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A GAME THEORETIC ANALYSIS OF VOLUNTARY EUTHANASIA AND PHYSICIAN ASSISTED SUICIDE

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In countries/states where voluntary euthanasia (VE) or physician-assisted suicide (PAS) is legal, the patient's decision about whether to request VE or PAS heavily relies on the information others provide. We use the tools of microeconomic theory to study how communication between the patient, his family and his physician influences the patient's decision. We argue that families have considerable power over the patient and that the amount of information that is transmitted from physician to patient might be severely diminished as a result of legalizing VE or PAS. We discuss our main results in the context of the ongoing normative debate over the legalization of VE and PAS. (*JEL* D8, I12)

I. INTRODUCTION

Should a patient with a terminal illness be allowed to prematurely end his life to avoid the ordeal of continuing to live under extremely unpleasant circumstances? This controversial question is one that goes back to ancient times, with different civilizations seemingly holding very different views on the matter. Currently, a large debate is taking place in many countries around the concepts of voluntary euthanasia (VE) and physician-assisted suicide (PAS). While some of the debate is over the term "euthanasia" itself, for our purposes, we will define euthanasia as the painless killing of a patient with a terminal or incurable physical condition to relieve pain and suffering. Euthanasia is voluntary (as opposed to involuntary and non-voluntary) if it is requested by the patient. The distinction between PAS and VE is that, in the former, the physician simply provides the lethal means (usually pills) to the patient, while in the latter, the physician directly causes the patient's death, usually by intravenously administrating a lethal drug.

Even though the public generally seems to be somewhat divided in its support for VE and PAS (Emanuel et al. [2016] reports that public support for VE and PAS in the United States has remained at approximately 49%–69% since the 1990s, in Western Europe it has been increasing, while it has been decreasing in Central and Eastern Europe), there have been some countries/states that have already proceeded to legalize different forms of assistance in dying: PAS is now legal in five U.S. states—California, Montana, Oregon, Vermont, and Washington—while VE and PAS are legal in Belgium, Canada, Colombia, Luxembourg, the Netherlands, and Switzerland. However, the norm in most countries is for neither VE nor PAS to be legalized despite an ongoing public discussion worldwide about its possible legalization.

The vast majority of this discussion has focused on the ethical and moral implications of legalizing VE and/or PAS.[1] This is understandable, as one's opinion about VE and PAS naturally depends on fundamental matters such

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1. For example, Keown (2004) describes several arguments against the legalization of VE and/or PAS, while Dworkin (1993) describes some of the arguments in favor.

ABBREVIATIONS

PAS: Physician-Assisted Suicide
PBE: Perfect Bayesian Equilibrium
VE: Voluntary Euthanasia

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as the value of human life and the importance of one's autonomy. However, these issues are not the subject of this paper; instead, our focus is on studying the manner with which a patient decides whether to request VE or PAS should he have such an option.

Several studies have shown that when people are deciding whether to request VE or PAS two of the main determinants are (a) their medical condition, and (b) the impact that their refusal to request VE or PAS might have on their family and friends (see the next section for related studies). In particular, with respect to (b), one of the concerns about legalizing VE or PAS is that patients might be too vulnerable to persuasion by those surrounding them (Battin 1992). A dying patient, knowing that he has only a few months to live, may be tempted to request VE or PAS to spare his family not only the financial difficulties that come with palliative treatment, but also the pain and suffering of witnessing his decay. Emanuel et al. (2016) present data provided by terminal patients from the states of Oregon and Washington about their end of life concerns. They show that 41% of patients from Oregon and 53% of patients from Washington who have requested PAS mentioned the concern over becoming a burden to their family and friends as a reason for such a request. Furthermore, in a survey conducted by Steinhauser et al. (2000), 89% of terminal patients regarded not being a burden to their family when dying as important and 85% believed it was important for their family to be prepared for their death.

Even though (a) and (b) seem to be determinant for the patient's end of life decision, the information the patient will have will be limited, that is, the patient will decide with incomplete information. In fact, it is likely that *others* have information that the patient would very much like to have before making a decision. Typically, patients are not medical doctors, so they rely on their physicians to obtain information regarding their condition. Patients must also rely on their families for information about the extent to which they are a burden to them, because only the family knows whether a patient is indeed a burden or rather, if the patient's survival, if only for a few more months, more than outweighs whatever burden might exist. Patients can certainly attempt to obtain this information by communicating with their families, but it is not obvious that such interaction will be informative. It is easy to conceive of a scenario in which a suffering family might hide this from the patient precisely to prevent him from requesting VE or PAS. This means that, not only might patients request VE or PAS because they are a burden to their loved ones, but, more disturbingly, patients might request VE or PAS because they *believe* they are a burden, and their families have no credible way of correcting this belief.

We think of the patient's end of life decision as a decision made with incomplete information and that will, at least to some extent, depend on the communication that is established between the patient, his physician and his family. The goal of this paper is to use some of the tools of microeconomic theory to study this interaction. To that end, we build a model where an arbitrary terminal patient interacts with his physician and his family before deciding whether to end his life by requesting VE or PAS. The interaction between the three players is modeled through a cheap talk model, where the informed parties—the patient's family and the patient's physician—send messages to the patient about their private information, which is, simply put, information about the (psychological) burden the family is experiencing and information about the patient's diagnosis. The patient then decides whether to request VE or PAS.

In the first part of the paper, we restrict our attention to the case where the physician is "honest," that is, he always relays whatever information he has so that he plays no strategic role. We do this so that we can focus on the family's role and its influence on the patient. This simpler version of the model allows us to discuss a few results. The most obvious one is that, provided the family's incentives are not perfectly aligned with the patient's, there will not be truthful revelation by the family, that is, the family provides some of the information it has to the agent but not all. This then leads to a second result, which we find to be quite relevant: either no information is transmitted, so that the agent makes his decision about whether to request VE or PAS uninformed about his family's private information, or, if there is some information transmitted, he decides exactly what his family would have wanted and not necessarily what he would have wanted had he been perfectly informed.

In the second part of the paper, we incorporate a strategic physician and, among other things, show that the physician will generally not be completely truthful and will hide some of the information he has from the patient. We also show that if the physician's preferences are independent of the private information held by the patient's family (the burden), the amount of information transmitted by the physician to the patient is particularly limited.

The remainder of this paper is organized as follows. In the next section, we discuss the related literature with a special emphasis on the literature on the issue of VE and PAS. In Section III, we present the model. In Sections IV and V we present the main results. Finally, in Section VI, we conclude. In Appendix S1, we discuss how to extend the model to allow family and physician to communicate privately.[2]

II. RELATED LITERATURE

Economic theory has a history of being used to study the interactions between patients and physicians that stems from the assumption that the physicians' own interests sometimes lead them towards behavior that is detrimental to their own patients. Recently, Jacobson et al. (2017) present evidence that corroborates this idea: they find that providing additional financial incentives to physicians contributed to an improvement in the quality of health care provided and increased the median life of patients. Essentially, the role of economic theory has been to study what type of behavior is generated by the physicians' private incentives and how to mitigate the potential negative implications those incentives might have on patients. However, to the best of our knowledge, this paper is the first that studies the interaction between patients, physicians, and families that precede the patient's decision about whether to request VE or PAS using the tools developed in economic theory.

Euthanasia and related concepts have not only been studied from a normative and ethical perspective but also from a positive perspective. One objective of the medical literature on euthanasia is understanding what drives people to request VE and/or PAS. Naturally, our work relies heavily on this literature.

The most direct way to study the causes of VE and PAS is to ask those who have requested it. The U.S. state of Oregon, where PAS has been legal since 1997, releases data about the end of life concerns of the patients who have requested PAS. According to Emanuel et al. (2016), up until 2015, the main concerns were losing autonomy (mentioned by 91% of the patients who have requested PAS), being less able to engage in activities that make life enjoyable (89%), loss of dignity (68%), losing control of bodily functions (48%), burden of family/caregivers (41%), inadequate pain control or concern about it (25%), and financial implications of treatment (3%). These data provide two insights that are relevant to this paper. First, those who have requested PAS do care about the impact of their decision on others. This can be seen directly by their concern about being a burden on their family and caregivers but also indirectly by their concern over the loss of autonomy. Second, patients care about how others see them, which is expressed by their concern about their loss of dignity. It is also interesting to note that, contrary to public belief, the concern about physical pain is not among the most important ones, as pain can generally be managed even with terminal patients.

One article that motivates our work is Steinhauser et al. (2000), who survey four subject groups—seriously ill patients, recently bereaved families, physicians, and hospice volunteers—and ask them to rate the importance of certain factors at the end of life. They find that there are some factors that are considered important by all subject groups: pain and symptom management, preparation for death, achieving a sense of completion, decisions about treatment preferences, and being treated as a "whole person." We would highlight the item on decisions about treatment preferences, which is something a patient can only do if properly informed by his physician.

However, there were several items that patients valued more than physicians, including being mentally aware, not being a burden, helping others and coming to peace with God. These differences reinforce the belief that physicians and patients do not have the same preferences. Because they may value different things and because what is communicated by the physician is largely determined by his own preferences, our analysis on what is communicated by the physician seems particularly relevant.

The same study also allows us to see that there are differences between what families and patients deem as important. In particular, families seem to overvalue the importance of the presence of the family when dying and the importance of not dying alone when compared to the patients' responses.

Other studies have also covered attitudes towards VE and/or PAS by the public in general and by the medical profession in particular. As mentioned in the introduction, public support for VE and PAS differs considerably from country

2. Appendix S1 is available at https://sites.google.com/site/franciscosilva2909/

to country. In fact, Emanuel et al. (2016), in their review of the available literature, state that it is difficult to paint a general picture of the public's views on VE and PAS because of the different ways in which studies frame the questions in their surveys and the different definitions that terms such as "euthanasia" have in different countries. The same paper also mentions that in the United States, "white persons, men, younger persons and the religiously unaffiliated tend to be more supportive" of VE and PAS. Other factors that have been mentioned as being correlated with a more positive view of VE and PAS include the educational level of the subject as well as how permissive they are towards other morally controversial behaviors (Cohen et al. 2006; Köneke 2014; Ryynanen et al. 2002).

The views of healthcare providers—physicians and nurses—are somewhat different. Physicians are more likely to support PAS than VE, but their support for either one is smaller than the general public's (Emanuel et al. 2016; Ryynanen et al. 2002). Their reluctance to support VE and PAS seems related to the fear of abuse and the uncertainty over the patient's condition, which makes them favor further development of palliative care (Kuuppelomaki 2000). Medical professionals express concern over the mental health of fellow physicians who would be required to help patients decide whether to request VE and PAS, as well as fear over being thought of as "killer doctors" (Kuuppelomaki 2000).

Overall, the medical literature on VE or PAS shows that the decision of the patient is extremely complex. When deciding, the patient thinks not only of himself but also about the impact of his decision on his family and close friends. It is also clear that the decision of the patient is made with incomplete information, which makes him particularly susceptible to the influence of his physician and of his family. These are the assumptions we make in our paper. Building on them, we study the interaction between the patient, his family and his physician in the following sections.

III. THE MODEL

There are three agents in the model: the patient, the patient's family, and the patient's physician. Family and physician have some information that is relevant for the patient's decision of whether to request VE or PAS. In particular, we assume that the private information that the physician holds is embedded in random variable $x \in [\underline{x}, \overline{x}]$, where $\underline{x} < 0 < \overline{x}$, while the private information that the family holds is embedded in random variable $y \in [\underline{y}, \overline{y}]$, where $\underline{y} < 0 < \overline{y}$. We assume that x and y are independent and continuous and denote by f_x and f_y the probability density function of each variable respectively.

If the patient chooses to request VE or PAS, the utility of each agent is normalized to 0. If the patient chooses not to request it, then the utility of the patient is given by $u^p(x, y) = x + \alpha y$, the utility of the family is given by $u^f(x, y) = x + y$, while the utility of the physician is given by $u^d(x, y) \in \mathbb{R}$.[3]

Random variable x is supposed to incorporate information specific to the medical condition of the patient: what he should expect from his last few months of life, how much pain he will be in, how much autonomy he will have, how the state of mind of other patients with the same condition has evolved, and so forth. A large value of x means that the discomfort of the last few months of life is anticipated to be small. Random variable y represents information that is specific to the family's state of mind and its relationship with the patient: a large value of y could mean that the family values highly the possibility of being with the patient for as long as possible, it could also represent the family's strong moral opposition to euthanasia, and so forth.

One way to interpret these random variables is as follows. Variable x represents the utility of not requesting VE or PAS if the patient was not influenced by his family. The family's utility u^f might be different than x. Variable y represents the difference between u^f and x. The assumption that x and y are independent simply means that, whatever makes patient and family have different preferences is independent of the patient's condition; instead it depends on the type of relationship that the family has with the patient and its views on VE and PAS. Because, by assumption, the patient is altruistic and cares about how his family is affected by his decision, he gives weight $\alpha > 0$ to y, even though y does not influence the patient directly.

An alternative way to understand the specific functional form assumed for u^p is by thinking that the patient cares directly about u^f and not about y. In this case, one can think of the patient's utility when he refuses to ask for VE or PAS as being given by $\theta_1 x + \theta_2 u^f(x, y) = (\theta_1 + \theta_2)x + \theta_2 y$, which, after normalizing by $(\theta_1 + \theta_2)$, becomes

3. We reserve the discussion on u^d to Section V.

$x + \alpha y$ where $\alpha = \frac{\theta_2}{\theta_1+\theta_2}$. The caveat of this interpretation is that it restricts α to the interval [0, 1], unlike the former interpretation.

To us, it is not clear which of the two interpretations has more merit. One would more naturally be inclined to favor the second one, as it has been used in different articles in Economics.[4] However, for this application, restricting α to belong to [0, 1] may sometimes not be that intuitive as the following example illustrates.

Imagine that, because the family is very poor and palliative care treatment is much more expensive than euthanasia, $y = -\frac{1}{2}$. Imagine also that $x = 1$. This means that, if the patient did not care about the impact of his decision on his family, he would prefer not to request VE or PAS (because $x > 0$). It also means that the family prefers the patient not to request VE or PAS (because $1 - \frac{1}{2} > 0$). Therefore, under the second interpretation of u^p, it follows that, the patient should choose not to request VE or PAS as both him and his family prefer it. However, we find it conceivable to think that the patient would choose to ask for VE or PAS because he may value the burden he causes more than his family does. Even though the patient knows his family prefers him not to request VE or PAS, he may still be tempted to ask for it to avoid the guilt of leaving his loved ones in an even more troublesome financial situation.

The game is as follows. It starts with the physician being privately informed of x and the family being privately informed of y. In the first stage, the physician sends a public cheap talk message $m_x \in M_x$. In the second stage, after observing m_x, the family sends its own cheap talk message $m_y \in M_y$ that is received by the patient. Finally, in the third stage, having observed m_x and m_y, the patient decides on whether to request VE or PAS. As is standard in cheap talk games, M_x and M_y are assumed to be arbitrarily large.[5]

Throughout the paper, we (implicitly) assume that the patient himself is always honest. This implies that the patient shares whatever information he has with both his physician and his family. Therefore, there is no loss of generality in assuming that the patient has no source of information other that what his physician and family report to him. It also justifies the assumption that the message sent by the physician is public; it would be more reasonable if the message was sent privately to the patient, but seeing as he is assumed to be honest, he would simply relay its content to the family.

We make this assumption of honesty because we do not find reasonable that a dying patient, going through all the emotional trials that come with such a state, would be able, at all times, to hide what he is feeling from either his loved ones, or even possibly his physician, in order to get any of these to be more honest. This type of strategic behavior does not seem compatible with the state of mind of dying patients. The reader might also be tempted to apply the same logic to the patient's family, which also goes through an emotionally trying process, so they too might be unable to hide how they are feeling. We would argue that the two are not the same. The patient's family is aware that it is the patient making the decision and that any wrong word might be interpreted as consent. It seems natural to us that families are not indifferent to this, and that would cause them to be careful in how they interact with the dying patient, anticipating how their words will be perceived. We do not think the patient has the same level of concern. The patient knows that he has the final say over his decision, and so it seems unlikely that he would have the presence of mind to strategically communicate with his family in order to obtain more information from them.

IV. FAMILY AND PATIENT

In this section, we assume that the physician is always honest and that this is common knowledge. This means that, at the beginning of the second stage, both family and patient know $x \in [\underline{x}, \overline{x}]$.

A. Definitions

Consider the subgame that starts with the family's decision for each $x \in [\underline{x}, \overline{x}]$. For each $y \in [\underline{y}, \overline{y}]$, the family chooses a message $m_y = \sigma^f(y) \in M_y$, where M_y is some arbitrary message set, while, for each message $m_y \in M_y$, the patient chooses whether to request VE or PAS ($\sigma^p(m_y) = 1$) or not ($\sigma^p(m_y) = 0$).[6] The typical equilibrium concept used in cheap talk games like this one is that of perfect Bayesian equilibrium (PBE) (see, e.g., Crawford and Sobel 1982). In words, for a strategy profile (σ^f, σ^p) to be a PBE, it must be that, for any $y \in [\underline{y}, \overline{y}]$,

4. See, for example, Bester and Güth (1998).

5. For the readers that are not familiar with cheap talk games, a cheap talk message is simply a costless message. Essentially, both physician and family communicate something to the patient who then makes a decision.

6. In the appendix, we show that there is no loss of generality in not allowing the players to randomize.

the family chooses its message m_y optimally given σ^p; for each message $m_y \in M_y$, the patient chooses its action $\sigma^p(m_y)$ optimally given his beliefs about y; and those beliefs are updated using Bayes' rule whenever possible.[7]

There are two types of PBEs: informative and uninformative. In an uninformative PBE, the sender (the family) chooses the same message regardless of its private information (the y). In this way, the receiver (the patient) infers nothing from observing the message of the sender. Uninformative PBEs are also called babbling PBEs and always exist (see Crawford and Sobel 1982). By contrast, in an informative PBE, the sender's message does depend on the private information. Seeing as the action space of the patient is binary, in an informative PBE, it would have to be that, for some values of y, the family sends a message that induces the patient to ask for VE or PAS, while for some other values of y, the family sends a message that induces the opposite behavior. By removing redundancies, and without loss of generality, we can then restrict attention to message sets M_y that are binary. We can also label the two messages of set M_y as $m_y = yes$ and $m_y = no$ (so that $M_y = \{yes, no\}$) and assume that $\sigma^p(yes) \geq \sigma^p(no)$. This means that, in an uninformative PBE, the family either sends $m_y = no$ for all $y \in [\underline{y}, \overline{y}]$ or $m_y = yes$ for all $y \in [\underline{y}, \overline{y}]$, in which case, the message itself has no meaning; while in an informative PBE, the family sends $m_y = no$ for some values of y and $m_y = yes$ for others, while the patient requests VE or PAS if and only if he observes $m_y = yes$, that is, in an informative PBE, $\sigma^p(yes) = 1 > \sigma^p(no) = 0$. Naturally, the labels *yes* and *no* are not meant to be literal; what is important to note is that, whenever an informative PBE exists, the family somehow expresses the desire that the patient requests VE or PAS for some values of the burden but does not for others.

Unlike uninformative PBEs, informative PBEs may not exist. In order for an informative PBE to exist, it must be that (a) the family finds it optimal to send message $m_y = yes$ if and only if y is such that the family prefers the agent to request VE or PAS, and (b) the patient finds it optimal to request VE or PAS if and only if he observes $m_y = yes$. If one defines

$$\hat{y}(x) = \begin{cases} \underline{y} & \text{if } x + \underline{y} \geq 0 \\ \overline{y} & \text{if } x + \overline{y} \leq 0 \\ -x & \text{otherwise} \end{cases} ,$$

condition (a) is equivalent to requiring that

$$\sigma^f(y) = \begin{cases} no & \text{if } y \geq \hat{y}(x) \\ yes & \text{if } y < \hat{y}(x) \end{cases} ,$$

while condition (b) can be satisfied if and only if

$$x + \alpha E(y|y < \hat{y}(x)) \leq 0 \leq x + \alpha E(y|y \geq \hat{y}(x)).$$

Given that, for some x, there could be two PBEs, one informative and one uninformative, there is the additional issue of choosing between the two. Farrell (1993) proposes a refinement that resolves this multiplicity called "neologism proofness" that is based on the idea that more informative equilibria are more likely to be played. Applied here, the concept is straightforward: a PBE is neologism proof if (a) it is informative or (b) if it is not informative but there is no informative PBE.[8] In what follows, we focus on neologism proof PBEs, which, by definition, always exist.

For each $x \in [\underline{x}, \overline{x}]$, one can then compute the neologism proof PBE, which enables us to determine for each $y \in [\underline{y}, \overline{y}]$ whether the patient will request VE or PAS ($\tau(x, y) = 1$) or not ($\tau(x, y) = 0$), that is, mapping $\tau : [\underline{x}, \overline{x}] \times [\underline{y}, \overline{y}] \rightarrow \{0, 1\}$ maps the family's and the physician's private information into a decision over VE and PAS. In the next section, we discuss this mapping in some detail.

B. Analysis

Existence of Informative PBE. Our first observation is that it is very well possible that informative PBEs do not exist even when the patient would benefit from knowing his family's private information. We illustrate with the following example:

Example 1 Suppose that $y \in [-1, 1]$, $E(y) = -\frac{1}{2}$, $x = \frac{3}{2}$, and $\alpha = 4$. It follows that, if the patient were to know y, he would prefer to request VE or PAS if and only if $y < -\frac{3}{8}$. By contrast, his family prefers him not to regardless of y. Because the patient is aware of this, he knows that anything that his family says is only to convince him not to request VE or PAS and, therefore, conveys no information regarding y. As a result, following his interaction with his family, his best guess about y is still given by $E(y) = -\frac{1}{2}$. Given that $-\frac{1}{2} < -\frac{3}{8}$,

7. The formal definition is provided in the appendix.

8. In the appendix, we show this statement.

the patient chooses to request VE or PAS, making a mistake for all $y > -\frac{3}{8}$.

Proposition 1 identifies when such a phenomenon occurs more generally.

PROPOSITION 1. *i. The agent's optimal choice depends on y if and only if $x \in (-\alpha\overline{y}, -\alpha\underline{y})$.*

ii. If $x \in (-\alpha\overline{y}, -\alpha\underline{y})$, there is no informative PBE if and only if $\alpha > 1$ and either $x < -\overline{y}$ or $x > -\underline{y}$.

Proof. Simple algebra. ■

Notice that a necessary condition for Proposition 1 to hold is that $\alpha > 1$, so that, to some extent, the patient cares more about the impact of his decision on his family than on himself—a kind of overaltruism. We would argue, however, that if there ever was an application where overaltruism was a reasonable assumption, it was this one. The general message of this simple result is almost paradoxical: if the two agents care too much about one another and this is commonly known and understood by both, communication may get compromised, and the patient may end up making an uninformed decision.

The Power of Information. Naturally, the patient prefers to be as well informed as possible when making his decision. Therefore, informative equilibria, when they exist, are better for the patient than uninformative equilibria. However, informative PBEs are quite peculiar.

Notice that, for a fixed x, the patient would like to request VE or PAS if and only if $y > -\frac{1}{\alpha}x$, while the family would like him to request VE or PAS if and only if $y > \widehat{y}(x)$. In general, $\widehat{y}(x) \neq -\frac{1}{\alpha}x$, so that there is disagreement between family and patient. If x is such that an informative PBE exists, then, in that equilibrium, the patient requests VE or PAS if and only if $y \geq \widehat{y}(x)$, that is, he chooses exactly what his family would have wanted. So, even though formally it is the patient who has the power to decide whether to request VE or PAS, it is as if it is the family that makes the decision. This happens because of the asymmetry of information; the family is better informed than the patient and can leverage that advantage into a more favorable decision.

In what follows, for simplicity, we assume that $y \sim U(k-1,\ k+1)$, where $k \in (-1,\ 1)$. Proposition 2 describes mapping τ for the case where $\alpha < 1$ and Figure 1 illustrates it.

PROPOSITION 2. *If $\alpha < 1$, there is $x_- \in [\underline{x}, \overline{x}]$ and $x_+ \in [\underline{x}, \overline{x}]$ such that*

$$\tau(x, y) = \begin{cases} 1 \text{ if } x < x_- \\ 1 \text{ if } x \in [x_-, x_+] \text{ and } y < \widehat{y}(x) = -x \\ 0 \text{ if } x \in [x_-, x_+] \text{ and } y \geq \widehat{y}(x) = -x \\ 0 \text{ if } x > x_+ \end{cases}.$$

If $x \notin [x_-, x_+]$, the informative PBE does not exist so the patient makes his decision based on his prior belief about y. If $x \leq x_-$, he chooses to request VE or PAS; if $x > x_-$, he chooses not to. If $x \in [x_-, x_+]$, the informative equilibrium does exist, so the patient requests VE or PAS if he receives the $m_y = yes$ message, which happens whenever $y < -x$.[9]

Type I and Type II Errors. One aspect of this analysis that is markedly different than most economic applications has to do with the appropriate welfare measure. If, instead of a patient making a life or death decision under the advice of his family, there was an abstract decision maker making an abstract decision after having consulted with an expert, it would be more or less consensual that a proper welfare measure would have to somehow depend on both agents' wellbeing. However, for this particular case, this does not seem as appropriate as one would think that the welfare should depend very little on what the family gets out of it.

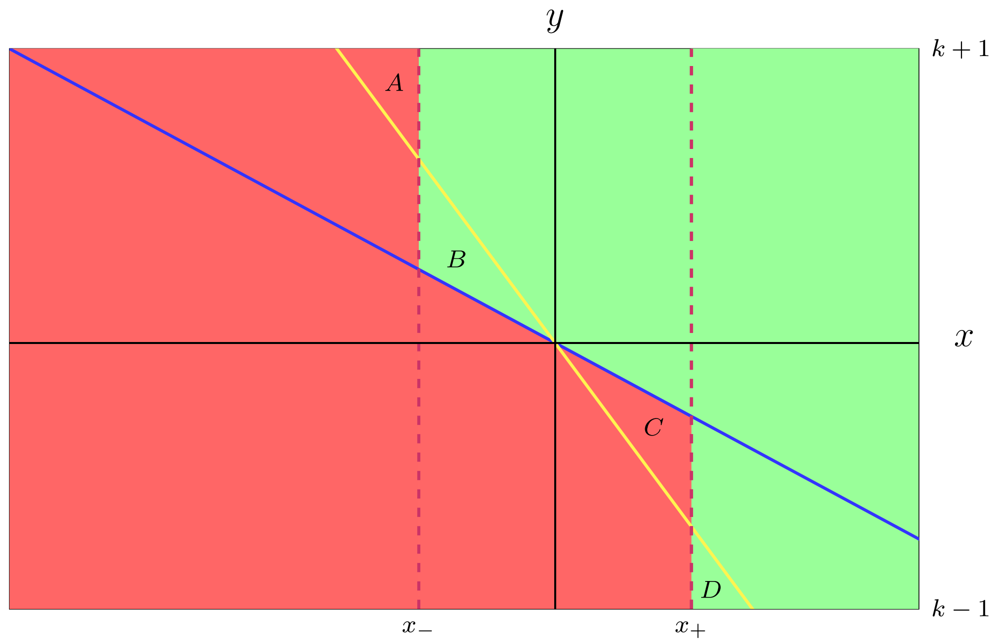
On the other hand, what also seems clear is that society views differently the two types of mistakes that the patient may make: a patient who requests VE of PAS but would have rather not had he been fully informed is more undesirable than a patient who does not request VE of PAS but would have had he been fully informed. Figure 1 depicts the extent of these two types of errors. Regions A and C represent the case where the patient requests VE or PAS but would have preferred not to had he known y, while regions B and D represent the case where the patient does not request VE or PAS but would have preferred to.

Example 2 If $\alpha < 1$ and $x \sim U(-T,\ T)$, where $T > \max\{\alpha(1-k), \alpha(1+k)\}$, then through some algebra we get that

$$(A + C) - (B + D) = -\frac{1}{2T}\frac{\alpha^2(1-\alpha)}{(2-\alpha)^2}k$$

9. Notice that, through some simple algebra, it follows that $x_- = -\frac{\alpha(1+k)}{2-\alpha}$ and $x_+ = \frac{\alpha(1-k)}{2-\alpha}$.

FIGURE 1
Description of τ for $\alpha < 1$



Note: The patient chooses to request VE or PAS in the red areas and not to in the green ones. The blue line represents the set of points where the family is indifferent ($-x$), while the yellow line represents the set of points where the patient is indifferent ($-x/\alpha$).

which is positive if and only if $k < 0$ and is decreasing with k.

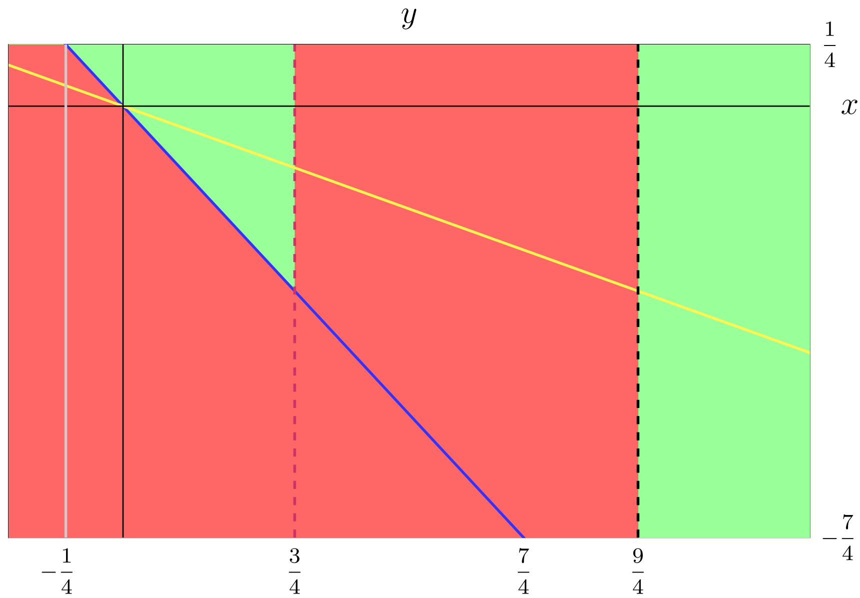
The previous example, with the uniform assumption on x, is such that the weight of each region is equal to its area. In that case, we see that if $k < 0$ (if there is an expected burden) there are more of the "wrong" type of mistakes ($A + C$ is larger than $B + D$). Furthermore, as the size of the expected burden increases, the difference between the two types of mistakes also increases. So, for example, if euthanasia is introduced with a very low price when compared to the palliative care cost this would not only lead to more cases of VE and PAS, but also to an increase in the frequency of "wrongful" requests for VE or PAS relative to the "wrongful" decisions of not requesting VE or PAS.

Possible Nonmonotonicity on the Patient's Decision. If $\alpha > 2$, a peculiar and somewhat paradoxical phenomenon may occur; $\tau(x, y)$ might be decreasing with x for some interval. We illustrate with a simple example: in Figure 2, we display mapping τ for the case where $\alpha = 3$ and $k = -\frac{3}{4}$. If $x < -\frac{1}{4}$, the family prefers the patient request VE or PAS for any y so that the only PBE is the uninformative one. Because x is sufficiently small, the patient requests VE or PAS despite being uninformed. When $x \in \left[-\frac{1}{4}, \frac{3}{4}\right]$, an informative PBE exists, so the patient requests VE or PAS if and only if his family sends message $m_y = yes$, which happens whenever $y > -x$. If $x > \frac{3}{4}$ however, the informative PBE no longer exists, because the conditional expectation of y after observing $m_y = no$ becomes too low; if $x > \frac{3}{4}$, we have that

$$x + 3E(y|y > -x) < 0.$$

Therefore, the patient will decide based on $E(y) = -\frac{3}{4}$. This means that if $x \in \left[\frac{3}{4}, \frac{9}{4}\right]$, the patient will request VE or PAS and if $x > \frac{9}{4}$, he will not. The striking aspect of this example is that an increase in x caused, for example, by an improvement in the patient's diagnosis, might actually make him request VE or PAS; for example, if $(x, y) = \left(\frac{1}{4}, 0\right)$, the patient

FIGURE 2
Mapping τ When $\alpha = 3$ and$k = -\frac{3}{4}$



chooses not to request VE or PAS but he does if $(x, y) = (1, 0)$. The reason is that this increase of x destroys the credibility of the *no* message; if x is too large, the family loses its ability to credibly communicate with the patient.

V. STRATEGIC PHYSICIAN

In the previous section, the physician was assumed to always report honestly to the patient. As discussed in the related literature section, there is evidence that this is not always the case: the fact that physicians have different incentives than the patient might lead them to practices that prove detrimental to the patient's health. In the specific context of terminal patients approaching the end of life, Morrison (1998) mentions several reasons why physicians might not engage in completely open communication with the patient, which include a fear that there might be a disagreement regarding future treatments. Gorsuch (2009) mentions that the discussions between patient and physician over the topic of VE and PAS are particularly delicate, as physicians might be tempted to influence their patients to request VE or PAS due to the high volume of resources required for appropriate palliative care.

In this section, we assume that the physician is endowed with his own preferences and chooses what to communicate in order to maximize his expected utility.

A. *Definitions*

We endow the physician with preferences over the decision of the patient that may depend on (x, y). In particular, we assume that the physician's utility is given by $u^d(x, y)$ if the patient does not request VE or PAS and is given by 0 if he does.

The addition of a strategic physician opens up a new source of uncertainty for the patient in that he is aware that the information that he receives from his physician might not be truthful. Because the physician has his own set of preferences, he is only expected to be honest insomuch as it benefits him. This does not necessarily mean that the physician is thought of as "selfish" as his preferences allow for altruism towards the patient. Nevertheless, even when he has the patient's best interests in mind, his decision of what to communicate to the patient is not a trivial one, as he also considers the impact that the information shared with the patient will have on the patient's family and their ability to influence the patient's decision.

In this section, we make the simplifying assumption that $\alpha \in (0, 1)$. Let us go through what constitutes an *equilibrium* of this game. Consider the patient's problem. For any pair $(m_x, m_y) \in M_x \times M_y$, he must choose whether to request VE or PAS ($\sigma^p(m_x, m_y) = 1$) or not ($\sigma^p(m_x, m_y) = 0$). His choice should maximize his expected utility, given his current beliefs about x and y. However, the only moments of those beliefs that are relevant for his decision are the conditional expectations, which we denote by $\mu_x(m_x)$ and $\mu_y(m_x, m_y)$ respectively (the belief over y might depend also on m_x because the family's choice might also depend on m_x). As a result, we impose that, in equilibrium,

$$\sigma^p(m_x, m_y) = \begin{cases} 1 & \text{if } \mu_x(m_x) + \alpha\mu_y(m_x, m_y) < 0 \\ 0 & \text{if } \mu_x(m_x) + \alpha\mu_y(m_x, m_y) \geq 0 \end{cases}.$$

As for the family, she first observes a message $m_x \in M_x$ and some $y \in [k-1, k+1]$. Given m_x, the family forms some belief about x and then, inferring what the patient's reaction will be, chooses some message $m_y = \sigma^f(m_x, y) \in M_y$. Once again, the only moment of the family's belief over x that is relevant is the conditional expectation $\mu_x(m_x)$. In fact, the family's problem is analogous to the previous section; instead of knowing x, the family has a conditional expectation of $\mu_x(m_x)$. Therefore, as discussed in the previous section, we can assume that $M_y = \{yes, no\}$. Furthermore, following the previous section, we assume that, in equilibrium, the family plays the neologism proof PBE of the previous section, that is, plays the informative PBE whenever available. To be concrete, this means the following: let $[x_-, x_+]$ denote the interval of x for which the informative equilibrium exists when x is known and, for simplicity, assume that $\underline{x} < x_- \leq x_+ < \overline{x}$; in equilibrium

$$\sigma^f(m_x, y) = \begin{cases} yes & \text{if } \mu_x(m_x) \in [x_-, x_+] \text{ and } y < -\mu_x(m_x) \\ no & \text{if } \mu_x(m_x) \in [x_-, x_+] \text{ and } y \geq -\mu_x(m_x) \\ no & \text{if } \mu_x(m_x) \notin [x_-, x_+] \end{cases}.$$

The physician's strategy is a choice of a message $m_x = \sigma^d(x) \in M_x$ per $x \in [\underline{x}, \overline{x}]$. Naturally, in equilibrium, the physician chooses m_x in order to maximize his expected utility taking into account everyone else's strategy. Finally, in equilibrium, all beliefs are updated according to Bayes' rule whenever possible.[10]

10. In the appendix, we provide a formal definition for our equilibrium concept.

B. Analysis

When Will the Physician Report Truthfully?. The first question we address has to do with what type of incentives should be put in place in order for the physician to want to report x truthfully. In particular, by thinking of u^d as a reduced form utility function that already incorporates all the relevant incentives (financial, moral, etc.), we ask what shape must u^d have in order for there to be an equilibrium where the physician reveals x truthfully. In general, it is not difficult to find such a function if one imposes no restrictions. For example, if $u^d = 0$ for all (x, y), the physician is indifferent to the patient's decision and so he has no reason not to be honest. However, as we show below, simple and intuitive requirements make honesty virtually impossible.

Let $u^* : [\underline{x}, \overline{x}] \times [k-1, k+1] \to \mathbb{R}$ represent a utility function for the physician, should the patient choose not to request VE or PAS, which induces truthful reporting by the physician in equilibrium, that is, the physician reports $m_x = x$ for all $x \in [\underline{x}, \overline{x}]$. Notice that, in equilibrium, once the physician reports some x, the patient ends up requesting VE or PAS if and only if he believes y is lower than some threshold. Therefore, one can think of the physician's problem as choosing which of the available thresholds over y he prefers, given x. If one imposes that u^* is (weakly) increasing with y, for each x, then

$$\widetilde{Y}(x) = \left\{ y \in \arg\max_{\widetilde{y} \in [k-1, k+1]} \int_{\widetilde{y}}^{k+1} u^*(x, y)dy \right\}$$

defines the set of thresholds the physician would prefer, if all were available to him.

PROPOSITION 3. *i. If u^* is (weakly) increasing with y, then, for all $x \in (x_-, x_+)$, $\widehat{y}(x) \in \widetilde{Y}(x)$.*

ii. There does not exist u^* that is strictly increasing and continuous with x and y.

Proof. See appendix. ■

Part (i) states that for truthful reporting to be an equilibrium, the physician must have the same preferences as the patient's family (and not the patient) at least for $x \in (x_-, x_+)$. In fact, in general, it does not follow that if the physician has the same preferences as the patient, he will report truthfully (provided $\alpha \neq 1$). The argument is that a sophisticated physician, who has the same preferences as the patient, might be afraid to fully disclose what he knows out of fear of what the patient's family, who has different incentives, might do.[11]

Part (ii) adds that, in general, there must be some discontinuity in the physician's preferences for truthful reporting to be an equilibrium. The intuition is easy to understand by taking another look at Figure 1. From (i), it must be that the physician has the same preferred threshold as the family, at least when $x \in (x_-, x_+)$, which is represented by the blue line. If one is close enough to x_- from the left and the physician's preferences are continuous, it has to be that his preferred threshold is close to $\hat{y}(x_-)$. But if that is the case, when the physician is of such a type, he would prefer to report x_- instead, because reporting truthfully would lead to the patient requesting VE or PAS regardless of y.

Part (ii) implies that it is virtually impossible to design a mechanism that provides incentives for physicians to truthfully report their diagnosis, unless such efforts target honesty directly (e.g., by having some type of supervision over the patient/doctor interaction). In the states where euthanasia and/or assisted suicide are legal, there generally is some type of requirement that the patient is advised by multiple physicians, but it is also the case that, often times, failure to satisfy such requirements leads to no punishment, which questions the role of such safeguards (Golden and Zoanni (2010)).

If the Physician is Aligned with the Family. Proposition 3 does not allow for the categorical statement that the patient is better off if physician has the family's best interests in mind rather than the patient's. First, because it only refers to conditions for honesty by the physician, which does not necessarily imply that the patient's expected utility is maximized; and second because if there is no truthful equilibrium, it is not clear whether the same intuition follows for other equilibria. So there is the need to analyze these other equilibria. As we have alluded to above, one may look at this problem by thinking of the physician as an expert with information about x, and the family as the decision maker, making a decision about the threshold over y below which the patient requests VE or PAS. Such a setup is very similar to standard cheap talk models with a continuous decision variable, and leads to a multitude of equilibria–see Crawford and Sobel (1982). By assuming a specific functional form for the physician's preferences, in particular $u^d(x, y) = x + \beta y$, where $\beta > 0$, we illustrate by way of example, in Figure 3, that neither making β closer to α or 1 always increases the patient's expected utility. In fact, it does seem as although the optimal β would be somewhere in the middle, at least for the particular set of parameters chosen. The details on how to build the equilibria, which essentially follow Crawford and Sobel (1982), are described in the appendix, as well the equilibrium selection criterion used.[12]

Figure 4 displays the equilibrium outcome for the case when $\beta = \alpha = \frac{1}{2}$—patient and physician have the same preferences—with the parameterization used to construct Figure 3. In this equilibrium, there are four distinct messages sent by the physician depending on the value of x. If $x < \gamma^1$, the physician sends a message that leads to the patient requesting VE or PAS regardless of y. If $x \in (\gamma^1, \gamma^2)$, the physician sends a message that leads to the patient requesting VE or PAS only if the family sends message $m_y = yes$ (which it does if y is sufficiently large). If $x \in (\gamma^2, \gamma^3)$, the same happens except that the family is less likely to report $m_y = yes$. Finally, if $x > \gamma^3$, the physician sends a message after which the patient always chooses not to request VE or PAS.

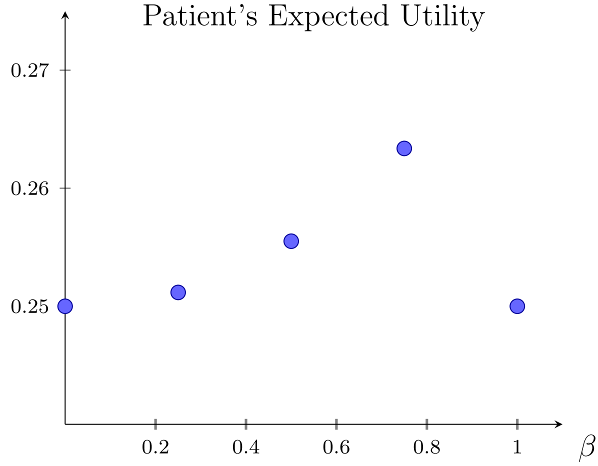
If the Physician Does Not Care About the Family's Burden. If the physician does not care about the family's burden, then there is some function $v^d : [\underline{x}, \overline{x}] \to \mathbb{R}$ such that $u^d(x, y) = v^d(x)$ for all (x, y). These preferences seem particularly pertinent, because there is evidence showing that physicians underestimate the importance of not being a burden has for their patients—see the related literature section; in particular, the discussion over Steinhauser et al. (2000).

One relevant case is when either $v^d(x) > 0$ for all $x \in [\underline{x}, \overline{x}]$ or $v^d(x) < 0$ for all $x \in [\underline{x}, \overline{x}]$, which

11. The formal argument of the proof is similar to Melumad and Shibano (1991) and follows because the physician's expected utility, conditional on the decisions of the family and of the patient, is single peaked with respect to the physician's report. If, by reporting truthfully the physician does not get his preferred threshold, he always has a better alternative available by either deviating slightly to the left or to the right on his report.

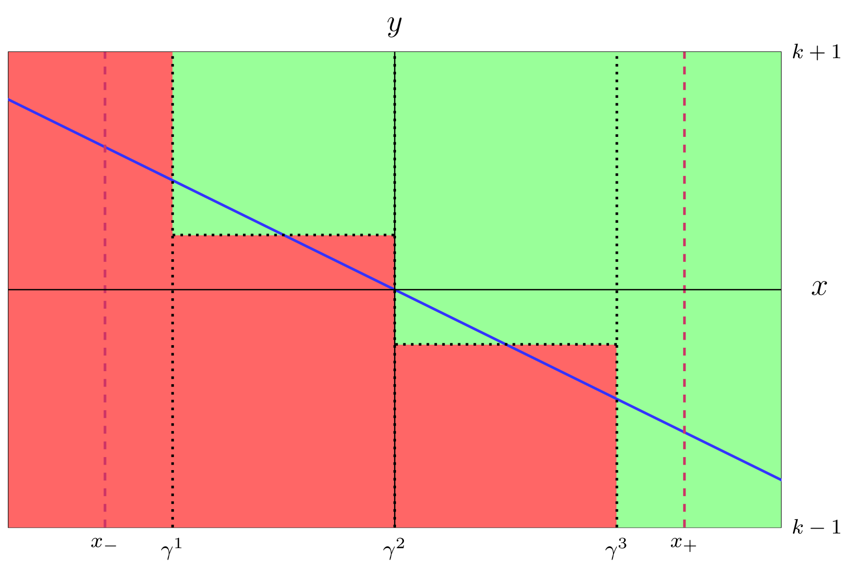
12. It is worth pointing out that this result crucially depends on the assumption that the patient is honest and relays every information he has to his family. If the patient was strategic and if the physician's preferences were equal to the patient's, the physician would always have an incentive to (privately) report truthfully to the patient, because the patient would only share this information with his family when advantageous.

FIGURE 3
Patient's Expected Utility in Equilibrium for 5 Values of β



Note: We have assumed that $\alpha = \frac{1}{2}$, $k = 0$, and $x \sim U(-1, 1)$. If $\beta = \frac{3}{4}$, the expected utility of the patient is larger than $\beta = \frac{1}{2}$ (when the physician has the same utility as the patient) and $\beta = 1$ (when the physician has the same utility as the family).

FIGURE 4
Description of τ for the Equilibrium Depicted in Figure 3, when $\beta = \alpha = 0.5$

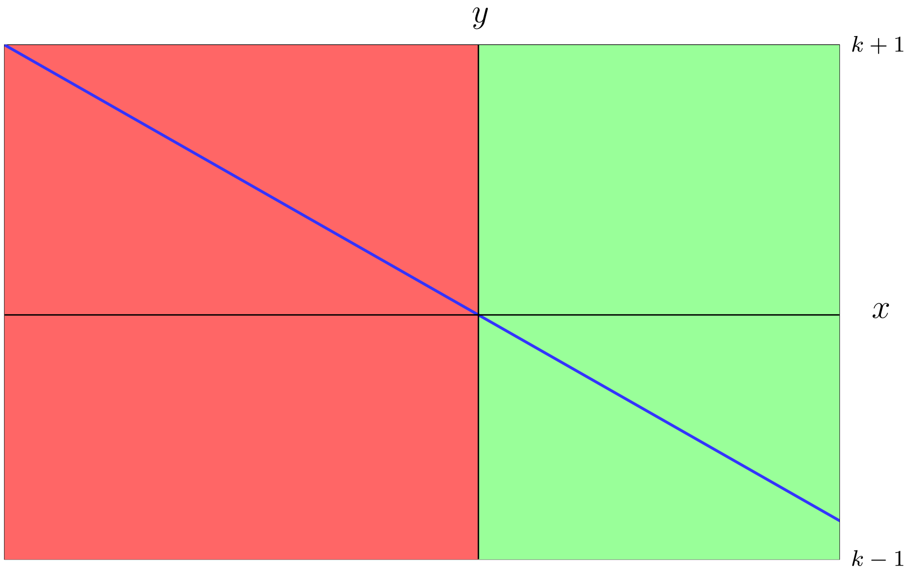


Note: The solid blue line represents the patient's indifference line.

might happen, for example, if the physician is morally opposed to VE and PAS and does not want the patient to request it, regardless of his condition. In this case, it trivially follows that there is no informative communication from the physician to the patient, as the physician would either prefer to report whatever message leads to the lowest or the largest probability that the patient requests VE or PAS. Therefore, the patient will be forced to decide without having

FIGURE 5

The Unique Equilibrium τ Where the Physician's Message is Informative under the Assumption that $v^d(x) > 0$ for all $x > 0$ and $v^d(x) < 0$ for all $x < 0$



any information about x, that is, having only a vague idea of what to expect from the last few months of life. However, the patient might have some information about y provided by the family. For example, if $E(x) = 0$, the family sends message $m_y = yes$ message if $y < 0$ and a $m_y = no$ message if $y \geq 0$, and the patient follows that advice. Therefore, the patient ends up requesting VE or PAS if and only if $y < 0$, that is, we go from the patient *also* caring about being a burden to the patient *only* caring about being a burden.

The other interesting case is when $v^d(x) > 0$ for all $x > 0$ and $v^d(x) < 0$ for all $x < 0$. This represents the case where the physician prefers the patient to request VE or PAS if and only if $x < 0$, which is what the patient would have preferred if he was not concerned about the impact of his decision on his family. In equilibrium, when $x < 0$, the physician prefers the patient to request VE or PAS and so he will select the message that leads to the largest probability that the patient requests VE or PAS. If $x > 0$, the opposite happens. Therefore, if $\underline{x}$ is sufficiently small and $\overline{x}$ is sufficiently large, the only equilibrium where the physician's message is informative is the one represented in Figure 5, where the patient requests VE or PAS if and only if $x < 0$. Notice that the physician ends up getting exactly the outcome he desires, which is also the outcome the patient would have preferred had he chosen to ignore the impact on his family. Even though this may seem like a good thing, at least for those who believe that choosing to request VE or PAS to avoid burdening one's family is not a good enough reason, it contains in itself a perversity towards the patient. If neither VE nor PAS are legal, there is no reason for the physician not to be completely honest about the patient's condition and what he should expect, as there is no decision for the patient to make. But, by allowing VE or PAS, a physician who is only concerned with the wellbeing of his patient in the sense described, is bound to transmit much less information to the patient. In particular, in the case of Figure 5, the physician goes from being honest about what the patient should expect from his condition to a simple recommendation on a course of action. This might leave the patient with a sense of insecurity and fear that is the result of the lack of information he receives.

VI. CONCLUSION

In this paper, we use the tools of microeconomic theory to study the communication patterns that would be established between patients, families, and physicians if VE or PAS were legalized. Although ours is a positive analysis, we believe that there are relevant insights to the ongoing normative debate around the legalization of VE&PAS. In particular, by analyzing how the information flows from physicians and families to patients, we are able to identify what we would characterize as unintended consequences of legalizing VE or PAS, some of which have already been publicly discussed in the literature.

One of the main concerns with legalizing VE or PAS is that patients will choose to request VE or PAS because they feel pressured into doing it either by society in general or by their families in particular (Hardwig 2013).[13] In our paper, we formalize this notion. In the first part of the paper, under the assumption that the physician is honest, we have shown that, provided there is an informative equilibrium, the patient follows the advice of his family, that is, he requests VE or PAS if and only if his family sends him message $m = yes$. Naturally, the labels on the messages do not need to be expressed literally by the patient's family; it is difficult to imagine a family directly telling a patient that he should request VE or PAS. What matters is how such messages are interpreted by the patient; in particular, whether he interprets a "yes" as the family acquiescing to his desire to end his life. Such interactions do not seem so farfetched if VE or PAS are legalized and commonplace:

> *Family members may want a loved one to remain alive as long as possible, while also harboring secret desires to be done with this painful process. Many people today are ashamed of such secret desires. … But if assisted suicide becomes legal, such desires will cease to be wrongful in such an obvious way. If patients themselves may decide to put an end to this painful process of dying, then it is not blameworthy for relatives of such a patient to inquire whether he or she may be thinking along these lines, and to offer sympathetic support for the idea. … Once assisted suicide ceases to be illegal, its many advantages to busy relatives will become readily apparent. More than merely an acceptable form of ending, relatives and friends may come to see it as a preferred or praiseworthy form of death.*
>
> Mann (2015)

Our analysis also reinforces the idea that families have considerable power over patients. As we show in Section IV, if there is an informative equilibrium, the patient does exactly what his family would have wanted and not necessarily what he would have preferred had he had the same information the family has. Put differently, suppose that the family holds some private information that, if made public, would make the patient choose differently than what the family would have wanted. What we find is that in any informative equilibrium, the family will keep part of that information private, which will actually make the patient take the action the family prefers. This result suggests that there is not a large difference between VE, where the patient has final say, and a form of involuntary euthanasia, where the patient's family has the power, because, even when the patient formally has the power, it is as if the patient's family is making the decision on account of being better informed.

Finally, one last argument that has been made against the legalization of VE&PAS is that the relationship between patients and physicians might become strained.

> *Trust will suffer profoundly in more subtle ways. Should physician-assisted suicide become a legal option, it will enter unavoidably – sometimes explicitly, sometimes tacitly – into many doctor-patient encounters.... Ineluctably, patients will now be forced to wonder about their doctor, regardless of how he handles the situation (of presenting the patient with the option of assisted suicide). Did he introduce the subject because he secretly or unconsciously wishes to abandon me, or worse, because he wishes I were dead? Does he avoid the subject for the same reasons, fearing to let me suspect the truth, or conversely, is it because he wants me to suffer.... Anyone who has experienced the subtle psychodynamics of the doctor-patient relationship should see immediately the corrosive effects of doubt and suspicion that will be caused by explicit (or avoided) speech about physician-assisted death.*
>
> Lund (1997)

In this paper, we formalize this idea. As we show in Section V, legalization of VE or PAS would inevitably lead to physicians being less than completely honest with their patients, which would result in patients being much less informed about their condition than what they would have been otherwise. This loss of information, in turn, is relevant because (a) it might hinder the patient's ability to make future decisions and (b) it has a direct negative impact on the patient' mental health; Steinhauser et al. (2000) document that the following were among the most

13. Caretakers might be particularly tempted to offer support for the early termination of life as they are especially affected by the patient's condition and frequently see their own health deteriorate (Hopps et al. 2017).

important factors for terminal patients: "having someone to talk to," "trusting one's physician," and "being able to discuss with him all issues regarding the end of life." Therefore, this last unintended consequence of legalizing VE or PAS suggests that the typical utilitarian argument that it cannot harm to legalize VE or PAS because no one is forced to request it deserves more scrutiny and debate. We end the paper with a simple example that shows that the legalization of VE or PAS can actually make the patient worse off, provided his value for information is large.

Example 3 Consider the interaction between the patient and his physician only (assume that $y = 0$ and is publicly known). The physician, privately informed of x, sends a cheap talk message m_x to the patient, who then chooses whether to request VE or PAS. Take the physician's utility to be $u^d(x) = x - x^*$, with $x^* \neq 0$, if the patient does not request VE or PAS, and 0 if he does.

Suppose the patient is affected by how transparent the physician is. In particular, imagine that, after receiving the physician's message, the patient experiences a loss of $\delta\widehat{Var}$, where $\delta \geq 0$ and $\widehat{Var}$ represents the posterior variance of x, conditional on the physician's message. If the physician is transparent (if the physician always reports $m_x = x$), then $\widehat{Var} = 0$, while if there is no information transmitted (in the case of the "babbling" equilibrium) then $\widehat{Var} = Var(x)$. This loss is irrelevant for the patient's decision as it occurs regardless of it and is merely a function of the physician's actions, that is, assume that $u^p = x - \delta\widehat{Var}$ if the patient does not request VE or PAS, while, if he does, his utility is given by $-\delta\widehat{Var}$. It follows that the patient requests VE or PAS if and only if $E(x|m_x) < 0$, which implies that the set of (perfect Bayesian) equilibria is the same for all δ, and is the one characterized in Section IV: there are essentially two equilibria.

By assuming that $x \sim U(-1, 1)$ and $x^* \in (-1, 1)$, it is easy to calculate the expected utility of each of them. The uninformative equilibrium, where the physician sends the same message regardless of x, leads to the patient being indifferent between requesting and not requesting VE or PAS and results in an expected utility of $-\delta Var(x) = -\frac{\delta}{3}$. The informative equilibrium, where the physician sends message $m = yes$ if $x < x^*$ and $m = no$ otherwise, is such that the patient requests VE or PAS if and only if $x < x^*$. His expected utility is then given by

$$\Upsilon(x^*, \delta) = -\frac{1}{2}\int_{-1}^{x^*} \delta Var(x|yes)d\widetilde{x} + \frac{1}{2}\int_{x^*}^{1} (\widetilde{x} - \delta Var(x|no))d\widetilde{x}$$

$$= \frac{1-(x^*)^2}{4} - \frac{\delta}{24}[(x^*+1)^3 + (1-x^*)^3].$$

Notice that the informative equilibrium is always preferred to the uninformative one as it leads to a more informed decision and less uncertainty, that is, for any $\delta \geq 0$ and $x^* \in (-1, 1)$, $\Upsilon(x^*, \delta) \geq -\frac{\delta}{3}$. What is more interesting is the comparison between $\Upsilon(x^*, \delta)$ and the expected utility of the agent if VE or PAS were not legal. In that case, there would be no reason for the physician not to report truthfully, so that the expected utility of the patient would be 0. It is then clear that if $\delta = 0$, legalizing VE or PAS increases the expected utility of the patient because $\Upsilon(x^*, 0) > 0$ for all $x^* \in (-1, 1)$. However, if $\delta > 0$, that may no longer be the case. In particular, for all $x^* \in (-1, 1)$, there is $\delta > 0$ such that $\Upsilon(x^*, \delta) < 0$.

APPENDIX A

A.1. DEFINITIONS (SECTION IV)

If, as is standard in cheap talk games, one was to allow mixed strategies by both players, a strategy for the family would be $\sigma^f : [\underline{y}, \overline{y}] \to \Delta M_y$ and a strategy for the patient would be $\sigma^p : M_y \to [0, 1]$, where $\sigma^p(m_y)$ represents the probability that the patient requests VE or PAS after observing m_y.

DEFINITION 1. *A PBE is composed of a strategy profile* (σ^f, σ^p) *and a belief function* $g_y : M_y \to \Delta[\underline{y}, \overline{y}]$, *and is such that (i) for all* $m_y \in M_y$,

$$\int_{\underline{y}}^{\overline{y}} f_y(y')\sigma^f(y')(m_y)dy' > 0 \Rightarrow g_y(m_y)(\widetilde{y}) = \frac{f_y(\widetilde{y})\sigma^f(\widetilde{y})(m_y)}{\int_{\underline{y}}^{\overline{y}} f_y(y')\sigma^f(y')(m_y)dy'}$$

for all $\widetilde{y} \in [\underline{y}, \overline{y}]$, *(ii) for all* $(y, m_y) \in [\underline{y}, \overline{y}] \times M_y$,

$$\sigma^f(y)(m_y) > 0 \Rightarrow m_y \in \arg\max_{m' \in M_y} \{(1 - \sigma^p(m'))(x + y)\},$$

(iii) for all $m_y \in M_y$,

$$\sigma^p(m_y) \in \arg\max_{a \in [0,1]}\{(1-a)(x + \alpha\mu_y(m_y))\},$$

where

$$\mu_y(m_y) \equiv \int_{\underline{y}}^{\overline{y}} y' g_y(m_y)(y')dy'.$$

An allocation is a mapping $\tau : [\underline{x}, \overline{x}] \times [\underline{y}, \overline{y}] \to [0, 1]$ where $\tau(x, y)$ represents the probability that the patient requests VE or PAS.

LEMMA 1. *Let $T_y(M_y)$ denote the set of allocations that are induced by some PBE for a given message set M_y. $T_y(\{yes, no\}) = T_y(M_y)$ for all M_y that contains at least two elements, as long as $\alpha \neq 1$ and $x \neq 0$.*[14]

Proof. First, notice that if there is a PBE where two messages induce the same decision by the patient (m_y and m'_y such that $\sigma^p(m_y) = \sigma^p(m'_y)$ it is possible to eliminate one of them, while shifting its weight to the one that remains, and still obtain the same outcome. Therefore, one may assume that all messages in a PBE lead to a different decision.

Next, notice that all family types $y > -x$ prefer the same message from the ones available—the one with the lowest probability of requesting VE or PAS, while all family types $y < -x$ prefer the same message but now it is the one with the largest probability of requesting VE or PAS. This means that it is possible to restrict attention to message sets with at most three messages.

Finally, if there are exactly three messages sent in a PBE, it must be that one of them is sent only by type $y = -x \in (k-1, k+1)$. Because $\alpha \neq 1$ and $x \neq 0$, upon receiving such message, the patient would not be indifferent, which means that the probability of requesting VE or PAS would be either 0 or 1. But in that case, one of the other groups would also strictly prefer to send that message, which contradicts the message being sent only by type $y = -x$. ■

Lemma 1 shows that, as long as the preferences of the patient and of the family are different, one can restrict attention to the set of PBEs where only two messages are available to the family: $m_y = yes$ and $m_y = no$. Without loss of generality, we assume that $\sigma^p(yes) \geq \sigma^p(no)$.

As discussed in the text, a babbling PBE always exists. For there to be an informative PBE where $\sigma^p(yes) > \sigma^p(no)$ and both messages are sent with positive probability, it must be that the $m_y = yes$ message is sent by types $y < \hat{y}(x)$ and the $m_y = no$ message is sent by types $y > \hat{y}(x)$, where $\hat{y}$ is defined in the text. Therefore, it follows that

$$x + \alpha E(y|y > \hat{y}(x)) \neq 0 \neq x + \alpha E(y|y < \hat{y}(x))$$

for almost every $x \in [\underline{x}, \overline{x}]$, that is, the patient is almost never indifferent. Hence, without loss of generality, we can assume that the patient follows a pure strategy as is assumed in the text. The family also strictly prefers one of the two messages except when $y = -x$, so that it is also without loss of generality that the family follows a pure strategy.

Given that there could be multiple PBEs we use the refinement of "neologism proofness" introduced by Farrell (1993). Loosely speaking, a PBE is *not* neologism proof if (i) for some set of $y-$ types, the family strictly prefers to send a message that is not sent in the PBE, as long as the patient is able to correctly identify this; and (ii) no other $y-$ type outside of such set has an incentive to send that same message. We show in Lemma 2 that, in this context, a PBE is neologism proof if it is informative or if there is no informative PBE.

LEMMA 2. *i. For all $x \in [\underline{x}, \overline{x}]$ such that the informative PBE exists, it is neologism proof.*

ii. The uninformative PBE is neologism proof if and only if the informative PBE does not exist.

Proof.

i. Consider an x for which the informative PBE exists. There must not be any neologism available for each family type that makes the family strictly better off, as the family is already getting its maximum expected payoff.

ii. Consider any x for which the informative PBE exists and consider neologisms $A = \{y : y > -x\}$ and $B = \{y : y < -x\}$. Suppose first that, for the given x, the uninformative equilibrium leads to the patient requesting VE or PAS. Given that an informative equilibrium exists, upon receiving the neologism A, the patient would prefer not to request VE or PAS. This is strictly preferred by all elements of A, while all nonmembers of A weakly prefer the patient to request VE or PAS. Thus, the noninformative PBE is not neologism proof. The same argument goes for the case when the uninformative equilibrium leads to the patient not requesting VE or PAS by using neologism B.

If the informative PBE does not exist, neither does a deviating neologism. Without loss of generality, suppose that the uninformative PBE leads to the patient requesting VE or PAS. If there was a neologism that would lead to some other outcome it would be strictly preferred by all elements of A. Hence, by the definition, the only possible neologisms that lead to deviations are A and B, which are only believed if an informative equilibrium exists. ■

A.2. DEFINITIONS (SECTION V)

We directly assume that each player follows a pure strategy so that $\sigma^p : [\underline{x}, \overline{x}] \to M_x, \sigma^d : M_x \times [k-1, k+1] \to M_y = \{yes, no\}$, and $\sigma^d : [\underline{x}, \overline{x}] \to M_x$. We also assume that

$$\underline{x} < x_- = -\frac{\alpha(1+k)}{2-\alpha} < x_+ = \frac{\alpha(1-k)}{2-\alpha} < \overline{x}.$$

DEFINITION 2. *An equilibrium is composed of a strategy profile ($\sigma^d, \sigma^f, \sigma^p$) and belief functions $g_x : M_x \to \Delta([\underline{x}, \overline{x}])$ and $g_y : M_x \times M_y \to \Delta([k-1, k+1])$, and is such that*

i. for all $m_x \in M_x$ such that

$$\int_{\underline{x}}^{\overline{x}} f_x(x')\mathbf{1}\{\sigma^d(x') = m_x\}dx' > 0,$$

it follows that

$$g_x(m_x)(\tilde{x}) = \frac{f_x(\tilde{x})\mathbf{1}\{\sigma^d(\tilde{x}) = m_x\}}{\int_{\underline{x}}^{\overline{x}} f_x(x')\mathbf{1}\{\sigma^d(x') = m_x\}dx'}$$

for all $\tilde{x} \in [\underline{x}, \overline{x}]$,

ii. for all $(m_x, m_y) \in (M_x, M_y)$ such that

$$\int_{\underline{x}}^{\overline{x}} \int_{k-1}^{k+1} f_x(x')\mathbf{1}\{(\sigma^d(x'), \sigma^f(m_x, y')) = (m_x, m_y)\}dx'dy' > 0,$$

it follows that

$$g_y(m_x, m_y)(\tilde{y}) = \frac{\mathbf{1}\{\sigma^f(m_x, \tilde{y}) = m_y\}}{\int_{k-1}^{k+1} \mathbf{1}\{\sigma^f(m_x, y') = m_y\}dy'}$$

for all $\tilde{y} \in [k-1, k+1]$,

14. If $x = 0$ it is easy to show, by simply following the proof of Lemma 1, that one can restrict attention to three messages, where the third message is sent only by type $y = 0$.

iii. for all $m_x \in M_x$,

$$\mu_x(m_x) \equiv \int_{\underline{x}}^{\overline{x}} x' g_x(m_x)(x')dx',$$

and for all $(m_x, m_y) \in M_x \times M_y$,

$$\mu_y(m_x, m_y) \equiv \int_{k-1}^{k+1} y' g_y(m_x, m_y)(y')dy',$$

iv. for all $(m_x, m_y) \in M_x \times \{\text{yes, no}\}$,

$$\sigma^p(m_x, m_y) = \begin{cases} 1 \text{ if } \mu_x(m_x) + \alpha\mu_y(m_x, m_y) < 0 \\ 0 \text{ if } \mu_x(m_x) + \alpha\mu_y(m_x, m_y) \geq 0 \end{cases},$$

v. for all $(m_x, y) \in M_x \times [k-1, k+1]$,

$$\sigma^f(m_x, y) = \begin{cases} \textit{yes if } \mu_x(m_x) \in [x_-, x_+] \textit{ and } y < -\mu_x(m_x) \\ \textit{no if } \mu_x(m_x) \in [x_-, x_+] \textit{ and } y \geq -\mu_x(m_x) \\ \textit{no if } \mu_x(m_x) \notin [x_-, x_+] \end{cases}, \textit{ and}$$

vi. for all $x \in [\underline{x}, \overline{x}]$,

$$\sigma^d(x) \in \arg\max_{m_x \in M_x} V(x, z(m_x)),$$

where

$$V(x, z) = \frac{1}{2}\int_z^{k+1} u^d(x, y)dy$$

and

$$z(m_x) = \begin{cases} k+1 \textit{ if } \mu_x \notin [x_-, x_+] \textit{ and } \mu_x + \alpha k < 0 \\ -\mu_x(m_x) \textit{ if } \mu_x(m_x) \in [x_-, x_+] \\ k-1 \textit{ if } \mu_x \notin [x_-, x_+] \textit{ and } \mu_x + \alpha k \geq 0 \end{cases}.$$

A.3. PROOF OF PROPOSITION 3

i. Fix any $\alpha \in (0, 1)$ and take $x \in (x_-, x_+)$ Notice that $\widetilde{Y}(x)$ is always a nonempty interval, for any u^*. Suppose $\widehat{y}(x) \notin \widetilde{Y}(x)$ so that there is $y' \in \widetilde{Y}(x)$ such that $y' \neq \widehat{y}(x)$. Let $x' \equiv -y'$. If $x' \in [x_-, x_+]$, then the physician strictly prefers to report x' over x, which is a contradiction to truthful reporting. If $x' < \underline{x}$, the difference between reporting x_- and reporting x is given by

$$\int_{\widehat{y}(x_-)}^{k+1} u^*(x, y)dy - \int_{\widehat{y}(x)}^{k+1} u^*(x, y)dy = -\int_{\widehat{y}(x)}^{\widehat{y}(x_-)} u^*(x, y)dy > 0$$

where the last inequality follows because $u^*(x, y) \leq 0$ for all $y \leq \widehat{y}(x_-)$ and $u^*(x, y) < 0$ for all y that is sufficiently close to $\widehat{y}(x)$. This contradicts truthful reporting by the physician. The same reasoning applies if $x' > x_+$, using x_+ as the deviating report.

ii. If u^* is strictly increasing with x and y, it implies that, for all $x \in [\underline{x}, \overline{x}]$, $\widetilde{Y}(x) = \{\widetilde{y}(x)\}$ for some $\widetilde{y}(x) \in [k-1, k+1]$. Recall that $u^*(x, y) > 0$ for all $y > \widetilde{y}(x)$. By continuity of u^*, it follows that $\widetilde{y}(x)$ must be continuous for all $x \in [\underline{x}, \overline{x}]$. Finally, using (i), it follows that $\widetilde{y}(x) = \widehat{y}(x)$ for all $x \in [x_-, x_+]$. Notice that, for all

$$\varepsilon \in \left(0, \int_{\widehat{y}(x_-)}^{k+1} u^*(x_-, y)dy\right)$$

there is $\widetilde{x} < x_-$, such that

$$\int_{\widehat{y}(x_-)}^{k+1} u^*(\widetilde{x}, y)dy > \int_{\widehat{y}(x_-)}^{k+1} u^*(x_-, y)dy - \varepsilon > 0$$

which is a contradiction, because the physician of type $\widetilde{x}$ would prefer to report x_-. The same reasoning applies to $x > x_+$ and so the result follows.

A.4. FIGURE 3—DETAILS

In the construction of Figure 3, we have assumed that $u^d(x, y) = x + \beta y$, where $\beta > 0$. Recall that

$$x_- = -\frac{\alpha(k+1)}{2-\alpha} \quad \text{and} \quad x_+ = \frac{\alpha(1-k)}{2-\alpha}.$$

Let $\mu_x(m_x)$ be the conditional expectation of x after m_x is observed and recall that the family's behavior only depends on $\mu_x(m_x)$. Notice that, for all $z \in [k-1, k+1]$,

$$V(x, z) = \frac{1}{2}\int_z^{k+1} (x + \beta y)dy,$$

where

$$z(m_x) = \begin{cases} k+1 \text{ if } \mu_x(m_x) < x_- \\ -\mu_x(m_x) \text{ if } \mu_x(m_x) \in [x_-, x_+] \\ k-1 \text{ if } \mu_x(m_x) > x_+ \end{cases}.$$

Therefore, it follows that, without loss of generality, one can restrict attention to equilibria where at most one message is sent that generates a conditional expectation below (above) x_- (x^+).

LEMMA 3. In equilibrium, if there are $m'_x, m''_x \in M_x$ sent with positive probability such that $x_- \leq \mu_x(m''_x) < \mu_x(m'_x) \leq x_+$, then, for any $\widehat{x} \in [\underline{x}, \overline{x}]$ for which $\sigma^d(\widehat{x}) = m'_x$, it follows that $\sigma^d(x) \neq m''_x$ for all $x > \widehat{x}$.

Proof. The result follows because

$$V(\bullet, z(m'_x)) - V(\bullet, z(m''_x))$$

is strictly increasing for all $x \in [\underline{x}, \overline{x}]$. ■

The previous lemma allows us to restrict attention to equilibria where message m_x is sent by an interval of x types. In Crawford and Sobel (1982), this leads to partition equilibria because the preferences of sender and receiver are assumed to be different for any value of the private information of the sender. However, in this case, if $x = 0$, physician and family have the same preferences, which is why it is possible to have equilibria with infinitely many such intervals.

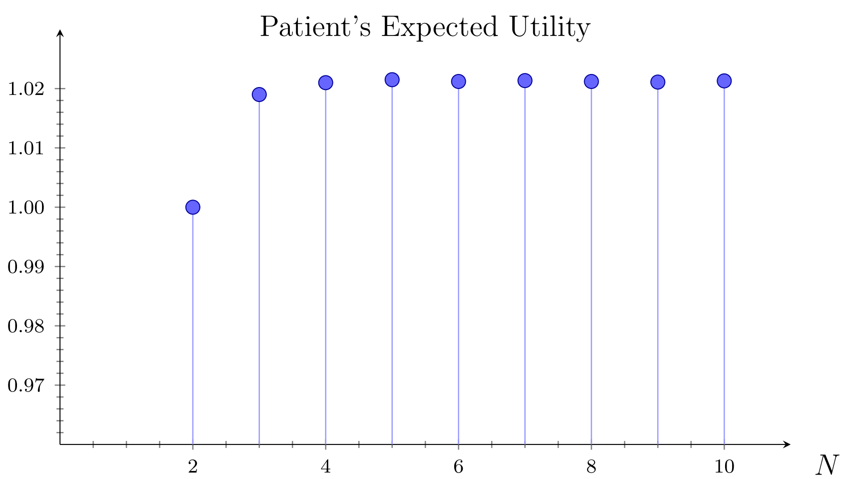
If $\underline{x}$ is sufficiently small and $\overline{x}$ is sufficiently large, an equilibrium always exists where, for all $x < -\beta k$, the physician reports $\underline{m}$ and if $x > -\beta k$ reports $\overline{m}$; the family always sends an uninformative message, and the patient chooses to request VE or PAS after receiving message $\underline{m}$ and not to after receiving $\overline{m}$. This equilibrium then entails two reporting intervals for the physician.

TABLE A1
Thresholds as a Function of N

N	γ^1	γ^2	γ^3	γ^4	γ^5	γ^6	γ^7	γ^8	γ^9
2	0								
3	−0.25	0.25							
4	−0.2857	0	0.2857						
5	−0.2916	−0.0416	0.0416	0.2916					
6	−0.2926	−0.0487	0	0.0487	0.2926				
7	−0.2928	−0.05	−0.0071	0.0071	0.05	0.2928			
8	−0.2928	−0.0502	−0.0083	0	0.0083	0.0502	0.2928		
9	−0.2928	−0.0502	−0.0085	−0.0012	0.0012	0.0085	0.0502	0.2928	
10	−0.2928	−0.0502	−0.0086	−0.0014	0	0.0014	0.0086	0.0502	0.2928

FIGURE A1

Expected Utility of the Patient as N Grows, under the Assumption that $\beta = 0.5$



Now, consider an equilibrium with $N > 2$ intervals, with $N-1$ indifference points, denoted by $\{\gamma^n\}_{n=1}^{N-1}$. Assuming that $x \sim U(\underline{x}, \overline{x})$, it must be that

$$V(\gamma^1, k+1) = V\left(\gamma^1, -\frac{\gamma^1 + \gamma^2}{2}\right). \tag{A1}$$

$$V\left(\gamma^n, -\frac{\gamma^{n-1} + \gamma^n}{2}\right) = V\left(\gamma^n, -\frac{\gamma^n + \gamma^{n+1}}{2}\right) \quad \text{for all } n \in \{2, N-2\}. \tag{A2}$$

$$V\left(\gamma^{N-1}, -\frac{\gamma^{N-2} + \gamma^{N-1}}{2}\right) = V(\gamma^{N-1}, k-1). \tag{A3}$$

For the equilibrium to exist it must also be that

$$-\frac{\gamma^1 + \gamma^2}{2} \geq x_-. \tag{A4}$$

$$-\frac{\gamma^{N-2} + \gamma^{N-1}}{2} \leq x_+. \tag{A5}$$

together with the assumptions that $\underline{x}$ is small enough so that $\frac{\gamma^1 + \underline{x}}{2} < x_-$ and that $\overline{x}$ is large enough so that $\frac{\gamma^{N-1} + \overline{x}}{2} > x_-$.

The expected utility for the patient in an equilibrium with $N > 2$ intervals is given by

$$\frac{1}{2(\overline{x} - \underline{x})}\left[\sum_{n=1}^{N-2} \int_{\gamma^n}^{\gamma^{n+1}} \int_{-\frac{\gamma^n + \gamma^{n+1}}{2}}^{k+1} (x + \alpha y) dy dx + \int_{\gamma^{N-1}}^{\overline{x}} \int_{k-1}^{k+1} (x + \alpha y) dy dx\right].$$

In the construction of Figure 3, we have assumed that $\alpha = \frac{1}{2}$, $k = 0$, $\underline{x} = -1$ and $\overline{x} = 1$. For each value of β there are infinitely many equilibria - one for each N. Consider, as an illustration the case where $\beta = \frac{1}{2}$. Table A1 illustrates how the thresholds change when N increases.

It is possible to see that, as N grows, an increasing number of intervals fit into a very small interval around 0 and so the increment in the expected utility of increasing N quickly converges to 0. Figure A1 confirms that the expected utility of the patient is more or less constant after a small value of N.

For all other parameters except $\beta = 1$, the pattern is the same, and so the equilibria we have used to build Figure 3 is the one with $N = 6$, precisely because the changes for larger N are very small numerically. When $\beta = 1$, there is no equilibrium for $N > 4$, and so we use $N = 4$ to obtain the corresponding expected utility.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. Supporting Information.