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Chapter Authors: Rena M. Conti, Ernst R. Berndt, Richard G. Frank

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## Early Retirement and DI/SSI Applications Exploring the Impact of Depression

Rena M. Conti, Ernst R. Berndt, and Richard G. Frank

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Later middle age is a time of economic stability for most people. This period also begins the transition to reduced health and less active work. The impact of health events in later middle age on employment choices and other indicators of economic well-being has been the focus of a number of recent economic studies (Dwyer and Mitchell 1999; Ettner and Kessler 1997; Ettner 2000; Panzarino 1998; Lerner et al. 2004; Lerner, Berndt, and Adler 2004). This work has contributed to explaining declines in disability associated with later middle age.<sup>1</sup>

The impact of mental health on activities of people in later middle age has been less extensively studied. Evidence suggests that mental disorders negatively affect labor market activity in both men and women (Ettner and Kessler 1997). Mental health may also affect an individual's ability to re-

Rena M. Conti is an instructor in Health Policy and Health Economics, Biological Sciences Division, University of Chicago. Ernst R. Berndt is the Louis B. Seley Professor of Applied Economics at the Sloan School of Management, Massachusetts Institute of Technology, and director of the program on Technological Progress and Productivity Measurement at the National Bureau of Economic Research. Richard G. Frank is the Margaret T. Morris Professor of Health Economics at Harvard University Medical School, and a research associate of the National Bureau of Economic Research.

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1. Most recent work has focused on declining disabilities and improved health among Americans sixty years and older (Cutler 2001; Manton and Gu 2001). A handful of studies have documented declining disability among Americans fifty years and older (Freedman, Martin, and Schoeni 2002; Freedman and Martin 1998; Freedman and Martin 1999). For raw trends see National Center for Health Statistics, 2003.

spond to adverse health events. Recent reports from the Social Security Disability Insurance (DI) and the Supplemental Security Insurance (SSI) programs highlight the disruption of mental disorders to labor market activities. Since the early 1990s, mental illnesses are the fastest-growing cause of new claims for income support from the DI and the SSI programs (U.S. Social Security Administration 2004). These trends appear to be concentrated among middle-aged preretirement adults, ages forty-five to sixty-four.

In this chapter, we attempt to develop a better understanding of the potential effects of one major mental health condition, depression, on work-related activities among people in later middle age. We hypothesize that depression may negatively impact work participation directly by reducing affected individuals' ability to work and interest in employment. Depression may also indirectly affect work through its interaction with physical illnesses and other life events. The analyses focus on three sets of outcomes: employment status, early retirement, and application for DI/SSI benefits. To examine the direct impacts of depression on work-related outcomes, we focus on individuals who experience an incident case of depression and compare these people to similar individuals who did not experience a new episode of depression. To estimate the indirect effects of depression, we compare the work activity responses to incident health events (health shocks) and other life events (widowhood) for people likely to have depression and a similar group of people without significant symptoms of depression.

The chapter is organized as follows. Section 12.1 of this paper presents a brief review of the relevant clinical, epidemiological, and economic literature. Section 12.2 presents our general conceptual approach to studying these issues and reviews the empirical strategies we employ to estimate the direct and indirect effects. Section 12.3 describes the data employed in the analyses. Section 12.4 presents results of simple and more complex empirical analyses and several robustness checks. Section 12.5 discusses study findings and implications for individuals and public policy.

## **12.1 Background**

### **12.1.2 Depression Impairment, Prevalence, and Factors Associated with Onset in Middle Age**

Depression is characterized by melancholy, diminished interest or pleasure in most or all activities, sleep disorders, and feelings of worthlessness. Depression episodes may come and go, last from several weeks to several months, and are followed by periods of relatively normal mood and behavior (Spitzer et al. 1995). There have been substantial advances in the treatment of depression in the past fifteen years. Despite this, depression re-

mains underrecognized and undertreated in the adult U.S. population (U.S. Department of Health and Human Services 1999; McGlynn et al. 2003).

The National Comorbidity Survey Replication (NCS-R) study finds that 6.6 percent of working-aged adults experienced an episode of depression in a given year (Kessler et al. 1994). Individuals aged eighteen to fifty-nine have a higher risk of lifetime major depressive disorder compared with individuals aged sixty and older. Women are also at higher risk for developing major depressive disorder compared with men. Episodes of depression are associated with significant functional impairment (Ormel et al. 1994). Major depression accounts for approximately 30 percent of all current DI/SSI claims.<sup>2</sup>

The indirect impact of depression on individuals' lives has been studied in recent clinical and epidemiological research (Kessler et al. 2003). Depression has been linked to a number of physical illnesses such as heart attacks and heart disease, strokes, diabetes, and cancer (Bruce and Hoff 1994; Carson et al. 2000; Gainotti, Azzoni, and Marra 1999; Surtees et al. 2003; Whyte and Mulsant 2002; Robinson, Morris, and Fedoroff 1990; Bottomley 1998; Spiegel 1996; Zellweger et al. 2004; Rudisch and Nemeroff 2003; O'Connor, Gurbel, and Serebruany 2000; and Musselman et al. 2003). The directionality of these relationships is unclear at this time; some studies suggest depression is an important antecedent risk factor for incident physical illness, while others suggest the opposite causal relationship (Krishnan 2000; Larson et al. 2001; Stewart et al. 2003; Dalton et al. 2002; Wulsin 2004, McMahon and Lip 2002). Regardless of the causal direction, comorbid depression appears to worsen the prognosis, prolong recovery, and may increase the risk of mortality associated with the physical illness (Black, Markides, and Ray 2003; Fultz et al. 2003; House et al. 2001; Jiang et al. 2003; Kotila et al. 1999; Ostir et al. 2002; Ramasubbu and Patten 2003; Williams, Ghose, and Swindle 2004; Carney and Freedland 2003; Rozanski, Blumenthal, and Kaplan 1999). There appears to be important gender differences regarding the negative consequences of depression associated with deteriorating physical health and other factors (Bruce and Hoff 1994; Bruce and Kim 1992). Major life changes, such as widowhood, have also been linked to the onset of depression in middle-aged adults (Pereira and Sloan 2002; Bruce 2002).

The quality of the epidemiological evidence associating depression in middle-aged adults with other social factors varies substantially. In the few studies that appear to use well-defined and reliable measurements of depressive symptoms and social characteristics, small sample sizes and/or highly specific study populations tend to be employed, limiting the statistical power and generalizability of the findings. With respect to life changes,

2. Personal communication with SSA research statistician, April 2002.

it is unclear from the epidemiological literature whether these factors affect the severity of illness or are precipitating factors in incident depressive episodes.

### 12.1.2 Previous Economic Literature

The existing literature focuses exclusively on direct impacts of illness on employment, earnings, and hours of work. A number of studies have documented the direct effects of poor health on contemporaneous labor force participation, DI/SSI applications and benefit receipt, and early retirement (Bazzoli 1985; Bartel and Taubman 1979; Berkovec and Stern 1991; Burtless 1987; Chirikos and Nestel 1985; Quinn 1977; Fenn and Vlachonikolis 1986; Breslaw and Stelcner 1987; Chirikos 1993; Costa 1996). The majority find that poor health is negatively associated with labor force participation and positively correlated with DI/SSI applications. More recent work has focused on declining health's negative impact on employment (Bound et al. 1999; Pelkowski and Berger 2004). Only two studies we identified explicitly decompose health measures into physical and mental illness (Berkowitz and Johnson 1974; Berkovec and Stern 1991). When such distinctions are made, mental illnesses appear to significantly increase the likelihood of labor force exit and disability program application and receipt.

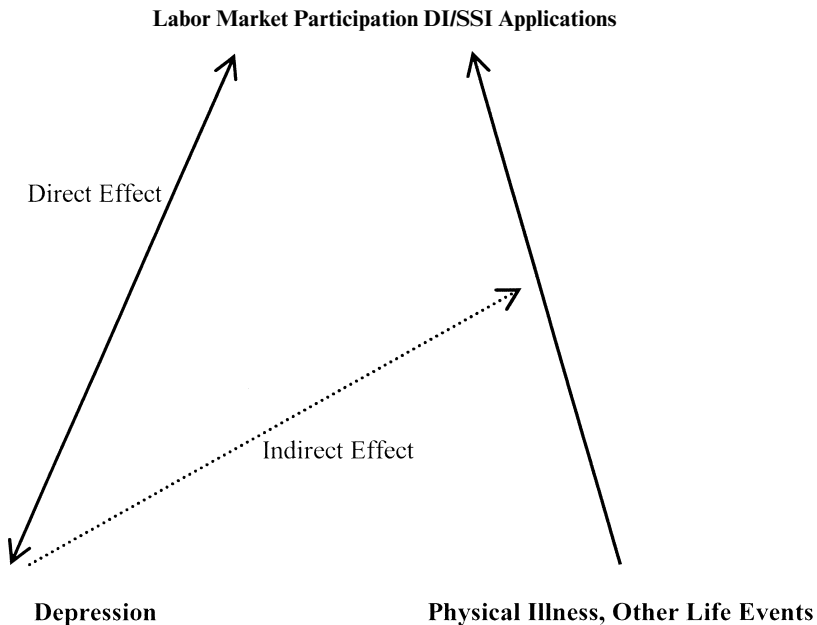
Most of the early literature treated health and health deterioration as exogenous to employment status. In contrast, a growing body of research recognizes that health and labor supply are jointly determined (Dwyer and Mitchell 1999). While the health production framework is well developed, empirical estimation strategies are more varied. When the possible endogeneity of mental health and labor supply is taken into account, there still appears to be significant decrements in employment, earnings, and hours of work for both men and women (Ettner and Kessler 1997; Ettner 2000; Panzarino 1998; Lerner et al. 2004; Lerner, Berndt, and Adler 2004).

Finally, consistent with a handful of recent clinical findings, several studies have viewed retirement as a process rather than a single event, and often that of last resort (Honig and Hanoch 1985; Ruhm 1990). Few studies have estimated the direct effect of health on labor force transitions other than the events of retirement, DI application, and DI receipt (Blau 1998). Two recent studies have investigated the dynamic effects of declining physical health on labor force participation and DI application and receipt in older workers (Bound et al. 1999; Smith 2005). In the first study, the authors report that declines in physical health are strongly associated with labor force exit, job change, and DI applications. In the second, the authors find that negative physical health shocks appear to increase out-of-pocket health care expenses, decrease the extensive margins of labor supply (whether to work or not), increase health insurance access primarily through government programs, and decrease household income.

## 12.2 Conceptual Framework and Analytical Plan

Taking the human capital model as a point of departure, we hypothesize that incident depression directly decreases labor supply. Based on clinical and epidemiological research, we also hypothesize that depression creates a new vulnerability to other shocks that may also negatively affect labor supply. These proposed pathways are summarized in figure 12.1. In terms of life events, we focus on widowhood, since it appears to be independently and robustly associated with the onset of depression in middle age, is easily and reliably measured in survey data, and is plausibly associated with employment opportunities and outcomes.

We adopt two empirical approaches to estimate these effects and to address the potential endogeneity of depression in labor supply (depicted in the figure as a reverse arrow leading from labor market outcomes to depression). In the first approach, we identify a subset of employed people likely to be depressed at baseline and compare their employment outcomes in subsequent survey waves with those of individuals who are not depressed. We interact baseline depression with incident physical illness (subsequent to the baseline) and widowhood to identify the indirect effects depression may have on the employment outcomes associated with these



**Fig. 12.1** The direct and indirect effects of depression on labor market participation and disability program application

life events. To do so, we difference out the independent effect physical illness and life events may have on labor supply decisions. We estimate the indirect effect using a difference in differences approach. For these analyses we control for baseline characteristics of individuals and obtain standard errors that account for the panel structure of the data.<sup>3</sup>

The second method identifies a subset of individuals with no history of psychiatric conditions and no significant symptoms of depression at baseline. Individuals are excluded from the study cohort if they have a physical illness or have lost a spouse at baseline. We estimate the direct effect of incident depression on labor supply and disability program participation. We also estimate the indirect effect of incident depression associated with incident physical illness and widowhood on employment outcomes.

We estimate both models using maximum likelihood. The generalized estimating equations (GEE) model is used to account for the panel structure of the data with non-Gaussian outcomes.<sup>4</sup> To aid in the interpretation of results, we calculate predicted probabilities for each of the outcomes under differing health and mental health states and obtain bootstrapped standard errors. We also perform several sensitivity analyses to assess the robustness of our findings.

We limit our analyses to individuals who are working at baseline to attenuate the possibility that loss of employment may cause an individual to experience depression at baseline or in subsequent periods. We also include regional indicator variables (Northeast, South, West and Midwest) to account for differing economic conditions across the nation. We include an interaction term between region and time dummies to control for differential regional employment and disability application trends. Finally, we include a number of demographic variables in our models that may impact labor market choices, including a respondent's race, educational attainment, and household wealth (total assets and nonhousing total assets).

Given differing labor market participation incentives and opportunities, as well as depression incidence for women and men, we stratify all analyses by gender. We also exclude individuals aged sixty-five years or older in the baseline period in all the analyses. We control for marital status in the baseline period and subsequent changes in marital status excluding widowhood in all empirical analyses. Finally, where possible we check dates of

3. For all analyses reported in the chapter we assume errors are clustered on an individual. We repeated analyses specifying AR1, AR2, AR3, and exchangeable errors terms within individuals. The results of the analyses do not change significantly.

4. We estimated both sets of analyses using conditional logits, and random effect probits in addition to using GEE. We report in this chapter results of the GEE analyses. The results do not significantly differ between estimating procedures. The advantage of GEE over other methodologies is its flexibility in discrete modeling of the error term and its small sample properties. However, GEE has been shown to be biased in estimating causal effects in unbalanced panels. For this reason, we chose to restrict our sample to a continuously enrolled population.

outcomes such as disability application, loss of a job and retirement against interview dates to help control for the possibility of retirement, disability application, and loss of a job preceding the depression episode. All outcomes are assessed at year  $t + 1$  when depression occurs in year  $t$ .<sup>5</sup>

### 12.3 Data

The analysis is conducted using data from the Health and Retirement Survey (HRS) (University of Michigan 1999). The survey includes a representative sample of noninstitutionalized men and women born between 1931 and 1941 inclusive, and their spouses or partners. The HRS oversamples blacks, Hispanics, and residents of the state of Florida, and provides population weights for analyses.<sup>6</sup> The first wave was conducted in the spring of 1992 and the winter of 1993 on approximately 7,600 households (12,654 individuals). The first follow up of HRS respondents was fielded approximately two years after the baseline; later waves of the survey have been fielded through 2002 (Juster and Suzman 1995).

The HRS contains extensive measures of income, assets, health insurance coverage, demographic characteristics, and family structure. Among these variables we use measures of employment including full-time and part-time work status, early (pre-age sixty-five) retirement and application for DI/SSI benefits (DI, SSI, and DI/SSI). Since approximately 75 percent of individuals who apply for DI benefits initially are rejected, and approximately 55 percent of these reapply or appeal this initial eligibility determination, often we do not observe the resolution of the application process (U.S. Social Security Administration 2004). Hence, we only include DI/SSI benefit application and appeals in our analyses. Previous studies have suggested that women may be less likely to report being retired when they have exited the labor market than men. Results of a preliminary analysis of the dataset are consistent with this observation; women are less likely to report being retired and more likely to report being not in the labor force conditional on previous employment in comparison to men overall. Therefore, we consider individuals in the main analyses to be retired if they report being retired or left the labor force in response to a survey question regarding self-reported labor force status conditional on previous employment.

The HRS contains an extensive range of health measures, including the prevalence of thirty-nine specific health conditions and a depression index based on the Center for Epidemiologic Studies Depression Scale (CES-D).

5. Responses in the last survey year are the exception. Here we take advantage of the timing of health and employment survey modules. The HRS fields three separate surveys in a given two year survey wave. In the final wave, we use the health responses from the first survey and employment responses from the last survey. The average timing between surveys is nine months.

6. Population weights are used for all analyses.



We employ measures of health conditions linked to depression in the clinical literature, specifically cardiovascular problems (including heart attacks and cardiovascular disease but excluding high blood pressure), stroke, any cancer, and diabetes.

Depression diagnosis is not part of the health conditions specifically identified (Steffick 2000). Therefore, our primary measure of depression is derived from the CES-D. The CES-D is a self-report survey instrument designed to measure the current prevalence of depressive symptoms in the general population (Radloff 1977). A shortened version of the full CES-D questionnaire is administered in the HRS, consisting of eight questions, each scored on a scale of 0–1. A response of zero indicates that the respondent did not experience the symptom in the past year; a score of one indicates the reverse. One major advantage of the CES-D for use in our study is that none of the measures are related to employment or work performance, thereby providing a measure of depression symptomology independent of work outcomes.

Identification of individuals likely suffering from a depressive episode is predicated on the reliability and validity of CES-D cutoff scores. In order to best identify individuals using this score, we relied on an extensive literature on the usefulness of the CES-D in identifying episodes of depression. No equivalent validity and reliability studies for shortened CES-D instruments have been performed in older populations to date. Short forms of the CES-D have been validated for general adult use and shown to be reliable and internally consistent in detecting probable depression (Kohout et al. 1993; Andresen et al. 1994). Several methods have been advanced to convert a cutoff score consistent with probable depression in the full survey (typically 16 out of a total possible score of 60) to the shortened version, each yielding similar results (a score of 2 to 3 out of a possible total score of 8 on the HRS version of the CES-D).<sup>7</sup> One recent work has investigated the validity of the full CES-D for recognizing depression in older community-dwelling populations aged fifty-five and older (Lyness et al. 1997). They report that the optimal cutoff score for identifying major depression in an older adult population using the full CES-D to be 20 to 21 out of a possible total score of 60. A score of 20 to 21 on the full CES-D survey is equivalent to a cutoff score of 4 in the shortened version using the proportionality method advanced by Kohout et al. (1993). We implement this cutoff in our sample; the primary measure of depression that we apply to our sample is an aggregate score of 4 or higher on the shortened CES-D in a given year.

7. Several researchers have suggested that findings from younger patient groups regarding the validity and reliability of implementing corresponding cutoffs in the full CES-D for detecting major depression may not apply to older persons. Specifically, older adults tend to underreport depressive symptoms. Comorbid physical illnesses may also confound questions regarding somatic symptoms of depression.

### 12.3.1 Study Cohort Definitions and Exclusions

For all analyses, we employ survey responses of individuals continuously enrolled between 1994 and 2000 (waves 2 to 5). We concentrate on this time period due to concerns regarding changes in the inclusion of specific CES-D questions in the depression screener and changes in the specific wording of allowable CES-D responses between years 1992 and 1994.<sup>8</sup> Responses from the 1994 survey are considered to be the baseline measures and as such define the before period of our study. Individuals are included in the study sample if they report that they worked during 1994, defined as working part-or full-time, not retired, and not unemployed. In the first set of analyses, we exclude all individuals who reported having diabetes, heart disease, back pain, cancer, or had a stroke in 1994 or earlier. We also exclude all individuals who report being a widow in 1994. In the second set of analyses, individuals who report a history of psychiatric problems or experience depressive symptomology consistent with depression in 1994 are excluded from the sample. We also excluded all individuals who reported having diabetes, heart disease, cancer, or had a stroke in 1994 or earlier. In the second analyses we also exclude individuals who report being a widow in 1994.

## 12.4 Results

### 12.4.1 First Analytical Strategy Results

We identified 2,457 men and 2,986 women respondents to the HRS that met our study criterion (table 12.1, panel a). Men were on average approximately two years older than women (54.6 versus 52.3 years of age). Approximately 6 percent of men and 12 percent of women were depressed at baseline based on our CES-D definition. Depressed men and women were more likely to experience a subsequent physical health shock in years 1996–2000 (30.3 percent among men and 18 percent among women) than individuals who were not depressed at baseline (20.3 percent among men and 13.5 percent among women). However, the incidence of widowhood in years 1994–2000 did not appear to be different for individuals depressed and not depressed at baseline (approximately 2.3 percent of men and 7.1 percent of women in each group).

We compared characteristics of depressed and not depressed individuals at baseline. The results are tabulated in table 12.2. Generally, a larger proportion of Hispanic individuals, those having less than a high school education, and poorer individuals (measured by housing and nonhousing as-

8. See Jones and Fonda (2004) for a new method to link responses from wave one and wave two in the HRS.

**Table 12.1** Description of study population

	Men	Women
<i>A. Strategy #1</i>		
Total N	2,457	2,986
Average age at baseline	54.6	52.3
Percentage depressed at baseline	6%	12%
Percentage depressed at baseline and develop physical illness	30.3%	18%
Percentage depressed at baseline and become widowed	2.3%	7.1%
Percentage develop physical illness, no depression	20.3%	13.5%
Percentage become widowed, no depression	2.3%	7.1%
<i>B. Strategy #2</i>		
Total N	1,345	1,821
Average age at baseline	54.6	52.5
Percentage develop depression	10%	15%
Percentage develop physical illness	18.3%	13%
Percentage become widowed	2.4%	6.6%
Percentage develop depression and physical illness	26.1%	18.7%
Percentage develop depression and become widowed	1.3%	9%

**Table 12.2** Comparison of baseline characteristics strategy #1

	Men				Women			
	Not depressed		Depressed		Not depressed		Depressed	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Married	<b>0.88</b>	<b>0.007</b>	<b>0.7</b>	<b>0.04</b>	<b>0.74</b>	<b>0.009</b>	<b>0.67</b>	<b>0.02</b>
Separated or divorced	0.08	0.008	0.104	0.02	0.11	0.007	0.13	0.02
Less than a high school education	<b>0.19</b>	<b>0.008</b>	<b>0.42</b>	<b>0.04</b>	<b>0.16</b>	<b>0.007</b>	<b>0.36</b>	<b>0.03</b>
Black	0.12	0.007	0.12	0.03	0.17	0.007	0.22	0.02
Hispanic	<b>0.07</b>	<b>0.007</b>	<b>0.18</b>	<b>0.02</b>	<b>0.07</b>	<b>0.005</b>	<b>0.21</b>	<b>0.02</b>
Has private health insurance	<b>0.08</b>	<b>0.008</b>	<b>0.57</b>	<b>0.04</b>	<b>0.8</b>	<b>0.008</b>	<b>0.65</b>	<b>0.03</b>
Nonhousing assets	72147.9	3352.9	64067	6103	61762.31	1639.2	40717	2808.3

Note: Bold font denotes values significantly different from zero at the 0.05 level.

sets) comprise the depressed than the nondepressed population at baseline. We controlled for these differing baseline characteristics in all analyses.

First differences (the direct effect of depression) and difference in differences (the indirect effect of depression) estimates are presented in table 12.3. Baseline depression alone appears to increase significantly DI/SSI applications and retirement among both men and women. Subsequent physical illnesses are positively associated with increased retirement and DI/SSI applications among men. Subsequent widowhood alone appears to be positively associated with labor force exit for both men and women. The

**Table 12.3 Strategy #1 results of first differences and difference in differences by gender**

Outcome	Baseline depression		Subsequent physical condition		Interaction baseline depression and physical condition		Subsequent widowhood		Interaction baseline depression and widowhood	
	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE
<i>Men</i>										
DI/SSI application										
Applies or reapplies for disability insurance	0.45**	0.16	0.46**	0.13	0.32**	0.17	0.09	0.29	0.57	0.5
Employment status										
Works	-0.92	0.88	-0.4**	0.07	-0.16	0.17	-0.007	0.2	-0.77**	0.34
Works at a full-time job	0.06	0.1	-0.3	0.06	-0.35**	0.15	-0.12	0.19	-0.38	0.26
Works at a part-time job	-0.11	0.16	-0.04	0.1	0.12	0.17	0.002	0.29	0.66	0.47
Retirement										
Leaves labor force	0.25**	0.14	0.14**	0.07	0.29**	0.15	0.08	0.2	0.24	0.43
<i>Women</i>										
DI/SSI application										
Applies or reapplies for disability insurance	0.63**	0.14	0.42**	0.11	0.24	0.16	0.002	0.15	0.55**	0.2
Employment status										
Works	-0.74	0.75	-0.25**	0.08	-0.21	0.2	-0.11	0.12	0.03	0.24
Works at a full-time job	-0.08	0.08	-0.09	0.06	-0.21	0.24	-0.21**	0.11	-0.08	0.11
Works at a part-time job	-0.16	0.12	-0.07	0.07	0.14	0.17	0.1	0.12	-0.42**	0.22
Retirement										
Leaves labor force	0.47**	0.15	0.11	0.08	0.1	0.2	0.14	0.12	0.13	0.24

\*\*Significant at the p = 0.05 level.

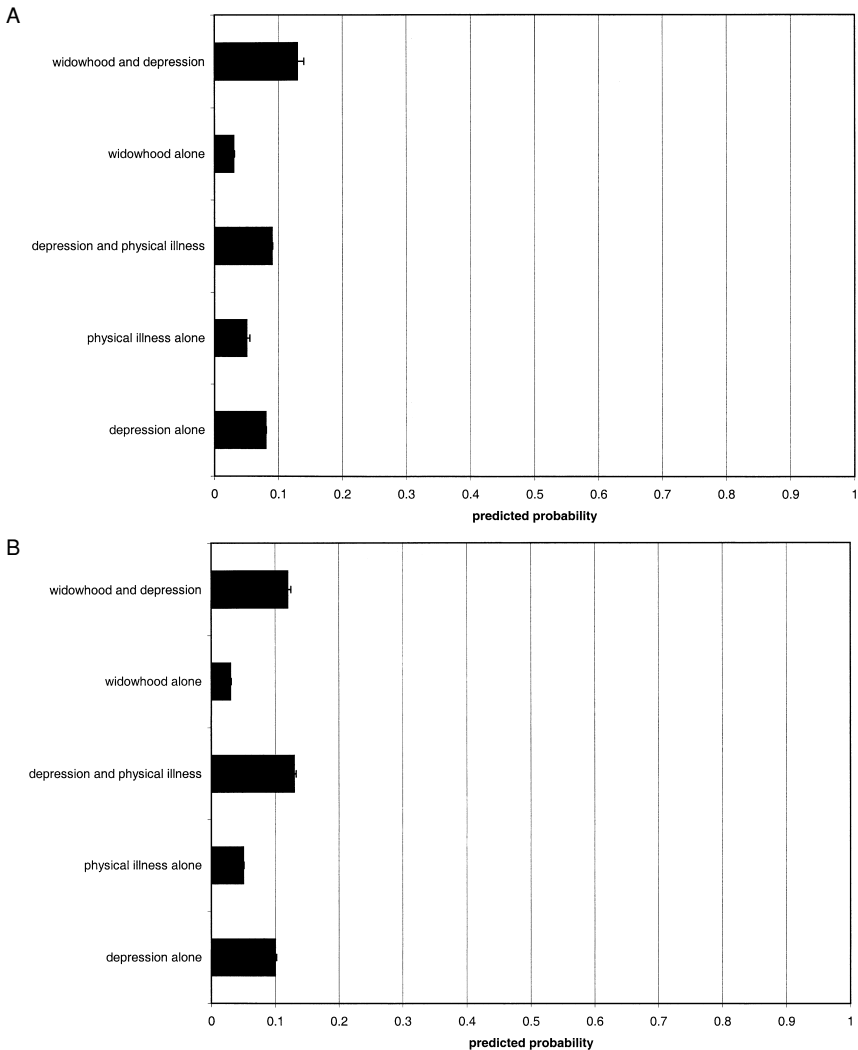
interaction of baseline depression with subsequent physical illness reduces full-time work for men, but has no significant impact on women's employment status. Baseline depression and subsequent widowhood appears to also have differential effects by gender; increasing retirement among men, but increasing DI/SSI applications and decreasing part-time work and the likelihood of holding a second job among women.

To aid in the interpretation of these findings, we used the regression parameter estimates to construct the predicted mean direct effects of depression alone, physical illness alone, and widowhood alone, and predicted mean indirect effects of depression interacted with incident physical illness and subsequent widowhood, on DI/SSI applications (fig. 12.2) and early retirement (fig. 12.3). All predicted effects are significantly different from zero at the 0.05 level using bootstrapped standard errors depicted as error bars in the figures. Generally, we find baseline depression alone appears to have a greater impact on predicting DI/SSI applications than incident physical illness alone. The interaction of baseline depression and incident physical illness increases the probability of applying for DI/SSI benefits (relative to only baseline depression or only subsequent physical illness) slightly for men. For women, the increase is substantial. For both men and women, while incident widowhood alone has only a small impact on the probability of applying for DI/SSI benefits, when interacted with baseline depression, subsequent widowhood has a large impact. Specifically, the interaction of baseline depression and subsequent widowhood increases both men's and women's likelihood of applying for DI/SSI benefits approximately fourfold over widowhood alone.

With respect to early retirement behavior (fig. 12.3), men appear to be more affected by physical health and widowhood shocks than are women. For men, the effect of physical illness alone on early retirement is larger than baseline depression alone. The interaction of widowhood and baseline depression generates a positive impact on men's early retirement behavior. However, the interaction of baseline depression and subsequent physical illness does not appear to differentially effect retirement. Similarly, the interaction of baseline depression and subsequent physical illness among women has no differential impact from that of subsequent physical illness alone. For women, the combination of baseline depression and subsequent widowhood has large impact on early retirement, but still is smaller than that for men.

#### 12.4.2 Second Analytical Strategy Results

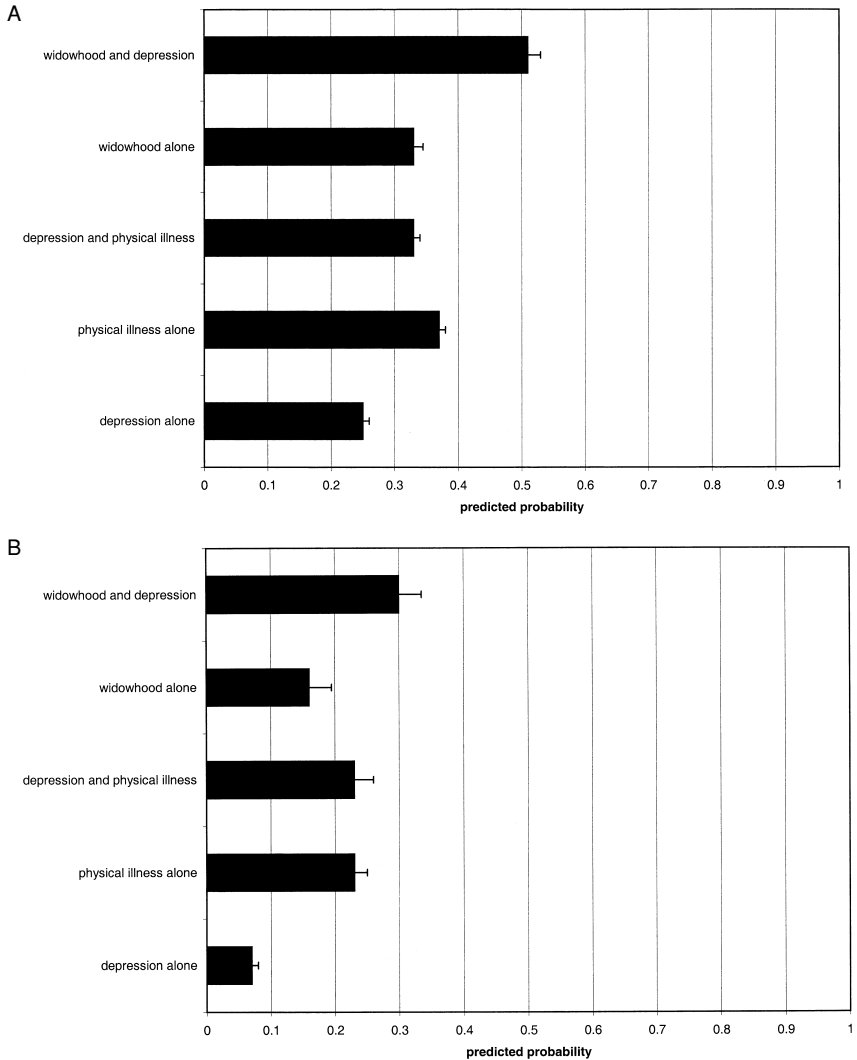
A total of 3,277 respondents to the HRS were included in the second set of analyses: 1,345 men and 1,821 women (table 12.1, panel b). Cumulatively, 139 men (10.1 percent) and 218 women (14.5 percent) experienced an incident episode of depression based on our CES-D definition, while 2.4 percent of men and 6.6 percent of women lost a spouse. Among individu-



**Fig. 12.2 Strategy 1, DI/SSI application: A, men; B, women**

als with subsequent episodes of depression, a larger percentage of men and women also developed an incident physical illness (26.1 percent and 18.7 percent, respectively) than those without subsequent depression (18.3 percent among men and 12.7 percent among women).

The generalized estimating equations (GEE) estimates of the direct and indirect effects of incident depression on various labor market outcomes are presented in table 12.4. For men, incident depression alone and incident physical illness alone appears to increase DI/SSI applications, and



**Fig. 12.3 Strategy #1, early retirement: A, men; B, women**

decrease employment overall, by approximately the same amount. The interaction between depression and physical illness increases the likelihood of DI/SSI application substantially. While subsequent widowhood alone has little impact on the employment status and DI/SSI application measures, the interaction of depression and widowhood appears to significantly increase DI/SSI application and early retirement among men. For women, depression alone directly decreases employment overall, and when

**Table 12.4 Strategy #2 GEE results by gender**

Outcome	Subsequent depression		Subsequent physical illness		Interaction depression and physical illness		Subsequent widowhood		Interaction depression and widowhood	
	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE	$\beta$	SE
<i>Men</i>										
DI/SSI application										
Applies or reapplies for disability insurance	0.26**	0.12	0.22*	0.11	0.49**	0.19	0.06	0.23	0.67	0.4
Employment status										
Works	-0.26**	0.09	-0.29**	0.1	-0.13	0.18	-0.09	0.23	-0.6	0.32
Works at a full-time job	-0.08	0.07	-0.2**	0.07	-0.32	0.19	-0.15	0.16	-0.5**	0.26
Works at a part-time job	-0.03	0.11	-0.12	0.11	0.33	0.2	-0.06	0.25	0.73	0.46
Retirement										
Leaves labor force	0.12	0.09	0.35**	0.09	0.05	0.17	0.11	0.23	0.62**	0.32
<i>Women</i>										
DI/SSI application										
Applies or reapplies for disability insurance	0.16**	0.1	0.34**	0.1	0.43**	0.17	-0.05	0.12	0.61**	0.17
Employment status										
Works	-0.24**	0.08	-0.22**	0.09	-0.27	0.18	0.04	0.09	-0.2**	0.17
Works at a full-time job	-0.02	0.06	-0.01	0.09	-0.37	0.24	0.04	0.08	-0.08	0.09
Works at a part-time job	-0.22*	0.08	-0.13	0.1	-0.05	0.17	0.03	0.1	-0.14	0.16
Retirement										
Leaves labor force	0.18**	0.08	0.22**	0.09	0.26	0.18	-0.06	0.09	0.23	0.17

\*\*Significant at the p = 0.05 level.

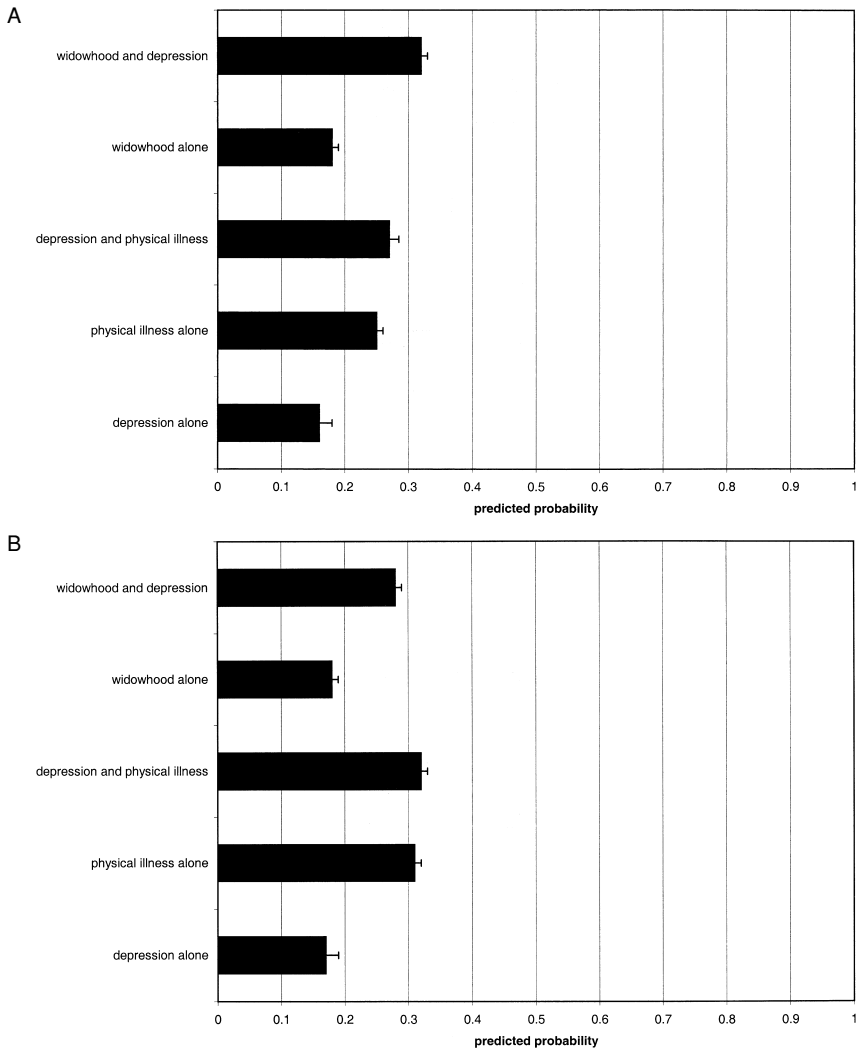


interacted with subsequent physical illness also directly increases the likelihood of DI/SSI applications; this interaction does not appear to have an effect on other measures of employment status or retirement behavior. While by itself subsequent widowhood has no impact on the various employment status measures, the interaction of incident depression with widowhood appears to increase the likelihood of DI/SSI application substantially, but has no significant effect on other employment and retirement outcomes.

To aid in the interpretation of these coefficients, we compute the mean predicted outcomes of the direct effects of depression, physical illness, and widowhood and their interactions on DI/SSI applications and early retirement. Results are reported in figure 12.4 and figure 12.5. All estimated predicted probabilities are significantly different from zero using bootstrapped standard errors (depicted as error bars in the figures).

For men, incident depression alone increases the likelihood of applying for disability benefits by 16 percent. This effect appears to be less than but approximately of the same order of magnitude than incident physical illness (increases DI/SSI applications by 25 percent). The interaction of incident depression and physical illness appears to have a larger effect on the likelihood of men applying for DI/SSI than each illness alone. Widowhood alone increases a man's likelihood of applying for disability benefits by 18 percentage points, similar in magnitude to incident depression and physical illness alone. Interestingly, the interaction of depression and widowhood increases the relative odds of applying for DI/SSI benefits by approximately twofold, to 32 percent, larger than incident depression and incident widowhood alone. For women, the magnitude of the direct effect of depression on DI/SSI applications is equivalent to men. However, incident physical illness alone and its interaction with depression appear to have a larger effect on DI/SSI applications for women in comparison to men. The indirect effect of depression and widowhood appears to be greater for men than for women (14 percent versus 12 percent). The direct effect of incident widowhood on DI/SSI application for women is similar to that of men as is the interaction of incident widowhood and depression, raising the likelihood of applying for DI/SSI benefits substantially more than each condition alone.

With respect to early retirement (fig. 12.5), incident depression appears to have a larger effect on the early retirement for women than physical illness alone, while for men the effects are similar. Women appear to be more likely to retire early due to the effects of incident depression alone than are men. The interaction of incident depression and physical illness increases the likelihood of early retirement more than the direct effects of depression and physical illness alone and are similar for men and women. Finally, while the effect on early retirement of incident widowhood alone is similar for men and women (in both cases being slightly smaller than physical illness

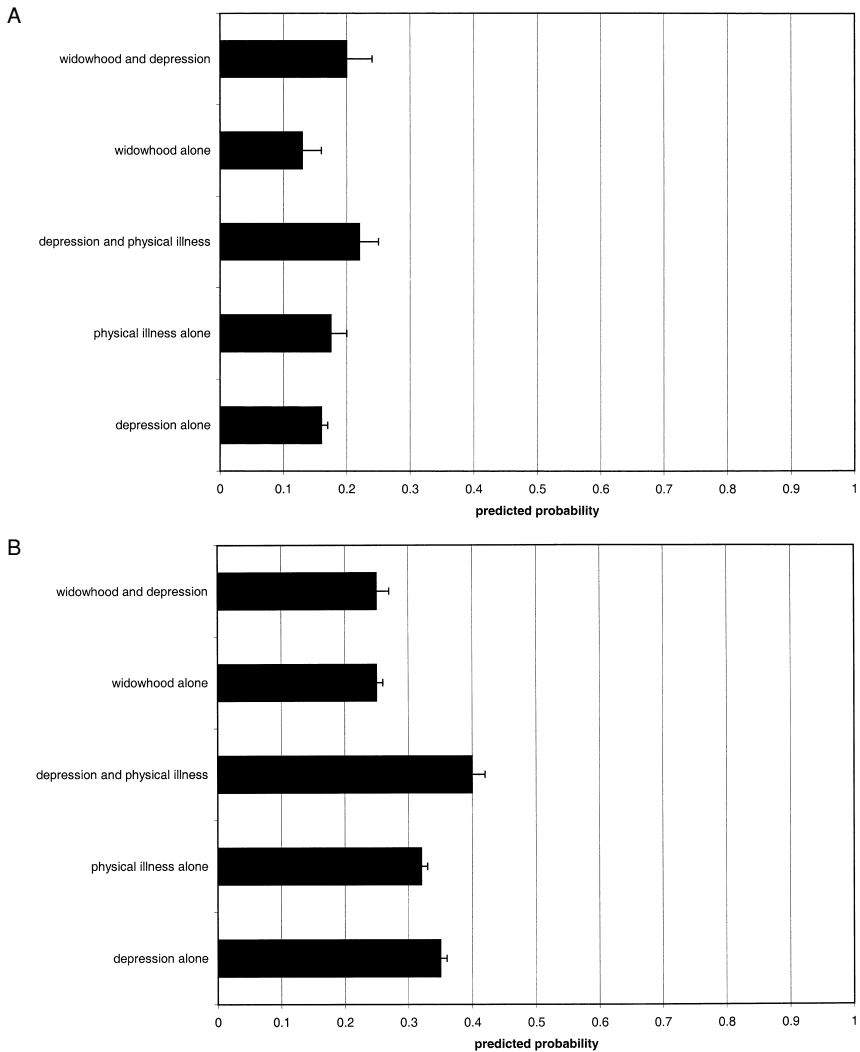


**Fig. 12.4 Strategy #2, DI/SSI applications: A, men; B, women**

alone), for men (but not for women) the interaction between incident depression and widowhood is considerably larger than each direct effect and greater than the indirect effect of depression and physical illness combined.

### 12.4.3 Sensitivity Analyses

To test the robustness of our findings, we performed a series of sensitivity analyses. First, we experimented with the definition of incident physical illness. In one set of analyses, we restricted our definition of incident phys-



**Fig. 12.5 Strategy #2, early retirement: A, men; B, women**

ical illness to include only heart disease, the largest group of incident physical illnesses experienced by the study cohorts. Generally, the significance of the results reported previously do not change; however, the predicted probabilities of applying for DI/SSI benefits and early retirement are lower than those estimated with all physical illnesses included in the models.

The clinical and epidemiological literature has associated pain in general (and in particular back pain) with depression among older adults (Bair et al. 2003; Eaton and Buka 2004; Larson, Clark, and Eaton 2004). Accounting

for this association may be important to labor market outcomes, particularly DI/SSI applications, since musculoskeletal problems alone are currently the second leading cause of DI/SSI applications (Autor and Duggan 2003). Therefore, in another set of analyses we expanded the definition of incident physical illness to include incident back pain, reestimated the models, and computed predicted mean direct and indirect effects of depression. Generally, for both men and women this addition elevated the predicted probability of applying for DI/SSI benefits and for retiring early over the original definition. Interestingly, this addition appears largely to eliminate the differential results discussed above between genders. This appears to be because more men than women report incident back pain problems.

To address the possibility that our definition of early retirement may be subject to measurement error due to differential reporting by gender correlated with depression and physical illness onset, we reestimated the models using a more exclusive measure of retirement behavior. Specifically, we considered individuals to have exited the labor force if they report being retired in response to a survey question regarding self-reported labor force status. Generally for men, the direction and magnitude of the direct and indirect effects of depression using the more exclusive measure of retirement are consistent with our original findings. However, women are more likely to report being not in the labor force conditional on previous employment in comparison to men overall. Thus, we expected that use of the alternative outcome measure may be particularly sensitive to women's labor market participation. We find that the results are consistent with this expectation: the direct effects of incident depression, incident physical illness, and widowhood alone appear to be approximately half as large with respect to the likelihood of retiring (and remain statistically significant) for women. The indirect effects of depression associated with physical illness and depression associated with widowhood are similarly smaller and remain statistically significant.

The CES-D is an instrument that does not directly provide information on a diagnosis of depression. In particular, it does not contain questions regarding duration and frequency of symptoms that are important diagnostic criteria. Thus, our reliance on the CES-D to determine depression cases may result in misclassification error. In order to assess our identification of cases of depression, we compare case classifications using the CES-D to the onetime fielding of a separate depression assessment tool, the Composite International Depression Instrument (CIDI), in the HRS that directly relates to the DSM-III diagnostic criteria. The HRS fielded the so called CIDI short form in the wave 3 (1996) survey only. A cutoff score of 5 out of 7 corresponds to a DSM-III diagnosis of major depression with high sensitivity and specificity (Steffick 2000).

Applying the CIDI criteria to the second study cohort, we identified a lower percentage of men and women (2.4 percent and 6.6 percent, respec-

tively) with depression compared to that classified as depressed when using the CES-D criteria in wave 3 only (7 percent and 9.6 percent, respectively). In order to determine the overlap in depression cases identified by both surveys we ran a probit regression of CESD cases on CIDI cases at the individual level. We found that determination of depression cases using the CES-D criteria identifies as depressed approximately 79 percent of individuals meeting depression criteria using the CIDI criteria. This represents a relatively high correlation between the two depression measures. The high concordance in depression identification indicated by comparisons between the CES-D and CIDI and the higher numbers of absolute cases attributed to the CES-D criteria suggest that the CES-D does a good job of predicting major depression, but may overidentify cases when duration in particular is not accounted for in the determination process. Therefore, misclassification of depression using the CES-D criteria alone likely results in a downward bias in the estimation of the direct and indirect effects of depression on labor force participation since some transient symptoms of depression are overweighted in the analyses and results.<sup>9</sup>

In our empirical approaches to identifying the direct and indirect roles of depression in determining labor force participation, we have concentrated on defining depression to be incident (in the second analytical strategy) or preexisting (in the first analytical strategy) in an attempt to address concerns regarding the endogeneity of employment and health status. Persistence of depressive symptomology and its potential impact on employment is a challenging issue. For the first strategy, we included in the regression specification a dummy variable if depression occurred in a subsequent survey wave. In the second strategy, once an individual has an incident depressive episode, we examine labor market outcomes in the subsequent survey year. For individuals who have persistent depression (i.e., remain depressed in a subsequent survey wave) we estimate subsequent labor market outcomes for this depression, which may be more properly considered prevalent. Both approaches represent conservative approaches to parameter estimation.

In an effort to evaluate the importance of persistent depressive symptoms in determining employment outcomes, we performed a small cross-sectional analysis using wave 5 (2000) data. Specifically, we created a cumulative measure of depression across the previous survey years (applying the exclusion criteria used to determine the cohorts in the first and second analyses separately). We then estimated the likelihood of DI/SSI application, retirement, and employment status outcomes in the cross section pre-

9. In a separate set of analyses, we applied a more restrictive definition of depression, employing a cutoff score of 5 on the shortened CES-D, to the cohorts and reestimated the models. For several outcomes we were unable to achieve convergence using maximum likelihood when applying this criteria. For the remaining analyses, the results were consistent with reported predicted probabilities discussed previously.

dicted by the number of depressive episodes experienced by an individual in the current and previous waves. In general, the persistence of depressive symptoms is estimated to increase the relative odds of applying for DI/SSI benefits and early retirement for both men and women. The effect of persistent depression is estimated to be monotonically increasing for men in DI/SSI applications and in retirement for both men and women. Notably, the persistence of depressive symptoms appears to be greater in women than in men.

Finally, to assess the robustness of these estimates we projected disability application rates and employment trends for men and women into an out-of-sample survey wave (wave 6, year 2002) using parameter estimates from our model. We then compared these results against actual employment and disability application rates contained in the recently released 2002 HRS data and model predictions applied to the data used in the main analyses.<sup>10</sup> To take into account the changing population surveyed in 2002, we limited our predictions to individuals working in 1994, with no physical illness, depression in 1994, and non-widows who are continuously enrolled in the HRS survey between 1994 and 2002. This yielded a sample of 948 men and 1,460 women.

The projections for the 2002 cohort differ by outcome. For DI/SSI applications, the power of the model is high (96 to 100 percent) in predicting which individuals will not apply for benefits but low (5 to 15 percent) in predicting which individuals will apply for benefits in 2002. On employment status measures (any employment, full-time employment, and part-time employment) the power of the model is high in predicting who will (85 to 98 percent) and will not (95 to 100 percent) work in wave 6. The power of the model is high (95 to 100 percent) in predicting who does not retire, but not very sensitive (4 to 10 percent) in predicting who retires in 2002. In essence, the models are predictive in predicting labor force participation in 2002, but are not reliable in predicting disability insurance applications and retirement among this population. The patterns are similar for men and women.

For interpretation we compare these results to the predictive power of in-sample predictions. On employment status measures (any employment, full-time employment, and part-time employment) and retirement, the predictive power of the model in the sample cohort is highly sensitive (98 to 100 percent) and highly specific (98 to 100 percent). Compared with the out-of-sample predictions, the model does a better job predicting who will and will not work and who will and will not retire in sample years. For DI/SSI applications, our in-sample model predictions are highly specific, predicting

10. Sensitivity is defined as the proportion of individuals predicted to have a positive outcome (i.e., apply for DI/SSI benefits and retire) who actually have these outcomes in 2002; specificity is the proportion of individuals who are predicted to have a negative outcome (i.e., do not apply for DI/SSI benefits, continue to work, do not retire) who actually do in 2002.

accurately 100 percent of men and women who do not apply for benefits and more sensitive than the out-of-sample predictions, predicting approximately 82 to 85 percent of men and women who do apply for benefits.

Differences in the predictive capabilities of the model regarding employment and retirement behavior in and out of sample may be accounted for by several factors. First, macroeconomic conditions in 2001–2002, the time period captured in wave 6, were very different from conditions in 1994–2000; stock market valuations fell substantially in 2000–2002, reducing the value of accrued assets including retirement portfolios, and employment overall fell during this period. Consequently, these changes may have altered the valuation of work relative to retirement among individuals at the margin. In addition, the proximity of Social Security benefit eligibility (simply by observing the cohort aging two more years) may also have altered the valuation of applying for disability benefits among individuals at the margin, given the low likelihood of receiving benefits in a time frame that does not directly compete with social security eligibility. This is consistent with the general trend of disability applications falling among individuals aged sixty-two and older observed in raw data from SSA. Finally, the 2002 data used for this analysis is from the preliminary release version and consequently was not subjected to the same extensive cleaning of the data used for 1994–2000. Therefore, some differences in the power of the model to predict labor market participation and disability outcomes out of sample may be due to data quality differences.

## **12.5 Interpretation of Findings and Implications**

Results of both estimation strategies indicate that symptoms of depression directly increases DI/SSI application and early retirement and decreases work for men and women. This is consistent with the previous economic literature that permitted for distinctions between physical and mental illnesses. This finding is also consistent with recent cost of illness estimates suggesting that the costs of depression associated with workplace outcomes are significant (Wang, Simon, and Kessler 2003). The magnitude of this effect appears to be of the same order of magnitude to that of physical illness both for men and for women and greater than that of widowhood alone.

Depression interacts significantly with physical illness in men and women to increase DI/SSI applications and early retirement and decrease full-time labor force participation. Depression's indirect negative effect on work outcomes through its interaction with widowhood is significant for men and women. Interestingly, this indirect effect appears to be differentially detrimental to men. This finding is consistent with the widower effect documented in the recent sociological literature (Iwashyna and Christakis 2003; Christakis and Iwashyna 2003).

These findings have important implications for interpreting disability levels and trends. First, several recent economic papers have accounted for the role of health in determining DI/SSI applications and other labor force outcomes, but have measured health using changes in aggregate mortality. Aggregate mortality statistics are likely correlated with the morbidity associated with acute and some chronic diseases but represent a rather imprecise measure of the health of the population. In particular, chronic illnesses appear to play an increasingly central role in determining the health of the population. Our results suggest that mental illness alone and in combination with physical illness exert important influences on retirement behavior and DI/SSI applications consistent with recent disability application and reciprocity trends. As such, they provide a more complete picture of how chronic disease (and in particular mental illness) impacts employment decisions, retirement, and disability applications.

Second, our results have important implications for interpreting trends in disability overall. The results of the analyses suggest that the interaction between depression and physical illness is substantial and significantly impacts DI/SSI applications. Therefore, holding depression's indirect effect on disability constant, physical illness's role in disability may be decreasing faster than previous research suggests.

There have been significant advances in the treatment of major depression over the past two decades. One major limitation of our dataset is its lack of detailed information on treatment. However, the impact of treatment receipt on individual's lives—related both to their overall health and continued participation in the labor force—may be substantial (Timbie et al. 2005). Research quantifying the impact of treatment on labor market outcomes is an important area for future study and appropriate policy making.

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