

Patient Preferences for Depression Treatment Programs and Willingness To Pay for Treatment: Heterogeneity and Anhedonia

Short title: Patient Preferences for Depression Treatment Programs

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Abstract

Background: Current estimates of the societal costs of depression do not include estimates of how much individuals diagnosed with Major Depressive Disorder (MDD) would be willing to pay to eliminate their depression or how much they would have to be paid in order to accept continued depression. Choice experiment data and discrete-choice random-utility models provide a useful method for valuing changes in mental health and mental-health treatment programs.

Aims of the study: (1) To demonstrate how choice questions and discrete-choice random-utility models can be used to estimate preferences over treatment programs for depression and willingness-to-pay (*WTP*) to eliminate depression. (2) To model and estimate the magnitude of the anhedonia impact of depression: consumption provides less utility when one is depressed. (3) To model heterogeneity in preferences for treatment programs for depression. (4) To derive preliminary estimates of *WTP* and willingness-to-accept (*WTA*) for eliminating and reducing depression, both with, and without side effects.

Methods: The data are from a choice experiment survey of 104 individuals diagnosed with a new episode of MDD. Individuals indicated their preferred treatment from options that varied in effectiveness, hours of psychotherapy per month, use of anti-depressants, money costs, and side effects (weight gain, little or no interest in sex, inability to orgasm). Choices over treatment alternatives, including no treatment, were modeled using a discrete-choice random-utility model. Preference parameters were estimated using maximum likelihood estimation.

Results and Discussion: Estimated *WTP* to eliminate MDD is large but side effects can substantially reduce *WTP*. Preferences over treatment programs, and *WTP*, vary as a function of the individual's age, gender, income category, body-mass-index, and family composition. Some depressed individuals seeking treatment have a high estimated probability of choosing no treatment. Depression has both a direct and indirect effect on utility. The indirect effect on utility (the anhedonia effect), where the utility from consumption varies with emotional state, causes a divergence between *WTP* and *WTA*. The results may only be generalizable to those who are referred to or directly seek treatment at a mental-health clinic and should be replicated with a larger sample.

Implications: The *WTP* estimates suggest that depression imposes a high cost on society beyond the cost of treatment and the cost of lost output. Willingness-to-pay should be included in any benefit-cost analysis of whether additional societal resources should be allocated to the treatment of depression. Side effects from anti-depressants also impose a large cost on society. Estimates such as the ones reported here could provide a mechanism for better matching treatment programs to the patient and thus potentially minimizing non-adherence. The *WTP* estimates suggest that the pharmaceutical industry could earn significant revenues by making anti-depressants more effective, reducing their side effects, or both.

Key words: Choice questions, discrete-choice random-utility models, depression, treatment preferences, *WTP*, *WTA*, income effects, anhedonia

JEL classification: I190, Q510

1 Background

Major Depressive Disorder (MDD) is a widespread and chronic problem and its effective treatment is difficult and expensive. Over their lifetime, 10 to 25% of women and 5 to 12% of men will suffer from MDD. More than half of individuals who experience one episode of MDD also experience a second [1]. Over the next decade experts predict that depression will become the second leading cause of disability [2].

There are numerous studies assessing the cost of depression in terms of treatment costs and lost productivity. For example, in 1990 the direct costs of treating depression (MDD, bipolar disorder, and dysthymia) in the United States totaled approximately \$12.4 billion while the indirect costs from lost output associated with MDD and bipolar disorder were even larger at \$22.3 billion [3]. The total annual cost of depression in Europe was estimated at €118 billion in 2004 [4].¹

These types of estimates exclude the “cost” of reduced enjoyment of life. Efficient allocation of limited resources requires knowing the values that individuals place on eliminating their depression. Policymakers can use this information to make decisions about how much public money to invest in depression treatment and research. Pharmaceutical firms can use it to decide how much to invest in research and development of anti-depressants.

One would expect both willingness-to-pay (*WTP*) to eliminate MDD and willingness-to-accept (*WTA*) continued MDD to be high: living with clinical depression greatly reduces one’s quality of life. Studies have found that individuals consistently rank MDD as worse than other chronic diseases (such as asthma, diabetes, hypertension, arthritis, neurological disease, heart disease, back problems) [6], impairments to physical health [7], and in some cases view severe MDD as equivalently bad or worse than death [8].

This study has multiple aims. One is to show how choice questions and discrete-choice random-utility models can be used to estimate preferences over treatment programs for depression and thus *WTP* to eliminate depression and *WTA* continued depression. Choice experiment data and discrete-choice random-utility models are standard tools for valuing commodities and policies, and have been extensively used in many fields to estimate preferences and *WTP* [9, 10, 11, 12]. This method has not been previously used to estimate preferences, *WTP*, or *WTA* for mental health programs.

A small literature has used the standard gamble approach [8], open-ended contingent valuation questions [13], and a limited choice format [14] to learn about preferences over MDD treatment programs. With the exception of [13], the focus of these studies has been on examining how patients feel about alternate treatment methods and demographic factors that explain these preferences, not quantifying *WTP* to reduce depression. [13] estimates *WTP* to avoid certain side effects. A recent article in this journal recently advocated using surveys to estimate *WTP* for a family member’s treatment for mental illness [15]. To our knowledge, there has been no previous work that estimates *WTA* in the area of mental health.

Because of difficulties separating out patient preferences from those of the health

¹See [5] for a literature review of depression cost-of-illness studies.

care-provider, estimates of WTP are difficult to obtain from observed treatments. Estimating WTA is even more problematic. One reason to use a choice experiment survey is that the patient’s actual treatment program (the observed “choice”) does not necessarily reflect the patient’s preferences: the observed choice is the outcome of a dance between the patient, the clinician, and the insurance company. Thus, looking at actual treatment choices may not be informative about patient preferences.

A second aim of the paper is to model and estimate the magnitude of the anhedonia impact of depression. Anhedonia, the diminished interest or pleasure in almost all activities, is a hallmark of depression. In economic terms, anhedonia could be viewed as reduced utility from consumption. In this paper, we test whether, as expected, depression level reduces the utility received from consuming other goods and quantify this impact. One interesting implication of the anhedonia effect is that it results in an individual having to be paid more to accept continued depression than she is willing to pay to end her depression ($WTA > WTP$).

An additional goal is to model the heterogeneity in preferences for treatment programs for depression. The probability of choosing a specific treatment is modeled and estimated as a function of the treatment options available, and as a function of observable characteristics of the individual such as age, income, gender, and family composition. Understanding systematic ways in which preferences for treatment vary is helpful in attempts to increase patient adherence and to design new drugs.

Finally, initial estimates of WTP and WTA are reported for eliminating and reducing depression, both with, and without side effects. To our knowledge, there have been no previous attempts to quantify, in dollars, the cost of depression to those depressed. The intent is not to suggest that these are the “numbers” but to indicate possible magnitudes and the extent to which the emotional costs of depression, in dollars, vary across individuals in predictable ways. The intent is not to provide an estimate of average WTP to eliminate depression for the entire population of individuals with MDD.

An emphasis is placed on examining the impacts of side effects on choice and WTP for treatment. This is important because many studies find that patients stop taking anti-depressants soon after starting treatment (e.g. [16]). In addition, the demand for anti-depressants has been found to be positively affected by reduced side effects [17]. We consider the possibility that if the side effects are sufficiently severe, some will prefer to remain depressed. The probability of choosing no treatment is estimated for those considering treatment.

2 Methods

2.1 The population of interest and the sample

The focus of the study was on adults who suffered solely from MDD, were considering treatment, and were eligible for outpatient treatment. Eligible patients were recruited from those adults seeking treatment for a new episode of MDD at a Kaiser Permanente (HMO) outpatient, mental-health facility in Colorado. Based on consultation with the clinicians and doctors at the clinic, we excluded from our population of interest individuals who had other mental disorders (bipolar disorder,

schizophrenia, psychotic features, etc.), who possessed substance abuse problems, or who were suffering from a life-threatening physical illness. We also excluded patients assessed as suicidal, requiring inpatient care, or deemed not mentally capable of being interviewed. The study includes individuals with and without prior treatment for depression.

We focus on this population for a number of reasons. A significant share of individuals with MDD seeks treatment; for example, [18] finds that 57% of individuals with MDD seek treatment. The focus of our study is on learning more about the characteristics of treatment that are important to patients when considering treatment and quantifying the value patients place on ending their depression, rather than on examining barriers that prevent patients from seeking treatment. Kaiser Permanente is the nation's largest HMO, with approximately 8.4 million members. Learning about the preferences of patients in a setting typical of how a significant number of HMO patients receive treatment can provide insight and guidance about a significant segment of the depressed population. Limiting the sample to those without co-morbidities allows for a cleaner analysis of depression treatment preferences.

All intake patients at the clinic, prior to meeting with a clinician, received a note informing them of the study. Clinicians conducted a semi-structured mental-health evaluation with each intake patient. While a formal instrument was not used to diagnose depression, this form of evaluation reflects current practice at this HMO. Clinicians were asked to use their best judgment in determining mild, moderate, or severe MDD. Clinicians were instructed by Kaiser to ask those with MDD to participate in the survey.

Surveys were administered in person to patients at the end of their intake appointment by an investigator (Jennifer Thacher), who was available to answer any questions. Kaiser Permanente provided her with an office in the clinic.

104 individuals completed the survey and provided usable data. Although several factors such as uneven clinician participation made it difficult to assess the precise number of patients who fully met the recruitment criteria, it is our sense that most individuals who were asked to participate in the study did and that a number of clinicians made serious efforts to recruit. Because intakes are randomly assigned to clinicians, we have no reason to believe that those individuals who completed our survey are unrepresentative in terms of our population of interest.

2.2 The survey instrument

The survey consisted of 37 questions, took approximately 15 minutes to complete, and consisted of four sections.² Section 1 provided background information about psychotherapy, anti-depressants, and side effects. It included questions on perceptions and attitudes about treatment. Section 2 consisted of five pair-wise choice questions and a question on the importance of each treatment characteristic in answering the choice questions. Section 3 collected demographic information and elicited information about any previous depression treatment. Section 4 asked a series of questions about the patient's experience at the clinic. The survey instrument

²The survey instruments can be found at www.unm.edu/~jthacher/DepressionSurvey.pdf.

underwent extensive testing and revisions and was pre-tested on populations at both the University of Colorado and Kaiser Permanente.

For each choice experiment, respondents chose their preferred treatment from two alternative depression treatment programs. Each question describes treatment by its effectiveness, cost, hours of psychotherapy, use of anti-depressants, and possible side effects. We allowed for three side effects: loss of sex drive, becoming non-orgasmic, and extent of weight gain. While there are other possible side effects of taking anti-depressants such as dry mouth and diarrhea, unlike the weight gain and sexual side effects, they are easily treatable.

Figure 1 (page 18) shows an example choice experiment from the survey. For example, the question in Figure 1 asks the respondent to choose between a treatment that eliminates her depression but causes a 15% weight gain and a treatment that reduces her depression but causes both the loss of sex drive and no-orgasm side effects. An additional question followed each choice pair and asked the individual to choose between the previously chosen treatment plan and no treatment. Asking a follow-up question generates more information about preferences than simply including the no-treatment option in the original choice.

In making these choices, individuals are choosing over three health states: their current level of depression, some depressive symptoms, and no depression. Respondents were told to assume that each treatment plan would last one year and permanently eliminate or reduce the depression. “Some depressive symptoms” was defined as a reduction in MDD where the individual still experiences some symptoms of depression. Respondents were told that the symptoms were not as severe as full depression but were more intense than the normal feelings of sadness experienced by non-depressed individuals. The alternatives in the choice sets have varying money costs and side effects.

Choice questions are easily designed so that there is independent variation in each attribute of a treatment program and can include treatment options not currently available.³

2.3 Data Analytic Procedures

2.3.1 Choice modeling

A discrete-choice random-utility model is assumed with K treatment alternatives, including no treatment. The individual is assumed to choose the preferred alternative given her current depression and her projection of what life would be like with either some depressive symptoms or no depression but additional costs and side effects. Each individual answered five sets of A , B choice pairs with follow-up.

Denote the deterministic component of the random-utility model for individual

³The design for the choice experiment was created by first generating a factorial design that only included reasonable combinations of attributes. For example, side effects could only occur when taking an anti-depressant and treatments with a higher number of hours of therapy were associated with higher costs. Using the SAS `%choiceff` macro, we selected 16 choice sets for the final design and divided it into four different survey versions [19] [20]. An additional simple first choice experiment was created by hand and added to each survey.

i choosing treatment k as:

$$V_{ik} = f(Y_i - P_k) + h(T_i - Hr_k) + g(\mathbf{X}_k). \quad (1)$$

Y_i is income, P_k is the money cost of alternative k , T_i is free time, Hr_k is the number of therapy hours, and \mathbf{X}_k is a vector of the characteristics of treatment k , including effectiveness and side effects. Income not spent on treatment, $(Y_i - P_k)$, is spent on consumption and time not spent on therapy, $(T_i - Hr_k)$, is spent in other activities.

Assuming that the error term follows an i.i.d. extreme value distribution, the probability that individual i chooses alternative A from the j^{th} choice pair is:

$$\Pr_{ijA} = \frac{e^{V_{ijA}}}{e^{V_{ijA}} + e^{V_{ijB}}}. \quad (2)$$

This is a standard discrete-choice random-utility logit model where the V are functions of a common set of preference parameters. The probability that individual i chooses no treatment, NT , over the preferred treatment alternative in the j^{th} choice pair is:

$$\Pr_{ijNT} = \frac{e^{V_{ijNT}}}{e^{V_{ijA}} + e^{V_{ijB}} + e^{V_{ijNT}}}. \quad (3)$$

We estimate two specifications of the utility function Equation 1. In both specifications, the deterministic component of utility from treatment is modeled as a function of the attributes used in the choice questions: time and money cost, type of treatment (whether it includes anti-depressants), effectiveness of treatment (whether it eliminates depression or only reduces it), and presence of side effects. The attribute levels in the choice questions were chosen to test whether these attributes are significant factors in treatment choice. The specifications vary in the inclusion of observable preference heterogeneity. Table 1 defines all variables used in these two specifications.

[Figure 1 here]

In specification 1, the utility individual i gets from treatment k is:

$$\begin{aligned} U_{ik} = & \beta_{d1}Depr_k + \beta_{ds1}DeprSym_k \\ & + (\alpha_{y1} + \alpha_{y2}Depr_k + \alpha_{y3}DeprSym_k)(Y_i - P_k) \\ & + \alpha_{t1}(T_i - Hr_k) \\ & + [\beta_{a1} + \beta_{o1}Org_k + \beta_{s1}Sex_k + \beta_{w1}Wt_k + \beta_{w2}Wt_k^{0.5}] AD_k \\ & + \varepsilon_{ik}. \end{aligned} \quad (4)$$

In this homogeneous-preference specification, depression affects utility both directly and indirectly. The first line of Equation 4 allows depression state to have a direct (and presumably negative) impact on utility, independent of consumption. $Depr_k$ and $DeprSym_k$ take a value of 1 if the health state in treatment k is depression or depressive symptoms, respectively. These terms are zero if the chosen treatment eliminates depression. The second line in Equation 4 captures the impact of consumption $(Y_i - P_k)$ on utility. The last two parameters, α_{y2} , and α_{y3} , allow

depression to affect utility indirectly through the utility one obtains from consuming goods. Thus, α_{y2} represents the anhedonia effect. This specification allows us to test whether individuals feel the same way about market goods regardless of their depression level. Note that this specification restricts the marginal utility of consumption to be constant for a given health state but allows the marginal utility of consumption to vary with health state. The third line of Equation 4 captures the time costs of treatment ($T_i - Hr_k$) while the fourth line shows the impact of three side effects: no orgasm (Org_k), reduced sex-drive (Sex_k), and weight gain (Wt_k). The side effect terms are zero if the treatment has no anti-depressant side effects. This homogeneous-preference specification assumes that everyone has the same preferences over treatment programs - obviously a highly restrictive and untenable assumption; the impact of side effects and costs on choice of treatment is likely to vary greatly across individuals.

Specification 2 allows for preference heterogeneity and is shown in Equation 5.

$$\begin{aligned}
U_{ik} = & (\beta_{d1} + \beta_{d2}Educ_i) Depr_k + (\beta_{ds1} + \beta_{ds2}Educ_i) DeprSym_k \\
& + (\alpha_{y1} + \alpha_{y2}Depr_k + \alpha_{y3}DeprSym_k + \alpha_{y4}LowY_i + \alpha_{y5}MidY_i) (Y_i - P_k) \\
& + (\alpha_{t1} + \alpha_{t2}Kid_i) (T_i - Hr_k) \\
& + \left[\begin{array}{l} \beta_{a1} + \beta_{a2}PrevAD_i + \\ (\beta_{o1} + \beta_{o2}Age_i + \beta_{o3}Female_i + \beta_{o4}Partner_i) Org_k + \\ (\beta_{s1} + \beta_{s2}Female_i + \beta_{s3}Age_i + \beta_{s4}Partner_i) Sex_k + \\ (\beta_{w1} + \beta_{w3}Female_i + \beta_{w4}BMI_i + \beta_{w5}Age_i) Wt_k + \beta_{w2}Wt_k^{0.5} + \end{array} \right] AD_k \\
& + \varepsilon_{ik}
\end{aligned} \tag{5}$$

In this heterogeneous-preference specification, preference parameters are allowed to vary with a variety of characteristics of the individual. The first line of this specification allows the direct effects of MDD and depressive symptoms on utility to vary with education level; $Educ$ takes a value of 1 if the individual has less than a college degree. The second line allows marginal utility of consumption to vary with both health state and household income level ($LowY_i$ and $MidY_i$). Thus, there are two types of income effects: the marginal utility from consumption depends on both the health state and the income category. The third line allows the marginal utility of time to vary as a function of whether the individual has children under five (Kid_i). In the last four lines, the disutility associated with side effects is allowed to vary as a function of age (Age_i), previous experience with anti-depressants ($PrevAD_i$), gender ($Female_i$), the presence of a live-in partner ($Partner_i$), and Body Mass Index (BMI_i). All were factors that we thought might influence how individuals would feel about the sexual and weight-gain side effects of anti-depressants.

The likelihood function for both specifications takes the following form:⁴

$$L = \prod_{i=1}^{107} \prod_{j=1}^5 (\Pr_{ijA})^{r_{ijA}} (1 - \Pr_{ijA})^{1-r_{ijA}} (\Pr_{ijNT})^{r_{ijNT}} (1 - \Pr_{ijNT})^{1-r_{ijNT}}. \tag{6}$$

⁴Choices by an individual are assumed independent. The sample size precluded us from modeling the possibility that an individual's responses might be correlated.

r_{ijA} takes a value of 1 when alternative A is chosen and 0 otherwise. r_{ijNT} is defined similarly. The maximum likelihood estimates of the β (the preferences parameters) are those that maximize Equation 6; they are the values of the preference parameters that maximize the likelihood of observing the 506 choices that were made.⁵ Estimation is with the *maxlik* procedure in Gauss [21].

2.3.2 WTP and WTA

Because the marginal utility of consumption is modeled as a function of health state in both the homogeneous and heterogeneous specifications, there are income effects in both specifications. Thus, WTP does not equal WTA . Define WTP for the homogeneous specification and consider an individual's WTP to go from a state with MDD (\mathbf{X}^0) to a state of non-depression (\mathbf{X}^1), holding time cost constant across the two states. An individual would be willing to pay an amount such that her utilities are the same in both states:

$$g(\mathbf{X}^0) + (\alpha_{y1} + \alpha_{y2})Y_i + \epsilon_{i0} = g(\mathbf{X}^1) + \alpha_{y1}(Y_i - WTP_i) + \epsilon_{i1}. \quad (7)$$

Thus the deterministic portion of WTP is:

$$WTP_i = \frac{g(\mathbf{X}^1) - g(\mathbf{X}^0)}{\alpha_{y1}} - \frac{\alpha_{y2}}{\alpha_{y1}}Y_i. \quad (8)$$

WTP is based on the constant marginal utility of consumption that applies in the improved state, α_{y1} . The first term, $\frac{g(\mathbf{X}^1) - g(\mathbf{X}^0)}{\alpha_{y1}}$, is the direct effect on utility of a change in emotional state: it is the direct utility increase from the elimination of the depression, expressed in dollars. The second term, $-\frac{\alpha_{y2}}{\alpha_{y1}}Y_i$, is the dollar value of the indirect effect on utility from a change in emotional state. Here one can see that if α_{y2} is negative (the anhedonia effect) it causes WTP to increase. For the same scenario,

$$WTA_i = \frac{g(\mathbf{X}^1) - g(\mathbf{X}^0)}{\alpha_{y1} + \alpha_{y2}} - \frac{\alpha_{y2}}{\alpha_{y1} + \alpha_{y2}}Y_i. \quad (9)$$

A similar interpretation holds for this formula, except that now things are valued on the basis of marginal utility of consumption when depressed ($\alpha_{y1} + \alpha_{y2}$). In Equation 9, the anhedonia effect (α_{y2}) impacts WTA in two ways: through the second term and through the marginal utility of consumption.

Comparing Equations 8 and 9 shows that in absolute terms, $WTA > WTP$, if $\alpha_{y2} < 0$. Looking ahead, we find $\alpha_{y2} < 0$. You must pay an individual more to remain depressed than she is willing to pay to eliminate her depression. Because individuals value dollars less when depressed (the anhedonia effect), depressed individuals must be paid significantly more to accept continuing MDD. The formulas for WTP and WTA are similar in the heterogeneous-preference specification, but also include traditional income effects and interactions with personal characteristics.

⁵Not all of the 104 respondents answered all five of the choice questions.

2.4 Sample and Attribute Data

All individuals in the study were diagnosed by a clinician as having MDD: 22% were diagnosed with mild MDD, 48% with moderate MDD, and 7% with severe MDD.⁶ Forty-five percent of the sample was receiving their first-ever treatment for depression. Of those who had previously received treatment, 76% received anti-depressants; of these, 56% experienced reduced sex drive, 42% experienced weight gain, and 36% experienced inability to orgasm.

Descriptive statistics for the variables used in the econometric models are presented in Table 1. 74% of the sample had less than a college degree. The average monthly income in the sample was \$4,519, with 23% of the sample earning less than \$30,000 per year and 43% earning between \$30,000 and \$80,000. Women comprised 74% of the sample. The average age of participants was 40.

Table 1 also includes descriptive statistics for the attribute levels used in the choice questions. For example, 66% of the treatments presented included the use of anti-depressants. The average weight gain among the three alternatives (A , B , and follow-up) in the choice questions was 2.8%.

[Table 1 here]

When choosing between treatment programs, respondents chose the least-cost alternative 35% of the time. They chose not depressed over some depressive symptoms 61% of the time. In 89% of the follow-up choices, respondents chose treatment.

3 Results

3.1 Value of treatment attributes

Tables 2 and 3 report the parameters estimates from both the homogeneous and heterogeneous-preference specifications (Equations 4 and 5). On the basis of a likelihood ratio test, the heterogeneous-preference specification explains the answers to the choice questions significantly better than does the homogeneous-preference specification and correctly predicts more of the choices made: 72% (67% in the homogeneous-preference specification) of the AB choices, 87% (87%) of the follow-up choices, and 63% (59%) of both choices. Thus, although both models give consistent results, we not surprisingly conclude that individual characteristics matter: there is no “one size fits all” treatment for depression. Preferences for depression treatment vary in predictable and observable ways.

As can be seen in Tables 2 and 3, most parameters are highly significant and of the expected sign across both specifications. *Ceteris paribus*, individuals prefer treatments that cost less ($\alpha_{y1} > 0$). Emotional state affects utility directly. The presence of either MDD or depressive symptoms lowers utility directly ($\beta_{d1} < 0$ and $\beta_{ds1} < 0$); as would be expected the effect is stronger for MDD than for depressive symptoms ($\beta_{d1} < \beta_{ds1}$). The direct effect of MDD on utility is greatest for those with

⁶For the remaining 23%, the clinicians identified them as having MDD, but did not identify a level.

a college degree ($\beta_{d2} > 0$) while the parameter β_{ds2} is insignificant, suggesting that education level does not affect the disutility directly caused by depressive symptoms.

Depression also affects utility indirectly by reducing the utility from consumption. The null hypothesis that current emotional state does not affect the utility from consumption is rejected ($LRT = 25.44 > \chi_2^2(.05) = 5.99$). As would be expected, the heterogeneous-preference specification shows that for a given health state, marginal utility from consumption drops as household income increases ($\alpha_{y4} > \alpha_{y5} > 0$). In summary, eliminating MDD increases an individual's utility level both because she prefers being not depressed ($\beta_{d1} < 0$) and because she values goods more when she is not depressed ($\alpha_{y2} < 0$).

[Table 2 here]

[Table 3 here]

In the heterogeneous preference model, the marginal utility of time is significant and positive for individuals with small children (α_{t2}), making those individuals, ceteris paribus, less likely to choose therapy. For everyone else, and like in specification 1, one cannot reject the null that the marginal utility of time is zero.

The fact that β_{a1} is insignificant while β_{a2} is significant suggests that some patients don't care whether treatment includes anti-depressants as long as treatment has no side effects; however, those with previous experience with anti-depressants prefer treatment programs that include them.

The negative parameter values for side effects in Table 2 show that, on average, side effects decrease the utility from treatment. However, when individual characteristics are accounted for (Table 3), the impacts of the side effects on utility are mixed. Not being able to orgasm is a negative ($\beta_{o1} < 0$) whose magnitude is unaffected by gender, but its negative impact declines significantly with age ($\beta_{o2} > 0$). Males care about loss of sex drive but one cannot reject the null hypotheses that females do not care about this side effect. Whether one has a live-in partner does not affect how one feels about the sexual side effects and age was not found to affect how one feels about loss of sex drive. For all but the skinniest men, gaining weight from taking anti-depressants makes individuals worse off; utility decreases at an increasing rate as the percent of weight gain increases. Females are impacted more than males ($\beta_{w3} > 0$). The negative impact increases with an individual's body-mass-index score ($\beta_{w4} < 0$).

All results in the following section are based on the heterogeneous-preference specification results.

3.2 Predicting treatment choice

The heterogeneous-preference specification can be used to investigate who is more or less likely to choose different types of treatments, including no treatment. As noted earlier, many depressed individuals prematurely stop treatment and many depressed individuals never seek treatment. Table 4 shows how for a representative individual, the probability of choosing no treatment varies as a function of income level for six

different costless treatment options.⁷ For example, if the treatment options were two hours of therapy a month at zero cost, or no treatment, only 4% of individuals from high-income households are predicted to choose no treatment but 18% of low-income households are predicted to choose no treatment. These numbers rise to 11% and 37% respectively if the individual has small children (not shown in table).

Table 4 also shows the extent to which side effects from anti-depressants increase the probability of choosing no treatment. For example, if the choice is between no treatment and treatment with anti-depressants with all three side effects, specification 2 predicts that 50% of low-income individuals will choose no treatment. Only 18% will choose no treatment if the anti-depressants are side effect free, an almost three-fold decrease.

Table 4 clearly shows that for all types of treatment, those from lower income categories are much more likely to choose not to treat their depression. This results from two effects: (1) eliminating MDD benefits lower-income individuals less because they consume less, and (2) for a given benefit, they are willing to pay less to achieve the benefit.

[Table 4 here]

Table 5 shows the variation in the probability of choosing competing treatment alternatives, including no treatment. Using the sample population, we calculated for each individual the probability of choosing from one of five possible treatment programs, including no treatment Table 5 reports the minimum, maximum, and mean probabilities of choosing the competing alternatives. These probabilities vary across individuals because of differences in their personal characteristics, such as income level, age, and gender. Treatment *B*, anti-depressants with the sexual side effects and a cost of \$50 per month, has the highest mean probability of being chosen. The model predicts that on average, there is a 31% chance that an individual in our sample would choose this treatment plan while there is a 19% probability that she would choose no treatment. Treatment *D*, anti-depressants with no side effects and a cost of \$350 per month has the next highest probability of being chosen (24%).

[Table 5 here]

As would be expected given the superior fit of the heterogeneous-preference specification, individuals deviate greatly from the average as a function of their observable characteristics. Columns two and three of Table 5 report the minimum and maximum estimated choice probabilities for each of the five alternatives. Consider Treatment *B*, anti-depressants with the sexual side effects and a cost of \$50. The patient in the sample least likely to choose this treatment (7%) is 18 years old, male, does not have a college degree or kids, earns less than \$30,000, and has not had previous treatment with anti-depressants. In contrast, the patient most likely to choose this treatment is a 66-year-old female with a college degree who possesses more free time than the young male patient; she has a 54% probability of choosing this option.

⁷The representative individual was identified based on the most common characteristics of individuals in our sample. Thus, for continuous demographic variables we used the mean value of the sample while for dummy demographic variables we used the modal value. Details on the values of these variables are provided in Table 4.

3.3 *WTA* and *WTP* estimates

Table 6 presents *WTA* and *WTP* estimates for the heterogeneous-preference specification. These estimates were calculated using Equations 8 and 9 and the estimates from Table 3. The estimated expected *WTP* to eliminate depression is high for many individuals. This is consistent with other studies that find individuals rank depression as worse than other chronic diseases [6], impairments to physical health [7], and that severe MDD is viewed as equivalently bad or worse than death [8].

[Table 6 here]

The survey indicated that the treatment plans would last for one year and permanently eliminate or reduce the depression, so the amounts reported are *WTP* per month for 12 months to permanently eliminate or reduce their depression. Table 6 reports *WTP* and *WTA* for a number of different treatment scenarios; in each case, it shows the expected value for a representative individual as well as the minimum and maximum values in the sample.

There are several important points to note about Table 6. For our representative individual, expected *WTP* is highest for a “magic-pill” cure (no side effects and no cost): \$686 per month. But the estimated amount varies across the individuals from \$305 to \$1700 as a function of her or his characteristics. An individual with less than a college degree, earning an annual income of less than \$10,000, and with no previous experience with anti-depressants has a *WTP* of \$305 for the magic-pill. An individual with a college degree, earning an annual income of \$150,000 or more, and who has no previous experience with anti-depressants is willing to pay \$1700.

WTP for the elimination of depression drops substantially when the cure requires one to endure side effects - non-monetary costs. For the representative individual, adding a 5% weight gain to the cure caused expected *WTP* to drop from \$686 to \$409; adding both sexual side effects reduces her *WTP* to \$227 - a three-fold drop. As shown by Table 6, *WTP* for a treatment varies with personal characteristics. In the case of the no-orgasm side effect, the maximum and minimum *WTP* referred to for this type of treatment in Table 6 refer, respectively, to a 41 year old with a college education earning \$125,000 per year and a 19 year old without a college degree earning less than \$5000 per year.

WTP for eliminating depression takes the largest number of different estimated values when the treatment includes all three side effects. As can be seen from Table 6 some individuals would actually have a negative estimated *WTP*, where the negative amount indicates that the treatment makes the individual worse off, even though it eliminates their depression. A young average-weight man without a college degree, without previous experience with anti-depressants, earning \$15,000 per year has the lowest overall *WTP* (-\$252): one would have to pay him \$252 a month to accept the treatment (negative *WTP* is *WTA*).

WTA is how much the individual would have to be compensated to forego a treatment plan. For example, while the representative individual in Table 6 has an estimated *WTP* of \$686 per month for the magic-pill cure, she would have to be compensated \$747 per month to forego this treatment. In comparison, she would only have to be compensated \$247 a month to forego a treatment with weight gain

and all three sexual side effects. The difference between \$686 and \$747 (and between \$227 and \$247) is because one values consumption less when one is depressed (the anhedonia effect). The estimated WTA of $-\$271$ in Table 6 indicates that there is a configuration of individual characteristics such that an individual with those characteristics would pay \$271 a month to avoid treatment that resulted in weight gain and all three sexual side effects (negative WTA is WTP).

4 Discussion

We find that preferences for treating MDD vary significantly as a function of observable characteristics of the individual. As a result, there is strong variation in *WTP*, *WTA*, and the probability of choosing competing treatments. [13] also found significant variation in *WTP* among patients.

Our finding that demographic characteristics are a significant factor in explaining treatment preferences is shared by [14] but not by [8]. While [13] found significant variation in *WTP* among patients, they did not find significant differences by income, gender, age, or education groups in stated *WTP* to avoid certain side effects.

We find empirical evidence that depression has both a direct and indirect effect on utility. The indirect effect on utility, where the utility from consumption varies with depression level, causes a divergence between *WTP* and *WTA*. This might be deemed the anhedonia effect: an additional dollar of consumption is worth less when one is depressed. We seem to be the first to quantify this effect.

Our finding that more severe levels of depression affect one more negatively is certainly not unexpected: [8] find a similar result, although their study was not able to quantify this effect.

The results also indicate substantial *WTP* to eliminate depression. This is not surprising given that individuals often view depression as comparable to life-threatening diseases such as cancer, and some view severe MDD as equivalently bad or worse than death. Thus, although at first glance some of our *WTP* estimates seem large, we find them plausible. \$3660 ($\305×12 months) is a lot for someone with a yearly income of less than \$10,000 to pay for a permanent cure free of side effects, but not that great when one considers what people pay and do to treat diseases such as cancer - borrowing would be required.

Care must be taken in drawing broad inferences from our small sample. In addition to its small size, we don't know how representative it is of the population of depressed individuals, without other co-morbidities, who seek treatment for MDD. In particular, since the majority of people seek care from general medical providers this sample may be more depressed than the general population of depressed individuals. Thus, results may only be generalizable to those who are referred to or directly seek treatment at a mental-health clinic. That said, these caveats do not negate our results that those in the sample have significant estimated *WTP* to change their emotional state and that a significant amount of that variation can be explained in terms of observable characteristics of the individual.

Our results are suggestive and indicate the desirability of conducting a similar study with a larger and more representative sample.

5 Implications for policy and treatment

5.1 For allocating resources to the treatment of depression

The *WTP* estimates suggest that depression imposes a high cost on society that is above and beyond the cost of treatment and the cost of lost output: many depressed individuals would pay dearly not to be depressed and would pay even more to not be depressed and not experience side effects. The costs in terms of reduced utility from depression should be included in any benefit-cost analysis designed to determine whether additional societal resources should be allocated to the treatment of depression.

In addition, the estimated large differences between *WTP* for reducing depression with and without side effects, suggests that side effects from anti-depressants also impose a large cost on society. The magnitude of these differences makes it less easy to dismiss the affect of sexual and weight-gain side effects on peoples' lives.

5.2 For treating the individual

Our finding that one treatment does not fit all is not new. However, our estimates suggest a mechanism for better matching treatment programs to the patient. Before any treatment plan is discussed with the patient, the treatment provider could have an estimate of the probability of a patient choosing each treatment option available as a function of the monetary costs to the individual (what their insurance would not pay for each option) and easily observable characteristics of the individual (age, gender, income, etc.). This information can provide a starting point for discussion given the limited time of the care provider. It could help the care provider better direct the discussion and to investigate further if the patient expresses a preference drastically different than what their demographics would suggest.

The types of estimates presented could also be used to prevent non-adherence. Many people do not adhere to an anti-depressant regime because of side effects. A clinic could schedule follow-ups for those most likely, in terms of their characteristics, to choose no treatment in the presence of side effects.

5.3 For the pharmaceutical industry

Currently, anti-depressants do not eliminate, or even reduce, depression in everyone who diligently takes them. In addition, many who take them experience sexual and weight gain side effects. Our *WTP* estimates suggest the magnitude of revenues that the pharmaceutical industry could earn by making the drugs more effective and reducing the side effects associated with the drugs.

5.4 For economic theory

Economists, for the most part, ignore the impact of emotional-health states on preferences, utility, and choice, and can overlook emotional state shifts as a reason for *WTP* and *WTA* divergence. This research provides estimates of how much the two can diverge because of depression.

5.5 For future research

In many senses, our study is a pilot study. The study should be done more generally with a larger sample and more protocols in place to assess response rates and representativeness. Doing so would provide more definitive estimates of *WTP* for the depressed population. To make our results more policy relevant, co-morbidities of depression need to be modeled, along with the depression.

Since the patients in our study were depressed, answering the choice questions required that they consider what it would be like to experience a different emotional state. Recent research shows that individuals tend to mispredict how much changes will affect their long-run utility [22]. This raises the question of whether the depressed mispredict what it would be like to be not depressed. To address this issue one could redo our study but follow the patients over time, recording treatment adherence, assessing their level of depression over time, and asking additional choice questions as their level of depression does or does not abate. Future research needs to monitor compliance and collect data from those who do and do not continue treatment. More data is needed on how individuals' trade-offs between effectiveness and costs might or might not change as treatment progresses.

There are many ways to model heterogeneity in choice other than assuming the heterogeneity is completely and deterministically generated by variations in observable characteristics of the individual. One could investigate probabilistic heterogeneity using a random-parameters framework or a latent-class model. Or, one could estimate models that allow for both explained and unexplained heterogeneity.

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Figure 1: Example choice experiment

10 If you had to choose, would you prefer Alternative A or Alternative B?

	Alternative A	Alternative B
Effectiveness	Not Depressed	Some Depressive Symptoms
Hours of psychotherapy per month	6 hours	6 hours
Use of anti-depressants	Yes	Yes
Your monthly cost for treatment	\$350	\$350
Weight gain from treatment	15% weight gain	None
Little or no interest in sex	Side effect occurs	No side effect
Inability to achieve an orgasm	No side effect	Side effect occurs
Check the box of the alternative you prefer	<input type="checkbox"/> I prefer Alternative A	<input type="checkbox"/> I prefer Alternative B

11 If you had to choose, would you prefer the alternative you chose in question 10 or would you prefer to receive no treatment and stay at your current level of depression? Check the appropriate box.

1 I prefer the alternative that I chose in question 10, including the costs and side effects, to my current condition

2 I prefer to receive no treatment and stay at my current level of depression

Table 1: Descriptive Statistics for Variables Used in Model

Variable	Description	Mean	Std Dev	N
Socio-demographic variables				
$Educ_i$	Individual i has less than a college degree (1=No college degree, 0=College degree)	0.74	0.44	104
$LowY_i$	Individual i has annual household income less than \$30,000 (1=Yes, 0=No)	0.23	0.42	104
$MidY_i$	Individual i has annual household income between \$30,000 and \$80,000 (1=Yes, 0=No)	0.43	0.50	104
Y_i	Monthly household income	\$4519	\$2496	104
Kid_i	Respondent has children under age 5	0.25	0.43	104
T_i	Average hours of free time per month	317	85	104
$PrevAd_i$	Previously received treatment with anti-depressants (1=Yes, 0=No)	0.42	0.50	104
Age_i	Age ^a	40	11	101
$Female_i$	Female (1=Yes, 0=No)	0.74	0.44	104
$Partner_i$	Has live-in partner (1=Yes, 0=No)	0.67	0.47	104
BMI_i	Body Mass Index score	28	7	104
Choice experiment attributes^b				
$Depr_k$	Emotional state in treatment k is continued MDD (1=Yes, 0=No)	0.33	0.47	1518
$DeprSym_k$	Emotional state in treatment k is Some Depressive Symptoms (1=Yes, 0=No)	0.24	0.43	1518
P_k	Average monthly price of treatment	\$102	\$121	1518
Hr_k	Average monthly therapy hours	2.6	2.7	1518
AD_k	Treatment involves use of anti-depressants (1=Yes, 0=No)	0.66	0.47	1518
Org_k	Treatment k results in no-orgasm side effect (1=Yes, 0=No)	0.16	0.36	1518
Sex_k	Treatment k results in reduced sex-drive side effect (1=Yes, 0=No)	0.22	0.42	1518
Wt_k	Percent increase in weight gain resulting from treatment k	2.8	4.7	1518

^a Missing observations were mean filled for estimation purposes

^b Mean levels for the choice question attributes are based on the three choice alternatives (A,B, follow-up) for all 506 choice questions answered.

Table 2: Homogeneous-Preferences Specification: Maximum Likelihood Estimates (506 Choices)

Independent Variable	Coeff	Coeff Est	S.E.	P-value
Direct effects of depression on utility				
Emotional state is continued MDD	β_{d1}	-1.26	0.44	0.00
Emotional state is Some Depressive Symptoms	β_{ds}	-0.08	0.28	0.39
Income Effects				
Consumption ^a	α_{y1}	3.08	0.81	0.00
(Consumption) x (Emotional state is continued MDD)	α_{y2}	-0.36	0.08	0.00
(Consumption) x (Emotional state is Some Depressive Symptoms)	α_{y3}	-0.13	0.06	0.01
Time				
Free-Time	α_{t1}	0.68	1.45	0.32
Use of anti-depressants				
Treatment involves use of anti-depressants	β_{a1}	0.12	0.18	0.26
No-orgasm side effect				
Treatment results in no-orgasm side effect	β_{o1}	-0.65	0.16	0.00
Sex drive side effect				
Treatment results in sex drive side effect	β_{s1}	-0.25	0.16	0.06
Weight-gain side effect				
Percent increase in weight gain from treatment	β_{w1}	0.03	0.05	0.26
Square-root of percent increase in weight gain from treatment	β_{w2}	-0.43	0.17	0.01
LnL			-465.57	
^a Consumption measured in thousands of dollars				

Table 3: Heterogeneous-Preferences Specification: Maximum Likelihood Estimates (506 Choices)

Independent Variable	Coeff	Coef Est	S.E.	P-value
Direct effects of depression on utility				
Emotional state is continued MDD	β_{d1}	-2.42	0.56	0.00
(Emotional state is continued MDD) x (Individual has less than a college degree)	β_{d2}	1.33	0.47	0.00
Emotional state is Some Depressive Symptoms	β_{ds1}	0*	-	-
(Emotional state is Some Depressive Symptoms) x (Individual has less than a college degree)	β_{ds2}	0*	-	-
Income effects				
Consumption ^e	α_{y1}	3.09	0.83	0.00
(Consumption) x (Emotional state is continued MDD)	α_{y2}	-0.27	0.07	0.00
(Consumption) x (Emotional state is Some Depressive Symptoms)	α_{y3}	-0.14	0.03	0.00
(Consumption) x (In low income bracket)	α_{y4}	0.87	0.25	0.00
(Consumption) x (In middle income bracket)	α_{y5}	0.29	0.13	0.02
Time				
Free time	α_{t1}	0*	-	-
(Free time) x (Has children under age five)	α_{t2}	5.04	2.13	0.01
Use of anti-depressants				
Treatment involves use of anti-depressants	β_{a1}	0*	-	-
(Treatment involves use of anti-depressants) x (Previously treated with anti-depressants)	β_{a2}	0.42	0.28	0.07
No-orgasm side effect				
Treatment results in no-orgasm side effect	β_{o1}	-1.67	0.54	0.00
(Treatment results in no-orgasm side effect) x (Age)	β_{o2}	0.02	0.01	0.03
(Treatment results in no-orgasm side effect) x (Female)	β_{o3}	0*	-	-
(Treatment results in no-orgasm side effect) x (Has live-in partner)	β_{o4}	0*	-	-
Sex drive side effect				
Treatment results in sex drive side effect	β_{s1}	-1.03	0.27	0.00
(Treatment results in sex drive side effect) x (Female)	β_{s2}	1.12	0.32	0.00

Table 3: (continued)

Independent Variable	Coeff	Coeff Est	S.E.	P-value
(Treatment results in sex drive side effect) x (Age)	β_{s3}	0*	-	-
(Treatment results in sex drive side effect) x (Has live-in partner)	β_{s4}	0*	-	-
Weight-gain side effect				
Percent increase in weight gain from treatment	β_{w1}	0.19	0.08	0.01
(Percent increase in weight gain from treatment) x (Female)	β_{w3}	-0.12	0.03	0.00
(Percent increase in weight gain from treatment) x (BMI)	β_{w4}	-0.0040	0.0020	0.02
(Percent increase in weight gain from treatment) x (Age)	β_{w5}	0*	-	-
Square-root of percent increase in weight gain from treatment	β_{w2}	-0.34	0.18	0.03
LnL		-432.306		

* Not significant - fixed at 0

a Consumption measured in thousands of dollars

Table 4: Probability Representative Individual Chooses No Treatment as a Function of Income and Treatment Characteristics

Treatment	Probability of Choosing No Treatment at Zero Cost		
	Income =20K	Income =55K	Income =90K
2 Hours of Therapy per Month	18%	9%	4%
Anti-depressants: No Side Effects	18%	9%	4%
No Orgasm Side Effect	30%	16%	8%
No Sex Drive	16%	8%	4%
5% Weight Gain	35%	20%	10%
All 3 Side Effects	50%	31%	17%

Representative Individual: $T = 7.944$, $Kid = 0$, $Educ = 1$, $PrevAD = 0$, $Female = 1$, $BMI = 27$, $Y = 4.499$, $LowY = 0$, $MidY = 1$, $Age = 40$

Table 5: Sample Variation in Probability of Choosing Competing Treatment Plans

Treatment Option	Probability Choose Treatment		
	Treatment Details	Mean	Min Max
A: Therapy Only	4 hours of therapy/month; Cost=\$400/month	13%	2% 25%
B: Anti-depressants Only	Sexual side effects; Cost=\$50/month	31%	7% 54%
C: Anti-depressants & Therapy	2 hours of therapy/month; 5% Weight Gain; Cost=\$250/month	13%	4% 30%
D: Anti-depressants Only	No side effects; Cost=\$350/month	24%	16% 37%
E: No Treatment	Cost=\$0	19%	4% 42%

Table 6: Monthly Expected WTP and WTA for Example Treatments that Eliminate MDD: Minimum and Maximum as a Function of Individual Characteristics and Estimate for a Representative Individual (R.I.)

Treatment	WTP for Treatment			WTA to Forego Treatment		
	Min	Max	R.I.	Min	Max	R.I.
Anti-Depressants: No Side Effects	\$305	\$1700	\$686	\$327	\$1864	\$747
Anti-depressants: Therapy - 2 hours	\$107	\$1700	\$686	\$115	\$864	\$747
Anti-depressants: No-Orgasm	-\$1	\$1480	\$478	-\$1	\$1623	\$520
Anti-depressants: 5% Weight Gain	\$19	\$1547	\$409	\$20	\$1696	\$440
Anti-depressants: Sexual Side Effects & 5% Weight Gain	-\$252	\$1098	\$227	-\$271	\$1203	\$247
Representative Individual: $T = 7.944$, $Kid = 0$, $Educ = 1$, $PrevAD = 0$, $Female = 1$, $BMI = 27$, $Y = 4.499$, $LowY = 0$, $MidY = 1$, $Age = 40$						