



Working with a Severe Mental Illness: Estimating the Causal Effects of Employment on Mental Health Status and Total Mental Health Costs

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Published online: 28 February 2019
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Abstract

Employment is an important goal for persons who have a severe mental illness (SMI). The current literature finds some evidence for a positive relationship between employment and measures of mental health (MH) status, however study design issues have prevented a causal interpretation. This study aims to measure the causal effect of employment on MH status and total MH costs for persons with SMI. In a quasi-experimental prospective design, self-reported data measured at baseline, 6-months, and 12-months, on MH status and employment are paired with Public Mental Health System (PMHS) claims data. The study population (N = 5162) is composed of persons with a SMI who received PMHS services for a year or more. Outcome variables are MH status symptom scores from the BASIS-24 instrument and total MH costs. The estimation method is full information maximum likelihood, which allows for tests of employment endogeneity. Outcomes with an insignificant test of endogeneity are estimated using tobit or ordinary least square (OLS). Employment has modest but meaningful effects on MH status (including overall MH status, functioning, and relationships) and reduces total mental health costs on average by \$538 in a 6-month period. Tests of endogeneity were largely insignificant, except for the depression score that tested marginally statistically significant. Interaction terms between baseline MH scores and employment indicated larger employment effects for individuals with worse baseline scores. This study demonstrates the non-vocational benefits of employment for individuals with SMI. Results have high generalizability and should be of interest to federal and state governments in setting appropriate disability policy and funding vocational programs. From a methodological perspective, future research should still be concerned with potential endogeneity problems, especially if employment status and MH outcomes are simultaneously measured and/or baseline measures of MH are not adequately controlled for future research should continue to examine the multi-dimensional nature of MH status and costs. Our analyses also demonstrate the practical use of a state-wide outcomes measurement program in assessing the factors that influence the recovery trajectories of individuals with SMI.

Keywords Employment · Employment mental health · Employment health · Mental health status · Mental health costs · Severe mental illness

Introduction

The nature of the relationship between employment and mental health (MH) is a complex subject with a literature that is increasingly using sophisticated statistical methods and longitudinal data to explore various aspects of the relationship. Part of the complexity in studying employment and MH is the bidirectional nature of the causal relationship. A number of studies have examined the causal effect of psychiatric illness on labor market outcomes such as employment status, hours worked, and measures of productivity (Chatterji et al. 2007, 2011; Ojeda et al. 2010; Banerjee et al. 2017). Results overwhelmingly support that psychiatric illness has a negative effect on labor market outcomes, though exact mechanisms and heterogeneity in effects of

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this causal relationship are still being explored. Looking at the relationship in the opposite direction (i.e. the effects of employment on MH), there is a growing literature that is examining the causal effects of employment on MH for the general population (Hamilton et al. 1997; Andrés 2004; Mandal and Roe 2008; Gathergood 2013; van der Noordt et al. 2014). The evidence largely supports that unemployment has negative (and likewise employment has positive), effects on measures of psychological well-being and population levels of psychiatric illness. Fewer studies, however, have examined the effects of employment on measures of MH status and other MH outcomes (e.g. health care costs) for individuals with a severe mental illness (SMI), in part because there are limited longitudinal datasets that have tracked both employment and MH outcomes for this population. To fill this gap, we take advantage of one state's public MH outcomes monitoring system that tracks both employment status and measures of MH status to estimate the causal relationship between employment and MH status and costs for persons with SMI.

Estimating causal effects of employment on non-vocational outcomes for adults with SMI presents clear research design challenges. Random assignment of employment in an experimental design to a treatment group and a control group with mandatory adherence is not feasible. Randomized trials of vocational interventions (e.g. trials that have compared models of supported employment (SE) to high quality vocational rehabilitation) are not assigning work randomly. Consequently, data collected from such trials to estimate the impact of employment status on MH outcomes will have similar methodological challenges as are present in other non-experimental data. To infer causality in non-experimental regression studies, the econometric problem of endogeneity must be addressed. Endogeneity occurs in a regression model when explanatory variables are correlated with the error term (Wooldridge 2010). Employment may be endogenous to MH outcomes in a structural sense, if the outcomes are determined simultaneously, and/or in a statistical sense, if there are difficult-to-measure individual or environmental characteristics, such as personality traits, that are both correlated with employment status and are directly related to MH outcomes. To address endogeneity, statistical approaches such as instrumental variables (IVs) estimation methods could yield unbiased estimates of causal employment effects, though finding data on instruments that are both strong predictors of employment status and statistically unrelated to the MH outcome variables is often infeasible.

Relevant recent literature illustrates these concerns. While almost all cross-sectional studies correlating employment to MH status for persons with SMI have noted problems in inferring causation, opposing interpretations of these associations have been offered. Whereas some studies used regression analysis to estimate the influence of MH indicators on contemporaneous employment status (Ojeda et al. 2010;

Salkever et al. 2007), other studies interpreted the association as a causal link from employment to MH; thus, Mueser et al. (1997) found that employed patients tended to have “lower symptoms...higher Global Assessment Scores...(and)...better self-esteem”, and concluded that “(t)hese findings underscore the potential importance of work in the overall rehabilitation process.” In a study that included both contemporaneous and follow-up outcome analyses, Burns et al. (2007, 2008) reported that subjects “who worked had better global functioning, fewer symptoms, and less social disability at final follow-up...Working was associated with having been in remission and out of hospital for the previous 6 months,...a slight decrease in depression, and with being in remission over the subsequent 6 months.” They conclude that this “evidence of work having beneficial effects on clinical and social functioning...merit(s) further exploration.”

Other noteworthy research includes work by Bell and associates (Bell et al. 1996; Bell and Lysaker 1997), who randomized 150 persons with SMI into paid and volunteer jobs. Actual work participation for the 22-week intervention was classified as full, partial, and nonparticipation. Full participants made up 62% of the paid work group and 18% of the volunteer group; thus, randomization appears to have influenced participation of subjects, but actual levels of participation were still probably influenced by unmeasured MH status measures, thus confounding inferences regarding causal employment effects on MH. Study results indicated that persons who worked a high percentage of weeks (paid or volunteer) had significantly lower Positive and Negative Syndrome Scale (PANSS) symptom scores than non-participants, and a lower rate of re-hospitalization (Bell et al. 1996). A more recent study (Kukla et al. 2012) compared data over a 2-year intervention period for 187 patients randomized to 1 of 2 different employment programs. Subjects were divided into four groups based on their 2-year work experiences over the follow-up period: no paid work, minimal paid work, steady paid noncompetitive work, and steady paid competitive work. Analysis of follow-up data in 6-month intervals showed significant employment group differences for PANSS total and positive scales; however, the only significant group-time interaction over the 24 months was for the negative PANSS subscale (with only the steady competitive group showing a steady decline) (Kukla et al. 2012). Authors from both of the above studies expressed caution in interpreting results as causal in nature.

In summary, the literature that is focused on the population with a SMI tends to report positive associations between MH status and employment but the vast majority of this literature uses contemporaneous data that make causal interpretation difficult (Marwaha and Johnson 2004). Studies that focused on individuals with SMI are often limited by small sample sizes; this inhibits the use of more than a few regression covariates, the use of IV techniques, and formal tests of

regressor endogeneity. A further limitation in much of this literature is the lack of lagged data that allow for the estimation of recursive models. More recent research that has focused on the effects of employment on MH outcomes for the general population, and that have controlled for endogeneity, have found a positive effect of employment on measures of MH such as mental distress (Hamilton et al. 1997), general psychological health (Andrés 2004; Gathergood 2013), the probability of treatment for anxiety (Gathergood 2013) and self-reported depressive symptoms (Mandal and Roe 2008). In the study by Hamilton et al. (1997) where a statistical test of endogeneity was performed, the authors reported that “results indicate an endogenous relationship” and that model estimates that did not control for endogeneity were “biased upwards”. Similar approaches have yet to be applied in studying causal effects of employment on MH outcomes for individuals with SMI.

This study investigates the causal impacts of employment status on five measures of MH status and MH costs using longitudinal observational data on a large sample ($N = 5162$) of patients with a SMI served by Maryland’s Public Mental Health System (PMHS). These study data are unique in that measures of employment status and MH status were periodically collected as a regular part of care. Using repeated measures on the same individuals, we construct a prospective study design that tracks changes in employment status and changes in measures of MH outcomes over time. In this design, MH outcomes are measured approximately 6 months after the change in employment status, allowing us to estimate employment effects using a recursive model that also controls for prior MH status. Additionally, to control for and test for potential endogeneity of employment, we use a full information maximum likelihood (FIML) estimation method that incorporates measures of local labor market rates similarly to an IVs methodology. This is the first study to our knowledge that uses a statistical methodology that is able to control for potential endogeneity in the estimation of the effects of employment on MH outcomes for persons with SMI. Furthermore, its use of a large population-level dataset is an advantage over previous studies that have mostly used small datasets from vocational rehabilitation trials, which implies broader generalizability in results and allows us to use a richer set of control variables.

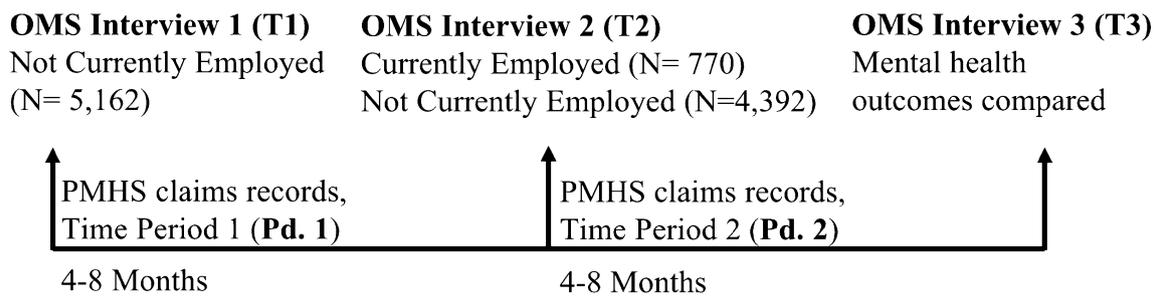
Data and Design

The study utilizes two data sources: the Outcomes Measurement Survey (OMS) data for those using Maryland’s PMHS from September 1, 2006 through August 31, 2009, and PMHS health care claims data for the same persons and time period. Maryland’s PMHS in this time period

was a fee-for-service system managed by an administrative services organization. MH clinics administered the OMS to each patient approximately every 6 months to document patient progress. The OMS includes a 24-question instrument called the Behavior And Symptom Identification Scale (BASIS-24) to measure self-reported MH status (Eisen et al. 2004; Cameron et al. 2007). The BASIS-24 questions aggregate into an overall score and seven status sub-scores, including scores for depression, functioning, relationships, emotional lability, psychosis, self-harm, and substance abuse. The instrument has been tested in multiple countries and has been found to be valid and reliable in the US among Whites, Blacks, and Latinos, in both the inpatient and outpatient settings (Eisen et al. 2006). The OMS contains several questions on employment, including: (1) “Are you currently employed?” (yes/no) and if you answer ‘no’, a follow-up question, (2) “Have you been employed (since last interview date/in the past 6 months)?”. In addition to the OMS, we obtained PMHS health care claims data in the relevant study period for all individuals in our study population. We extracted patient diagnoses, demographics, and service reimbursement information.

The study population was selected from all PMHS users (excluding those with Medicare coverage whose care was not managed) for whom at least 3 consecutive and largely complete (19 out of 24 BASIS-24 questions completed) OMS records existed in the 9/1/2006–8/31/2009 period ($N = 8577$). For patients with more than three OMS records, earlier records were chosen over later records to mitigate effects from the recent recession. For these 8577 patients, further study inclusion criteria were: reporting “not currently employed” in OMS Interview 1, having a primary diagnosis of an SMI, being aged 18 to 65, and being eligible for PMHS services through supplemental security income (SSI) or other non-family programs. This study population ($N = 5162$) was then divided into an employment group ($N = 770$) of those who report being “currently employed” at the time of the second OMS interview, and a comparison group ($N = 4392$) who report being “not currently employed”. Figure 1 below illustrates the prospective research design. Of those who reported they were employed at OMS Interview 2, 59.5% also reported being employed at OMS Interview 3. For those who reported that they were not employed at OMS Interview 2, only 3.4% reported that they were employed at OMS Interview 3.

The study population was 56% women, 48% White non-Hispanic, 40% Black non-Hispanic, and 12% other races. For primary diagnosis, there were 26% with a diagnosis of schizophrenia, 24% with a diagnosis of bipolar, 36% with a diagnosis of major depression, and 13% with another SMI.



Note: 59.5% of those employed at OMS T2 also reported being employed at T3. Only 3.44% of those not employed at T2 reported being employed at OMS T3.

Fig. 1 Prospective study design

Primary diagnosis was assigned as the most frequent diagnosis from each individual's PMHS records, using only the primary diagnosis field. ICD-9-CM codes used were the following: 295.10–295.95, 296.33, 296.34, 296.43, 296.44, 296.53, 296.54, 296.63, 296.64, 296.80, 296.89, 297.1, 298.9, 301.22, 301.83 (see Table 1 for further diagnosis category definitions). Table 1 presents descriptive statistics on the different variables used in the study, by employment status at T2.

Outcome Measures

Of the total of 8 BASIS-24 scores produced from 1 questionnaire (1 overall score and 7 subscale scores), this study uses the overall score and 4 sub-scale scores, including depression, functioning, relationships, and emotional lability, as outcome variables measured at T3 (see Table 1 for variable definitions). The distributions for other subscale scores were non-normally distributed and therefore were only used as control variables. Responses to BASIS-24 questions are on a five-point ordered scale and were aggregated via a proprietary algorithm into continuous scores ranging from 0 to 4. In our study, all BASIS-24 scores were inverted for easier interpretation, where a 0 represents the worst possible score and 4 represents the best possible score.

Total MH service cost was also used as an outcome variable, defined as the sum of all reimbursements for PMHS-covered services rendered in the time period between Interviews 2 and 3 divided by the number of days in the time period. Since this variable's distribution is approximately log-normal, it was analyzed in natural log form. Average total MH service cost was \$4778 in period 1 and \$4752 in period 2.

Explanatory Variables

Explanatory variables include baseline variables for each outcome variable, the time 2 binary employment indicator, and a rich set of individual characteristics. Individual characteristics include (1) an indicator of employment in the 6 months prior to Interview 1, (2) an indicator for whether any SE services were accessed in period 1, (3) other baseline MH and primary diagnosis indicators, (4) individuals' demographic characteristics and living situation, (5) PMHS eligibility group (e.g. eligibility through receipt of SSI), and (6) indicators of attachment to a particular provider. Three different variables were used to measure different aspects of local labor market conditions. These were (i) a measure of local unemployment rates at the county level, (ii) a measure of employment rates at the tract level for individuals with incomes below the poverty level, and (iii) a measure of employment rates at the zip-code level based on a similar population with SMI, but who only had two consecutive OMS records and therefore did not meet study inclusion criteria (see Table 1 for more details).

Data Analytic Procedures

Using FIML, we estimated coefficients for a recursive regression model with two parts: (1) a probit equation for employment at time 2 and (2) a Tobit equation for the mental status outcome at time 3 [or ordinary least squares (OLSs) for total MH costs]. We assume normally distributed random disturbances (Roodman 2011) for each equation and we allow for cross-equation correlation of disturbances for the same person (which occurs if the employment indicator is endogenous). Normality of all outcome variables were assessed based on histograms and measures of skewness and kurtosis. FIML estimation allows us to formally test for

Table 1 Variable definitions and summary statistics, by employment status

Variable names	Variable description	Employed T2 (N=770)			Not employed T2 (N=4392)			T-test/chi square	p-value		
		Mean	SD	Max	Mean	SD	Max				
Outcome variables											
Depression T3	Depression score Interview 3 (0 poor health to 4 best)	2.59	0.89	0	4	2.31	0.96	0	4	-7.5	<0.001
Relationship T3	Relationships score Interview 3 (0 poor health to 4 best)	2.59	0.85	0	4	2.37	0.91	0	4	-6.1	<0.001
Functioning T3	Functioning score Interview 3 (0 poor health to 4 best)	2.39	0.72	0.40	4	2.17	0.73	0	4	-7.8	<0.001
Emotional lability T3	Emotional lability score Interview 3 (0 poor health to 4 best)	2.39	1.04	0	4	2.24	1.08	0	4	-3.6	<0.001
Overall score T3	Overall symptom score Interview 3 (0 poor health to 4 best)	2.80	0.67	0.53	4	2.59	0.72	0.22	4	-7.6	<0.001
Mental health cost PD2 (thousands \$\$)	Total Public Mental Health System reimbursements between Interviews 2 and 3	4.3	7.3	0	57.5	4.8	7.7	0	104.7	1.7	0.094
Explanatory variables											
Baseline values for outcome variables											
Depression T1	Depression score Interview 1 (0 poor health to 4 best)	2.32	0.94	0	4	2.12	0.99	0	4	-5.1	<0.001
Relationship T1	Relationships score Interview 1 (0 poor health to 4 best)	2.43	0.90	0	4	2.26	0.93	0	4	-4.7	<0.001
Functioning T1	Functioning score Interview 1 (0 poor health to 4 best)	2.19	0.77	0	4	2.06	0.75	0	4	-4.5	<0.001
Emotional lability T1	Emotional lability score Interview 1 (0 poor health to 4 best)	2.25	1.08	0	4	2.08	1.11	0	4	-4.0	<0.001
Overall score T1	Overall symptom score at Interview 1 (0 poor health to 4 best)	2.60	0.69	0.71	4	2.44	0.74	0.24	4	-5.5	<0.001
Mental health cost PD1 (thousands \$\$)	Total Public Mental Health System reimbursements between Interviews 1 and 2	4.5	7.2	63	56.8	4.8	7.5	35	80.1	1.0	0.296
Prior employment and supported employment covariates											
Prior employment T1	Any employment in 6 months prior to OMS Interview 1?	0.35	0.48	0	1	0.12	0.32	0	1	391.3	<0.001
SE services PD1	Any SE services between Interviews 1 and 2?	0.12	0.33	0	1	0.02	0.14	0	1	188.2	<0.001
Other baseline mental health and diagnosis											
Substance abuse T1	Substance abuse score Interview 1 (0 poor health to 4 best)	3.52	0.74	0	4	3.57	0.74	0	4	1.8	0.068
Self harm T1	Self-harm score Interview 1 (0 poor health to 4 best)	3.67	0.66	0	4	3.57	0.78	0	4	-3.3	0.001
Psychosis T1	Psychosis score Interview 1 (0 poor health to 4 best)	3.16	0.93	0	4	2.97	1.03	0	4	-4.9	<0.001
Pdx schizophrenia	Primary diagnosis schizophrenia (ICD-9 295.10–295.95)	0.23	0.42	0	1	0.27	0.44	0	1	16.5	0.001
Pdx bipolar	Primary diagnosis bipolar (ICD-9 296.43, 296.44, 296.53, 296.54, 296.63, 296.64, 296.80, 296.89)	0.26	0.44	0	1	0.24	0.43	0	1		
Pdx depression	Primary diagnosis depression (ICD-9 296.33, 296.34)	0.34	0.47	0	1	0.37	0.48	0	1		
Pdx other SMI	Primary diagnosis 'other' SMI (297.1, 298.9, 301.22, 301.83)	0.17	0.37	0	1	0.12	0.33	0	1		

Table 1 (continued)

Variable names	Variable description	Employed T2 (N = 770)			Not employed T2 (N = 4392)			T-test/chi square	p-value		
		Mean	SD	Max	Mean	SD	Max				
PMHS eligibility											
Eligibility uninsured	Uninsured and meets PMHS coverage requirements [doesn't include medical assistance (MA)]	0.28	0.45	0	1	0.11	0.31	0	1	278.7	<0.001
Eligibility SSI	Eligible by having supplemental security income (SSI) (includes MA)	0.34	0.47	0	1	0.52	0.50	0	1		
Eligibility PAA	Eligible through public assistance to adults (PAAs), an income assistance program for those aged, blind, or disabled living in community-based residences (includes MA)	0.11	0.32	0	1	0.10	0.30	0	1		
Eligibility ABD	Eligible through being aged, blind or disabled (ABD) (includes MA)	0.07	0.25	0	1	0.14	0.34	0	1		
Eligibility PAC	Eligible through primary adult care (PAC) (includes ambulatory care MA)	0.20	0.40	0	1	0.13	0.34	0	1		
Clinical treatment duration											
Intake T1	Interview 1 is an intake/first service visit at clinic	0.28	0.45	0	1	0.31	0.46	0	1	13.6	<0.001
Treated < 1 year T1	Treated at Interview 1 clinic for less than 1 year	0.25	0.43	0	1	0.19	0.39	0	1		
Treated > 1 year T1	Treated at Interview 1 clinic for more than 1 year	0.47	0.50	0	1	0.50	0.50	0	1		
Demographics											
Female	Female dummy variable	0.48	0.50	0	1	0.58	0.49	0	1	25.8	<0.001
Black	Non-Hispanic Black dummy variable	0.34	0.47	0	1	0.41	0.49	0	1	91.9	<0.001
White	Non-Hispanic White dummy variable	0.45	0.50	0	1	0.49	0.50	0	1		
Other	All other race dummy variable	0.21	0.41	0	1	0.10	0.30	0	1		
Age	Age in years, 18–65	36.2	10.7	18	55	40.1	10.2	18	55	9.9	<0.001
Living situation											
Private residence with family	Private residence with family or significant other	0.60	0.49	0.00	1.00	0.58	0.49	0.00	1.00	28.6	<0.001
Private residence non-family	Private residence alone or with non-family roommates	0.14	0.35	0.00	1.00	0.20	0.40	0.00	1.00		
Residential rehabilitation facility	Residential rehabilitation facility	0.19	0.39	0.00	1.00	0.14	0.34	0.00	1.00		
Homeless	Homeless	0.04	0.20	0.00	1.00	0.04	0.21	0.00	1.00		
Other living situation	Other living situation	0.03	0.18	0.00	1.00	0.04	0.19	0.00	1.00		
Local employment variables											
SMI employment rate zip	Employment rate at Interview 2 for each zipcode (from population not included in study because individuals only had two OMS records)	0.14	0.06	0	0.375	0.13	0.05	0	0.375	-6.3	<0.001
Below poverty employment rate tract	Employment rate for those with income below the poverty threshold at the tract geographic level (American Community Survey data)	0.32	0.16	0	1	0.29	0.15	0	1	-6.1	<0.001
Unemployment rate county	County unemployment rate, 6 months prior to OMS Interview 1	3.96	1.20	2.3	11	4.38	1.31	2.3	11	8.2	<0.001

endogeneity of the employment indicator. The equations for our FIML estimation are as follows:

$$\begin{aligned} \text{Employment } T2_i = & \psi_0 + \psi'_1 \text{prior employment}_i \\ & + \psi'_a \text{BASIS-24 } T1 \text{ scores and MHcost PD1}_i \\ & + \psi'_b \text{individual characteristics}_i + \psi'_c \text{labor market variables}_i + \varepsilon_i, \end{aligned} \quad (1)$$

$$\begin{aligned} \text{MH status } T3_i = & \beta_0 + \beta_1 \text{employment } T2_i + \beta_2 \text{employment } T2 * \text{MH status } T1_i \\ & + \beta'_a \text{BASIS-24 } T1 \text{ scores and MH cost PD } 1_i \\ & + \beta'_b \text{individual characteristics}_i + \varepsilon_i. \end{aligned} \quad (2)$$

We specify both a “main” employment effect (β_1) and an interaction effect (β_2) between the employment dummy and the baseline value of the dependent variable measure of MH status. For the dependent variable of total MH costs, there is no interaction term used. This specification, using an interaction with baseline MH status, is similar to the multiplicative specification of health “production functions” in the health economics literature (Phelps 1997; Salkever 1976) and is consistent with the possibility that treatment should have more positive effects on persons in poorest health relative to persons in better levels of health. It also reflects the notion of “floor” and “ceiling effects”, since the value for each symptom score is in the range from 0 to 4, where a 4 reflects the best health. All covariates are used in both equations with the exception that the covariate group for labor force indicators is excluded in Eq. 2. The results of the endogeneity test in the FIML estimations will inform whether the FIML estimation method is necessary (where the endogeneity test is statistically significant) or not. In the case that endogeneity is not found to be an issue, we will run single equation models using Eq. 2 only.

Results

Results from various models are presented in Tables 2, 3, 4 and 5. Table 2 presents standalone results from Eq. 1 in the form of average marginal effects to illustrate what covariates are strong predictors of employment. Two different versions of Eq. 1 are shown, Model A whose specification is used in FIML estimations for all outcome variables except the overall score, and Model B which is used for the overall score. Results from the two forms of Eq. 1 are nearly identical and show that the strongest predictors of employment are having had any SE services in period 1 and having been employed in the 6 months prior to T1. Other predictors of employment include PMHS eligibility category, living situation, and local labor market variables. Local labor market variables are in

the expected direction with both employment rate variables having positive coefficients and the unemployment rate vari-

able having a negative coefficient. Both the county unemployment rate and the census tract below poverty employment rate are statistically significant at the 0.05 level while the zip-code level employment rate for persons with SMI is marginally significant.

Principal results from FIML estimations are presented in Table 3 (full FIML results with coefficients from both equations are available upon request). The test of endogeneity (ρ), reported in Table 3, is a one-tailed test on the correlation of the error terms between the two models; the expected sign is positive for all BASIS-24 outcome variables and negative for total costs because omitted factors that make employment more likely should also improve MH status and lower total costs. A significant test statistic implies employment endogeneity is present; an insignificant result suggests control for endogeneity is unnecessary and a single equation Tobit or OLS for costs is appropriate. Error correlation test statistics are for the most part insignificant, with the depression score (+0.41, $p=.081$) and the relationship score ($-.162, 0.170$) being the closest to being statistically significant. The correlation test statistics are in the expected direction for the depression, functioning, and emotional lability scores (all positive). For the relationships score, functioning score, and total MH costs, the test statistic is in the opposite than expected direction, though p-values are highly insignificant for functioning (0.785) and total costs (0.668). The depression score test statistic is the most ambiguous in its marginally significant p-value of 0.081. While many of these test statistics are insignificant, which implies using a single equation model is sufficient, it may be that the inclusion of a large number of individual characteristics as covariates obviates the need for treating T2 employment as endogenous.

The estimated main (β_1) and interaction (β_2) regression coefficients for T2 employment are also presented in Table 3. Given that most of the error correlation test statistics are statistically insignificant, we will only focus on the depression score. Depression score FIML results for β_1 ($-.14, 0.679$) and β_2 ($-.11, 0.003$) suggest that, controlling for endogeneity, employment does not have an effect

Table 2 Average marginal effects from probit models on outcome employment status at time 2

DV: Employment T2	Model A ^a (N=5162)		Model B ^b (N=5143)	
	dydx	p-value	dydx	p-value
Female	−0.012	0.216	−0.011	0.257
Black	0.007	0.490	0.008	0.470
Other	0.036	0.012	0.037	0.011
Age (years)	−0.002	0.000	−0.002	0.000
Prior employment T1	0.115	0.000	0.115	0.000
Any SE services PD1	0.213	0.000	0.212	0.000
Overall score T1			0.028	0.099
Depression T1	0.011	0.152		
Functioning T1	0.013	0.151	0.012	0.174
Relationship T1	0.006	0.294	0.001	0.825
Emotional lability T1	0.004	0.478	−0.001	0.943
Psychosis T1	0.003	0.563	0.001	0.904
Self harm T1	0.001	0.835	−0.001	0.899
Substance abuse T1	−0.014	0.038	−0.015	0.020
Total MH cost PD1	−0.0077	0.076	−0.007	0.105
Pdx schizophrenia (ref=depression)	−0.017	0.237	−0.018	0.209
Pdx bipolar (ref=depression)	−0.002	0.881	−0.003	0.817
Pdx other SMI (ref=depression)	0.027	0.052	0.026	0.060
Eligibility uninsured (ref=SSI)	0.118	0.000	0.119	0.000
Eligibility PAA (ref=SSI)	−0.035	0.130	−0.033	0.155
Eligibility ABD (ref=SSI)	−0.014	0.402	−0.013	0.441
Eligibility PAC (ref=SSI)	0.082	0.000	0.083	0.000
Intake T1 (ref=treat > 1 year)	−0.051	0.000	−0.052	0.000
Treated < 1 year T1 (ref=treat > 1 year)	0.004	0.758	0.0032	0.788
Private residence non-family (ref=private family)	−0.013	0.329	−0.013	0.330
Residential rehabilitation facility (ref=private family)	0.083	0.000	0.080	0.000
Homeless (ref=private family)	−0.015	0.535	−0.014	0.548
Other living situation (ref=private family)	0.023	0.373	0.022	0.381
SMI employment rate zip	0.167	0.051	0.158	0.066
Below poverty employment rate tract	0.103	0.000	0.101	0.000
Unemployment rate county	−0.010	0.013	−0.010	0.011
N	5162		5143	
Wald chi-square	691.6	<0.001	607.9	<0.001
Pseudo R ²	0.159		0.159	

^aModel A excludes overall score at Interview 1 as a covariate due to high collinearity between the overall score and the depression score. This specification for the probit equation was used in all FIML models except where the outcome was the overall score at Interview 3

^bModel B excludes depression at Interview 1. This model for the probit was used in the FIML model for the outcome overall score at Interview 3

on depression. Looking at the calculated average marginal effect, which accounts for both β_1 and β_2 coefficients, the effect of employment on depression is statistically insignificant (−.37, 0.206).

Single equation Tobit estimation coefficients differ from the FIML coefficients primarily in the results of the main (β_1) coefficients. All of the β_1 Tobit coefficient estimates are positive and clearly significant except emotional lability (0.18, 0.051 two-tailed). The β_1 coefficient should be

interpreted as the effect of employment on the T3 score where the baseline score is 0 (poorest health), whereas the β_2 coefficient is interpreted as the additional effect of employment for each unit increase in the baseline score. Taking the overall score as an example, working at T2 is expected to improve the overall T3 score by 0.18 points for someone with an overall baseline score of 2.0 ($0.4 - 2 * .11$). β_2 coefficients are statistically significant for the overall, depression, and relationships scores in the Tobit results.

Table 3 Test of employment endogeneity, coefficient results, and average marginal effects for mental health status scores and total mental health costs

DV	Depression		Relationships		Functioning		Emotional lability		Overall score		Total MH costs (per day)	
	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value
(1) Test of endogeneity	0.409	0.081	-0.162	0.170	-0.025	0.785	0.074	0.712	0.198	0.266	0.046	0.668
(2) Results: coefficients	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient ^a	p-value
FIML estimation coefficients ^b	Probit/Tobit	Probit/Tobit	Probit/Tobit	Probit/Tobit	Probit/Tobit	Probit/Tobit	Probit/Tobit	Probit/Tobit	Probit/Tobit	Probit/Tobit	Probit/OLS	
Main effect (β_1)	-0.14	0.679	0.66	0.001	0.30	0.023	0.06	0.852	0.19	0.373	-4.95	0.300
Interaction effect (β_2)	-0.11	0.003	-0.12	0.001	-0.06	0.074	-0.06	0.087	-0.11	<0.001	-	-
Single equation coefficients	Tobit		Tobit		Tobit		Tobit		Tobit		OLS	
Main effect (β_1)	0.43	<0.001	0.40	<0.001	0.27	0.002	0.18	0.051	0.40	<0.001	-2.91	0.006
Interaction effect (β_2)	-0.12	0.001	-0.11	0.004	-0.06	0.112	-0.06	0.130	-0.11	0.001	-	-
(3) Results: marginal effects	dydx	p-value	dydx	p-value	dydx	p-value	dydx	p-value	dydx	p-value	dydx ^a	p-value
FIML average marginal effect of employment (β_1 and β_2)	-0.37	0.206	0.36	0.029	0.17	0.095	-0.05	0.864	-0.08	0.670	-\$5	0.301
Single equation estimation—average marginal effect of employment (β_1 and β_2)	0.17	<0.001	0.14	<0.001	0.15	<0.001	0.06	0.130	0.12	<0.001	-\$3	0.006
Single equation <i>standardized</i> average marginal effects of employment (β_1 and β_2) ^c	0.18	<0.001	0.16	<0.001	0.20	<0.001	0.05	0.131	0.17	<0.001		
N	5124		5154		5153		5162		5067		5135	

^aCoefficients/marginal effects for total costs are retransformed using Duan’s smearing estimator

^bCoefficients are from the second equation of the full information maximum likelihood estimation (FIML). Each FIML estimation consists of a probit estimator for the first equation and a Tobit model for the second equation (except OLS for total costs)

^cTo help illustrate effect size, all single equation models were re-run using standardized versions of the BASIS-24 variables (both for outcome variable at time 3 and predictor at time 1). While truncated variables present challenges in producing standardized coefficients, in this case our estimates using Tobit versus OLS were remarkably close, allowing us to use OLS for standardized estimates of the marginal effect of employment

Table 4 Marginal effects of employment on mental health status scores at various percentiles of baseline mental health scores, from single equation Tobit regression models

Percentile	Depression		Relationships		Functioning		Emotional lability		Overall score	
	dydx	p-value	dydx	p-value	dydx	p-value	dydx	p-value	dydx	p-value
10th Percentile of baseline score at T1	0.33	<0.001	0.29	<0.001	0.21	<0.001	0.14	0.046	0.24	<0.001
25th Percentile of baseline score at T1	0.26	<0.001	0.22	<0.001	0.18	<0.001	0.10	0.047	0.18	<0.001
50th Percentile of baseline score at T1	0.16	<0.001	0.13	<0.001	0.15	<0.001	0.06	0.116	0.12	<0.001
75th Percentile of baseline score at T1	0.07	0.038	0.06	0.114	0.12	<0.001	0.01	0.754	0.06	0.024
90th Percentile of baseline score at T1	0.01	0.821	0.01	0.865	0.10	0.011	−0.03	0.626	0.01	0.730
N	5124		5154		5153		5162		5067	

For total MH costs, the single equation OLS result means that employment reduces total costs on average by \$2.91 per day (after the Duan smearing transformation was applied) (Duan 1983).

Part 3 of Table 3 shows the estimated average marginal effects of employment. Because most of the tests of endogeneity were statistically insignificant, we will primarily focus on the single equation estimation results. The average marginal effect of employment incorporates estimates from both β_1 and β_2 coefficients. The average marginal effects of employment on BASIS-24 scores are modest in effect size, but are positive and statistically significant for all scores except for emotional lability (0.06, 0.130). The effect of employment is a score improvement of 0.17 for depression, 0.14 for relationships, 0.15 for functioning, and 0.12 for the overall score. The average marginal effect of employment on total MH costs is the same as the coefficient value of $-\$2.91$ or an approximate reduction of \$3 per day.

While it is important to focus on average marginal effects of employment, a key strength of our study is that we utilize an interaction term in our MH status score models that enables us to consider marginal effects for individuals with different levels of baseline MH. Table 4 presents a range of marginal effects for individuals with different baseline scores, expressed in the table as the relevant percentile of the baseline score (e.g. 10th percentile or 25th percentile); the lower the percentile, the worse is the baseline score (and closer to 0). For all scores, the lower the baseline MH status, the bigger is the marginal effect of employment. For example, with the overall score, individuals with a baseline score at the 25th percentile have a marginal effect of employment 3 times as large as for individuals with a baseline score at the 75th percentile, an effect of 0.18 points compared to 0.06 points.

Table 5 presents the full single equation average marginal effect results, where T2 employment status is assumed to be exogenous. The lagged (T1) outcome variables have strong and significantly positive coefficients, as expected. Most other covariates have only modest associations with MH outcome variables, however several covariate results

are worth mentioning. It is important to recognize that our FIML estimations only tested for employment endogeneity and we do not infer any causal effects in other covariate relationships. The most striking covariate results in Table 5 are for the OLS regression on total MH costs. Having any SE services in period 1 and having a diagnosis of schizophrenia (reference = depression) is associated with higher total costs of \$3.33 per day and \$3.26 per day, respectively, whereas having a diagnosis from the category of ‘other SMI’ (reference = depression) is associated with lower total costs of \$2 per day. Being in the uninsured eligibility category, which has a lower level of PMHS coverage, is associated with lower total costs (reference = SSI) of \$5.26 per day. Being eligible for PMHS coverage through the aged, blind, or disabled (ABD) eligibility category or the primary adult care (PAC) program is associated with lower total costs of \$2.44 and \$4.36 per day, respectively, compared to those with SSI. Finally, being eligible through public assistance for adults (PAAs), an income assistance program for the ABD living in community-based residences, is associated with higher total costs of \$14 per day compared to those with SSI.

Discussion

This study sought to address potential endogeneity to be able to infer causal effects of employment on MH outcomes for individuals with SMI. Our results suggest endogeneity is not a major concern in our estimations, although the test of endogeneity for the depression score was marginally significant. Where the test of endogeneity was clearly not significant, the inclusion of numerous model covariates may have mitigated the extent of omitted variable bias. Furthermore, our research design made sure that the measures of MH outcomes were not simultaneously measured with measures of change in employment status. The conclusion is that employment has modest (but by no means insubstantial) effects that were positive on different measures of MH status and negative for costs. For the depression score, the marginally significant test of endogeneity implies that the single

Table 5 Full results for average marginal effects from single equation regression models (Tobit for BASIS-24 scores, OLS for total mental health costs)

Variables	Depression		Relationships		Functioning		Emotional lability		Overall		Total MH costs (per day)	
	dydx	p-value	dydx	p-value	dydx	p-value	dydx	p-value	dydx	p-value	dydx	p-value
Employment T2	0.17	<0.001	0.14	<0.001	0.15	<0.001	0.06	0.130	0.12	<0.001	-0.91	0.006
Overall score T1	0.31	<0.001	0.03	0.150	0.11	<0.001	0.11	<0.001	0.40	<0.001	-0.17	0.777
Depression T1	0.14	<0.001	0.08	<0.001	0.33	<0.001	0.04	0.137	0.08	<0.001	-0.61	0.349
Functioning T1	0.03	0.021	0.31	<0.001	0.04	<0.001	0.02	0.199	0.010	0.401	-0.23	0.590
Relationship T1	0.07	<0.001	0.05	0.002	0.03	0.019	0.35	<0.001	0.03	0.011	0.24	0.593
Emotional lability T1	0.05	<0.001	0.03	0.043	0.02	0.092	0.09	<0.001	0.05	<0.001	-0.01	0.977
Psychosis T1	-0.01	0.495	0.00	0.992	-0.01	0.654	-0.02	0.252	-0.02	0.179	-0.28	0.626
Self harm T1	-0.03	0.086	-0.02	0.205	-0.02	0.083	0.04	0.017	-0.01	0.280	-0.87	0.120
Substance abuse T1	-0.06	0.008	-0.01	0.817	0.00	0.823	-0.12	<0.001	-0.03	0.042	0.21	0.780
Female	0.11	<0.001	-0.03	0.222	0.07	<0.001	0.04	0.201	0.05	0.003	0.66	0.388
Black	0.05	0.172	-0.01	0.773	0.03	0.415	0.06	0.146	0.03	0.242	0.68	0.605
Other	0.00	0.084	0.00	0.299	0.00	0.172	0.00	0.006	0.00	0.542	-0.04	0.313
Age	0.02	0.477	0.07	0.042	0.04	0.120	0.01	0.841	0.03	0.191	-1.19	0.284
Prior employment T1	0.05	0.375	-0.01	0.895	0.05	0.354	0.06	0.354	0.02	0.572	3.33	0.056
Any SE services PD1	0.01	0.584	-0.03	0.005	0.004	0.624	0.03	0.009	0.00	0.790	22.41	<0.001
Total MH cost PD1 (per day)	0.13	<0.001	-0.04	0.273	0.06	0.023	0.18	<0.001	0.07	0.001	3.26	0.002
Pdx schizophrenia (ref = depression)	-0.01	0.746	-0.03	0.348	0.01	0.646	-0.10	0.002	-0.03	0.114	1.49	0.126
Pdx bipolar (ref = depression)	-0.01	0.854	-0.07	0.075	-0.04	0.189	-0.03	0.510	-0.01	0.688	-2.00	0.053
Pdx other SMI (ref = depression)	-0.05	0.201	-0.07	0.081	-0.09	0.005	-0.05	0.231	-0.06	0.059	-5.26	<0.001
Eligibility uninsured (ref = SSI)	0.01	0.848	-0.03	0.614	0.08	0.046	-0.09	0.143	-0.02	0.601	14.17	<0.001
Eligibility PAA (ref = SSI)	-0.15	<0.001	-0.080	0.035	-0.13	<0.001	-0.18	<0.001	-0.12	<0.001	-2.44	0.056
Eligibility ABD (ref = SSI)	-0.11	0.004	-0.10	0.011	-0.10	<0.001	-0.14	0.001	-0.10	<0.001	-4.36	0.000
Eligibility PAC (ref = SSI)	0.06	0.043	0.03	0.254	0.02	0.329	0.04	0.246	0.03	0.117	-2.13	0.024
Intake T1 (ref = treat > 1 year)	0.023	0.425	0.030	0.329	0.043	0.064	0.013	0.688	0.017	0.427	0.85	0.369
Treated < 1 year T1 (ref = treat > 1 year)	-0.03	0.293	-0.05	0.091	0.02	0.511	0.01	0.657	-0.02	0.393	-0.73	0.437
Private residence non-family (ref = private family)	0.04	0.397	0.05	0.258	0.02	0.640	0.07	0.188	0.04	0.167	1.05	0.494
Residential rehabilitation facility (ref = private family)	0.04	0.517	-0.02	0.745	0.06	0.161	-0.08	0.201	-0.01	0.760	1.21	0.577
Homeless (ref = private family)	-0.06	0.271	-0.16	0.009	0.00	0.958	-0.12	0.089	-0.07	0.101	0.24	0.915
Other living situation (ref = private family)	5124		5154		5153		5162		5067		5135	
N	91.1	<0.001	36.8	<0.001	75.4	<0.001	80.1	<0.001	103	<0.001	498	<0.001
F-test	0.148		0.075		0.168		0.128		0.214		0.809	
Pseudo R ²												

equation estimate of employment is biased upwards and that we should be cautious in interpreting the single equation depression model result as the causal effect of employment. For other results, we are more confident in inferring causal effects. Our results are generally consistent with prior studies (Mueser et al. 1997; Burns et al. 2008; Bell et al. 1996; Kukla et al. 2012) that found a moderately positive effect of employment. However, because our data was based on PMHS users during usual care settings across an entire state, our results represent the most generalizable study to date.

As stated above, the magnitude of the employment effect on measures of MH status is small. To help illustrate effect size and also for comparison across the different measures of MH status, standardized regressions were run using standardized forms of the outcome variable at time 3 and its lagged version at time 1. The employment effects measured in the standardized regressions are then all in terms of standard deviations of the outcome variable. Our standardized regressions show that employment effects are very similar for the different measures of MH status where the employment effect was statistically significant (i.e. depression, relationships, functioning, and the overall score); the average effect sizes range between 0.15 and 0.20 standard deviations. However, these effect sizes in terms of standard deviations also underscore the modest effect that employment has, on average. For total MH costs, the average marginal effect of employment over the roughly 6-month period totaled \$538 ($-\$2.91 * 185$, the average number of days in period 2). Compared to average costs in period 2 of \$4752, this represents a cost reduction of 11.3%.

In considering the implications and generalizability of our analyses and results, several potentially important study limitations should be kept in mind. First, generalizability may be limited by the study's requirement of three consecutive OMS records, which equates to approximately 1 year in the PMHS. As a result, the study population consists of more persistent PMHS users and is not representative of more transient users.

Second, we lack more detailed information on employment (e.g. number of weeks and hours worked, earnings, occupational type) that may be relevant for MH status impacts. In particular, we do not know the duration of employment (reported at the time 2 OMS). Although we do know the employment status at time 3 and find that approximately 60% of those employed at time 2 also reported being employed at time 3, we cannot be sure that the individual was consistently employed in the 6-month interval. We do, however, have information from the OMS on whether individuals were working at time 2 in "competitive" jobs (76%) versus "non-competitive" jobs (24%). We also have information on whether individuals who reported being employed in competitive jobs at time 2 received any SE services in the past 6 months (12%). Since previous research documents

high rates of unstable employment in non-supported jobs (Salkever et al. 2003a, b), results from future analyses that take account of these differing job types will be of interest.

Third, the databases available for this study did not include information on medical co-morbidities, an omission which is potentially problematic since persons with SMI have high rates of such co-morbidities (Daumit et al. 2010; Sokal et al. 2004; Jones et al. 2004), and since these co-morbidities often impact depression and other MH status indicators (Dixon et al. 2001; Mueser et al. 2000).

Fourth, our analysis of PMHS service cost impacts was limited to the outcome of total service costs, but interpretation of total cost impacts is not straightforward (Bush et al. 2009; Salkever et al. 2014). In particular, evidence of negative employment effects on cost could result from either more effective treatment patterns or more restricted access to effective treatment. Further research on more detailed measures of service use and cost patterns would clearly be desirable.

Finally, while we do examine a range of measures of MH status, we were unable to examine all BASIS-24 subscales due to non-normality in the distribution of those scores. It will be important for future research to apply similar methodologies to estimate effects on other aspects of MH status such as psychosis, self-harm, and substance abuse.

Conclusions

While most adults with a SMI in the US (80%) are not working (Diehl et al. 2014), a majority of those surveyed state they do want to work (Burke-Miller et al. 2006; McQuilken et al. 2003). Employment services such as SE (Luciano et al. 2014) are considered a critical component in the treatment of SMI as employment is a valued goal in recovery (Warner 2009; Provencher et al. 2002; Hogan 2003). A number of states such as Maryland have implemented statewide access to SE (Salkever et al. 2018), however funding is often a major restriction (Drake et al. 2016) and take-up of services remains low. This study demonstrates that employment positively impacts MH status and may reduce the costs of MH services, supporting the argument that employment has non-vocational benefits for individuals with SMI (Bond and Drake 2014; Blustein 2008).

This study is novel in its use of a quasi-experimental research design to estimate employment effects on MH outcomes for the population with a SMI. We find evidence of modest effects of employment on various dimensions of MH status and total MH costs. We find some evidence of endogeneity of employment in the model on self-reported BASIS-24 depression scores, but otherwise tests of endogeneity were statistically insignificant. We did, however, use a large set of covariates, including various measures

of baseline MH, which may help explain the insignificant endogeneity tests. From a methodological perspective, future research should still be concerned with potential endogeneity problems, especially if employment status and MH outcomes are simultaneously measured and/or baseline measures of MH are not adequately controlled for. Future research should continue to examine the multi-dimensional nature of MH status and costs for persons with SMI. Our findings also highlight the significant influence of patient heterogeneity, and especially baseline MH status, in producing heterogeneous results of interventions. Finally, our analyses demonstrate the practical use of a state-wide outcomes measurement program (Fisher and Rivard 2010) in assessing the factors that influence the recovery trajectories for PMHS patients. We believe these findings will be helpful in guiding future research on effects of the increasing variety of employment options becoming available to persons with SMI.

Compliance with Ethical Standards

Conflict of interest This study comes out of work from a Dissertation and no funding was obtained for the research herein. Authors declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors. This study was reviewed by the University of Maryland, Baltimore County (UMBC) IRB and was considered exempt.

References

- Andrés, A. R. (2004). Determinants of self-reported mental health using the British Household Panel Survey. *Journal of Mental Health Policy and Economics*, 7(3), 99–106.
- Banerjee, S., Chatterji, P., & Lahiri, K. (2017). Effects of psychiatric disorders on labor market outcomes: A latent variable approach using multiple clinical indicators. *Health economics*, 26(2), 184–205.
- Bell, M. D., & Lysaker, P. H. (1997). Clinical benefits of paid work activity in schizophrenia: 1-Year followup. *Schizophrenia Bulletin*, 23(2), 317–328.
- Bell, M. D., Lysaker, P. H., & Milstein, R. M. (1996). Clinical benefits of paid work activity in schizophrenia. *Schizophrenia Bulletin*, 22(1), 51–67.
- Blustein, D. L. (2008). The role of work in psychological health and well-being: A conceptual, historical, and public policy perspective. *American Psychologist*, 63(4), 228.
- Bond, G. R., & Drake, R. E. (2014). Making the case for IPS supported employment. *Administration and Policy in Mental Health and Mental Health Services Research*, 41(1), 69–73.
- Burke-Miller, J. K., Cook, J. A., Grey, D. D., Razzano, L. A., Blyler, C. R., Lefkowitz, H. S., et al. (2006). Demographic characteristics and employment among people with severe mental illness in a multisite study. *Community Mental Health Journal*, 42(2), 143–159.
- Burns, T., Catty, J., Becker, T., Drake, R. E., Fioritti, A., Knapp, M., et al. (2007). The effectiveness of supported employment for people with severe mental illness: A randomised controlled trial. *The Lancet*, 370(9593), 1146–1152.
- Burns, T., Catty, J., White, S., Becker, T., Koletsi, M., Fioritti, A., et al. (2008). The impact of supported employment and working on clinical and social functioning: Results of an international study of individual placement and support. *Schizophrenia Bulletin*, 35(5), 949–958.
- Bush, P. W., Drake, R. E., Xie, H., McHugo, G. J., & Haslett, W. R. (2009). The long-term impact of employment on mental health service use and costs for persons with severe mental illness. *Psychiatric Services*, 60(8), 1024–1031.
- Cameron, I. M., Cunningham, L., Crawford, J. R., Eagles, J. M., Eisen, S. V., Lawton, K., et al. (2007). Psychometric properties of the BASIS-24[®] (Behaviour and Symptom Identification Scale-Revised) mental health outcome measure. *International Journal of Psychiatry in Clinical Practice*, 11(1), 36–43.
- Chatterji, P., Alegria, M., Lu, M., & Takeuchi, D. (2007). Psychiatric disorders and labor market outcomes: Evidence from the National Latino and Asian American Study. *Health Economics*, 16(10), 1069–1090.
- Chatterji, P., Alegria, M., & Takeuchi, D. (2011). Psychiatric disorders and labor market outcomes: Evidence from the National Comorbidity Survey-Replication. *Journal of Health Economics*, 30(5), 858–868.
- Daumit, G. L., Anthony, C. B., Ford, D. E., Fahey, M., Skinner, E. A., Lehman, A. F., et al. (2010). Pattern of mortality in a sample of Maryland residents with severe mental illness. *Psychiatry Research*, 176(2–3), 242–245.
- Diehl, S., Douglas, D., & Honberg, R. (2014). Road to recovery: Employment and mental illness. Arlington, VA. <http://www.nami.org/work>.
- Dixon, L., Goldberg, R., Lehman, A., & McNary, S. (2001). The impact of health status on work, symptoms, and functional outcomes in severe mental illness. *The Journal of Nervous and Mental Disease*, 189(1), 17–23.
- Drake, R. E., Bond, G. R., Goldman, H. H., Hogan, M. F., & Karakus, M. (2016). Individual placement and support services boost employment for people with serious mental illnesses, but funding is lacking. *Health Affairs*, 35(6), 1098–1105.
- Duan, N. (1983). Smearing estimate: A nonparametric retransformation method. *Journal of the American Statistical Association*, 78(383), 605–610.
- Eisen, S. V., Gerena, M., Ranganathan, G., Esch, D., & Idiculla, T. (2006). Reliability and validity of the BASIS-24[®] mental health survey for whites, African-Americans, and Latinos. *The Journal of Behavioral Health Services and Research*, 33(3), 304.
- Eisen, S. V., Normand, S. L., Belanger, A. J., Spiro, A., & Esch, D. (2004). The revised behavior and symptom identification scale (BASIS-R): Reliability and validity. *Medical Care*, 42, 1230–1241.
- Fisher, W. H., & Rivard, J. C. (2010). The research potential of administrative data from state mental health agencies. *Psychiatric Services*, 61(6), 546–548.
- Gathergood, J. (2013). An instrumental variable approach to unemployment, psychological health and social norm effects. *Health Economics*, 22(6), 643–654.
- Hamilton, V. H., Merrigan, P., & Dufresne, É (1997). Down and out: Estimating the relationship between mental health and unemployment. *Health Economics*, 6(4), 397–406.
- Hogan, M. F. (2003). New Freedom Commission report: The president's New Freedom Commission: Recommendations to transform mental health care in America. *Psychiatric Services*, 54(11), 1467–1474.

- Jones, D. R., Macias, C., Barreira, P. J., Fisher, W. H., Hargreaves, W. A., & Harding, C. M. (2004). Prevalence, severity, and co-occurrence of chronic physical health problems of persons with serious mental illness. *Psychiatric Services*, 55(11), 1250–1257.
- Kukla, M., Bond, G. R., & Xie, H. (2012). A prospective investigation of work and nonvocational outcomes in adults with severe mental illness. *The Journal of Nervous and Mental Disease*, 200(3), 214–222.
- Luciano, A., Drake, R. E., Bond, G. R., Becker, D. R., Carpenter-Song, E., Lord, S., et al. (2014). Evidence-based supported employment for people with severe mental illness: Past, current, and future research. *Journal of Vocational Rehabilitation*, 40(1), 1–13.
- Mandal, B., & Roe, B. (2008). Job loss, retirement and the mental health of older Americans. *Journal of Mental Health Policy and Economics*, 11, 167–176.
- Marwaha, S., & Johnson, S. (2004). Schizophrenia and employment. *Social Psychiatry and Psychiatric Epidemiology*, 39(5), 337–349.
- McQuilken, M., Zahniser, J. H., Novak, J., Starks, R. D., Olmos, A., & Bond, G. R. (2003). The work project survey: Consumer perspectives on work. *Journal of Vocational Rehabilitation*, 18(1), 59–68.
- Mueser, K. T., Becker, D. R., Torrey, W. C., Xie, H., Bond, G. R., Drake, R. E., & Dain, B. J. (1997). Work and nonvocational domains of functioning in persons with severe mental illness: A longitudinal analysis. *The Journal of Nervous and Mental Disease*, 185(7), 419–426.
- Mueser, K. T., Yarnold, P. R., Rosenberg, S. D., Swett Jr, C., Miles, K. M., & Hill, D. (2000). Substance use disorder in hospitalized severely mentally ill psychiatric patients: Prevalence, correlates, and subgroups. *Schizophrenia Bulletin*, 26(1), 179–192.
- Ojeda, V. D., Frank, R. G., McGuire, T. G., & Gilmer, T. P. (2010). Mental illness, nativity, gender and labor supply. *Health Economics*, 19(4), 396–421.
- Phelps, C. E. (1997). *Health economics* (2nd ed., pp. 16–19). Reading, MA: Addison-Wesley.
- Provencher, H. L., Gregg, R., Mead, S., & Mueser, K. T. (2002). The role of work in the recovery of persons with psychiatric disabilities. *Psychiatric Rehabilitation Journal*, 26(2), 132.
- Roodman, D. (2011). Fitting fully observed recursive mixed-process models with *cmp*. *The Stata Journal*, 11(2), 159–206.
- Salkever, D., Abrams, M., Baier, K., & Gibbons, B. (2018). Impacting entry into evidence-based supported employment: A population-based empirical analysis of a statewide public mental health program in Maryland. *Administration and Policy in Mental Health and Mental Health Services Research*, 45(2), 328–341.
- Salkever, D., Gibbons, B., & Ran, X. (2014). Do comprehensive, coordinated, recovery-oriented services alter the pattern of use of treatment services? Mental health treatment study impacts on SSDI beneficiaries' use of inpatient, emergency, and crisis services. *The Journal of Behavioral Health Services and Research*, 41(4), 434–446.
- Salkever, D. S. (1976). The family provision of children's health: Comments. In R. Rosett (Ed.), *The role of health insurance in the health services sector* (pp. 256–259). New York: National Bureau of Economic Research.
- Salkever, D. S., Karakus, M. C., Slade, E. P., Harding, C. M., Hough, R. L., Rosenheck, R. A., et al. (2007). Measures and predictors of community-based employment and earnings of persons with schizophrenia in a multisite study. *Psychiatric Services*, 58(3), 315–324.
- Salkever, D. S., Shinogle, J. A., & Goldman, H. (2003a). Return to work and claim duration for workers with long-term mental disabilities: Impacts of mental health coverage, fringe benefits, and disability management. *Mental Health Services Research*, 5(3), 173–186.
- Salkever, D. S., Slade, E. P., & Karakus, M. C. (2003b). Employment retention by persons with schizophrenia employed in non-assisted jobs. *Journal of Rehabilitation*, 69(4), 19–26.
- Sokal, J., Messias, E., Dickerson, F. B., Kreyenbuhl, J., Brown, C. H., Goldberg, R. W., & Dixon, L. B. (2004). Comorbidity of medical illnesses among adults with serious mental illness who are receiving community psychiatric services. *The Journal of Nervous and Mental Disease*, 192(6), 421–427.
- van der Noordt, M., IJzelenberg, H., Droomers, M., & Proper, K. I. (2014). Health effects of employment: A systematic review of prospective studies. *Occupational and Environmental Medicine*. <https://doi.org/10.1136/oemed-2013-101891>.
- Warner, R. (2009). Recovery from schizophrenia and the recovery model. *Current Opinion in Psychiatry*, 22(4), 374–380.
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. Cambridge, MA: MIT Press.

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