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Physician-assisted Suicide as a Real Option

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Abstract

In this paper we propose a theoretical model of evaluating the economic costs and benefits of euthanasia. The contemplation of euthanasia is modeled akin to the valuation of a real option. Our modeling of the decision shows that euthanasia is optimal when certain conditions are satisfied. The findings in this paper suggest that if more money is spent on medical research (such as pain management), the demand for Euthanasia could be reduced.

Key words: Euthanasia, physician-assisted suicide, real option.

JEL Classifications: I12, I18, D81

Euthanasia as a Real Option

Introduction

While its legal status is unclear, euthanasia (or physician-assisted suicide), when considered implicitly, is a relatively common practice in the United States. Markson (1995) points to the American Hospital Association's recognition that in the United States as many as 6,000 deaths per day are in some way planned by the patients, their families or physicians.

Few attempts have been made to tackle the issue of life and death analytically. Hamermesh and Soss (1974) propose a model of suicide and suggest that a person will commit suicide when the expected remaining lifetime utility from living is negative. Their conjecture is tested with empirical data. Their empirical results show that the elderly, as a group, have a higher suicide rate. The suicide rate also increases as the unemployment rate goes up. These results suggest that there is a correlation between income, age, and the likelihood to commit suicide. The elderly, as a group, have lower income and are more likely to suffer medical conditions that require a large sum of money to cure or manage. Following Dixit and Pindyck (1994), the suicide model of Hamermesh and Soss is not complete because it ignores the uncertainty factor and, thus, the option value of living. Since the option value to live usually is very large, the circumstances under which suicide is rational must be far bleaker than those found by Hamermesh-Soss.

What circumstances can be bleaker than a diagnosis of terminal illness? For terminally ill patients, death is not the only certainty, but so are physical pain and mental

suffering. In a way, we can view life after a diagnosis of terminal illness as a period of time in which the patient's overwhelming experience is that of futility. This period can be viewed as an experience of disutility. There are also high medical costs that must be borne by the patient, the patient's family, or the society to prolong life. Thus, the decision to not prolong death could be beneficial to all parties involved.

On the other hand, the active decision to not prolong life beyond its natural course can have a direct economic cost. For instance, the legal preparation (e.g., obtaining and possibly enforcing the provisions of an advance directive) and the arrangement of medical facilities required to ensure an unimpeded death can be quite expensive. Furthermore, such decisions impose emotional costs on both the patient and the family members. Therefore, if the potential benefits from euthanasia are greater than the costs, then its selection can be seen as a rational choice.

2. Euthanasia as an Option

Consider a patient who just learned from his physician that he has terminal illness. Assume that he can only choose between two alternatives (options): euthanasia or continue the usual or more aggressive treatments in hope of extending life. Denote V_t as the benefit of euthanasia at the time when terminal illness is diagnosed. V_t includes the cost of continued treatments avoided and the pain and suffering associated with the terminal illness that can also be avoided with euthanasia. To obtain V_t , a patient must pay M_t , an amount we interpret as a fixed, upfront cost consisting of: the medical cost for pain management and other related medical services to the end of life, possible legal costs, and

the mental burdens placed on the patient and related family members that stem from making such a decision (Markson, 1995).

Melinek (1974), Jones-Lee (1989), and Viscusi (1993, 2004) provide foundations upon which to evaluate the economic value of life. Their methods are helpful in constructing numerical values for V_t and M_t . These two variables are, of course, time varying. A patient can start with no pain at all and live until the last day of life without any pain. For this patient the benefit from euthanasia is, obviously, zero. On the other hand, the patient may start with no pain and, as health deteriorate, increased pains start to have an effect on the decision process.

Note that V_t aggregates the cost avoided from the day the patient discovered he has terminal illness to his death. Thus, as t increases, V_t decreases. From a project valuation perspective, we can view pain and suffering as negative cash flows. The benefit of euthanasia is to avoid the realization of the negative cash flows. We can assume that the patient can confidently estimate the amount of pains (negative cash flows) he/she will suffer until death. On the other hand, improvements in medical technologies and medicines may lead to treatments that could possible result in a cure of the illness, thus making euthanasia less attractive. Let's assume V_t follows a geometric Brownian motion of the form,

$$\frac{dV}{V} = \alpha_v dt + \sigma_v dz_v, \quad (1)$$

where $\alpha_v \leq 0$ is the rate of decline for the potential benefits from euthanasia as the patient ponders the decision, σ_v is the standard deviation for the percentage change in V_t , and z_v is a standard Wiener process. Here, the patient knows the value of euthanasia at the time

of the diagnosis. If he postpones the decision, the value will be different. For similar reasons, we also assume the cost, M_t , follows another geometric Brownian motion,

$$\frac{dM}{M} = \alpha_m dt + \sigma_m dz_m. \quad (2)$$

The cost for the medical service will change over time, so does the emotional cost for the patient and relatives. While the prospect of losing a family member may be unbearable at first, seeing how the patient suffers may change the family members' attitude towards euthanasia. Therefore, the sign of α_m tends to be negative as well.

A similar problem involving the value of waiting to invest can be found in McDonald and Siegel (1986). They suggest the solution that involves finding a number C^*_t , for every time t , such that if $V_t/M_t \geq C^*_t$, then, as applied to our problem, euthanasia is optimal. The problem for the patient and the family members is to find a boundary value to maximize the value

$$E_0[(V_t - M_t)e^{-\mu t}],$$

where E_0 denotes the expectation at the time of diagnosis and μ denotes a subjective discount rate. Let the present value of euthanasia be X , McDonald and Siegel (1986) show that

$$X = (C^* - 1)M_0 \left(\frac{V_0/M_0}{C^*} \right)^\varepsilon, \quad (3)$$

where

$$\varepsilon = \sqrt{\left(\frac{\alpha_v - \alpha_m}{\sigma^2} - \frac{1}{2} \right)^2 + \frac{2(\mu - \alpha_m)}{\sigma^2}} + \left(\frac{1}{2} - \frac{\alpha_v - \alpha_m}{\sigma^2} \right), \quad (4)$$

$C^* = \varepsilon/(\varepsilon-1)$, $\sigma^2 = \sigma_v^2 + \sigma_m^2 - 2\rho_{vm}\sigma_v\sigma_m$, and ρ_{vm} is the instantaneous correlation between the rates of increases in V and M . Since $\alpha_v < 0 \leq \mu$, therefore $\varepsilon > 1$ holds and the solution is well defined.

Note that ε is decreasing in α_v and increasing in α_m . Since X is decreasing in ε , the value of euthanasia is increasing in α_v and decreasing in α_m . The economic interpretation of these two conditions is as follow. Since α_v is negative, an increase in value of α_v implies that the benefit from euthanasia (V_t) is decreasing at a slower rate. Therefore, the value of euthanasia is high. An increase in α_m , on the other hand, implies the cost of euthanasia goes down at a slower rate. From a purely emotional standpoint, if family members are having hard time letting the patient go, then it means there would be an increasing α_m . In that case, our formulation of the rationale for selecting euthanasia is diminished, as we would expect.

Table 1 presents some numerical simulation results. Panel A shows that, for values of $C_o = V_o/M_o$ that are significantly smaller than 1, the value of X is close to zero. As the value of C_o exceeds 1, the value of X begins to increase at an increasing rate. This result suggests that if the benefit of euthanasia out-weights the cost, the benefit of euthanasia goes up faster. If the insurers follow the suggestion set forth in Fung (1993) and compensate the insured for choosing not to pursue further medical treatments, the value of C_o will be significantly above 1.

Panel B shows that the value of the instantaneous correlation between the rates of increases in V and M , ρ_{vm} , has a positive impact on the value of X . As the correlation coefficient increases, the value of X increases. Moreover, the value of X increases at an increasing rate as the value of ρ_{vm} increases. A main implication of this result is that if the

cost of euthanasia increases, along with an increase in value of V_t , the benefit of euthanasia will increase.

Note that our model has some important policy implications as well. If a given society wants to reduce the demand for euthanasia, then more money should be spent on medical researches and services devoted to the goal of reducing pain and suffering for terminally ill patients.

Since the benefits of euthanasia are derived from avoiding pain and suffering associated with additional treatment and medications, making life after a terminal illness diagnosis painless will certainly reduce the potential benefits of euthanasia. The hospices and palliative care medicine movement in recent years is aiming precisely at this goal. On the other hand, the society can also make the cost of euthanasia go up. Religious and political condemnations will definitely have a positive effect on the cost of euthanasia (Markson, 1995). Likewise, the society can reallocate valuable medical (and financial) resources that are currently being spent on terminally ill patients, to help patients that are not terminally ill¹. That is, euthanasia can be encouraged as a form of altruistic behavior (see, for examples, Fung (1993), Callahan (1987), and Kervokian (1991)). If family members see death as a “good” deed rather than a tragedy, their attitudes may change and the cost of euthanasia may go down.

¹ As point out by Bryne and Thompson (2000), as much as 20% of an individual’s lifetime expenditures on health care are borne in the last year of life, and 40% of those are borne in the last month. Expenditures on treatments that are ultimately unsuccessful account for \$67 billion annually, or 12% of total spending on health care (1987 figure). As the elderly population increases, this figure will only go up over time.

3. Medical Breakthroughs and Sudden Death

While the prospect of something better coming up makes the option of suicide for people who are not terminally ill irrational, would the same be true for patients who are terminally ill? Suppose that there is a possibility that the diagnosis is incorrect. It could be that the diagnosis is really not a terminal illness, or a cure may soon be available if the patient waits. Furthermore, assume there is also a possibility that a sudden death may occur. Strokes or complications from treatments and medications are some of the common causes of sudden death. We can incorporate these events into our model by allowing V_t to take a discrete jump to zero (if the patient is not terminally ill the value of euthanasia is zero; similarly, a sudden death also reduces the value of euthanasia to zero). Let the probability of a wrong diagnosis or a medical breakthrough be π , then the stochastic process for V_t now follows a mixture of Poisson-Wiener process of the form,

$$\frac{dV}{V} = \alpha_v dt + \sigma_v dz_v + d\pi, \quad (5)$$

where $d\pi = -1$ with probability λdt and $d\pi = 0$ with probability $1 - \lambda dt$. The expected benefit from euthanasia is now,

$$E_0[(V_t - M_t)e^{-(\mu+\pi)t}]. \quad (6)$$

Let $X^*(\pi)$ be the value of euthanasia at time t with probability of a wrong diagnosis or a medical breakthrough, then

$$X^*(\pi) < X. \quad (7)$$

Therefore, the value of euthanasia is strictly smaller if there is a positive probability of wrong diagnosis or medical breakthrough. However, this does not imply that the conjecture in Dixit and Pindyck (1994) is correct under this model. Euthanasia is still

rational whenever $V_t(\pi) - M_t \geq 0$, or as long as $X^* > 0$. This conclusion is to be expected: Even if there is a possibility that the diagnosis is incorrect, the patient is likely to contemplate euthanasia when suffering a certain amount of pains due to the illness. If the suffering from waiting is too high, the patient still should seek euthanasia. The same holds true for patients who wait for medical breakthroughs. However, the existence of uncertainties does guarantee that the value of euthanasia is strictly smaller than it would be if there were no uncertainties.

4. Conclusion and Discussion

In this paper, we proposed a theoretical economic model of calculating the costs and benefits of euthanasia. The decision to seek euthanasia is modeled akin to the valuation of a real option. Our model concludes that euthanasia is optimal when certain conditions are satisfied. The discussion in this paper provides some policy implications. Different policies, ranging from the amount of money spent on medical research to social and religious attitude, could affect the demand for euthanasia. Though our model is motivated under the assumption of a diagnosis of terminal illness, the analysis, however, can be applied to all patients who are facing physical pain and/or psychological suffering from illnesses that have little or no chance of recovery. For further research, one direction would be to conduct surveys with terminally ill patients and their families and the medical professions to determine the likely boundary condition that will make euthanasia rational, and, perhaps, quantifying the potential benefits. Specifically, if we have access to good estimates for the underlying parameter values, we can estimate the value of euthanasia via equation (3).

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Table 1

Panel A: How X varies with C_o

C_o	10	6.0	4.0	2.0	1.0	0.8	0.6	0.4	0.2	0.1
σ^2	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
ε	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57
C^*	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
X	662.56	297.66	157.72	53.25	17.98	12.68	8.08	4.28	1.45	0.49

* Assumptions: $\alpha_m = -0.03$, $\alpha_v = -0.03$, $\mu = 0.05$, $\sigma_m = 0.1$, $\sigma_v = 0.1$, $\rho_{vm} = -0.99$ Panel B: How X varies with ρ_{vm}

ρ_{vm}	-0.99	-0.8	-0.6	-0.4	-0.2	0.0	0.2	0.4	0.6	0.8
σ^2	0.04	0.036	0.032	0.028	0.024	0.02	0.016	0.012	0.008	0.004
ε	2.57	2.67	2.79	2.94	3.13	3.37	3.70	4.19	5	6.84
C^*	1.64	1.6	1.56	1.51	1.47	1.42	1.37	1.31	1.25	1.17
X	157.72	172.69	193.9	224.03	269.63	345.1	488.23	828.78	2097.15	19159

* Assumptions: $\alpha_m = -0.03$, $\alpha_v = -0.03$, $\mu = 0.05$, $\sigma_m = 0.1$, $\sigma_v = 0.1$, $C_o = 4$