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Modeling and Estimating Preferences Over
Treatment Programs for Depression

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Modeling the effectiveness, money costs, time costs, use of psychotherapy, and side effects of antidepressants. After the individuals choose their preferred alternative, they are asked which treatment option is preferred to remaining depressed. Each respondent is paired with another respondent. The data is used to estimate 3 random-utility models. Preliminary findings indicate that the value of consuming market goods is less when one is depressed. The willingness-to-pay, WTP , to eliminate one's depression and willingness to pay to avoid sexual and weight-gain side effects can be high but varies significantly across individuals as a function of observable characteristics. (3) At sufficiently high WTP to avoid side effects, some individuals will prefer to remain depressed.

utility framework is used to model the choice of treatment as a function of the characteristics of the individual. Characteristics of treatment include effectiveness, anti-depressants, and sexual and weight-gain side effects. Characteristics, including cost, time, and previous experience with side effects, are also included. The value of market goods is affected by one's depression. The willingness to eliminate or reduce depression is a function of the side effects. Preliminary findings indicate that the value of consuming market goods is less when one is depressed. This drives a wedge between the willingness to pay to avoid sexual and weight-gain side effects as a function of observable characteristics. At sufficiently high WTP to avoid side effects, some individuals will prefer to remain depressed.

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The data used to estimate the models come from a choice question survey administered to depressed patients at a mental health facility in Colorado.¹ A choice question asks an individual to choose her preferred alternative from some discrete number of alternatives, each described in terms of the levels of a common and finite site of characteristics. Figure 1 is an example choice question.

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

	<u>Alternative A</u>	<u>Alternative B</u>
Effectiveness	Not Depressed	Not Depressed
Hours of psychotherapy per month	6 hours	4 hours
Use of anti-depressants	Yes	Yes
Your monthly cost for treatment	\$300	\$300

Figure 1: Example Choice Question

In this study, the individual is presented with five pairs of treatment programs and chooses her preferred alternative in each pair. Each treatment is described in terms of its money cost, hours of psychotherapy, use of anti-depressants, and side effects experienced if the treatment includes anti-

responses to value, in dollars, treatment programs for depression.

Responses to choice questions are stated-preference data (SP data) in contrast to revealed preference data (RP data). RP data consists of observed behavior and choices that can be used to infer values. SP data are statements about the respondents' preferences. Existing RP data has limited capabilities to estimate preferences over health treatment programs. Reasons include: the widespread presence of insurance within the US and universal health care systems outside the US, which obscures the supply demand relationship; much of the decision-making is done by the clinician; and the non-participation of certain populations in the health care market (Johnson et al, 2000). For these reasons, market prices are unobserved or do not reflect the full values of the services. In addition, since the researcher cannot control the independent variables in a revealed preference study, the researcher may be unable to determine the relative importance of variables because of correlations.³ SP studies, such as choice

this new drug. This procedure is repeated for each side effect. The occurrence of multiple side effects at the same time is not considered. A lower and upper bound for WTP for multiple risk reduction is estimated. The upper bound is calculated as the average over all respondents of the sum of the WTP for each individual side effect. The lower bound on WTP is calculated by identifying for each individual the side effect over which she had the greatest WTP and then averaging over all individuals. On average, individuals were willing to pay the most (\$Can21.9 per month) to reduce the risk of blurred vision by 5% and the lowest (\$Can11.4 per month) to reduce the risk of dry mouth by 25%.

patients took the Shedler QuickPsychoDiagnostics (QPD) survey on a handheld device (Schedler et al, 2000). The QPD is an initial evaluation tool that provides, among other things, a depression score for each patient, a listing of depression symptoms, and any co-morbidities, such as anxiety or substance

ability level is grade six, as assessed by the Flesch-Kincaid Grade Level score. A representative survey can be found in Appendix 3. The survey has four sections. Section 1 provides background information about psychotherapy and anti-depressants, including side effects associated with anti-depressants. Questions are asked about perceptions and preferences concerning the different elements of treatment and time constraints. This section is intended to get the respondent thinking about trade-offs in terms of treatment programs. The answers to the questions in this section can be compared with the responses to the choice questions. In addition, the answers to these questions can be modeled along with the responses to the choice questions. They can also be used to model preference heterogeneity. Section 2 consists of the five pair-wise choice and follow-up questions, followed by a question (#18) asking the respondent how important each characteristic was in their answers to the choice questions. Section

From this, 16 choice sets were selected for the final design. The final design was divided into four blocks of four choice sets, resulting in four di

are on average rated as Pretty Important. Number of therapy hours is rated as Somewhat Important. While the average rankings are not significantly different from each other, they vary significantly across individuals.

Forty five percent of respondents would need to take time off work in order to attend therapy sessions while 31% would need to arrange for child care. The most commonly picked descriptions of therapy are: helpful, chance to deal with things, self-exploration, and problem-solving. The most commonly picked descriptions of anti-depressants are: helpful, embarrassing, and common method.

2.1 Summary Statistics

Table 2 shows the share of times that the chosen alternative had certain attributes. For example, 61% of the time, individuals choose a treatment plan that eliminates their depression over a treatment plan that merely reduces it. Table 3 shows how respondents answer the follow-up question on the basis of treatment. In 89% of the follow-up choices, treatment, which either eliminated or reduced depression, is chosen.

	Frequency	Percentage
Eliminated Depression	114	61%
Had Lower Weight Gain Side Effect	262	70%
No Orgasm Side Effect Does Not Occur	149	65%
No Sex Side Effect Does Not Occur	123	51%
Involved Therapy^a	121	62%
Use of Anti-Depressants^a	47	40%

^a both therapy and anti-depressants ^b treatment program could include

Table 2: What Share of Times did the Chosen Alternative Have Certain Attributes?

Follow-up Choice	Frequency	Percentage	Description
Choose Not Depressed over Current Depression	257	84%	Choose Not Depressed over Current Depression
Choose Current Depression over Not Depressed	29	6%	Choose Current Depression over Not Depressed
Choose Some Depressive Symptoms over Current Depression	134	28%	Choose Some Depressive Symptoms over Current Depression
Choose Current Depression over Some Depressive Symptoms	31	4%	Choose Current Depression over Some Depressive Symptoms

Table 3: Treatment Choices in Follow-up Question

As noted earlier, after the set of choice questions, respondents use a five point scale to identify the importance of each attribute in answering the choice questions. In order to identify potential sources of heterogeneity, OLS regressions were run on how respondents ranked the importance of each attribute as a function of personal characteristics. However, when an individual answers that an attribute was important to him, it is not clear whether it was important in a positive or negative way. Therefore, the expected sign of the preference parameter may be positive or negative.

These regressions show that respondents who are older, more highly educated, work more hours

In general, how individuals feel about the side effects is a function of gender and age. For example, compared to men, women tended to rate the weight gain side effect

+ ž + ž

probability

imply an estimated maximum willingness-to-pay, β_1 , of \$1471 per month to eliminate depression by therapy alone and \$810 to reduce depression through the same method, a ratio of almost two to one.¹⁸ In interpreting these results, it should be recalled that these estimates do not allow for any individual heterogeneity in preferences. These estimates are an average over all income levels. Furthermore, these amounts would be paid a limited amount of time, while the costs of not treating depression can increase proportionately over time.

Ignoring monetary costs, one's utility if treated solely with anti-depressants is

$$= 2.29 + (\beta_2 \cdot 58 + \beta_3 \cdot 27 + \beta_4 \cdot 1.08) + 6 \quad (6)$$

On average, estimated β_1 to eliminate depression through anti-depressants only is approximately \$300 less than the β_1 to achieve the same outcome through therapy alone. If treatment combines both therapy and anti-depressants,

$$= 0.2[\beta_1] + 2.67 + (\beta_2 \cdot 58 + \beta_3 \cdot 27 + \beta_4 \cdot 1.08) + 6$$

The parameter estimate on β_1 is not significantly different from the parameter estimate on β_1 but it is significantly larger than the parameter estimate on β_1 . Estimated β_1 to eliminate depression with both therapy and anti-depressants is \$1350.

Similar to Revicki and Wood (1998) and O'Brien et al (1995), the results suggest that individuals view some side effects as being worse than others. By assumption, the impact of side effects from anti-depressants is the same independent of whether one receives therapy. Estimated β_5 is \$548 per month to avoid weight gain¹⁹, \$295 to avoid the no-orgasm side effect, and \$138 to avoid the no sex-drive side effect.

3.2 Model 2: Allowing the Value of Goods to Depend on Emotional state

Model 2 generalizes Model 1 by allowing the value of market goods to differ depending on one's emotional state. The conjecture is that individuals get greater pleasure from the consumption of goods when they are not depressed. Assume

$$\begin{aligned}
 &= (\bar{z} + \bar{z} + \bar{z}) (\dots) + \bar{z} [\dots] \\
 &+ \bar{z} + \bar{z} \\
 &+ \bar{z} + \bar{z} \\
 &+ \bar{z} + \bar{z} + \bar{z} \\
 &+ 6
 \end{aligned} \tag{7}$$

where

- = Emotional state is depressed (1=Yes, 0=No)
- = Emotional state is some depressive symptoms (1=Yes, 0=No)

Equation 7 is identical to Equation 2 except \bar{z} is generalized to $(\bar{z} + \bar{z} + \bar{z})$; that is, this specification allows the marginal utility of money to differ as a function of the three emotional states. Assuming Equation 7, income does not drop out of the choice probabilities. Income effects are implied in the sense that the alternative chosen in the choice pairs affects one's emotional state, which in turn affects the value one places on market goods. Table 5 shows the parameter estimates for this model.

Parameter		Estimate	Est./s.e.	Prob.
MU of Income= - (money cost parameter)	α_m	2.21	2.5500	0.0054
Reduction in MU of Income if Depressed	α_{m1}	-0.36	-4.5300	0.0000
Reduction in MU of Income if Depressive Symptoms	α_{m2}	-0.08	-1.9200	0.0274
MU of Time= - (time cost parameter)	α_t	0.04	0.7580	0.2242
Constant		1.01	2.2700	0.0110

Table 5: Model 2 Maximum Likelihood Parameter Estimates

The mean log likelihood is -0.89. Model 2 correctly predicts 70% of the AB choices, 89% of the follow-up choices, and 63% of both choices. A likelihood ratio test was performed to test the hypothesis that $\bar{z} = \bar{z} = 0$. This hypothesis was rejected at the 1% level. Model 2 statistically dominates Model 1.

The conjecture is confirmed. The estimated marginal utility of money is 2.21 if the individual is not depressed, 2.13 (2.21 - 0.08) if the individual has some depressive symptoms and 1.84 if the individual is depressed. Consumption loses 17% of its value when an individual is depressed.

Given that Model 2 incorporates income effects, calculation of $\frac{\partial U}{\partial z}$ is more complicated and no longer equals $\frac{\partial U}{\partial z}$.²⁰ Consider an individual's decision to eliminate her depression through the use of therapy alone. Ignoring the insignificant time costs associated with therapy and assuming zero cost for treatment,²¹

$$= \frac{\partial U}{\partial z} + \frac{\partial U}{\partial z} \quad (8)$$

Equation 8 shows that eliminating depression has two effects on an individual's utility level. The first term is an income effect. Eliminating depression increases

Income	WTP	WTA
\$30,000	\$1,128	\$1,351
\$55,000	\$1,471	\$1,763
\$90,000	\$1,853	\$2,351

Table 6: Estimated WTP vs WTA by Income Level (when depression can be eliminated by therapy alone)

Table 9 shows the average and for individuals in the sample when depression could be eliminated using therapy .

	Average	Std Dev	Min	Max
WTP	\$1,458	\$422	\$783	\$2,780
WTA	\$1,747	\$506	\$939	\$3,330

Table 7: Sample WTP vs WTA (when depression can be eliminated with therapy alone)

Assuming no side effects, the estimated average to eliminate depression with only anti-depressants is \$1206 per month; estimated is \$1444. Generalizing the model to allow the value of goods to depend on one's emotional state increases the and associated with successful treatment of depression. Model 1 was underestimating for these scenarios.

In Model 2, estimated to avoid side effects and side effects depends on the reference point (depressed, some depressive symptoms and not depressed). For example one could ask how much an individual on anti-depressants who is currently experiencing side effects but no depression would pay per month to eliminate those side effects. This amount is calculated using the individual's marginal utility of money when she is not depressed. For this scenario, estimated to avoid weight gain is \$484 per month. It is \$258 to avoid the no-orgasm side effect and \$156 to avoid the no sex-drive side effect. = as we are assuming the same emotional state in both scenarios.

Alternatively, one could use the model to estimate what a depressed individual would pay per month to not gain weight. To value that scenario, one would use the marginal utility of money that applies when the individual is depressed. For the weight gain, this estimated is \$580; the individual is willing to pay more when depressed because money is worth less when one is depressed.

Using anti-depressants alone or in combination with therapy to eliminate depression when it results in all three side effects has a negative but not significant impact on utility. The combined impact of the side effects cancels out the gain from eliminating the depression.

Summarizing, Model 1 and 2 give different results and Model 2 is statistically preferred. Both Model 1 and Model 2 are highly restrictive in that, conditional on emotional state, both assume everyone has the same preferences over depression treatment programs. Model 2 suggests that with side effects, treatment with anti-depressants will be an improvement for some and a (non-significant) deterioration for others. Previous studies have found a similar result: severe depression is considered worse than an improved emotional state combined with medication side effects (Revicki and Wood, 1998). Model 3 generalizes Model 2 by allowing preferences for treatment to vary as a function of observable characteristics of the individual. In this case, when certain personal characteristics are accounted for, some individuals do not rank the elimination of their depression as an improvement and in certain extreme cases view the treatment and improved emotional state as worse than their current depression.

3.3 Model 3: Preference Heterogeneity

Model 3 generalizes Model 2 by making parameters a function of characteristics of the individual. We investigated the impact of the following individual characteristics: household income, gender, education level, the individual's current level of depression as rated by the clinician, race/ethnicity, age, previous experience with the side e

For example, the impact of weight gain side-effect, ($\beta_1 + \beta_2 + \beta_3 + \beta_4$) is a function of gender, previous experience with this side effect, and whether one is underweight according

is, individuals with more income have a higher
because of di

to eliminate depression and side effects. Simply

13 1 68 + 6 . She would rather remain depressed than experience the weight-gain side effect, and is close to indifferent between remaining depressed and not being depressed but experiencing the no orgasm side effect. She is affected little by the no sex drive side effect. Alternatively, if the same female was moderately depressed, $\beta = 1.62$ 1.02 13 1 68 + 6 , she is indifferent being not depressed with the weight gain or remaining depressed, but she would not accept both the weight gain and no orgasm side effects. In the case of severe depression, she is indifferent between all three side effects and eliminating her depression. The result that to avoid side effects varies with income level and demographic characteristics is different from O'Brien et al (1995).

4 Extensions

As noted earlier, this paper remains a work in progress. The primary work to be done deals with exploring additional types of preference heterogeneity. Model 3 will be expanded to deal with other potential sources of preference heterogeneity. Additional examination of how individuals answered attitudinal questions will be used to help identify and model this heterogeneity. In addition, this paper will explore how latent class models and cluster analysis can be used to model heterogeneity.

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$$\begin{aligned}
n &= \left(\frac{1}{\sigma} \right) r \left(\frac{1}{\sigma} \right) \\
&= \left[\left(\frac{1}{\sigma} + \epsilon \right) \geq \left(\frac{1}{\sigma} + \epsilon \right) \right] r \left[\left(\frac{1}{\sigma} + \epsilon \right) \geq \left(\frac{1}{\sigma} + \epsilon \right) \right] \\
&= \left[\left(\frac{1}{\sigma} + \epsilon \right) r \left(\frac{1}{\sigma} + \epsilon \right) \right]
\end{aligned}$$

By assumption, the error terms $\epsilon_1, \epsilon_2, \epsilon_3$ are independent draws from the extreme value distribution. Given this assumption, we can rewrite the above as

$$\begin{aligned}
n &= \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \left(\frac{1}{\sigma} + \epsilon_1 \right) \left(\frac{1}{\sigma} + \epsilon_2 \right) \left(\frac{1}{\sigma} + \epsilon_3 \right) \\
&= \int_{-\infty}^{\infty} \left[\left(\frac{1}{\sigma} + \epsilon_1 \right) \right]_{-\infty}^{\infty} \int_{-\infty}^{\infty} \left[\left(\frac{1}{\sigma} + \epsilon_2 \right) \right]_{-\infty}^{\infty} \int_{-\infty}^{\infty} \left(\frac{1}{\sigma} + \epsilon_3 \right)
\end{aligned}$$

For the extreme value distribution, $\epsilon_1 = \exp(-\epsilon_1)$ and $\epsilon_2 = \exp(-\epsilon_2)$. Substituting,

$$\begin{aligned}
n &= \int_{-\infty}^{\infty} \left[\exp(-\epsilon_1) \right]_{-\infty}^{\infty} \int_{-\infty}^{\infty} \left[\exp(-\epsilon_2) \right]_{-\infty}^{\infty} \int_{-\infty}^{\infty} \exp(-\epsilon_3) \\
&= \int_{-\infty}^{\infty} \exp(-\epsilon_1 - \epsilon_2) \exp(-\epsilon_3) \\
&= \int_{-\infty}^{\infty} \exp(-\epsilon_1 - \epsilon_2 - \epsilon_3)
\end{aligned}$$

and

$$= \frac{ij_{NT}}{ij_A + ij_B + ij_{NT}}$$

6 Appendix 2

Effectiveness Attribute		
Level	Frequency	Percent
Some Depressive Symptoms	365	36%
Not Depressed	641	64%

Therapy Hours Attribute		
Level	Frequency	Percent

Sex Drive Side Effect Attribute		
Level	Frequency	Percent
No Sex Drive Side Effect Does Not Occur	680	68%
No Sex Drive Side Effect Occurs	326	32%

Weight Gain Side Effect Attribute		
Level	Frequency	Percent
No Weight Gain	521	52%
5% Weight Gain	244	24%
10% Weight Gain	130	13%
15% Weight Gain	111	11%

	Not Depressed	Therapy Hours	Cost	Anti-Depressants	No Orgasm	No Sex Drive	Weight Gain
Not Depressed	1.00	0.18	0.23	0.07	0.20	0.27	-0.09
Therapy Hours	0.18	1.00	-0.02	-0.09	-0.24	0.09	-0.44
Cost	0.23	-0.02	1.00	-0.12	-0.09	-0.35	-0.32
Anti-Depressants	0.07	-0.09	-0.12	1.00	0.05	0.30	0.14
No Orgasm	0.20	-0.24	-0.09	0.05	1.00	0.00	-0.11
No Sex Drive	0.27	0.09	-0.35	0.30	0.00	1.00	0.02
Weight Gain	-0.09	-0.44	-0.32	0.14	-0.11	0.02	1.00

Design Correlation between Attribute Differences