

Estimating Earnings Losses due to Mental Illness: A Quantile Regression Approach

Dave E. Marcotte^{1*} and Virginia Wilcox-Gök²

¹Associate Professor, Department of Public Policy, University of Maryland Baltimore County, Baltimore, MD, USA

²Associate Professor, Department of Economics, Northern Illinois University, DeKalb, IL, USA

Abstract

Background: The ability of workers to remain productive and sustain earnings when afflicted with mental illness depends importantly on access to appropriate treatment and on flexibility and support from employers. In the United States there is substantial variation in access to health care and sick leave and other employment flexibilities across the earnings distribution. Consequently, a worker's ability to work and how much his/her earnings are impeded likely depend upon his/her position in the earnings distribution. Because of this, focusing on average earnings losses may provide insufficient information on the impact of mental illness in the labor market.

Aims: In this paper, we examine the effects of mental illness on earnings by recognizing that effects could vary across the distribution of earnings.

Methods: Using data from the National Comorbidity Survey, we employ a quantile regression estimator to identify the effects at key points in the earnings distribution.

Results: We find that earnings effects vary importantly across the distribution. While average effects are often not large, mental illness more commonly imposes earnings losses at the lower tail of the distribution, especially for women. In only one case do we find an illness to have negative effects across the distribution.

Implications: Mental illness can have larger negative impacts on economic outcomes than previously estimated, even if those effects are not uniform. Consequently, researchers and policy makers alike should not be placated by findings that mean earnings effects are relatively small. Such estimates miss important features of how and where mental illness is associated with real economic losses for the ill.

Received 15 July 2003; accepted 21 October 2003

Introduction

Tens of millions of American workers suffer from mental illness every year.* During the past decade, we have come to better understand the effects of mental illness on the economic lives of the afflicted. In general, mental illness has relatively large employment effects. However, the extent to which mental illness has negative effects on earnings has been found to be less uniform.

There has been a substantial amount of research published in the past few decades estimating the earnings effects of mental illness. Much of that research, especially the most recent, has devoted significant attention to developing instrumental variables (IV) estimators to control for unobserved heterogeneity between workers who suffer from mental illness and workers who do not. Still, much remains to be understood about the effects of mental illness on workers' earnings. Not only may workers afflicted with mental illness differ from their healthy peers in ways that are hard to measure, but once afflicted it is likely that a separate non-random process plays a role in determining who remains employed or how substantially illness impedes work.

Several factors shape the extent to which illness impairs workers' abilities to maintain employment or work effectively. First, and most importantly, there is substantial variation in access to treatment. During the past three decades, there have been remarkable advances in treatment. So, disparities in access can result in important differences in the consequences of illness. Second, employment contracts vary in the extent to which mental illness might be accommodated in the workplace. Salaried workers and those with generous leave policies may be more likely to maintain employment and earnings even if afflicted with an episode of illness. Those paid hourly rates or with little leave may not fare as well.

Access to health care and the nature of the working environment play important roles in determining the

* Correspondence to: Dave E. Marcotte, Associate Professor, Department of Public Policy, University of Maryland Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250, U.S.A

Tel.: +1-410-455 1455

Fax: +1-410-455 1172

E-mail: marcotte@umbc.edu

Source of Funding: This research was supported by the National Institute of Mental Health (R01-MH56463-01).

* Estimates of the 12-month prevalence of mental disorders in the United States (excluding alcohol/substance abuse or dependence) are about 22 to 30 per 100 persons in the adult population (see Regier *et al.*¹ for estimates based on the Epidemiological Catchment Area Study and Kessler *et al.*² for estimates from the National Comorbidity Survey).

economic consequences of mental illness. In considering the earnings effects of mental illness, it is important to recognize that there is a substantial amount of variation in access to health care and sick leave and other employment flexibilities across the earnings distribution. As a result, focusing on average earnings losses may provide insufficient information on the impact of mental illness in the labor market. Rather, this may mean that the extent to which a worker's ability to work, and how much his/her earnings from such work are impeded depend upon his/her position in the earnings distribution.

In this paper, we reexamine the effects of mental illness on earnings. We consider whether the traditional focus on mean effects provides too limited a set of information about the consequences of mental illness on earnings. We contend that such effects could vary across the earnings distribution, and that focusing on mean effects may mask important earnings losses associated with mental illness.

We employ a quantile regression approach to estimate the effects of various mental illnesses at key points in the earnings distribution (conditional on the values of the independent variables in the analysis). We find that earnings effects vary substantially across the conditional distribution. In general, we find negative earnings effects to be larger at the bottom of the distribution. In only one case do we find an illness to have uniformly negative effects.

Below, we briefly review what is known about the labor market effects of psychiatric disorders. We then turn to the general estimation problems confronting researchers in this area, and to our estimation model. Finally, we present our results and discuss their implications.

Background

Substantial research on the labor market consequences of mental illnesses began in the 1970s. Bartel and Taubman,³ employing data from the National Academy of Sciences (NAS), estimated that a general indicator of mental illness is associated with earnings losses on the order of 20% per year. Using Epidemiological Catchment Area (ECA) data, Frank and Gertler⁴ estimated similar earnings losses to be 21%.

This first wave of research found that earnings losses varied both by severity and by disorder. For example, Bartel and Taubman⁵ and Benham and Benham⁶ found that mental illnesses involving the most severe symptoms are associated with large earnings losses, perhaps 40%. Those involving less severe symptoms are associated with losses of about 10%. Other researchers have found that workers suffering from schizophrenia earn substantially less than otherwise comparable workers – while the impacts of other disorders are less severe (Miller and Kelman).⁷

Problems in the estimation of the labor market effects of mental illness were clear in Miller and Kelman's⁷ research using the ECA data. The authors found that affective disorders (which include depression and bi-polar disorders) were associated with *increased* earnings. Writing that they "do not accept the implication that, all other things equal, having an affective disorder diagnosis increases one's

income", Miller and Kelman attributed the unexpected finding to the endogeneity of mental illness in earnings equations.

Beginning in the mid-1990s, a second wave of research made use of the National Comorbidity Survey (NCS), the first nationally representative survey to provide substantial information about symptoms and prevalence of non-substance abuse mental illnesses. Data from the NCS, conducted between 1992 and 1994, comprised a national probability sample of 8,098 Americans. All previous studies used community level data, precluding accurate generalization to the national level. Unlike other nationally representative survey datasets, the NCS included information about mental illness and labor market outcomes, as well as several exogenous risk factors for mental illness. This allowed researchers to address the problem of endogeneity in estimating the effects of various mental illnesses on labor market outcomes.

In the first study using the NCS, Ettner *et al.*⁸ employed an instrumental variables approach to handle the estimation problems to which Miller and Kelman⁷ attributed their counterintuitive results. The authors used the number of psychiatric disorders exhibited by the respondent's parents and the number of psychiatric disorders experienced by the respondent before the age of 18 to create instrumental variables for psychiatric disorders. The instrumental variables were used to estimate the effect of psychiatric disorders on both the probability of employment and earnings. The authors found evidence of significant earnings losses associated with mania for women and a decrease in employment probability for both men and women due to major depression.

Using instrumental variables constructed using information in the NCS describing the parental history of psychiatric disorders, Marcotte *et al.*⁹ found substantial earnings losses associated with selected mental illnesses – with larger negative effects for women.

Both the more recent research using national probability samples and the previous research have generally concluded that a substantial component of the labor market losses due to mental illness are dis-employment effects (Ettner *et al.*,⁸ and Ettner¹⁰). This is not surprising because illnesses that can impair cognitive functioning, perception, and behavior surely limit productivity and raise the costs of working for the ill.

In the research reported here we consider whether the relationship between mental illness and labor market losses is more complicated than that assumed in the literature thus far. While allowing for the potential endogeneity of mental illness and earnings, we posit that workers with lower incomes face potentially more serious consequences if they become mentally ill. We expect this for at least two reasons. First, income is an important determinant of insurance coverage (Fronstin¹¹ and Institute of Medicine¹²) and access to health care (Smith¹³ and Smith and Kington¹⁴). Hoffman and Pohl¹⁵ estimate that persons with incomes under \$20,000 have a more than 33 percent chance of being uninsured, while those with incomes over \$50,000 have only an 8.5 percent chance of being uninsured.

Access to health care is likely to be an extremely important determinant of the extent to which mental illness impedes work. Berndt *et al.*¹⁶ and Berndt *et al.*¹⁷ have shown that adequate treatment and access to pharmacotherapy can have substantial positive effects on the ability of workers to regain pre-morbid levels of productivity.

Second, workers with relatively low wages often have the least flexible working arrangements, the poorest access to sick leave, or other support in the workplace that might accommodate the ill (e.g. see McCrate,¹⁸ Jacobs and Steinberg¹⁹ and Brown²⁰). Both because of poorer access to treatment and less flexible employment situations and leave benefits, lower income workers are likely to suffer relatively large economic losses. If so, previous estimates of mean earnings effects may be an inadequate characterization of earnings losses due to mental illness.

In the next section, we describe the empirical difficulties associated with estimating the effects of mental illness on employment outcomes. We then describe our basic and full estimating models and procedures - including how features of the illnesses can help us solve estimation problems, and how we employ our quantile regression approach in this context.

Empirical Models

In estimating earnings losses due to illness, economists have typically specified earnings equations rooted in the human capital literature. The usual earnings model is a linear equation relating observable worker and job characteristics to the log of annual earnings. To estimate the effect of illness on earnings, simple yes/no indicators of illness are typically included among the independent variables in the regression equation, and the coefficients interpreted as the marginal earnings loss due to various illnesses.

In our context, such indicators, which we will call (M), would take on the value of one if the individual suffers from a particular mental illness, and zero otherwise. The standard earnings model is represented by the following equation:

$$E_i = \beta_0 + X_i\beta_1 + M_{iD}\beta_2 + C_i\beta_3 + e_i \quad (1)$$

where E_i is a vector of observations on annual earnings for the i th individual. X_i is a vector of socioeconomic and demographic characteristics. M_{iD} is a vector of dummy variables for a set of D mental illnesses. C_i is a vector measuring consumption of alcohol and illegal drugs. β_1 , β_2 , and β_3 are conformable vectors of coefficients relating each of these factors to earnings. Finally, e_i is the stochastic term.

Unlike many physical illnesses that may reasonably be considered exogenous, mental illness presents potentially serious estimation problems. The focus of previous research has been the possibility that the onset of mental illness may be related to factors determined in the labor market, most importantly earnings. Other research has suggested that factors that predict mental illness also affect labor market outcomes. In particular, it is supposed that personality traits such as excessive motivation or drive, or

working in high stress occupations at once increase risk of illness, and lead to higher than expected wage outcomes.*

For these reasons, previous research has generally treated the onset of mental illness as endogenous, concluding that a single equation model will likely misestimate the causal effects of mental illness on earnings or other labor market outcomes. One way to conceptualize the resultant estimation difficulties is to make explicit a component of the error term, π_i , measuring an individual's propensity for mental illness - arising either due to personality traits, stress, or job-outcome affected factors. Doing so yields the following model:

$$E_i = \beta_0 + X_i\beta_1 + M_{iD}\beta_2 + C_i\beta_3 + \pi_i + \phi_i \quad (2)$$

where ϕ_i is assumed to be i.i.d $\sim N(0, \sigma_\phi^2)$ and orthogonal to all regressors and π_i . The estimation problem arises because $E(\pi_i|M_{id}) \neq 0$, for some $d \in D$. The solution most often employed in this context is to develop an instrumental variables estimator of the effect of mental illness on labor market outcomes. If appropriate instruments can be found, the instrument will be uncorrelated with π_i , and the resultant estimator will be consistent.

In our empirical analyses, we begin with this estimation strategy. We estimate a two-stage model to identify the earnings effects of four principal non-substance abuse mental illnesses; major depression, anxiety disorders, dysthymia, and anti-social personality disorders.† We omit workers with other, less prevalent, mental illnesses from our analyses, so that the comparison group is workers with no history of mental illness.

To develop our instruments, we utilize information on family history with these various mental illnesses. Family history of illness is a well-established risk factor for mental illness. While family history can affect the likelihood an individual suffers from mental illness, we expect that it has no direct bearing on labor market outcomes.* So, similar to previous research, we estimate first stage models of the following type:

$$M_{id} = \alpha_{d0} + X_i\alpha_{1d} + C_i\alpha_{2d} + H_{id}\alpha_{3d} + e_{id} \quad (3)$$

Where M_{id} is a dummy indicating whether individual i suffers from mental illness d . H_{id} is a vector of measures of family history with the disorder d . We estimate equation 3 assuming the errors follow a cumulative logistic distribution and also as linear probability models.† We then use the

* There is substantial empirical support from the medical and epidemiological literature for these claims.

† Dysthymia is a disorder characterized by a moderately depressed mood state, persisting for at least two years.

* Family history may affect the accumulation of human capital during childhood, but we will control for pre-determined levels of schooling.

† Linear probability models are used to predict the probabilities of the four mental illnesses in addition to the logistic models because logistic models may yield inconsistent estimates of the earnings losses due to mental illnesses. We find that the two models yield similar estimates of earnings losses.

predicted probabilities of these disorders as instruments in regressions to identify the marginal effect of various mental illnesses on earnings:

$$E_i = \beta_0 + X_i\beta_1 + M_{iD}^{IV}\beta_2 + C_i\beta_3 + e_{i2} \quad (4)$$

where M_{iD}^{IV} is a vector containing predicted values of each of the D mental illnesses, obtained in the first stage regressions, and β_2 is a conformable vector of coefficients.

In principle, this instrumental variables solution provides consistent estimates of the direct effects of various mental illnesses on earnings, even in the presence of a non-random error component associated with mental illness. But the IV solution has limitations. By estimating the second stage via least squares, IV estimates only provide information on mean earnings effects of mental illness.* We will consider whether the earnings effects of mental illness are uniform across the distribution of earnings by expanding beyond mean effects. We examine the effects of mental illness on earnings at several key points in the conditional distribution of earnings.

To estimate the effects of mental illness across the distribution, we estimate the model developed in Equation 4 using a quantile regression approach. In quantile regression, the object is to estimate the quantiles of the dependent variable conditional on the values of the independent variables. Thus, when we refer to a specific quantile or to the distribution of earnings, we are referring to the *conditional distribution* of the dependent variable. This is similar to least squares regression in which the objective is to estimate the mean of the dependent variable conditional on the values of the independent variables.†

For the θ th quantile, we estimate β_θ by solving the following minimization problem:*

$$\min_{\beta} \frac{1}{n} \left\{ \sum_{i:E_i \geq Z_i\beta} \theta |E_i - Z_i\beta| + \sum_{i:E_i < Z_i\beta} (1 - \theta) |E_i - Z_i\beta| \right\} \quad (5)$$

where $Z_i = [1 X_i M_{iD}^{IV} V C_i]$ and $\beta' = [\beta_0 \beta_1 \beta_{2D} \beta_3]$

Here, M_{iD}^{IV} is a vector of instrumental variables for the presence of a set of D mental illnesses. β_{2D} is a conformable vector of coefficients. Using this quantile regression strategy, we estimate the effects of mental illness on workers at

* One might think of the effect of mental illness on conditional earnings as embedded in an initial decision about work. If the instrument employed here is not orthogonal to the error term in the work decision, the IV estimator may not be consistent. Moreover, restricting analysis to conditional earnings means that the underlying structural parameters of the joint relationship between mental illness and employment and earnings cannot be estimated. To estimate the structural parameters we could use a two-part model such as the Tobit model. Unfortunately, such models rely heavily on distributional assumptions that do not hold in the context of the current problem. Using the conditional moment test of normality suggested by Pagan and Vella,²¹ we reject the hypothesis that the distribution of log earnings is censored normal.

† Like median regression, quantile regression finds the regression plane that minimizes the sum of the absolute residuals rather than the sum of the squared residuals.

* Adapted from Buchinsky.²²

different points in the conditional distribution. If it is the case that income is positively related to access to treatment and flexibility and accommodations on the part of employers, we expect earnings losses associated with mental illness to be larger for workers at lower quantiles.

Data

We carry out our estimation strategy using data from the National Comorbidity Survey (NCS). The NCS is a nationally representative survey designed to study the prevalence, causes, and consequences of comorbidity between substance abuse disorders and nonsubstance abuse psychiatric disorders (Kessler *et al.*)² The data are a stratified, multi-stage area probability sample of persons 15-54 years old, living in the 48 coterminous states. For our purposes, we restrict our analysis to respondents 18 years old or older. The survey was conducted between September, 1990, and February, 1992, by the Survey Research Center (SRC) of the University of Michigan. The response rate was 82.6 percent with 8098 total respondents (Kessler *et al.*)² Of the full sample, 5,877 respondents were administered Part II of the survey, which provides detailed information on individual and family history with mental illness. We restrict our analysis to this sub-sample, and weight accordingly.

Diagnoses of mental illness are based on respondents' answers to the NCS. The NCS used a modified version of the Composite International Diagnostic Interview (CIDI), a state-of-the-art structured diagnostic interview instrument administered by trained lay-interviewers. Responses to CIDI questions are used to diagnose the lifetime and 12-month prevalence of several DSM-III-R psychiatric disorders, including substance abuse disorders.* We use the 12-month prevalence rate in the research reported here because recent episodes of mental illness are more likely to have a significant impact on labor market performance.

Because the NCS was designed to study risk factors as well as prevalence, the NCS interview included family history assessments of parental psychopathology, questions about childhood adversity, measures of social networks and support, and information about stressful life events and difficulties (Kessler *et al.*)² We use this information about clinical and family background to measure, and instrument for, the presence of mental illness. To construct instruments for a particular disorder, we make use of information about parents' experiences with symptoms associated with and treatment for that disorder. For example, to construct instruments for depression, we make use of information on whether an individual's mother and/or father had bouts of depression, experienced depressive periods during which he or she lost weight or couldn't sleep or experienced other symptoms, or whether he was hospitalized or treated for depression. We make use of similar information for other disorders. In addition we use behavioral correlates to instrument for antisocial personality disorders, such as

* Commitment and memory probes were used to minimize recall problems.

frequent physical fighting, lying, and frequent trouble with the law.

The NCS also contains data describing individuals' labor market experiences, as well as other relevant economic and demographic information. Respondents are asked about their labor market participation and that of their partners, if relevant. We also know basic information about respondents, such as their education level, employment status, family income, and share of family income. These variables allow us to analyze the relationship between mental illness and income.

Because earnings information is not available in the NCS data, we use respondents' annual personal income as a proxy measure for earnings.* To improve the quality of this proxy, we limit our analyses of income to those who report participating in the work force. Nonetheless, we cannot identify fully the sources of personal income. Because non-labor income is less likely to be affected by disabilities due to illness, we expect that our analyses may underestimate the effects of affective disorders on respondents' earnings.

Results

Descriptive Statistics

In **Table 1**, we present descriptive statistics for the NCS sample, in total and by gender. The first several rows provide information on economic outcomes and demographic characteristics of the sample. The final set of rows provides information describing the sample's experience with mental illness. Anxiety disorders were the most commonly occurring class of mental illnesses, which include generalized anxiety disorder, panic disorders, and various phobias. Overall, 21.8 percent of the sample reported symptoms sufficient for a diagnosis of some form of anxiety disorder. 14.0 percent of the sample reported suffering from major depression; 2.9 percent suffered from dysthymia; and 12.9 percent of the sample suffered from anti-social personality disorder or a related disease.

The second and third columns of **Table 1** illustrate the different 12-month prevalence rates of various mental illnesses for men and women. Women are more likely to have suffered from anxiety disorders, major depression, and dysthymia during the previous 12 months than are men. Indeed, fully 25.8 percent of women have suffered from anxiety disorders and 18.6 percent from major depression. This compares to 18.3 and 9.9 percent among men, respectively. Men, however, are much more likely to suffer from anti-social personality disorders than women.

Ordinary and Instrumental Variable Estimates of Illness on Income

With these findings on the prevalence and patterns of mental illness in mind, we next consider the effects mental illnesses

have on respondents' incomes. Both because of the substantially different prevalence rates by gender, and because labor market experiences differ by gender, we estimate these effects separately for men and women.* In **Table 2** we present ordinary and IV estimates of the effects of various mental illnesses on the log of earnings. In the first column of **Table 2**, we present ordinary least squares (OLS) estimates of the relationship between mental illness and earnings for women, in the third column we present estimates for men. These are estimates of the model described in Equation 1. In columns two and four we present IV estimates for women and men. These are estimates obtained from the two-stage procedure described in Equation 3 and Equation 4. The coefficients in **Table 2**, and subsequent tables, are interpretable in the standard way. To conserve space and to focus on the parameters of interest, we do not report the coefficients of the control variables here.†

The results in **Table 2** suggest that for women, only anxiety disorders significantly reduce earnings. We find that OLS estimates suggest that anxiety disorders are associated with a 0.124 log unit decrease in earnings. This is a 11.7 percent decrease in earnings compared to their healthy peers. The IV estimate is substantially larger. The coefficient on anxiety disorders reported in the second column suggests that women suffering from such disorders earn 48.8 percent less than their healthy peers.

The results in columns (iii) and (iv) suggest that mental illness has no significant effect on the earnings of men. This is consistent with previous research that mental illness has relatively little average effect on men's earnings.

The bottom panel of **Table 2** presents *p-values* from relevant tests of the suitability of our family history instruments for estimating the effect of mental illness on earnings. With the exception of dysthymia for men, in every case the instruments are significantly correlated with occurrence of various mental illnesses among our sample members. There is also substantial evidence that mental illness is endogenous in this context. Among women, the Hausman-Wu test rejects exogeneity of the two most common disorders, depression and anxiety disorders at the 10 percent level. Among men, we reject exogeneity for depression, anxiety and anti-social personality disorders. The final row of **Table 2** presents the *p-value* on the overidentification tests for women and men. In both cases, the χ^2 test statistic was sufficiently large to lead us to reject the null hypothesis that none of our family history instruments were endogenous. Perhaps family history is endogenous because parental illness affects children in lasting and unmeasured ways, or because as adults, those with ill family members devote time to caring for their relatives, at the expense of market work.* As a result, while the family history instruments may improve our ability to estimate the earnings effects of mental illness, we cannot be

* These data are reported in interval form, with 23 possible categories. We assign to respondents the midpoint of the category in which they report.

* A Chow test confirmed that the parameters of the relationship between men and women differ.

† The full set of results is available upon request from the authors.

* We are indebted to an anonymous referee for this latter point.

Table 1. Descriptive Statistics of NCS Sample

	Full Sample (<i>N</i> = 3,431)	Women (<i>N</i> = 1,651)	Men (<i>N</i> = 1,780)
Income (in 1999 US dollars)	29,151 <i>23,540</i>	21,974 <i>17,415</i>	35,594 <i>26,305</i>
Age	35.2 <i>9.7</i>	35.7 <i>9.8</i>	34.7 <i>9.6</i>
White	0.807 <i>0.395</i>	0.788 <i>0.409</i>	0.825 <i>0.380</i>
Married	0.609 <i>0.488</i>	0.597 <i>0.491</i>	0.619 <i>0.486</i>
Education			
High School Dropouts	0.107 <i>0.309</i>	0.085 <i>0.279</i>	0.126 <i>0.332</i>
High School Graduates	0.497 <i>0.500</i>	0.494 <i>0.500</i>	0.501 <i>0.500</i>
Some College	0.264 <i>0.441</i>	0.296 <i>0.456</i>	0.235 <i>0.424</i>
College Graduates	0.132 <i>0.338</i>	0.125 <i>0.331</i>	0.138 <i>0.345</i>
Self-Rated Physical Health			
Excellent	0.253 <i>0.435</i>	0.246 <i>0.431</i>	0.260 <i>0.439</i>
Very Good	0.405 <i>0.491</i>	0.408 <i>0.491</i>	0.402 <i>0.490</i>
Good	0.272 <i>0.445</i>	0.269 <i>0.443</i>	0.275 <i>0.447</i>
Mental Illness			
Depression	0.140 <i>0.347</i>	0.186 <i>0.389</i>	0.099 <i>0.299</i>
Dysthymia	0.030 <i>0.171</i>	0.041 <i>0.198</i>	0.020 <i>0.140</i>
Anti-social Personality Disorders	0.129 <i>0.335</i>	0.056 <i>0.230</i>	0.195 <i>0.396</i>
Anxiety Disorders	0.218 <i>0.413</i>	0.258 <i>0.438</i>	0.183 <i>0.387</i>

Note: Mental illness is measured as prevalence in the 12 months prior to interview.
Standard deviations in italics.

confident that we have entirely solved the endogeneity problem.

Quantile Regression Estimates

Next, we examine whether these average effects characterize the effects of mental illness on earnings across the conditional distribution. We estimate the model summarized in Equation 5 for the 10th, 25th, 50th, 75th and 90th quantiles. Again, we do this separately for women and men. We summarize the findings from our quantile regression analyses in **Figure 1** and **Figure 2**. The figures present coefficients and 95 percent confidence bands for each of the mental

illnesses, estimated at the various quantiles. To conserve space and to focus on the parameters of interest, we do not report the coefficients of the control variables here.*

In **Figure 1**, we present results for women. In an important respect, the quantile estimates give a different picture than the mean effects presented in **Table 2**. For each disease, mental illness has significant effects on earnings at the 10th quantile. For major depression, anxiety disorders, and dysthymia these effects are negative and often substantial.

* The full set of results are available upon request from the authors.

Table 2. OLS and IV Estimates of the Earnings Effects of Mental Illness

Sample	Dependent variable: log of earnings			
	Female		Male	
	OLS Variable (i)	IV (ii)	OLS (iii)	IV (iv)
Depression	.064 (.064)	-.100 (.369)	-.009 (.067)	.105 (.183)
Dysthymia	-.129 (.120)	.225 (.785)	-.143 (.136)	-.081 (.246)
Anxiety Disorder	-.124 (.058)	-.608 (.286)	-.077 (.053)	-.035 (.280)
Anti-social Personality Disorders	-.177 (.107)	-.011 (.630)	-.004 (.052)	.068 (.267)
Tests of Instrument Quality		p-value		p-value
Major Depression				
F-test of Instrument Relevance*		<0.01		<0.01
Hausman-Wu test of endogeneity†		0.07		0.07
Dysthymia				
F-test of Instrument Relevance*		<0.01		0.35
Hausman-Wu test of endogeneity†		0.12		0.14
Anxiety Disorder				
F-test of Instrument Relevance*		<0.01		<0.01
Hausman-Wu test of endogeneity†		0.06		0.05
Anti-social Personality Disorders				
F-test of Instrument Relevance*		<0.01		<0.01
Hausman-Wu test of endogeneity†		0.11		0.05
Test of Overidentifying Restrictions**		<0.01		<0.01

Note: All models also control for education, marital status, age, age-squared, self-rated physical health, drinking behavior, and indicators of recent and past alcohol and substance abuse.

Standard Errors are in parentheses. Coefficients in bold are significant at the .05 level.

Mental illness is measured as prevalence in the 12 months prior to interview.

* *Ho*: Instruments not related to potentially endogenous regressor.

† *Ho*: No endogeneity.

** *Ho*: All instruments exogenous.

However, only anxiety disorders have significant negative effects on earnings for women at higher quantiles. This is not surprising, since anxiety disorders were the only form of mental illness that was associated with negative average earnings effects in both the ordinary and instrumental variables models presented in **Table 2**.

In general however, and even for anxiety disorders, the effects of mental illness on earnings are much smaller at higher quantiles. Only at the bottom of the distribution do we observe negative, significant effects of mental illness on earnings for women.*

* The effects are not limited to the 10th quantile. Generally, they are observed at all quantiles below the 25th.

In **Figure 2**, we present results for men. For men, there is some evidence that the effect of mental illness on earnings outcome varies across the distribution. Consistent with the average effects obtained in the ordinary and IV estimated models, we find less evidence of any effect of mental illness on earnings for men. However, again at the bottom tail of the distribution mental illness appears to have significant earnings effects. At the 10th quantile, anti-social personality disorders are associated with losses in income for men. Again, the effects of anti-social personality disorders become smaller and insignificant at higher points in the distribution. In addition, the point estimates of the effects of anxiety disorders on earnings losses are relatively large at the 10th quantile, though the confidence interval includes zero. Interestingly for men, it appears that dysthymia has relatively

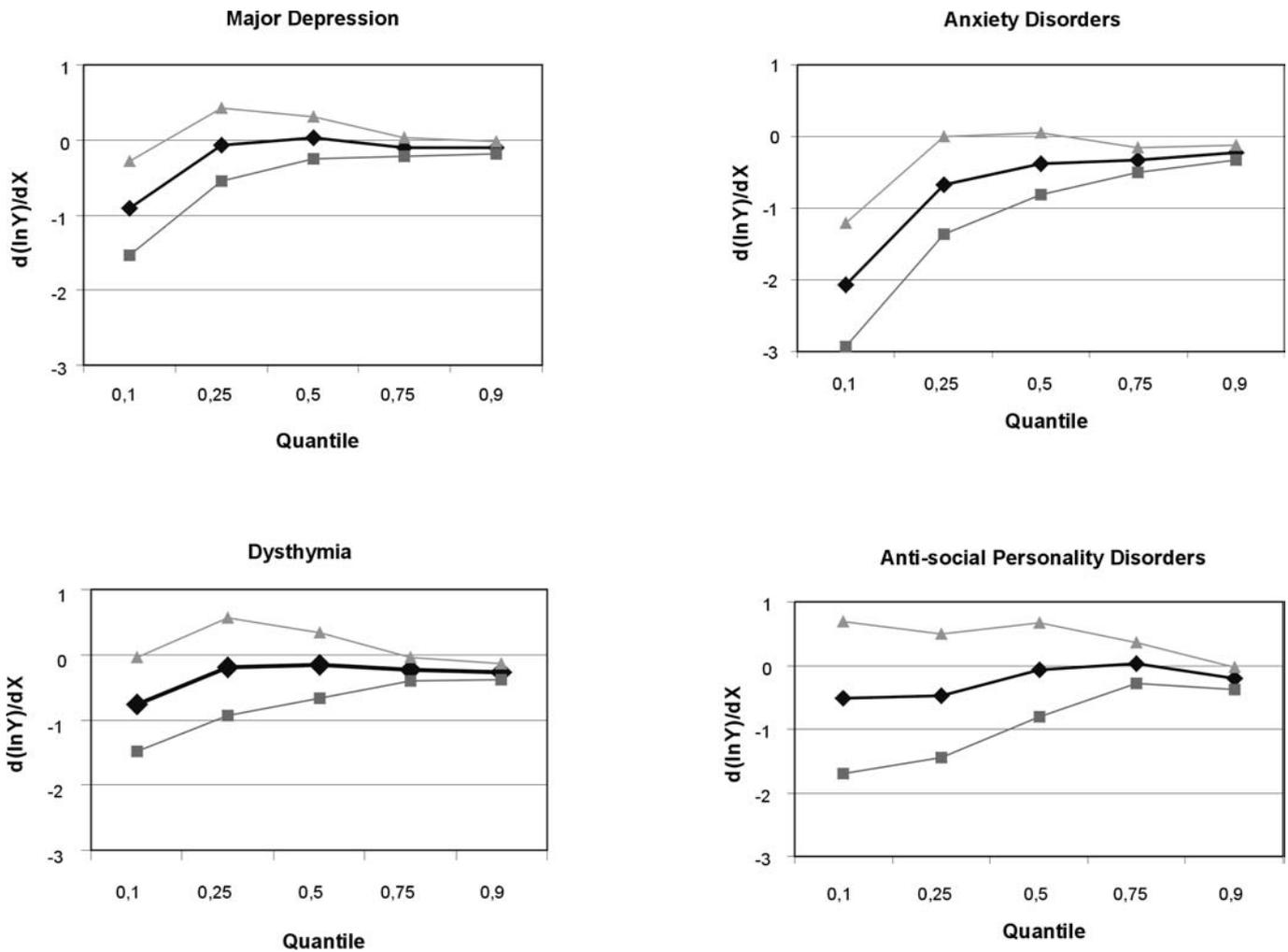


Figure 1. Effects of Mental Illness on Earnings, by Quantile: Women

Note: ▲ Upper Bound 95% Confidence Interval.
 ◆ Estimate.
 ■ Lower Bound 96% Confidence Interval.

large negative effects on earnings at the median and above. Such negative effects do not occur at the 10th and 25th quartiles. This may be due to the type of tasks performed by men in higher paying positions. Compared to men working in more routine jobs, the tasks performed by men working in higher paying positions may be more complex and therefore more vulnerable to the disruptive effects of continuous low level depression (dysthymia).

Comparison of the mean effects estimates and the quantile regression results make clear that mental illness can have substantially different effects at different points in the conditional distribution. In general, mental illness appears to have large and significant effects on earnings at the bottom of the distribution. We find less evidence of such effects at the median and above. Even in the case of anxiety disorders among women, where ordinary and instrumental variables estimators identified significant earnings losses at the mean, the quantile regression results find much larger losses at the bottom of the distribution. Consequently, estimators that

minimize deviations around the mean miss how and where illness is associated with earnings losses.

Limitations

While the relatively large impact of mental illness on earnings at the bottom tail of the conditional earnings distribution is important for understanding relationships between illness and economic outcomes, there are two important limitations to the analyses we have been able to conduct here. First, we seek to draw on information about family history to identify the effects of mental illness on earnings. Though we have found that family history is substantially correlated with an individual's own mental illness, we were not able to rule out that the family history measures used here are exogenous in the determination of subsequent earnings. Despite the fact estimates of the average effect of mental illness on earnings may pick up

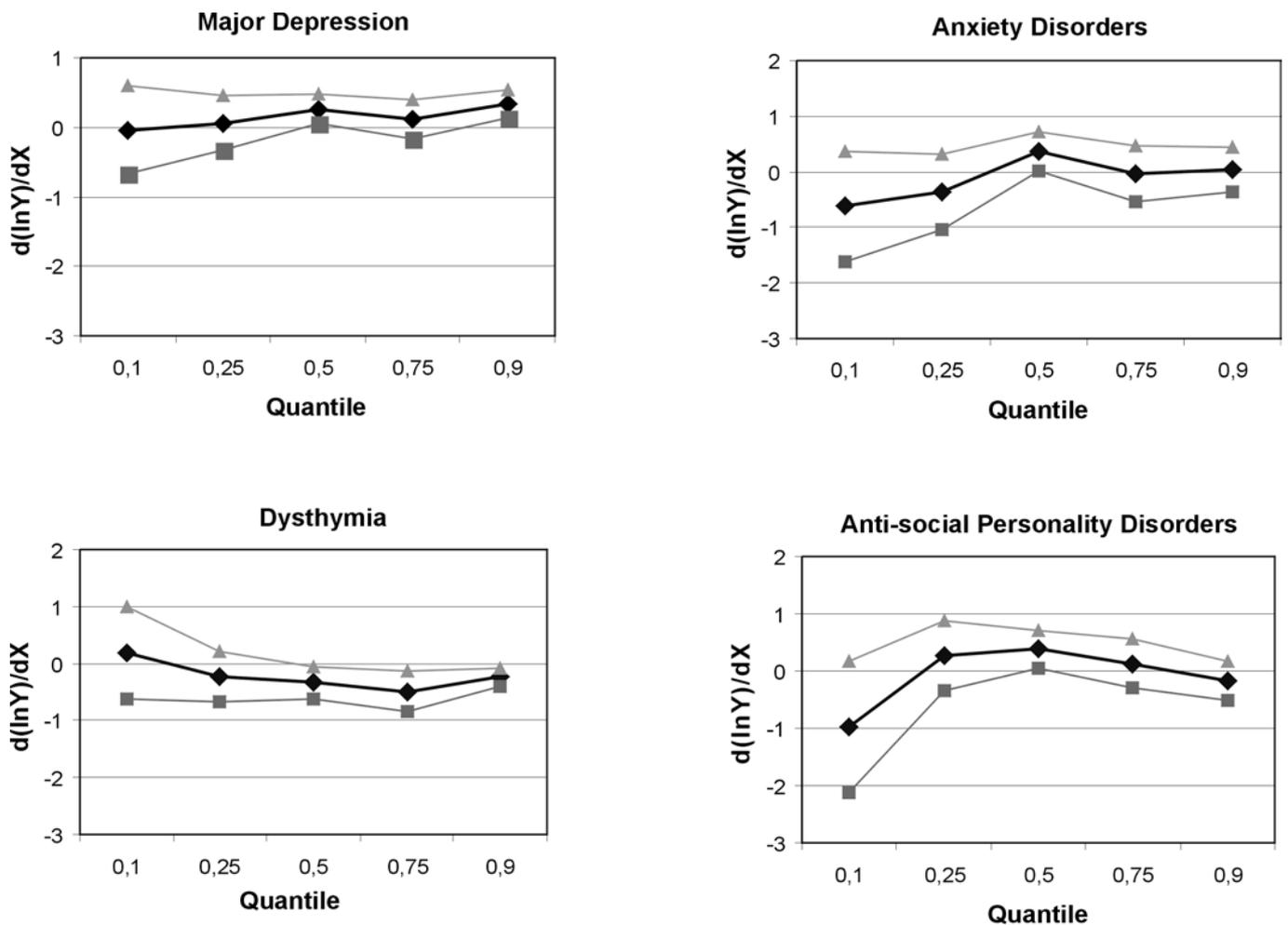


Figure 2. Effects of Mental Illness on Earnings, by Quantile: Men

Note: ▲ Upper Bound 95% Confidence Interval.
 ◆ Estimate.
 ■ Lower Bound 96% Confidence Interval.

aspects of family history, we do not view this as a substantial limitation to fulfilling our principal task. Since we aim to compare returns at different points in the conditional earnings distribution, the extent to which our IV measures pick up family history (rather than own illness) effects is unlikely to vary across the distribution. So, we anticipate that the patterns observed across the distribution observed here likely reflect real differences in illness effects.

Second, it is difficult to fully sort out the cause of the empirical pattern of large impacts of mental illness on earnings at the bottom tail of the conditional earnings distribution observed here. One explanation arises if one assumes that the onset and severity of mental illness is independent of position in the distribution, even if the consequences are not. If illness afflicts people similarly across the distribution, then the relatively large impact on those at the bottom of the distribution is consistent with the fact that income is an important determinant of access to health care and that low income workers are less likely to

have flexible work environments or sick/disability leave on their jobs. For any disease with a given severity, we would expect that workers receiving no treatment, and for whom pay and employment are more closely linked to short-term performance, would suffer relatively large economic losses.

However, the pattern of larger earnings losses at the bottom of the distribution might also arise if especially debilitating cases of mental illness cause workers to shift down in the distribution. This could arise through a selection process in which workers with especially debilitating cases fall to the bottom of the distribution, perhaps moving to poorly paying positions to accommodate their illness. To the extent that this occurs, our estimated effects of mental illness at the bottom of the distribution may be picking up a severity effect.

Clearly, these two explanations have vastly different implications. The first suggests that illness among workers with little economic means imposes substantial losses. If this is the case, ensuring such workers get access to treatment and encouraging economic and social support during episodes of

Table 3. Mental Illness Prevalence Rates Overall, and by Position in the Earnings Distribution

Illness	Overall	Position in the Earnings Distribution						Chi-Square [H0: Prevalence independent of position in distribution]
		0 - 10%	10 - 25%	25 - 50%	50 - 75%	75 - 90%	90 - 100%	
Women								
Depression	18.6	16.6	14.4	19.1	28.6	19.2	11.2	12.18
Dysthymia	4.1	4.6	3.5	3.3	8.9	3.7	7.1	8.97
Anxiety Disorders	25.8	31.8	24.1	29.7	25.1	21.7	13.4	17.83
Anti-social Personality Disorders	5.6	9.6	3.0	5.7	4.9	5.2	2.7	10.77
Men								
Depression	9.9	11.3	11.4	11.9	9.2	8.5	7.8	3.45
Dysthymia	2.0	2.4	1.3	3.1	2.2	0.2	0.0	6.95
Anxiety Disorders	18.3	24.1	22.1	25.0	15.6	17.1	10.2	21.99
Anti-social Personality Disorders	19.5	29.8	24.1	23.6	17.8	12.9	10.7	24.94

Note: Test statistics in bold are significantly different from zero at the 5% level.

illness might be sensible responses to mitigate losses. The second suggests the ill at the bottom of the distribution suffer the largest losses because their illnesses are relatively severe. If this is the case, one might be dubious about whether efforts to treat or provide vocational rehabilitation could substantially improve the economic prospects of this group.

We cannot ascertain the severity of illness with the NCS data. However, we can examine whether a selection process causes mental illness prevalence rates to vary contemporaneously across the distribution. If the larger earnings effects at the bottom tail of the conditional distribution observed here arise because illness causes workers to sort into the bottom tail, in general we should observe higher rates of prevalence in the bottom tail of the distribution. In contrast, if the onset of illness is independent of position, we may observe similar rates of prevalence across the distribution. Of course, similar rates of prevalence do not indicate how the severity of illness among workers at the bottom of the conditional distribution compares to those in higher quantiles. However, they would be consistent with the absence of a selection mechanism.

In **Table 3** we present overall prevalence rates of each of the mental illnesses examined here and prevalence rates at different points in the earnings distribution. We present these rates separately by gender. The results are somewhat mixed. Recall that for women, depression, dysthymia, and anxiety disorders were estimated to have substantial and significant negative earnings effects at the bottom of the earnings distribution. For depression and dysthymia there is no evidence that prevalence rates are higher at the bottom of the distribution. Only for depression do prevalence rates vary significantly across the distribution, and in this case, workers at the bottom have relatively low rates. Consequently, for these diseases among women it does not appear that the relatively large earnings effects at the bottom tail are due to a substantial effect of illness on position in the distribution. For anxiety disorders among women, prevalence rates are significantly higher in the bottom tail of the distribution. Thus, for this disorder it is possible that our estimated earnings effects misrepresent causal parameters, because illness affects a person's position in the distribution.

Among men we found negative effects of mental illness for both anxiety and anti-social personality disorders. For both of these disorders, we find significantly higher prevalence rates in the bottom tail of the distribution, consistent with the possibility that these illnesses have an effect on the person's position in the earnings distribution. Thus, in these two cases our estimated earnings effects may be biased by nonrandom selection of ill persons into the bottom tail of the distribution. We also found large negative earnings effects of dysthymia on earnings at and above the median. We do not find a statistically significant difference in prevalence rates for dysthymia across the conditional earnings distribution, suggesting that our estimates for this disorder are not biased by nonrandom selection.

Finally, our analysis focuses on the impact of mental illness on the earnings of individuals who remain in the work force despite their illness. We do not attempt to include in our estimate the effect on the earnings of individuals who

leave employment because of mental illness. As pointed out in the literature review, the empirical evidence indicates that employment effects comprise a substantial component of the labor market losses due to mental illness, especially among women. So, workers who remain in the workforce despite a mental illness may differ in unmeasured ways from those who leave the workforce. If so, using only the selected group of afflicted workers to estimate our quantile regression model would lead to underestimation of earnings losses due to mental illness.*

While the incorporation of employment effects is beyond the focus of this paper, it can be noted that the magnitude of the bias depends upon the probability of workforce exit in each quartile. For example, assume that workers in lower quantiles are less attached to the workforce because of lower wage rates. Then the probability of workforce exit due to mental illness will be higher among these workers and the underestimation of the earnings effect will be greater at these quantiles.

Conclusions

In this paper we re-examine the effects of mental illness on earnings to assess the extent to which any such effects vary across the distribution of earnings. Heretofore, all estimates of such effects have been made using methods that minimize deviations around the mean. While average effects are often not large, our findings suggest that such estimates miss important features of the impact of mental illness on earnings. We find that the largest effects of mental illness are at the lower tail of the earnings distribution. Consequently, mental illness can have larger effects on economic outcomes than previously estimated, even if those effects are not uniform.

Presently, we are unable to fully sort out whether the relatively large earnings differences associated with mental illness at the bottom tail of the distribution are due to larger impacts of disease on poorer workers, or to the possibility that workers with more substantial illnesses are selected into the bottom of the distribution. Our analysis of contemporaneous prevalence rates across the distribution finds evidence consistent with both possibilities, depending on the disease. More fully sorting out the explanation for the relatively large earnings effects of mental illness at the bottom of the distribution will require better, longitudinal data.

Until such data become available, the present findings make clear that earnings effects of illness vary substantially across the distribution. In particular, mental illness is associated with large earnings losses among workers in the lower tail. This is especially true for women. Consequently, researchers and policy makers alike should not be placated

* Marcotte and Wilcox-Gök²³ compare conditional and censored estimates of earnings losses due to depression and find a large earnings effect due to self-selection out of the labor force, especially among women. However, the use of two-stage estimators when the second stage is a probit analysis has been shown to yield inconsistent estimators (Bhattacharya, McCaffrey, and Goldman).²⁴

by findings that mean earnings effects are relatively small. Such estimates miss important features of how and where mental illness is associated with real economic losses for the ill.

Acknowledgements

The authors thank participants in seminars at Washington University, the Health Economics Research Centre at Oxford University, Northern Illinois University, and at the meetings of the Allied Social Sciences Association (Health Economics Research Organization) meetings for comments. We benefited especially from the suggestions of Philip Clarke, Will Manning, and Gary Zarkin. However, all opinions and responsibilities are those of the authors.

References

1. Regier DA, Narrow W, Rae D, Manderscheid R, Locke B and Goodwin F. The de Facto U.S. mental and addictive disorders service system. *Arch Gen Psychiatry* 1993; **50**: 85-94.
2. Kessler RC, McGonagle KA, Zhao S, Nelson CB, Hughes M, Eshleman S, Wittchen HU, and Kendler KS. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: Results from the National Comorbidity Survey. *Arch Gen Psychiatry* 1994; **51**: 8-19.
3. Bartel A and Taubman P. Health and labor market success: the role of various diseases. *The Review of Economics and Statistics* 1979; **61**: 1-8.
4. Frank RG and Gertler PJ. Assessment of measurement error bias for estimating the effect of mental distress on income. *J Human Resources* 1991; **26**: 154-164.
5. Bartel A and Taubman P. Some economic and demographic consequences of mental illness. *J Labor Econ* 1986; **4**: 243-256.
6. Benham L and Benham A. 1981. Employment, earnings, and psychiatric diagnosis. In Fuchs, ed. *Economic Aspects of Health*, 203-20. Chicago: University of Chicago Press.
7. Miller LS and Kelman S. estimates of the loss of individual productivity from alcohol and drug abuse and from mental illness. In Frank and Manning eds. *Economics and Mental Health*. Baltimore: Johns Hopkins Press, 1992.
8. Ettner SL, Frank RG and Kessler RC. The impact of psychiatric disorders on labor market outcomes. *Industrial and Labor Relations Review* 1997; **51**(1): 64-81.
9. Marcotte DE, Wilcox-Gök V. and Redmon DP. 2000. The labor market effects of mental illness: The case of affective disorders. In *The Economics of Disability*, D. Salkever and Sorkin, A. (Greenwich, CT: JAI Press), 181-210.
10. Ettner S. 2000. The relationship between labor market outcomes and physical and mental health, exogenous human capital or endogenous health production? In *The Economics of Disability*. Greenwich, CT: JAI Press, 1-31.
11. Fronstin P. 2000. *sources of health insurance and characteristics of the uninsured: analysis of the March 2000 current population survey*. Issue Brief No. 228. Washington, DC: Employee Benefit Research Institute.
12. Institute of Medicine. *Coverage matters: insurance and health care*. Washington, DC: National Academy Press, 2001.
13. Smith JP. Healthy Bodies and Thick Wallets: The dual relationship between health and economic status. *J Econ Perspectives*, 1999; **13**(2): 146-166.
14. Smith JP and Kington R. 1997. Race, socioeconomic status, and health in late life. In Martin and Soldo, eds. *Racial and Ethnic Differences in the Health of Older Americans*. (Washington, DC: National Academy Press), 106-162.
15. Hoffman C and Pohl M. *Health Insurance Coverage in America: 1999 Update*. Washington, DC: The Kaiser Commission on Medicaid and the Uninsured, 2000.
16. Berndt ER, Finkelstein SN, Greenberg PE, Howland RH, Keith A., Rush AJ, Russell J, Keller MB. Workplace performance effects from chronic depression and its treatment. *J Health Econ* 1998; **17**: 511-335.
17. Berndt E, Bailit HL, Keller MB., Verner JC, Finkelstein SN. Health care use and at-work productivity among employees with mental disorders. *Health Affairs* 2000; **19**: 244-256.
18. McCrate E. 2002. *Working Mothers in a Double Bind*. Employment Policy Institute Briefing Paper, #124 (Washington, DC: EPI).
19. Jacobs J and Steinberg R. Compensating differentials and the male-female wage gap: evidence from the New York State comparable worth study. *Social Forces* 1990; **69**: 439-468.
20. Brown C. Equalizing differences in the labor market. *Quarterly Journal of Economics* 1980; **94**(1): 115-134.
21. Pagan A and Vella F. Diagnostic tests for models based on individual data: a survey. *Journal of Applied Econometrics* 1989; **4** (0) (Supplement, December 1989): S29-59.
22. Buchinsky M. *Recent advances in quantile regression models: A practical guide for empirical research*. Brown University Working Paper, May 1997.
23. Marcotte DE and Wilcox-Gök V. *Conditional and censored earnings losses due to depression*. Working Paper, Department of Economics, Northern Illinois University, 2002.
24. Bhattacharya J, McCaffrey D and Goldman D. *Estimating probit models with endogenous covariates*. RAND working paper, August 1999.