0, he would rationally commit suicide if the cost of doing so is negligible since $u(I_0) < 0$. However, he might end up wanting to live if he can buy a lottery. For since he would commit suicide for all $I < I_d$, suicide truncates the effective utility to $u(I) = 0$ for all $I < I_d$. Such truncation makes the utility function convex over part of the income range starting at the origin.

Convexity in the utility function creates an incentive to gamble. An optimal gamble would give no income if one loses since all $0 < I < I_d$ are worth no more than $I = 0$ since the person commits suicide for all such I. The optimal fair value of I if the gamble succeeds (I_w) can be found by maximizing

$$\left.\begin{array}{rr} & (1-p)u(0) + pu(I_w) \\ subject\,to & (1-p)0 + pI_w = I_0 \\ or & pI_w = I_0 \end{array}\right\} \tag{3.2}$$

The optimal I_w is where

$$\frac{d\log u(I_w)}{d\log I_w} = 1 \tag{3.3}$$

That is, where a ray from the origin is tangent to the utility function (see Figure 1).

The optimal income if one wins the gamble (I_w) and the optimal income if one loses ($I = 0$) are both independent of the initial income ($I_0 < I_d$). However, the probability that it would be worthwhile to live – the probability of winning the gamble – is positively related to initial income ($p = \frac{I_0}{I_w}$). Even though one would want to die in the absence of any gamble, the optimal gamble could significantly raise the probability of living, especially if the initial income was not so low.

The same analysis holds for all $I_0 \le I_w$, even if $I_0 > I_d$, so that a person would not commit suicide in the absence of gambling. However, when $I_0 \ge I_d$, gambling raises rather than lowers the probability of dying. A fair lottery would still make him better off as long as $I_0 < I_w$. For it is still optimal to have $I = 0$ if he loses – there is no cost to

reducing I as long as the losing income is less than I_d. This income must be less than I_d to pick up convexity in the utility function that makes the lottery attractive. But if the losing income equals 0, I_w is still determined by Equation (3.3). Therefore, the probability of suicide – that is, of losing the lottery – is low ($1-p=1-\frac{I_0}{I_w}$), if the initial income is not far from the optimal income. If the initial income exceeds I_w, there is no gain from a lottery and no induced suicide since the utility function would be concave in the relevant region.

There is an important difference between gambles that are attractive to suicidal persons and those attractive to persons above the suicidal cut-off. The former prefer gambles with a chance of a large gain, whereas the latter prefer those with a (small) chance of a large loss. This behavioral difference may help determine whether gamblers fall in the suicidal category.

In our judgment, economists have overstated the general importance of risk aversion because of their concentration on the behavior of the middle and upper classes who own financial instruments, take out fire and other insurance on their homes, have health insurance, and engage in other behavior that reflects some aversion to risk. But none of this evidence helps to explain the behavior of the significant numbers of those at the bottom, or reasonable close to the bottom, who do not own houses, stocks, or bonds, and have little or no auto or health insurance. Nor does it explain the behavior of persons who are miserable, or close to being miserable, perhaps because they experienced sizable declines in their circumstances, even though by absolute standards their circumstances are still quite good.

The main implication of our approach to the analysis of suicide is that persons at the bottom end of the utility distribution are likely to be risk preferrers rather than risk averse. They are willing to take risks, even with bad terms, that might pull them out of their dire or bad circumstances. Such risk-taking behavior takes many different forms.

Suppose that a person becomes a more efficient utility machine that adds a constant level a to her utility from living but does not change the utility from dying (see Figure 1).

This not only lowers the income at which utility becomes zero ($I_d' < I_d$) but also lowers the income where the utility function has a unitary elasticity (compare I_w' to I_w in Figure 1). Then a person with income between I_w' and I_w would no longer be willing to accept an optimal fair lottery that lowers income to zero. And for a person who is willing to continue to buy a fair lottery ($I_o < I_w'$), the probability of dying in an optimal fair lottery ($1 - p = 1 - \left(\frac{I_o}{I_w'}\right)$) would fall since I_w' is less than I_w.

The lottery itself may involve risk to life – a job may have some chance of death – as in volunteering for a risky mission, or accidents on a risky construction site – or the risk may be a serious accident from fast driving in a car, or injury and prison from being in gang or heavy drug use, overeating, or heavy drinking. The variable I in Figure 1 and in the utility function in Equation (5.2) need not refer to income, but could refer to prestige, standing, self-respect, or any other variable. If say self-respect falls below a certain level (I_d), a person might want to commit suicide. If he starts with a low amount of self-respect, so that he does want to commit suicide, he might raise his esteem by engaging in a risky job or other activity. If he loses the gamble, he dies "accidentally", but he would have chosen to die anyway if he didn't take the risk. However, he also might raise significantly his self-respect and his chances of living.

Again, however, he could take a chance on dying even if his initial self respect were sufficient to want him to continue to live. For if $I_d \leq I_0 < I_w$, he would want to live in the absence of the gamble. But he might still join the army or a gang that raises his risk of dying because it also gives him a chance to have lots of self-respect ($I = I_w$).

Gambles that involve some chance of accidents on the job, while driving, using drugs, etc. may not be "fair" in the actuarial sense. That all depends on supply and demand for the activity. This does not change the desire to have $I = 0$ if the gamble fails and $I = I_w$ if it succeeds. But the probability of these events depends on supply and demand. For example, if the supply of persons to an activity is such that expected utility equals their utility without the gamble, then

$$p = \frac{u(I_0)}{u(I_w)} < \frac{I_0}{I_w} \tag{3.4}$$

Conversely, if the gamble is more favorable than a fair gamble.

It is well know that many accidents and other so-called natural deaths may be in effect suicides, which makes statistics on suicide even more dubious than otherwise. This analysis of gambles shows more precisely the sense in which an accident may be a substitute for suicide, and how incentives to commit suicide may encourage activities that lead to "accidental" deaths.

Psychiatrists have claimed that many accidental and other deaths are due to a "death instinct" that leads to "carelessness, foolhardiness, neglect of self, imprudence, resignation to death, mismanagement of alcohol or drugs, disregards of live-saving medical regimes, brink of death patterns, etc." (Shneidman [1968, page 387]; see also the collection of articles in Farberow [1980]).

Our analysis also concludes that many deaths result from a weak desire to live, but we do not presuppose any "death instinct". Quite the opposite: according to our analysis, miserable people turn drugs, gangs, drinking, overeating, risky jobs, etc. in a sometimes desperate effort to find a way out of their circumstances. They are willing to take these risks to their lives because they would be worse off if they did not.

This analysis implies that individuals with low levels of utility would be more likely to smoke, drink heavily, use drugs, become criminals, and engage in other dangerous activities. A study by the National Center for Health Statistics shows that 40 million adult Americans who were often either depressed, lonely, restless, bored, or upset during the previous two week period are far more likely to smoke, drink heavily, or do both (see NCHS, 1993, November 4).

If the gambles of miserable people fail, and they become drug addicts, alcoholics, obese, or spend much of their time in jail, they would be worse off than they were before they desperately turned to these activities. They may then be attracted by suicide, even if they were not suicidal before they these gambles. Suicide rates are unusually high for alcoholics (see Covan [xxxx]; Plot, et al. [xxxx]; Maris [1981]; Rushing [1968]; and

Farberow [xxxx]). Male drug users are 20 times more likely than non users to commit suicide (see Lipsedge, 1996), and men who smoke a pack of cigarette per day are about 4 times more likely than non smokers to commit suicide (see Miller and Rimm, 2000).

This analysis also explains why people who take risky jobs, engage in stunts, drive fast, use drugs, etc. often appear to attach little value to their lives. If $I_0 < I_w$, a person would be willing to engage in an actuarially unfair activity that may involve death; by unfair is meant from equation (3.4) that $pI_w < I_0$. He could still be raising his expected utility considerably above what it would be if he didn't gamble $u(I_0)$. This does not even imply that he places no value on living without the risk - $u(I_0)$ could be greater than 0. But the gamble may raise his utility even if it increases the probability that he dies, and even if the gamble is unfair from an actuarial standard.

The optimal winning and losing outcomes would be the same for all persons with the same preferences whose initial income, self-respect, etc., fell between zero and I_w. But the probability of losing in a fair gamble, or in gambles with a given degree of unfairness, is greater for persons with the worse initial position. This suggests that the more desperate people choose more risky jobs, more dangerous drugs, etc.

Some psychoanalysts claim that all accidental deaths have elements of suicide. This is true in the trivial sense that voluntary actions could be avoided, so that people who rationally choose a life-threatening activity are choosing to die with a certain probability. A more interesting statement is that an accidental death is the equivalent of a suicide if the person would commit suicide had the accident not killed him. In our analysis, whenever accidental deaths are associated with outcomes in the interval $I < I_d$, people would commit suicide if the accidents did not kill them.

Another way to link accidents to suicides is to recognize that potentially suicidal persons ($I_0 \leq I_w$) are willing to accept some unfair gambles involving loss of life while all others must be compensated to expose themselves to greater risks of dying (if the utility function is concave for all $I \geq I_d$). An element of "suicide" may be involved whenever a

person is willing to raise his risk of dying without being compensated by at least the actuarially fair amount.

3b. Suicide Attempts and "Successes"

People often suffer greatly when a child, parent, or close friend takes his life. An unhappy person may try to gain attention, friendship, and sympathy from others by complaining how rotten he feels, visiting a psychiatrist or priest, refusing to eat much or go to parties, and in other ways.

A suicide attempt is often a good way to gain sympathy and attention. On this interpretation, suicide attempts are partly a "cry for help" from spouses, children, and friends.

From this perspective it is necessary to distinguish between actual suicides and suicide **attempts**. A few analysts have interpreted suicide attempts as **signals** of misery (for formal analyses of suicide as signaling see Rosenthal, 1993; Cutler, Glaeser, and Norberg, 2001). However, they may be very weak signals and not very credible if the chances of succeeding in ending one's life are negligible. A good signals to friends and others of unobserved misery is a suicide attempt with a significant but far from certain chance of succeeding. A serious attempt that may cause physical damage and even death can get the message across, and can separate people who are truly miserable from those who just pretend to be.

Our approach is related, but does not depend on signaling. Fundamentally, we assume that a suicide attempt raises the marginal utility from giving sympathy to the attempter by parents, friends, children, or others – perhaps because they feel guilty about the attempt. An attempt "cues" a reaction in sympathizers (see Laibson, 2001, Francis, 2004). This "cross-derivative" assumption is related to analyses of gift-giving, such as why individuals donate to beggars, or why seeing an attractive dessert may be a cue that stimulates a demand for this dessert. On this view, the more serious the attempt, the more sympathy that is forthcoming because the effect on the sympathy cross-derivative is greater with more serious attempts.

This interpretation links suicide attempts to our general analysis of gambling by desperate persons. Since the degree of sympathy is assumed to rise with the likelihood that a suicide attempt succeeds, less happy persons will tend to choose suicide methods that have a greater chance of succeeding. Looked at in this way, suicide attempts are a dangerous activity chosen by unhappy persons that is an alternative or complement to drugs, drinking, gangs, overeating, risky jobs, and other dangerous activities. As with these other risks, persons who die from suicide attempts lost their gamble because they preferred to live and gain sympathy, respect, or whatever else defines a successful attempt.

To formalize the analysis, assume that a person (called s) can attempt suicide by a method that has a probability p of succeeding. She increases the sympathy she receives if she survives the attempt, measured by $1-p$, and the increase is larger, the smaller the probability of surviving.

What determines the optimal p (or optimal method) chosen by s? That depends on the degree of sympathy she receives at different values of p. Assume there is a parent, child, friend, etc, denoted by A, with a utility function V(x, g, p), where x is the consumption of A, g is the sympathy she gives the would-be suicider (s), and p is the probability introduced above that an attempt succeeds. We assume that $\partial V/\partial g>0$, $\partial V/\partial x>0$, and $\partial(\partial V/\partial g)/\partial p>0$. The last assumption is crucial, for it implies that suicide attempts with higher probabilities of succeeding elicit greater sympathy from A. Own consumption x could, but need not, depend on the utility of s, so our analysis could have altruism. Indeed, we could assume that higher p's raise the degree of altruism, which then would be one mechanism through which higher p's induce greater sympathy.

Presumably higher g lowers x, so that A's have a trade off between greater sympathy and greater own consumption. Then given p, A chooses optimal values of both x and g. The cross derivative assumption and this trade off between g and p implies that an increase in p raises g, according to an optimal function for A g(p), with $g'>0$.

We assume a two-stage game where s goes first and chooses p, and then A chooses g. We also assume that A cannot commit beforehand to any particular g, so that A reacts to the p

chosen by s. This implies that s chooses its optimal p, knowing that the reaction of A leads to the sympathy function $g(p)$, with $g' > 0$, and $g'' \leq 0$.

The optimal p chosen by s depends on its initial level of sympathy S^0 and $g(p)$. We assume that these are substitutes, as in the simple additive case:

$$u(S) = u(S^0 + g(p)) \tag{3.5}$$

Then s chooses a p^* that maximizes her expected utility

$$V = (1-p)u(S^0 + g(p)) + pu(0) \tag{3.6}$$

where $u(0)$ is the utility from being dead, which we have assumed is 0. Then the first order condition to maximize her utility with respect to p is

$$\frac{u'(S^0 + g(p^*))}{u(S^0 + g(p^*))} = \frac{1}{(1-p^*)g'(p^*)} \tag{3.7}$$

This equation can be solved for the optimal p^*, where $\frac{p^*}{(1-p^*)}$ is the odds of succeeding in an attempt. The smaller p^*, the higher the ratio of suicide attempts to actual suicides. Our formulation recognizes that suicide attempts that are weak and unlikely to succeed may generate little sympathy (g(0) may be close to 0), but higher p's raise the degree of sympathy: $g'(p) > 0$).

It is easy to show that an increase in S^0 by Δ increases the ratio of suicide attempts to "successes":

$$\frac{dp}{d\Delta} = \frac{(1-p)g'u'' - u'}{2u'g' - (1-p)(g')^2 u'' - (1-p)u'g''} < 0 \quad \text{since } u'', g'' \leq 0 \tag{3.8}$$

So that persons who start with more sympathy would use less lethal methods if they do attempt suicide. In this sense, p^* is also an N informative signal of the person's situation since it is negatively related to the attempter s's level of sympathy before her attempt.

Suppose there is a change in the sympathy-generating function $g(p,\beta)$, though an increase in a parameter β. If the effects of p and β were separable, so that $g_{p\beta} = 0$, then

$$\frac{dp^*}{d\beta} < 0 \tag{3.9}$$

Under these assumptions, more effective producers of sympathy would use less lethal suicide methods. However, $g_{p\beta} > 0$ would be one force leading persons who are more effective producers of sympathy to use more lethal methods since the marginal product of more effective methods rises. In that case, the effect of an uncompensated increase in β would be ambiguous.

We have not made any assumption about the sign of the first derivative of A's utility with respect to p, the probability that s succeeds in committing suicide. Yet it is reasonable to assume that

$$\partial V/\partial p < 0, \text{ with } \partial(\partial V/\partial p)/\partial p > 0 \tag{3.10}$$

This means that an increase in the probability of committing suicide lowers the utility of friends, parents, children, and other concerned persons. The reason is that they may feel "guilty" if someone they are close to attempts suicide, and the guilt is greater, the more serious is the attempt.

The sign of $\partial V/\partial p$ is invariant under monotonic transformations of V, and hence affects behavior and is a testable assumption. It implies that sympathizers (the A's) would try to prevent suicides by would be suiciders (s) because A's would be worse off, even if they were not altruistic to s. The A's would support laws that make suicide attempts a "crime", which provides one way to understand why such laws have existed in many societies throughout history. Moreover, the A's would avoid being friends with suicide attempters since attempts lower their utility, and might end friendships with persons who do make such attempts. This is similar to the way people may try to avoid beggars, even though they make contributions to the beggars when they see them.

This is one way that our analysis differs from the signaling approach. In our approach, the sympathizer wants to reduce attempts because that lowers their utility, whereas in the signaling approach they may welcome attempts because that gives them information about the misery of attempters.

Nor does the signaling approach seem as good an explanation of why women and teenagers have very high ratios of attempts to suicides. Do sympathizers have less information about the true state of women than of men? The opposite seems to be the case since machoism prevents many men from speaking about their feelings, while most women have no such inhibitions. A more reasonable story is that it is easier for women to elicit sympathy than men- the g(p) is higher and possibly steeper for women- because men are supposed to be "strong" and more immune to psychological distress.

Of course, the proximate reason for why women "succeed" less often is that they choose methods - such as poison and pills – that are less likely to succeed than those chosen by men – guns and other violent methods. But why do women choose these methods? As suggested above, one compelling explanation is that women can get sympathy more easily than men, although women may be less familiar with more lethal methods (see section 6). Note that women not only have a much lower propensity to commit suicide, but also they are far less likely to die from drug overdoses, alcoholism, homicides, and other self-inflicted causes. The same story may explain the high ratio of teenagers attempts to suicides

This analysis suggests two separate variables: the ratio of suicide attempts to successes, and the rate of suicide. Both women and teen-agers have much higher attempt ratios than adult men, but women have a low actual suicide rate while teenagers in recent years have a reasonably high rate (see Cutler, Glaeser, and Norber, 2001). The signaling story has trouble explaining the growth in teen age suicide rates, but not one based on deterioration in their utility levels due to the increase in divorce rates and related factors (see Cutler, Glaeser, and Norborg, 2001)

3c. Crime

Criminal activity is especially interesting for our purposes because the evidence on deterrence provides a test of the implication of our analysis that many criminals are risk

preferrers. Expected utility maximization implies that holding expected punishment constant, an increase in the probability of conviction to risk preferrers has a greater deterrent effect on their incentive to commit crimes than does the same percentage increase in the magnitude of the punishment if convicted. The opposite holds for risk averse criminals. Virtually every study shows that certainty of punishment has a much greater deterrent effect than does the size of the punishment (see Ehrilch, 1973, and Wilson and Herrnstein, 1986, pp. 1xx-xx).

Although there may be other explanations for this finding, it clearly is consistent with the view that criminals tend to be risk-pReferrers. Our explanation of such a positive attitude toward risk is that criminals tend to be at the lower end of the utility distribution, where the utility function is effectively convex. If not apprehended and convicted, crime offers financial and other types of utility gains that provide an escape from the somewhat desperate conditions that caused willingness to take even bad risks.

Therefore, we can explain the attitudes toward risk implicit in their different responses to conviction and punishment without assuming that criminals are irrational, or that there is a criminal "class" with a particularly favorable attitude toward risk. Bad circumstances can lead to criminal behavior, and/or gambling, heavy drinking, and smoking.

3.d Suicide Bombers and Martyrs

Our analysis of the link between risk taking and suicide also has some interesting implications about the current phenomena of suicide bombers, and the much older phenomena of martyrs and heroes. We have assumed that suicide yields a zero utility, but a suicide bomber, or a military hero who gives his life to destroy enemies or to save allies, may get much utility from giving his life, and less utility if he fails and lives. Since no mission is sure to succeed, we assume there is uncertainty about whether a bomber, etc will succeed in destroying enough of his enemies.

To model this simply (see figure 2), assume a utility M if a suicide bomber succeeds, and a utility F if he fails, where F< M. Failure might mean being caught and imprisoned, being shot without harming anyone, missing the target and killing oneself, etc. Suppose the probability of succeeding is p, and he gets X if he does not engage in the bombing. Clearly he would like to take on the mission to bomb if

$$pM + (1-p)F \geq X \qquad (3.11)$$

Given p, M, and F, the larger is X, the less likely a person would go on a suicide mission. For example, regardless of p, he is willing to go if X<F, and he is not willing if X>M. This is probably the basis for the conclusion of many persons that poorer individuals are more likely to become suicide bombers.

But especially M and p may not be the same to everyone. M is produced by persuasion that certain individuals or groups are the enemy, as Israelis to some Palestinians, Americans to some Iraqis, Hindus to some Moslems in India, etc. Teen-agers and other young persons are especially prone to such influences, whether in schools (madrasses), the military, etc. So it is not surprising that young persons are disproportionately represented in suicide missions.

Moreover, different missions have different p's, and possibly also different M's and F's. Assume that M and F are fixed, but that the probability of success, p, varies among missions. How would a terrorist group allocate different potential suicide bombers to different missions, given an incentive compatibility constraint that potential bombers have to be willing to undertake their assigned missions? The answer is that the lower the X, the "income" without taking the mission, the more an individual is willing to take missions with low probabilities of success, whereas persons with high X's (still < M) would only take missions that have high probabilities of success.

This implies that successful suicide bombers may have relatively high X's-such as those who participated in 9/11- since persons with relatively high X's only take missions with high probabilities of success. By contrast, the set of all those who attempt suicide missions would have relatively low X's. This would make it misleading to test whether "poverty" breeds suicide bombers (?see, e.g., Krueger, et al.) mainly from looking at the backgrounds of successful bombers.

4. Suicide and the Option Value of Waiting

With perfect certainty, a person could continue living for a while with the expectation that he would commit suicide at a particular point in the future. Future decisions become much murkier when utility streams are highly uncertain. Yet uncertainty adds an

additional major advantage to postponing suicide; namely, the chance that the situation will improve enough to change one's mind about suicide - perhaps an illness was wrongly diagnosed or becomes treatable by new methods, or a would-be-suicider discovers a way to rebuild a lost fortune. If the situation worsens rather than improves, suicide can always be used at that time to truncate the magnitude of any fall in utility (although, see section 6 for some qualifications due to the cost of suicide).

Maximizing individuals recognize that there will be no second chance if they are killed or permanently injured from actions that might reduce or eliminate their present unhappiness. As a result, even very unhappy persons might decide to postpone drastic actions in the hope that their situations will get better in the future. They can always take these actions later if their misery continues or worsens. The opportunity to postpone to the future provides unhappy persons with an "option value" from waiting.

The value of the option from waiting depends on several variables with a clear economic interpretation (see Dixit,1992, for a good exposition of option price theory; he also briefly mentions an application of the theory to the analysis of suicides; also see Cutler, Glaeser, and Norberg, 2001). The value of waiting is smaller, the greater is the discount rate on future utilities since the discounted value of future benefits is then smaller relative to the present cost of being miserable. Even with the same degree of unhappiness, this implies more desperate actions, including suicide attempts, among poorer, less educated, and younger persons since they tend to discount the future more (see Becker and Mulligan, 1997).

The value of waiting is obviously greater, the more rapidly utility is expected to rise over time since utility then tends to be larger in the future. Utility rises more over time for persons who have had only temporary misfortunes than for those with permanent ones. Divorce, unemployment, or a serious illness is more bearable if before long a person expects to remarry, find another job, or get well. Utility of older people tends to increase less rapidly over time since their health and mental capacities may be declining.

The analysis of suicide under certainty implies that if a person commits suicide, it is at the **beginning** of a stretch when his utility is negative. But this implication is not consistent with the observation mentioned shortly that some people commit suicide only

after being miserable and depressed for a while. To explain these and other observations, it is useful to bring in the option value from uncertainty about the future utility stream.

An important implication of option theory for our purposes is that a person might not commit suicide even if current utility is negative, and even if the discounted value of expected utilities is negative over all segments of life from the present into the future. The reason for postponing is that events may not turn out to be as bleak as they look at present. In particular, a forward looking person definitely would not commit suicide at t if $u(t) = 0$, and if expected utility over all future segments were negative. For there is no loss in utility from waiting until t+1, and the next year may bring sufficiently good news which eliminates the desire to commit suicide. If bad news comes instead, he could commit suicide at t+1 and be no worse off than if he ended his life at t.

But then the option value of delaying implies that he might want to continue living at t even if $u(t) < 0$, and even if all expected utility sequences were also negative. The possibility of getting good news during t, and of truncating the consequences of bad news, could make him willing to endure another unpleasant year or more. How low utility during t could be before it "pays" to commit suicide depends on the nature and extent of variability in future outcomes. The greater the variability, the greater the advantage of continuing to live even if the present and future appear rather grim.

The foundation of option value theory is that people prefer uncertainty about the future if they can respond quickly to bad news. Suicide that is conditional on the outcomes of the uncertainty is one way to truncate losses after getting bad news.

It may also pay for unhappy persons to postpone suicidal actions if the natural opportunities from living offer better terms that the suicidal gambles available. For example, instead of joining a gang, turning to drugs, etc., a miserable teenager may prefer to wait in the expectation that a good job, marriage, or other events will come along that will make him much happier. Presumably, the opportunities provided from life are more favorable to unhappy young people than they are to older persons, depressed by serious illness and permanent loneliness.

Suicides may only be the tip of the iceberg for the set of persons who get little out of living. There may be others who expect negative utility, but they continue to hold on while being unhappy, depressed, or even miserable because they hope for an improvement in their fortunes. If that occurs, they may live fulfilled and happy lives. Eventually, some of the others who continue to be unhappy may give up hope of any significant improvement, and decide that suicide is preferable to the pain of continued living.

Section 5 argues that declines in income, a divorce, unemployment, and other negative events may greatly reduce utility because current utility is highly dependent on comparisons between one's current and past situations. An analysis of the gain from waiting adds option value considerations for expecting suicide attempts and other drastic actions to be conditional on receiving bad news. It may pay to postpone drastic actions to see what the future brings, and to take these actions only when it bring bad news.

Option value theory has an even stronger implication. Suicide attempts and other drastic steps may be conditional simply on **not** getting **good** "news". A person who waits to see what the future brings may take drastic actions when the future does not significantly improvement his circumstances. A person may not attempt suicide on the onset of a serious depression, but may do so if it does not lift after a while. Only the hope that the future will get better enables many depressed persons to cope with their misery, often for years.

Virginia Woolf, for example, committed suicide only after several prior bouts of serious depression. A person who becomes unemployed may not do anything drastic right away because he expects to find another job, but he may turn to heavy drinking and other drastic steps if he remains unemployed for a lengthy period. One study found that while all unemployed men had higher than average suicide rates, the rates were far higher for the long term unemployed (see Hawton and Catalan, 1987). This analysis also implies that teenagers who join very violent gangs, or persons who stop "fighting" serious and painful illnesses, have given up expecting any significant natural improvement in their circumstances.

5. Preferences, Happiness, and Suicides

In recent years considerable data have been collected on the reported degree of "happiness" among individuals classified by income class, age, race, gender, employment, marital status, and other variables (the pioneering use of these data is by Easterlin, 1974; valuable recent discussions are Blanchflower and Oswald, 2004, and Frey and Stutzer, 2001). These data indicate, for example, that richer persons are happier than poorer ones within a nation, and that employed persons are happier than unemployed.

However, the elasticity of the relation between average happiness and a country's average income is low, and average happiness hardly rises over time as countries with reasonable income levels become still richer. Other regularities in the happiness data include that happiness falls with worsening health, and divorce, women appear happier on average than men, happiness tends to rise with age and education, and American blacks appear to be much less happy than American whites (see Blanchflower and Oswald, 2004).

The regularities in the happiness data are sufficiently strong that they have generated a sizeable and growing literature that applies them to different problems. To the extent that happiness reflects the utilities that motivate behavior in economic theory, the data on the relation between happiness and income within and between societies suggest strong mean reversion in utilities with respect to income and consumption. By that we mean in particular that the indirect utility function would depend on a person's income today compared to his average income in the past, and possibly also his position in the income distribution today compared to an average of his past positions.

One example of such a utility function is

$$U_i = U(y_i - ay_i^*, y_{ir} - by_{ir}^*) \tag{5.1}$$

Where y_i^* is an average of i's past income, y_{ir} is the ranking of i's income in the income distribution of his "peers", and y_{ir}^* is an average of his past peer rankings, and a and b are parameters that measure the degree of mean reversion. If $a = b = 0$, utility only depends on current income and current rank, while if $a = b = 1$, mean reversion is complete in the long run. That means that a permanent increase in a person's income

relative to both his past incomes and the incomes of his peers will initially increase his utility, perhaps by a lot. However, over time his utility would fall back to his initial level as the average of his past incomes rises both absolutely and relative to those of his peers. The reversion in utility is faster, the greater the relative weight given to the recent past in y_i^* and y_{ir}^*.

The happiness data suggest that a and b are neither 0 nor 1, but are much closer to 1 than to zero. Under the assumption that happiness is bounded, and that evolution maximizes fitness through maximizing incomes, Rayo and Becker (2004) show that evolution tends to produce a utility function like that in the above equation, with a and b close to 1.

Note that mean reversion in utility suggested by the happiness data and evolutionary theory, links these approaches to the literature on habits and addictions. For an increase in a person's current income raises his current income relative to his past incomes. If U is a concave function of both its arguments, and if $a > 0$, this implies that an increase in current income raises his utility from an increase in say next period's income. For next period's average of past incomes would rise, and given concavity, that would raise the utility from an increase in next period's income above this period's income. This complementarity between this years and next years incomes is a necessary condition for habitual behavior with forward looking behavior, and is sufficient for myopic behavior (see Becker, 1992).

If a and b are not too far from 1 in equation (5.1), and if people compare themselves with peers who have incomes close to their usual incomes, then the happiest individuals are those who recently experienced significant increases in their economic circumstances, and the most miserable are those who suffered sharp declines in circumstances. They stay happier or miserable longer, the less the recent past is weighted in y_i^* and y_{ir}^*. This analysis leads to the expectation that suicide rates would be relatively high among individuals who recently experienced severe declines in their economic circumstances. If esteem and status enter the utility function in the same way as income, involving comparisons with others and with past status, then suicide should also be significantly related to declines in status, prestige, and similar determinants of utility.

This implication is confirmed by the evidence on what circumstances lead to greater propensities to commit suicide. Thus, suicide is much greater for unemployed workers, for the recently divorced and those rejected by long term partners, for persons recently jailed, for persons who retire, for those who contract an incurable disease, and for persons who suffer large losses in their wealth. For example, 13% of jail suicides occur within the first 3 hours of confinement, 33% within first 24 hours, 89% within first 3 months, and only 4% occur after 5 months[1]. All these persons have experienced significant declines in their incomes, or in their esteem relative to their past esteem.

On the other hand, if a and b are not much below 1 for both income and esteem, this theory implies that suicide rates should only be mildly higher for persons who were born and remain poor, who were born with an incurable disease, who have already spent several years in prison - as confirmed in the data above -, who have been divorced for many years, who give up finding jobs comparable to the ones they lost, etc. The evidence does support these implications; for example, suicide rates are not unusually high for persons who have been divorced for several years, or for persons who have always been poor (see x, y, z).

When people are very much concerned about how their current position compares with their past, they can readily become miserable after their situation deteriorates sufficiently quickly and by a large enough amount, even if the absolute level of their position is rather good. A person who is still well off financially may be quite miserable after a stock market crash because he is no longer as wealthy as he had been. The suicide of Robert Maxwell a decade ago is a good example of that. This illustrates why recessions have much greater effects on welfare than would be indicated simply by the magnitude of changes in income and wealth. A decline **relative** to what people are accustomed to can make them quite unhappy.

An aging person may become depressed as his mental and physical health declines because he is aware of all his past activities that are no longer possible. A star athlete may

[1] Lindsay M. Hayes and Joseph R. Rowan, *National Study of Jail Suicides: Seven Years Later* 36, 54 (National Center of Institutions and Alternatives, Feb. 1988). These are jail, not prison, statistics; but people sent to prison usually have already spent considerable time in jail, awaiting trial.

be unable to cope well with the end of his career because he no longer gets the acclaim he had grown dependent on.

This evidence on timing of suicides might be explained by heterogeneity in utility functions rather than by habits and invidious comparisons with others. For example, if there is a sizeable distribution of utility among those entering prison, those with low levels of utility prior to entering prison would be more likely to commit suicide. As a result, the great majority of convicted criminals who survive the first year or so of being jailed may well have utilities above the suicide threshold. A substantial literature shows that it is difficult to distinguish the effects of such heterogeneity from state dependence, although it is possible to make progress with panel data and enough functional form assumptions (see the important paper on this by Heckman, 1982).

To be sure, many economists are justifiably skeptical of the value of the happiness data because they are so subjective. The main defense has been that they give consistent answers in different surveys - e.g., higher income persons in a country are generally happier than lower income persons. Consistency is not enough, however, to use happiness data to explain behavior, and there are few attempts to evaluate how well happiness data explain different kinds of behavior. Suicide is the definitive choice, and is presumably linked to extreme unhappiness, so it would be valuable to determine whether reported unhappiness is linked to suicide. The evidence available by different groups offers only modest support.

Table 1 present data on the distribution of reported degree of happiness by ages of men and women, and for whites and blacks. Women are somewhat happier than men. But these happiness data do not offer support for the much greater rate of suicide attempts among women, and their much lower suicide rate.

What stands out is that young black males - and to a lesser extent young black females - report being much less happy than young whites. This obviously would not explain the lower suicide rate of young blacks than young whites, but the data do shed light on the much greater propensity of young blacks than young whites to engage in crime, heavily use crack, smoke, and take other life-endangering risks.

Young men are also considerably more unhappy than middle aged and older men. This would help explain why young men are so prone to choose many more risks to their lives, including fast driving, risky games, military service, and suicide attempts.

We have also run regressions on state suicide rates by race, gender, and age against reported incidence of unhappiness, state incomes, and race, gender, and age. The unhappiness variable has a weak effect; differences in the incidence of unhappiness explain only a negligible part of state differences in suicide by race, age, gender, and income.

6. The Cost of Committing Suicide

Up to this point, we have assumed that the only cost of suicide is the loss of any expected utility from continued living, including (though we have not discussed this extensively) any loss of interdependent utility because of the impact of the suicide on family members. This presumably is one reason why suicide is more common among single than married people.

Moreover, it is apparent that the act of suicide itself has a "price". Even if utility from living is expected to be negative in all future periods as well as at present, a person will not commit suicide if the price is high enough. The smallest element of that price is the monetary cost and time cost of committing suicide. More important costs are (1) the evolutionarily adaptive fear of death; (2) the pain and other unpleasantness of the actual killing, including risk of failing and being left crippled; and (3) the possibility of supernatural sanctions, such as (in Christianity) loss of afterlife utility (heaven) and incurring afterlife disutility (hell, in Catholicism).

The cost may be negative too, as when the disgraced Samurais in traditional Japan who did not commit suicide would be considered cowards. Martyrs are celebrated not only in Islam but in Christianity and in secular societies. Cost (2) would help explain the much higher suicides rates of men versus women (including elderly women) because men are more knowledgeable about guns. Another empirical implication of cost (2) is that suicide rates will be higher for doctors than for other people (see ?). Doctors of either sex have greater knowledge than lay persons of how to kill oneself quickly, painlessly, and with certainty. Another piece of evidence on cost is that when England required non-lethal gas

in stoves, the suicide rate declined (see ?); suicide by gas stove was simple, effective, painless, and not "messy". The lower suicide rate of religious Christians also receives empirical support (…).

To formalize the analysis, let us assume that someone really would commit suicide if it was costless, but it is not. As discussed above, the costs may be mainly psychic or monetary, but we do not distinguish them in this analysis. Assume there are different methods, and methods with greater probabilities of success are more costly in one way or another. Without such an assumption, at least around the equilibrium, a person who really wants to commit suicide always chooses the most lethal method. So let the net cost of attempting suicide be rising and convex functions of the probability that the attempt succeeds. Let C(p) be the cost if the attempt fails, with C'>0 and C">0, and let D(p) be the anticipated cost if the attempt succeeds, with D'≥0. And D"≥0.

The utility if the attempt fails is then

$$U = U(X-C(p)), \text{ where } U'>0, \text{ and } U''<0, \qquad (6.1)$$

The utility if the attempt succeeds is

$$U = U(0-D(p)) \qquad (6.2)$$

The optimal p maximizes expected utility

$$V=(1-p)U(X-C(p) +pU(0-D(p)) \qquad (6.3)$$

The problem is to choose the optimal p, given the C and D functions and given X. The first order condition is

$$(1-p^*)C'(p^*)U'(X-C(p^*))+pD'(p)U'(0-D(p))=-U(X-C(p^*))+U(0-D(p)) \qquad (6.4)$$

The LHS measures the marginal cost of raising the probability of succeeding, while the RHS measures the marginal benefit. Note that for suicide to be an optimal option, U (X)< 0; otherwise, benefits cannot be positive. Even so, as the RHS shows, benefits are positive only if the disutility from dying exceeds the disutility from living. Since U(X)< U(0), benefits would be positive from more effective methods of committing suicide as long as because of religious or other individual objections to suicide, the expected cost is not sufficiently greater if the person succeeds than if she fails. Otherwise, the RHS could

be negative and suicide would not be optimal even though X is sufficiently low to make U(X)< U(0).

Note that given the C and D functions, benefits are more likely to be greater, the lower X is; that is, the more desperate the person is. Some desperate individuals may elect to commit suicide even when they have strong religious or other costs of taking their own lives.

An interesting question related to desperation is whether the more desperate- persons with lower X's and more negative U's- choose methods with higher or lower probabilities? While the benefits are greater since –U is greater to the more desperate, their costs are also greater since U'(X-C(p)) is greater for persons with lower X's. We investigate this question by differentiating the FOC in eq. (6.4) with respect to X to get

$$dp/dX = \{(1-p)C'U''(X-C(p)) + U'(X-C(p))\}/<0 \qquad (6.5)$$

The denominator is negative by the SOC needed for the FOC to give maximum expected utility. But the sign of the numerator is ambiguous since the first term is negative and the second term is positive. One might intuitively expect that given the same cost functions to more and less desperate persons, the more desperate would choose more lethal methods. But eq. (6.5) shows that this is not necessarily the case, that more desperate persons may optimally choose less lethal methods of committing suicide.

If the degree of concavity (measured by U" relative to U') is quite low, so that the slope of utility function is similar to the more and less desperate, then the first term in the numerator would be relatively small. Then the numerator would tend to be positive, and not surprisingly, less desperate persons would use less lethal methods. However, if the degree of concavity is very strong, so that the slope of the utility function is much higher to more desperate persons, then more desperate persons would optimally choose less lethal methods.

On the whole, however, we believe that more desperate persons tend to use methods with higher probability of success. This is partly because the less desperate may mainly need a little more sympathy. Methods with relatively low probabilities of success may be

sufficient to get them enough sympathy to make it worthwhile to continue to live(see Section 3b).

The costs of suicide bear importantly on the option theory developed earlier, where we suggested that, given variability of future utilities, it may pay to wait to commit suicide because you can truncate the downside by killing yourself if the gamble goes against you and your utility is lower than you expected. This assumes that the cost of suicide will be the same in the future as it is now. But it may rise in the important class of cases discussed under the heading of "physician-assisted suicide" (see Posner 1995, ch. 10). A person who believes but is not certain that he has a fatal disease may wish to defer suicide until he is certain, but may fear that the progress of the disease will render him incapable of doing so at that time. In other words, the cost of suicide too may change over time. Put differently, the option that we discussed earlier may become impossible to exercise. If physicians are permitted to assist suicide, the effect is to lower the cost of future suicide, presumably to the point where it is no higher than it would be now – in fact it may be lower.

The net effect may be an actual reduction in the suicide rate. Suppose that in period one, the probability of an agonizing death in period two is P and the utility of that state is $-U$, while the probability of recovery is $1-P$ and the utility of the recovered state is V, and the cost of suicide in period one is C, and in period two is ∞. Then the undiscounted benefit of committing suicide in period one is PU and the cost is $(1-P)V+C$. If we assume this is less than PU, then everyone would commit suicide in period 1.

If, however, suicide can be deferred to period two at the same cost C, the net cost of committing suicide in period 1 is C, so there are no suicides in period one (because there are no benefits from committing suicide prematurely). The total number of suicides is then the fraction P of the number that would have occurred in period one. So, for example, there would be 1,000 suicides in period one if suicide in period two is prohibitively costly (and therefore no suicides in period two). If $P=0.9$, there will be no suicides in period one if physician-assisted suicide at cost C is allowed in period two, and 900 suicides in period two, for a net saving of 100 lives.

Of course, physician-assisted suicide could also raise the suicide rate in our example if $PU < (1-P)V + C$. For then there would be no suicides if the cost $= \infty$ in second period, and the fraction P if $PU > C$ with assisted suicide that has cost C.

7. Impulsive Suicides?

The emphasis on mean reversion in utility and the option value of waiting for good news indicates that there may be considerable gain from not committing suicide during various periods of negative utility. For favorable events may occur, and utility would increase as one becomes accustomed to reduced circumstances. This emphasis on the advantages of waiting raises the question of whether a significant fraction of suicides are "impulsive".

This term can mean various things, but we use it only for individuals who have very high (myopic) discount rate. Impulsive behavior could also mean in the suicidal context that individuals overestimate the permanence of negative utility levels. Psychologists who emphasize an "hedonic treadmill" often assume overestimation of the permanence of bad and good times (see, e.g., Gilbert).

We believe that some suicides are impulsive in any reasonable meaning of that word, but we do not believe that impulsiveness is the dominant cause of suicide. To be sure, one explanation of why heavy smokers, heavy drinkers, and heavy users of other drugs are more likely to commit suicide is myopic individuals become heavy users of harmfully addictive drugs.

However an alternative explanation that is an application of rational behavior is that persons with low utility, and hence potential suiciders, are likely to turn to smoking, drinking heavily, and other risky activities.

We do not provide any decisive tests about the importance of impulsive suicides, but differences in suicide rates among various demographic and other groups are not likely to be explained mainly by differences in their impulsive propensities. For it is hard to argue that older men are more impulsive than middle-aged or young men, or that whites are more impulsive than blacks, or that men are so much more impulsive than women, or that doctors are more impulsive than others with similar education, or that the propensity to impulsiveness rises after divorce or unemployment.

The more compelling explanation is that these and other groups with high suicide rates have a much higher incidence of very unhappy people than groups with low suicide rates. Of course, it is possible that individuals in all groups discount the future excessively, so that very unhappy individuals choose destructive actions because they give insufficient weight to possible improvements in their circumstances. This is one justification for laws that forceably hospitalize or sedate suicidal individuals, although another explanation is the psychic costs their suicides impose on parents, children, and others.

In addition, persons who commit suicide only after several bouts of depression (such as Virginia Woolf) can hardly be said to have acted "impulsively". Nor is impulsive a relevant explanation of suicides by individuals with painful and fatal diseases.

Indeed, we believe that the fear of death and other "costs" of suicide are probably more important in reducing the number of suicides than impulsiveness is in increasing their number. Teen-agers may be good candidates for impulsive behavior, but they had low suicide rates in most nations prior to 25 years ago. Our theory implies that young persons had low suicide rates because they have high option values of waiting for better times. Cutler, Glaeser, and Norberg (2001) explain the sharp growth in suicides rates among American teenagers during the post 25 years mainly by the deterioration of families, and by a social multiplier that produces a large increase in teen suicides from relatively small initial causes. Moreover, impulsiveness does not help explain why both women and teen-agers have high ratios of suicide attempts to "successes".

A. Appendix

Under certainty and with continuous time (we are indebted to Avinash Dixit for suggesting a continuous time formalization), a person would maximize

$$V(L) = \int_0^L e^{-\sigma t} u(t) dt$$

where σ is the instantaneous rate of discount that could include an exogenous hazard rate of death from "natural" causes. There also could be an upper limit to length of life (T), where $U(j) = 0$, $j \geq T$. The first order condition for an interior $L(< T)$ is that

$$e^{-\sigma L} u(L) = 0, \text{ or } u(L) = 0,$$

with the second order condition for a local maximum

$$e^{-\sigma L} u'(L) - \sigma e^{-\sigma L} u(L) < 0, \text{ or } u'(L) < 0$$

These conditions show that to contemplate choosing death at age L^*, it is necessary that utility equals zero then, and that it becomes negative at a slightly older age. If the utility function is continuous, this implies it must be positive in the immediate interval before L^*. These are only necessary local conditions. To find a global maximum, the present value of the utilities at all the ages that satisfy these conditions must be compared not only with each other, but also with the utility at T (= to zero).

Partial References

Becker, Gary S., and Casey B. Mulligan. 1997. The Endogenous Determination of Time Preference. *The Quarterly Journal of Economics,* Vol. 112, No. 3. (August): 729-758.

Becker, Gary S. 1992. Habits, Addictions, and Traditions. *Kyklos*, Vol. 45 (3): 327-45.

Blanchflower, David, and Andrew Oswald. 2004. Well-Being Over Time in Britain and the USA. *Journal of Public Economics*, 88: 1359-1386.

Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting System (WISQARS) [Online]. (2003). National Center for Injury Prevention and Control, Centers for Disease Control and Prevention (producer). Available from: URL: www.cdc.gov/ncipc/wisqars. (2004, July, 21).

Cutler, David M., Edward L Glaeser, and Karen Norberg. 2001. Explaining the Rise in Youth Suicide". In *Risky Behavior among Youths: An Economic Analysis* ed. Jonathan Gruber. Chicago: University of Chicago Press, Series: (NBER-C) National Bureau of Economic Research Conference Report.

Davis, J. A. and T. W. Smith. 2003. General Social Surveys, 1972-2002, Machine-readable data file, Chicago: National Opinion Research Center (producer), Storrs, CT: The Roper Center for 23 Public Opinion Research (distributor).

Dublin, L.I. 1963. Suicide: A Sociological and Statistical Study. New York, NY: Ronald Press.

Durkheim, E. 1897. Le Suicide. Translated by JA Spaulding & G Simpson (1952). Routledge & Kegan Paul Ltd, London.

Easterlin, R.A. 1974. Does Economic Growth Improve the Human Lot? Some Empirical Evidence. In *Nations and Households in Economic Growth: Essays in Honour of Moses Abramowitz*, edited by P.A. David and M.W.Reder, Academic Press, New York and London.

Ehrlich, Isaac. 1973. Participation in Illegitimate Activities: A Theoretical and Empirical Investigation. *Journal of Political Economy*, Vol. 81 (3) (May/June): 521-565.

Farberow, Norman L (ed.). 1980. The many faces of suicide: indirect self-destructive behavior / edited by. New York: McGraw-Hill.

Frey, Bruno S., and Alois, Stutzer. 2001. Happiness and Economics: How the Economy and Institutions Affect Human Well-Being. Princeton University Press.

Hamermesh, Daniel S., and Neal M. Soss. 1974. An Economic Theory of Suicide. *Journal of Political Economy*, vol. 82(1) (Jan.-Feb): 83-98.

Hayes, Lindsay M., and Joseph R. Rowan. 1988. National Study of Jail Suicides: Seven Years Later 36, 54 (National Center of Institutions and Alternatives, February).

Hawton, K., and J. Catalan. 1987. Attempted suicide: a practical guide to its nature and management. Oxford: Oxford University Press.

Heckman, James. 1982. Heterogeneity and State Dependence. In *Studies in Labor Markets* edited by Sherwin Rosen. Chicago: University of Chicago Press.

Hume, David. 1783. Essays on suicide and the immortality of the soul / David Hume; with a new introduction by John Valdimir Price. Bristol, England: Thoemmes Press, 1992.

Lipsedge, Maurice. 1996. Psychiatric Disorders. In *Medical Selection of Life Risks*. edited by R. D. C. Brackenridge and W. John Elder. Third Edition. NY: Stockton Press.

Narrow, W.E. 1998. One-year prevalence of depressive disorders among adults 18 and over in the U.S.: NIMH ECA prospective data. Unpublished table.

Miller, M., D. Hemenway, and E. Rimm. 2000. Cigarettes and suicide: A prospective study of 50,000 men. *American Journal of Public Health*; 90: 768-773.

Posner, Richard A. 1995. Aging and Old Age. Chicago: University of Chicago Press.

Rayo, Luis, and Gary S. Becker. 2004. Evolutionary Efficiency and Happiness. Manuscript. University of Chicago.

Rosenthal, Robert W. 1993. Suicide attempts and signalling games. *Mathematical Social Sciences*, Elsevier, vol. 26(1), 7: 25-33.

SAMHSA, Office of Applied Studies, National Survey on Drug Use and Health, 2002.

Schoenborn CA, and J. Horm. 1993. Negative moods as correlates of smoking and heavier drinking: Implications for health promotion. Advance data from vital and health statistics; no 236, Hyattsville, Maryland: National Center for Health Statistics.

Schopenhauer, Arthur. 1974. Parerga and Paralipomena: short philosophical essays; translated from the German by E. F. J. Payne. Oxford [Eng.]: Clarendon Press.

Wilson, James Q., and Richard Herrnstein. 1985. Crime and Human Nature. New York: Simon and Shuster.

Table 1

Distribution of people by their degree of happiness by Gender, Race and Age
United States – Average 1991-1998-2002

	Very Happy	Fairly Happy	Not Very Happy	Not at All Happy		Very Happy	Fairly Happy	Not Very Happy	Not at All Happy	
	Males					**Females**				
Age										
18-25	29.6%	55.6%	11.3%	3.5%	100%	37.4%	51.5%	10.4%	0.6%	100%
26-35	25.5%	65.0%	8.7%	0.8%	100%	37.0%	51.4%	10.9%	0.8%	100%
36-45	34.1%	55.0%	9.7%	1.2%	100%	39.9%	49.2%	8.7%	2.2%	100%
46-55	37.2%	57.4%	4.9%	0.5%	100%	41.1%	52.6%	4.7%	1.6%	100%
56-65	45.9%	45.9%	7.4%	0.8%	100%	42.3%	47.2%	9.2%	1.2%	100%
66-89	44.8%	50.0%	3.9%	1.3%	100%	36.5%	56.9%	4.2%	2.4%	100%
	Males - White					**Females - White**				
Age										
18-25	31.1%	55.5%	10.1%	3.4%	100%	41.7%	48.3%	9.2%	0.8%	100%
26-35	26.3%	67.1%	6.1%	0.5%	100%	42.0%	49.5%	8.5%	0.0%	100%
36-45	34.7%	54.8%	9.1%	1.4%	100%	41.4%	48.6%	8.8%	1.2%	100%
46-55	39.2%	55.4%	4.7%	0.7%	100%	41.2%	51.5%	5.5%	1.8%	100%
56-65	48.2%	43.6%	7.3%	0.9%	100%	46.4%	43.5%	9.4%	0.7%	100%
66-89	44.7%	51.1%	2.8%	1.4%	100%	37.3%	56.5%	3.9%	2.4%	100%
	Males - Black					**Females - Black**				
Age										
18-25	18.2%	45.5%	27.3%	9.1%	100%	35.7%	50.0%	14.3%	0.0%	100%
26-35	21.2%	57.6%	18.2%	3.0%	100%	27.1%	50.8%	16.9%	5.1%	100%
36-45	33.3%	53.3%	13.3%	0.0%	100%	32.1%	56.6%	5.7%	5.7%	100%
46-55	28.0%	64.0%	8.0%	0.0%	100%	33.3%	66.7%	0.0%	0.0%	100%
56-65	11.1%	77.8%	11.1%	0.0%	100%	19.0%	66.7%	9.5%	4.8%	100%
66-89	46.2%	38.5%	15.4%	0.0%	100%	32.1%	60.7%	7.1%	0.0%	100%

Sources: Own calculations using General Social Survey.

Figure 1

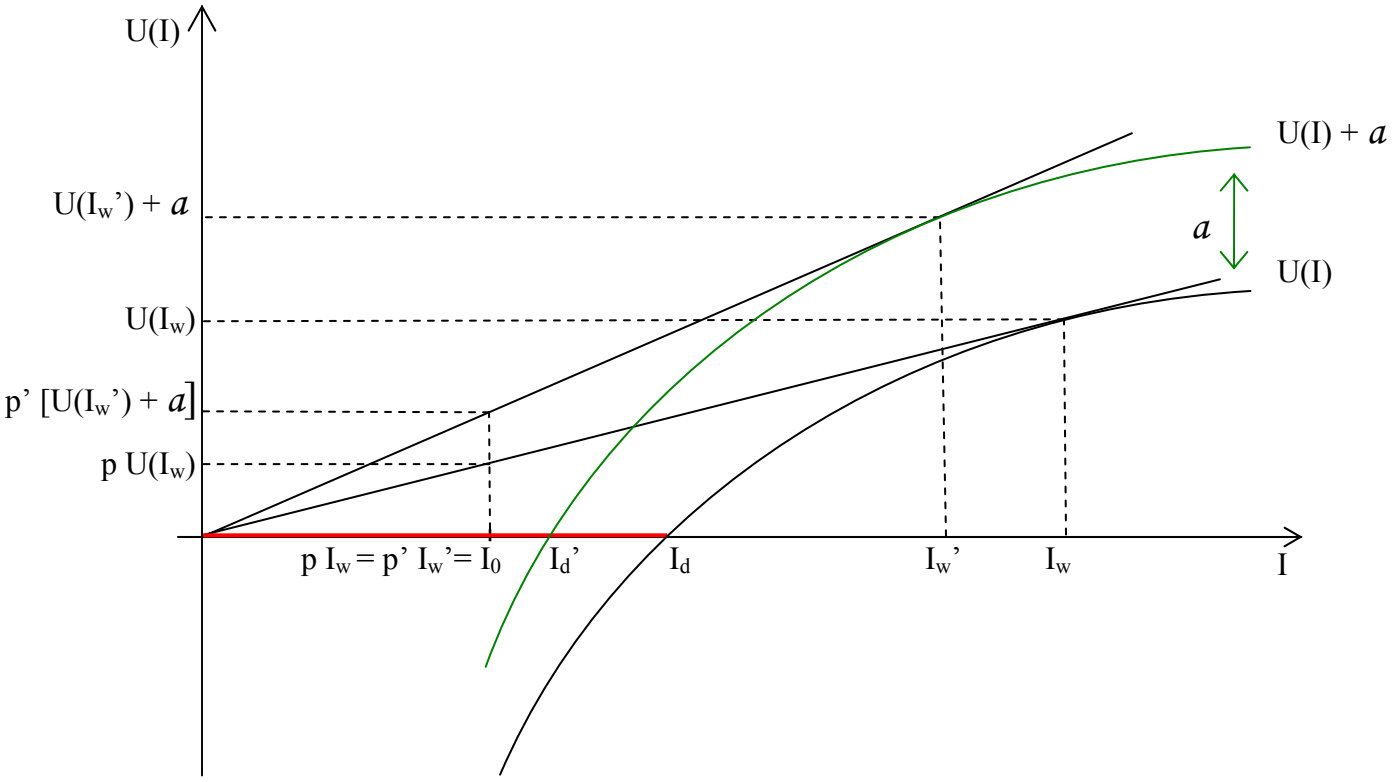

Figure 2

Suicide Bomber