Effects of Great Recession on Income Poverty

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1 Study Aim

The aim of this study is to analyze how households with a working age adult with disability compare with households with no adult with disability, during the *great recession*, using "Income Poverty" as a measure of economic wellbeing, when controlling for demographic factors such as gender, marital status, education, race and origin.

2 Sample

For this analysis data from US Census Bureau's SIPP 2008 panel survey was used. [1]. Questions on whether the households had a working age adult with disability were asked in wave-6 of the survey, which ended in August, 2010. Households that participated in wave-6 were included in our sample. There were a total of 34,850 households in wave six. Survey data upto wave-15 were used in our sample. Survey results from July, 2008 through June, 2013 were included in the analysis. Households whose reference person remained the same throughout the 2008 panel were kept in the sample. The reference persons of the households were also required to be 18 years or older throughout the 2008 panel. The final sample had 33,547 households that satisfied all the inclusion criteria.

[1] For more information on the SIPP 2008 panel schedule, please refer to this US Census Bureau website

3 Methods

Total monthly household income was divided by monthly federal poverty level (FPL) and then averaged over quarters to estimate FPL100-ratio. An FPL100-ratio lower than one in any quarter indicated the household was below 100% Federal poverty level in that quarter. Averaging monthly values over a quarter reduced the noise in the response variable by eliminating the month-by-month variability in the income data. In the sample, the monthly income data ranged from -$27,180 to $108,900, the average being $5240 and median $3,874. The negative incomes were associated with households owning business that incurred lossed in those months. The FPL100-ratio ranged from -17.95 to 89.48, with the average being 3.817 and the median 2.924. In the sample, 7,865 out of 33,547 households (23.44%) had at least one working age adult with disability during the observed time period, as identified in wave-6 of the survey. Data from July 2008 (2008-Q3) through May 2013 (2013-Q1) were analyzed. This period overlapped with twelve of the eighteen months [2] of the "Great recession" and its long wake.

3.1 Mixed-effects model for income poverty

A mixed (fixed and random) effects model was fit to estimate the impact of the presence of a working-age adult with disability in a household on its FPL100-ratio. Let Y denote the vector or responses (FPL100-ratio). Let θ denote the vector of fixed effect factors like gender, marital status, education level, race, origin of household head, along with their interactions. Let β denote another fixed effect of time, represented as quarters, starting from 2008-Q3 and ending in 2013-Q1. Let b denote the household level random effect (random intercept). Then, the mixed-effects ([2]) model for the responses, for each household i can

[2] NBER Recession Cycles

be written as

$$Y_{ij} = X_i\theta + \beta t_j + b_i + \epsilon_{ij} \tag{1}$$

where, ϵ_{ij} are regarded as measurement errors, i goes from 1 to H, the number of households, j goes from 1 to T, the total number of quarterly observations for every household. In this model, the response from the i^{th} household at time t_j is assumed to differ from the population mean $X_i\theta + \beta t_j$ by a household effect b_i and a within household measurement error ϵ_{ij}. The within household and between household errors are assumed to be normal and independent ($b_i \sim \mathcal{N}(0, \sigma_b^2)$, $\epsilon_{ij} \sim \mathcal{N}(0, \sigma^2)$, $b_i \perp\!\!\!\perp \epsilon_{ij}, \forall i, j$). The effect of "time" is a fixed effect and it could be considered part of the fixed effect design matrix X. However, the problem of interest is to test a linear hypothesis about the disability-by-time interaction, to detect the effect of disability on the mean response over the period of the study. Hence, the "time" covariate is denoted separately. During estimation it will be estimated as a fixed effect.

All analysis were conducted using the statistical software R ([5]), version 3.3.1. The mixed effects models were fit using the R-package "lme4" ([1]) and all hypothesis tests were done using the R package "lmerTest" ([3]). The final model was fit with some of the fixed effect factors along with their interactions after performing "backward elimination" on the full model. Elimination of the fixed effects were done by the principle of marginality, that is: the highest order interactions are tested first: if they are significant, the lower order effects were included in the model without testing for significance. The p-values for the fixed effects are estimated from the F statistics, with "Satterthwaite" approximation ([6]) denominator degrees of freedom. The p-values for the random effect were computed from likelihood ratio tests ([4]).

3.2 Model for income poverty, with baseline correction

In order to isolate the effect of the *great recession* on income poverty (response), measured by FPL100-ratio, the values of the response at the beginning of study period (2008-Q3) were subtracted from each household's responses. Consequently, all FPL100-ratios of all households at 2008-Q3 were zero. The same model as in eq 1 was fit to this baseline-corrected responses. The problem of interest was to test a linear hypothesis about the disability-by-time interaction.

4 Results

5 Limitations

1. Although a linear mixed effects regression model discovered some conventional and some interesting patterns in the relationships between response and demographic factors, along with disability, the trajectory of income poverty over the study period for some households were not linear. This modeling approach does not capture trajectory shapes of individual households. A non-parametric fitting of the income poverty trajectories could be tried as a pre-processing step before testing for differences in behavior between different groups of households.

6 Tables

	Sum Sq	Mean Sq	NumDF	F.value	p.value
yearqtrNum	145.47	145.47	1	12.07	0.0005
race_origin	5752.68	2876.34	3	238.71	0.0000
education	29404.45	14702.23	2	1220.15	0.0000
gender:race_origin	104.06	34.69	3	2.88	0.0345
gender:ms	1813.16	1813.16	1	150.47	0.0000
ms:race_origin	2070.73	690.24	3	57.28	0.0000
race_origin:adult_disb	26.90	8.97	3	0.74	0.5255
gender:adult_disb	237.05	237.05	1	19.67	0.0000
ms:adult_disb	0.12	0.12	1	0.01	0.9222
yearqtrNum:adult_disb	145.47	145.47	1	12.07	0.0005
adult_disb:education	109.34	54.67	2	4.54	0.0107
gender:ms:adult_disb	56.78	56.78	1	4.71	0.0299

Table 1: Model 1: FPL100 vs demographic factors, time and disability

	Sum Sq	Mean Sq	NumDF	F.value	p.value
yearqtrNum	138.47	138.47	1	11.52	0.0007
race_origin	151.47	75.73	3	6.30	0.0018
education	72.76	36.38	2	3.03	0.0485
gender:race_origin	181.68	60.56	3	5.04	0.0017
gender:ms	721.70	721.70	1	60.04	0.0000
ms:race_origin	556.33	185.44	3	15.43	0.0000
race_origin:adult_disb	21.56	7.19	3	0.60	0.6163
gender:adult_disb	19.75	19.75	1	1.64	0.1999
ms:adult_disb	31.83	31.83	1	2.65	0.1037
yearqtrNum:adult_disb	138.47	138.47	1	11.52	0.0007
adult_disb:education	35.49	17.75	2	1.48	0.2285
gender:ms:adult_disb	14.38	14.38	1	1.20	0.2740

Table 2: Model 2: FPL100 vs demographic factors, time and disability with baseline differences in FPL100 eliminated

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
Female Married - Female Not married	0.74	0.03	0.0000	0.74	0.03	0.0000
Male Married - Female Not married	0.92	0.04	0.0000	0.92	0.04	0.0000
Male Not married - Female Not married	0.65	0.04	0.0000	0.65	0.04	0.0000
Male Married - Male Not married	0.27	0.03	0.0000	0.27	0.03	0.0000
Male Married - Female Married	0.18	0.04	0.0000	0.18	0.04	0.0000
Female Married - Male Not married	0.09	0.04	0.0436	0.09	0.04	0.0436

Table 3: Post-hoc Tukey test of gender and ms

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
Black - Others	-0.53	0.07	0.0000	0.22	0.07	0.0007
Black - White	-0.90	0.05	0.0000	0.14	0.04	0.0022
Hispanic - Others	-0.46	0.07	0.0000	0.16	0.07	0.0184
Hispanic - White	-0.83	0.05	0.0000	0.07	0.05	0.1144
Black - Hispanic	-0.07	0.07	0.2663	0.06	0.06	0.2924
Others - White	-0.37	0.06	0.0000	-0.08	0.05	0.1159

Table 4: Post-hoc Tukey test of race-origin

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
High School or less - Some college, diploma, assoc	-0.47	0.03	0.0000	0.02	0.03	0.4373
High School or less - Bachelors or higher	-1.76	0.04	0.0000	-0.06	0.03	0.0849
Some college, diploma, assoc - Bachelors or higher	-1.29	0.03	0.0000	-0.08	0.03	0.0140

Table 5: Post-hoc Tukey test of education

References

[1] Douglas Bates, Martin Maechler, Ben Bolker, Steven Walker, et al. lme4: Linear mixed-effects models using eigen and s4. *R package version*, 1(7), 2014.

[2] Garrett M Fitzmaurice, Nan M Laird, and James H Ware. *Applied longitudinal analysis*, volume 998. John Wiley & Sons, 2012.

[3] Alexandra Kuznetsova, Per Bruun Brockhoff, and Rune Haubo Bojesen Christensen. Package lmertest. *R package version*, 2, 2015.

[4] Christopher H Morrell. Likelihood ratio testing of variance components in the linear mixed-effects model using restricted maximum likelihood. *Biometrics*, pages 1560–1568, 1998.

[5] R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2016.

[6] Franklin E Satterthwaite. An approximate distribution of estimates of variance components. *Biometrics bulletin*, 2(6):110–114, 1946.

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
Female Married - Female Not married	0.74	0.03	0.0000	0.36	0.03	0.0000
Male Married - Female Not married	0.92	0.04	0.0000	0.37	0.04	0.0000
Male Not married - Female Not married	0.65	0.04	0.0000	0.29	0.04	0.0000
Male Married - Male Not married	0.27	0.03	0.0000	0.08	0.03	0.0110
Female Married - Male Not married	0.09	0.04	0.0436	0.07	0.04	0.0950
Male Married - Female Married	0.18	0.04	0.0000	0.01	0.04	0.8001

Table 6: Post-hoc Tukey test of gender and marital status

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
Married White - Not married White	0.75	0.02	0.0000	0.37	0.02	0.0000
Married Black - Not married White	-0.27	0.06	0.0000	0.44	0.06	0.0000
Married Hispanic - Not married White	-0.37	0.06	0.0000	0.30	0.05	0.0000
Married Black - Not married Others	0.01	0.09	0.8911	0.43	0.08	0.0000
Married Black - Not married Black	0.52	0.05	0.0000	0.24	0.05	0.0000
Not married Black - Not married White	-0.78	0.05	0.0000	0.20	0.05	0.0000
Not married Hispanic - Not married White	-0.54	0.06	0.0000	0.21	0.05	0.0001
Married Hispanic - Not married Others	-0.09	0.09	0.3030	0.29	0.08	0.0001
Married Black - Not married Hispanic	0.27	0.08	0.0006	0.23	0.07	0.0013
Married Black - Married Others	-0.56	0.09	0.0000	0.25	0.08	0.0013
Married Others - Not married White	0.29	0.07	0.0000	0.19	0.06	0.0026
Married Others - Not married Others	0.57	0.07	0.0000	0.18	0.06	0.0048
Not married Hispanic - Not married Others	-0.26	0.09	0.0026	0.20	0.08	0.0095
Not married Black - Not married Others	-0.51	0.08	0.0000	0.19	0.07	0.0103
Married Hispanic - Not married Hispanic	0.17	0.04	0.0001	0.09	0.04	0.0271
Married Black - Married Hispanic	0.10	0.08	0.1926	0.14	0.07	0.0476
Married Hispanic - Married Others	-0.66	0.08	0.0000	0.11	0.08	0.1352
Married Black - Married White	-1.02	0.06	0.0000	0.07	0.05	0.1899
Not married Hispanic - Married Others	-0.83	0.09	0.0000	0.02	0.08	0.7908
Not married Others - Not married White	-0.28	0.07	0.0001	0.01	0.06	0.8850
Not married Black - Married Others	-1.07	0.08	0.0000	0.01	0.07	0.8958
Not married Black - Not married Hispanic	-0.25	0.07	0.0006	-0.01	0.07	0.8662
Married Hispanic - Married White	-1.12	0.06	0.0000	-0.07	0.05	0.1894
Not married Black - Married Hispanic	-0.42	0.07	0.0000	-0.10	0.06	0.1051
Married Others - Married White	-0.46	0.07	0.0000	-0.18	0.06	0.0041
Not married Hispanic - Married White	-1.29	0.06	0.0000	-0.16	0.05	0.0029
Not married Black - Married White	-1.54	0.05	0.0000	-0.17	0.05	0.0004
Not married Others - Married White	-1.03	0.07	0.0000	-0.36	0.06	0.0000

Table 7: Post-hoc Tukey test of MS and race origin

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
Male White - Female White	0.40	0.03	0.0000	0.14	0.03	0.0000
Female Black - Female Others	-0.38	0.09	0.0000	0.41	0.08	0.0000
Male Hispanic - Female Others	0.02	0.09	0.8198	0.40	0.08	0.0000
Male Black - Female Others	-0.08	0.09	0.3988	0.38	0.08	0.0000
Female Black - Female White	-0.85	0.06	0.0000	0.22	0.05	0.0000
Male Others - Female Others	0.60	0.09	0.0000	0.35	0.08	0.0000
Male Hispanic - Female White	-0.45	0.06	0.0000	0.21	0.06	0.0003
Male Black - Female White	-0.56	0.07	0.0000	0.19	0.06	0.0012
Female Hispanic - Female Others	-0.33	0.09	0.0003	0.26	0.08	0.0013
Male Hispanic - Female Hispanic	0.35	0.06	0.0000	0.14	0.06	0.0162
Male Others - Female White	0.13	0.08	0.0901	0.16	0.07	0.0190
Female Black - Female Hispanic	-0.05	0.08	0.5194	0.15	0.07	0.0323
Male Black - Female Hispanic	0.25	0.08	0.0027	0.12	0.07	0.1164
Female Black - Male White	-1.25	0.06	0.0000	0.08	0.05	0.1262
Female Hispanic - Female White	-0.81	0.06	0.0000	0.07	0.05	0.1650
Male Hispanic - Male White	-0.85	0.06	0.0000	0.07	0.06	0.2074
Male Black - Male White	-0.95	0.07	0.0000	0.05	0.06	0.3831
Female Black - Male Others	-0.98	0.09	0.0000	0.06	0.08	0.4639
Male Hispanic - Male Others	-0.58	0.09	0.0000	0.05	0.08	0.5439
Male Black - Male Others	-0.68	0.09	0.0000	0.03	0.08	0.7174
Male Others - Male White	-0.27	0.08	0.0004	0.02	0.07	0.7651
Female Black - Male Hispanic	-0.40	0.08	0.0000	0.01	0.07	0.9142
Male Black - Male Hispanic	-0.10	0.08	0.2292	-0.02	0.08	0.7893
Male Black - Female Black	0.30	0.06	0.0000	-0.03	0.06	0.6399
Female Hispanic - Male Others	-0.93	0.09	0.0000	-0.09	0.08	0.2903
Female Hispanic - Male White	-1.20	0.06	0.0000	-0.07	0.06	0.2291
Female Others - Female White	-0.48	0.08	0.0000	-0.19	0.07	0.0055
Female Others - Male White	-0.87	0.08	0.0000	-0.33	0.07	0.0000

Table 8: Post-hoc Tukey test of gender with race and origin

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
Black no - Others no	-0.49	0.08	0.0000	0.30	0.07	0.0000
Black no - White no	-0.93	0.05	0.0000	0.16	0.05	0.0008
Hispanic no - Others no	-0.45	0.08	0.0000	0.18	0.07	0.0088
Black no - White yes	-0.37	0.06	0.0000	0.12	0.06	0.0262
Black no - Hispanic no	-0.04	0.07	0.5328	0.11	0.06	0.0627
Black no - Others yes	-0.06	0.11	0.5774	0.15	0.10	0.1193
Black yes - White yes	-0.88	0.08	0.0000	0.11	0.07	0.1246
Black yes - Others yes	-0.57	0.12	0.0000	0.14	0.11	0.1845
Hispanic yes - White yes	-0.77	0.09	0.0000	0.10	0.08	0.2029
Hispanic yes - Others yes	-0.46	0.13	0.0003	0.13	0.11	0.2438
Hispanic no - White no	-0.89	0.05	0.0000	0.04	0.05	0.3396
Hispanic no - Others yes	-0.02	0.11	0.8663	0.04	0.10	0.6885
Black no - Hispanic yes	0.40	0.10	0.0001	0.02	0.09	0.8183
Hispanic no - White yes	-0.33	0.06	0.0000	0.01	0.05	0.8813
Black no - Black yes	0.51	0.09	0.0000	0.01	0.08	0.9069
Black yes - Hispanic yes	-0.11	0.11	0.3524	0.01	0.10	0.9127
White no - Others yes	0.87	0.10	0.0000	-0.00	0.09	0.9615
Others yes - White yes	-0.31	0.10	0.0029	-0.03	0.09	0.7329
White no - White yes	0.56	0.04	0.0000	-0.04	0.04	0.3359
Hispanic no - Hispanic yes	0.44	0.10	0.0000	-0.09	0.09	0.2905
Hispanic no - Black yes	0.55	0.09	0.0000	-0.10	0.08	0.1965
Others no - Others yes	0.43	0.12	0.0002	-0.14	0.10	0.1705
White no - Hispanic yes	1.33	0.09	0.0000	-0.14	0.08	0.0812
White no - Black yes	1.44	0.08	0.0000	-0.15	0.07	0.0345
Others no - White no	-0.44	0.06	0.0000	-0.14	0.06	0.0148
Others no - White yes	0.12	0.07	0.0878	-0.17	0.06	0.0066
Others no - Hispanic yes	0.89	0.11	0.0000	-0.28	0.09	0.0035
Others no - Black yes	1.00	0.10	0.0000	-0.29	0.09	0.0010

Table 9: Post-hoc Tukey test of race and origin with adult disb

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
Male no - Female no	0.52	0.03	0.0000	0.18	0.03	0.0000
Male yes - Female yes	0.30	0.05	0.0000	0.12	0.04	0.0071
Male no - Female yes	0.90	0.06	0.0000	0.09	0.05	0.0993
Male no - Male yes	0.60	0.06	0.0000	-0.04	0.05	0.4796
Female no - Female yes	0.37	0.05	0.0000	-0.10	0.05	0.0450
Female no - Male yes	0.07	0.06	0.2366	-0.22	0.06	0.0001

Table 10: Post-hoc Tukey test of gender with adult disb

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-value 2
Married no - Not married no	0.50	0.03	0.0000	0.25	0.02	0.0000
Married yes - Not married yes	0.50	0.04	0.0000	0.19	0.04	0.0000
Married no - Not married yes	0.99	0.06	0.0000	0.16	0.05	0.0020
Married no - Married yes	0.48	0.05	0.0000	-0.04	0.05	0.4381
Not married no - Not married yes	0.49	0.05	0.0000	-0.10	0.05	0.0443
Not married no - Married yes	-0.02	0.06	0.7627	-0.29	0.05	0.0000

Table 11: Post-hoc Tukey test of MS and adult disb

Factor Levels	Est 1	Std Err 1	p-value 1	Est 2	Std Err 2	p-val
no High School or less - no Some college, diploma, assoc	-0.52	0.03	0.0000	0.06	0.03	0.0
yes High School or less - no Some college, diploma, assoc	-0.90	0.06	0.0000	0.09	0.05	0.0
yes Some college, diploma, assoc - no Bachelors or higher	-1.83	0.06	0.0000	0.01	0.05	0.8
yes High School or less - no Bachelors or higher	-2.25	0.06	0.0000	-0.01	0.05	0.7
no High School or less - yes High School or less	0.38	0.06	0.0000	-0.02	0.05	0.0
yes High School or less - yes Some college, diploma, assoc	-0.42	0.05	0.0000	-0.02	0.05	0.5
yes Some college, diploma, assoc - yes Bachelors or higher	-1.24	0.06	0.0000	-0.05	0.06	0.3
no High School or less - yes Some college, diploma, assoc	-0.04	0.06	0.5078	-0.05	0.05	0.3
no Bachelors or higher - yes Bachelors or higher	0.60	0.07	0.0000	-0.06	0.06	0.3
yes High School or less - yes Bachelors or higher	-1.66	0.06	0.0000	-0.07	0.06	0.2
no High School or less - no Bachelors or higher	-1.87	0.03	0.0000	-0.04	0.03	0.1
no High School or less - yes Bachelors or higher	-1.28	0.07	0.0000	-0.10	0.06	0.1
no Some college, diploma, assoc - yes Some college, diploma, assoc	0.48	0.06	0.0000	-0.11	0.05	0.0
no Some college, diploma, assoc - yes Bachelors or higher	-0.75	0.07	0.0000	-0.16	0.06	0.0
no Some college, diploma, assoc - no Bachelors or higher	-1.35	0.03	0.0000	-0.10	0.03	0.0

Table 12: Post-hoc Tukey test of adult disb and education