Online Appendix to 'How Important Is Health Inequality for Lifetime Earnings Inequality?'

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1 Data Description

1.1 Panel Study of Income Dynamics

We use waves 2003–2017 of the PSID (covering years 2002–2016). The PSID is biennial over this period. We do not use waves prior to 2003 because the PSID expanded its disability and health-related questions in the 2003 wave to include questions on specific medical conditions, activities of daily living (ADL's) and instrumental activities of daily living (IADL's) which we rely on to construct individuals' frailty indices. For the base sample, the only restriction is that a person is a household head or the spouse of a household head and at least 25 years of age. PSID only collects detailed health information for household heads and spouses. A good description of the PSID household head definition is in Heathcote et al. (2010). The base sample consists of 22,143 individuals (10,600 men, 11,543 women).

Table 1 lists the 27 variables we used to construct the frailty index for PSID respondents. The index is constructed by summing the variables in the first column of the table using their values which are assigned according to the rules in the second column. Then dividing this sum by the total number of variables observed for the individual in the year. The

Table 1: Health Variables used to construct frailty index for PSID respondents

Variable	Value
Some difficulty with ADL/IADLs:	
Eating	Yes=1, No=0
Dressing	Yes=1, No=0
Getting in/out of bed or chair	Yes=1, No=0
Using the toilet	Yes=1, No=0
Bathing/showering	Yes=1, No=0
Walking	Yes=1, No=0
Using the telephone	Yes=1, No=0
Managing money	Yes=1, No=0
Shopping for personal items	Yes=1, No=0
Preparing meals	Yes=1, No=0
Heavy housework	Yes=1, No=0
Light housework	Yes=1, No=0
Getting outside	Yes=1, No=0
Ever had one of following conditions:	
High Blood Pressure	Yes=1, No=0
Diabetes	Yes=1, No=0
Cancer	Yes=1, No=0
Lung disease	Yes=1, No=0
Heart disease	Yes=1, No=0
Heart attack	Yes=1, No=0
Stroke	Yes=1, No=0
Arthritis	Yes=1, No=0
Asthma	Yes=1, No=0
Loss of memory or mental ability	Yes=1, No=0
Psychological problems	Yes=1, No=0
Other serious, chronic condition	Yes=1, No=0
BMI ≥ 30	Yes=1, No=0
Has ever smoked	Yes=1, No=0

construction of this frailty index mostly follows the guidelines laid out in Searle et al. (2008), and uses a set of PSID variables similar to the index created in Yang and Lee (2009).

Table 2 reports summary statistics on the PSID sample used for the dynamic panel estimations. The sample consists of household heads and spouses aged 25 to 64. All individuals in the sample are in at least 3 consecutive waves of the PSID over the 2002–2016. Annual earnings are total annual labor earnings (including wages and salaries, bonuses, overtime tips, commissions, professional practice or trade, any additional job income, and any miscellaneous labor income). Annual hours are the total annual work hours for all jobs, including overtime. Hourly wage is a PSID constructed variable that is constructed using annual

Table 2: Summary statistics on our dynamic panel PSID sample

	2002	2004	2006	2008	2010	2012	2014	2016	Pooled 2002-2016
Panel A: Mean (median) [standard deviation] of sample characteristics									
Age	40.75	41.2	41.73	42.36	42.97	43.77	45.64	47.53	42.65
	(41)	(42)	(42)	(42)	(42)	(42)	(44)	(46)	(42)
	[11.11]	[11.77]	[12.33]	[12.85]	[13.34]	[13.7]	[13.7]	[13.69]	[12.72]
Frailty	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.11
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.10)	(0.10)	(0.07)
	[0.09]	[0.09]	[0.1]	[0.1]	[0.11]	[0.11]	[0.12]	[0.12]	[0.11]
Annual Earnings	$39,913.5	$39,951.17	$39,779.58	$39,670.04	$36,294.58	$36,659.7	$36,554.79	$38,088.25	$38,526.71
	(30,944.81)	(30,446.27)	(30,277.88)	(29,730.3)	(26,121.94)	(25,100)	(26,256.93)	(27,860.24)	(29,174.36)
	[73,161.16]	[68,148.32]	[65,088.35]	[77,401.9]	[58,809.46]	[92,687.86]	[70,310.25]	[56,168.13]	[68,482.15]
Annual Hours	1,698.71	1,675.51	1,647.33	1,550.34	1,466.27	1,492.25	1,495.81	1,482.53	1,590.6
	(1,960)	(1,960)	(1,944)	(1,880)	(1,820)	(1,856)	(1,872)	(1,888)	(1,920)
	[965.19]	[990.17]	[989.62]	[949.76]	[1,011.75]	[1,030.75]	[1,051.32]	[1,064.97]	[999.24]
Hourly Wage	$22.84	$23.27	$23.03	$24.38	$24.01	$23.27	$23.67	$25.27	$23.50
	(17.84)	(17.94)	(17.74)	(18.96)	(18.09)	(17.56)	(18.04)	(18.89)	(18.06)
	[25.85]	[28.3]	[23.46]	[27.15]	[26.59]	[25.73]	[23.07]	[26.81]	[25.37]
Panel B: Fraction of sample by characteristics									
Male	0.45	0.45	0.45	0.45	0.45	0.45	0.44	0.44	0.45
High School Dropouts (HSD)	13.47	13.31	13.06	13.02	13.04	13.04	13.12	12.86	13.21
High School Graduates (HS)	55.62	55.06	54.56	54.33	53.97	53.47	53.49	53.42	54.51
College Graduates (CL)	30.91	31.63	32.39	32.66	32.99	33.48	33.39	33.72	32.28
$+\Delta$ Frailty	-	0.28	0.32	0.3	0.28	0.28	0.27	0.27	0.29
$-\Delta$ Frailty	-	0.13	0.13	0.13	0.13	0.13	0.14	0.14	0.13
Observations (N)	9,665	10,100	10,647	11,174	11,536	11,663	10,809	10,206	85,800
# of Individuals (n)									14,269
Average # of Years Observed (T)									6.01

Note: Means are reported; median values are reported in parentheses; standard deviations are reported in brackets.

earnings and annual hours. It is adjusted by PSID for outliers. Education was cleaned and reassigned so that education is constant across all waves for each individual. Labor force status is considered not employed if annual hours is between 0 and 259 and employed (workers) if annual hours are 260 or more.

1.2 Health and Retirement Survey

The HRS is a biennial longitudinal survey of Americans over age 50. Aside from spouses of respondents, the HRS does not survey individuals under the age of 51. We use the HRS waves spanning the period 1998 to 2014. Our sample consists of 205,711 observations of 36,032 individuals (15,860 men and 20,172 women). We construct a frailty index for HRS respondents in the same way as for PSID respondents. The lifecycle dynamics of frailty in the HRS and PSID samples are very similar even though the HRS contains a larger number of deficit variables (36 versus 27). See Hosseini et al. (2019) for additional details.

Table 3: Diff-in-Hansen test, Y-lag set only (p-value) for regressions in Tables 2 and 3 in the paper

	Everyone				Workers			
	(1) Overall	(2) By Educ	(3) By Health	(4) By Age	(5) Overall	(6) By Educ	(7) By Health	(8) By Age
Effect of Frailty on Earnings	0.796	0.516	0.960	0.479	0.434	0.388	0.283	0.249
Effect of Frailty on Hours	0.971	0.730	0.838	0.557	0.060	0.059	0.063	0.069
Effect of Frailty on Wages					0.085	0.097	0.098	0.065

1.3 Medical Expenditure Panel Survey

The MEPS consists of a collection of rotating two-year panels. We use MEPS data from the 2000 to 2016 period. Our sample consists of respondents aged 25 to 84 years. We do not include individuals aged 85 years or older because, starting in 2001, MEPS top codes age at 85. The base sample contains 345,022 observations on 191,165 individuals (88,389 men and 102,776 women). The frailty index is constructed in the same way as for PSID and HRS respondents as has similar lifecycle dynamics. See Hosseini et al. (2019) for additional details.

2 Dynamic Panel Analysis: More Results

In Section 2.2 of the paper we use a dynamic GMM panel estimator to estimate the impact of frailty on earnings, hours and wages. In this section of the appendix we present additional results regarding validity of instruments, causality, and further diagnostics.

2.1 Additional diagnostic tests

Table 3 presents p-values of the diff-in-Hansen tests on the y-lag explanatory variables only for the regressions in Tables 2 and 3 in the paper. Notice that in all regressions we fail to reject the null that the instruments for the y-lag variables are valid.

2.2 Comparison with OLS and fixed effect estimators

For purposes of comparison, we estimate Equation (1) in Section 2.2 of the paper using OLS and fixed effect estimators, and compare the results to our system GMM estimates. The results are presented in Tables 4, 5, 6 and 7 for the overall effect, the effect by education, by health, and by age group, respectively. The three panels in the table show results for earnings, hours, and wages, respectively.

Table 4: Comparison with OLS and Fixed Effect Estimator, Average Frailty Effect

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
Panel A. Earnings Regressions						
$\log(\text{earnings}_{t-1})$	0.564***	0.206***	0.283	0.555***	0.098***	1.474***
	(0.006)	(0.004)	(0.364)	(0.013)	(0.006)	(0.509)
$\log(\text{earnings}_{t-2})$	0.188***	-0.021***	0.396	0.240***	-0.031***	-0.640
	(0.006)	(0.005)	(0.298)	(0.012)	(0.006)	(0.454)
frailty_t	-4.973***	-8.818***	-5.374***	-0.519***	-0.471***	-0.978**
	(0.138)	(0.235)	(1.653)	(0.044)	(0.084)	(0.447)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.580	0.432		0.601	0.080	
Panel B. Hours Regressions						
$\log(\text{hours}_{t-1})$	0.554***	0.200***	0.399	0.332***	-0.027***	0.003
	(0.006)	(0.004)	(0.322)	(0.008)	(0.006)	(0.345)
$\log(\text{hours}_{t-2})$	0.180***	-0.028***	0.263	0.157***	-0.090***	0.304
	(0.006)	(0.004)	(0.257)	(0.007)	(0.006)	(0.218)
frailty_t	-3.626***	-6.655***	-3.887***	-0.175***	-0.442***	0.070
	(0.100)	(0.172)	(1.188)	(0.028)	(0.056)	(0.246)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.556	0.400		0.234	0.001	
Panel C. Wage Regressions						
$\log(\text{wage}_{t-1})$				0.525***	0.067***	0.212
				(0.010)	(0.006)	(0.541)
$\log(\text{wage}_{t-2})$				0.288***	-0.028***	0.532
				(0.009)	(0.006)	(0.489)
frailty_t				-0.378***	-0.028	-0.623**
				(0.037)	(0.073)	(0.263)
Observations				34,170	34,170	34,170
R^2				0.592	0.056	

Notes: Panel A (top) shows regression results for the effect of frailty on earnings. Panel B (middle) shows regression results for the effect of frailty on hours. Panel C (bottom) shows regression results for the effect of frailty on wages. All regressions include controls (marital status, marital status interacted with gender, number of kids, number of kids interacted with gender, time dummies, and quadratic in age). 'FE' is fixed effect (within groups) estimation. 'Good/Bad Health' is frailty below/above the 75th percentile. 'Young/Old' are individuals younger/older than 45 years of age. Standard errors are in parenthesis. R^2 is adjusted R-squared for OLS, and overall R-squared for FE. $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

We would like to point out couple of observations. It is well known that the OLS estimates of the coefficients on lagged values of the left-hand-side variable have an upward bias. Moreover, as Nickell (1981), Arellano and Bond (1991), and Bond (2002) have shown, the estimates acquired via a fixed effects estimator have downward bias. Therefore, an unbiased estimate should lie between the OLS and FE estimates. As Bond (2002) argues, if multiple lags of the left-hand-side variable are included on the right-hand-side, the sum of the coeffi-

cients on these variables must satisfy this condition. In other words, a necessary condition for the dynamic panel estimates to be unbiased is that the sum of the estimated values of α_1 and α_2 in Equation (1) in the paper are smaller than the corresponding sum of OLS estimates, but larger than those from the fixed effect estimation. We cannot statistically reject this condition in any of our estimations. Therefore, our regressions pass this consistency test.

Note, also that in Tables 4 through 7 the OLS estimation shows a significant effect of frailty on hours even for those who continuously work. This is likely due to the fact that, in these OLS estimations, individuals' fixed effects are ignored. The fixed effects are included in the FE estimation but this estimator is biased.

2.3 Robustness to instrument set

Following the recommendation of Roodman (2009), we explore the robustness of our estimates to the set of lagged levels and differences we use as instruments. For the results reported in Section 2.3 in the paper we used lags 4–5 as instruments for everyone and 5–6 as instruments for workers. Here, we report the results of each estimation using either lags 3–4, lags 4–5, or lags 5–6.

We find that the results are robust to variation in the set of instruments used. Table 8 reports the results for the overall effect of frailty on earnings, Table 9 reports results for the effect by education, Table 10 reports the results for the effect by health, and Table 11 reports results for the effect by age group. The three panels in the tables show results for earnings, hours, and wages, respectively. Notice that, while not all of the alternative regressions pass all the diagnostic tests, the estimated effects of frailty are generally similar in magnitude and significance across the choice of lags used for instruments. The estimated effects using the full sample are generally more consistent across the lag set than the ones run only on the workers. However, the alternative worker results that differ the most from the baseline ones are also the ones where the empirical specification tends to fail the tests for instrument validity.

2.4 Instrument power tests

The Hansen and diff-in-Hansen tests only test for instrument exogeneity, not instrument power. To test instrument power, we use the methodology of Staiger and Stock (1997) and Stock and Yogo (2005) following Wintoki et al. (2012). That is, we look at the strength of the F-statistics in the first stage regressions. Under the system-GMM, there are two "first stage" equations, one for levels with instruments of first differences and one for first differences

with instruments of levels. We regress the endogenous variables from each equation on their corresponding instrument set, which yields an F-statistic that we evaluate for instrument strength.

To run the instrument power tests, we run OLS regressions of the endogenous variables specified on the right-hand-side of the system-GMM structure on the appropriate instrument specification allowing for dynamic adjustments in the time periods available. Each endogenous variable is regressed on it's instruments starting with the fourth lag alone and then adding the fifth lag. Each equation generates an F-statistic which is used to test whether the parameters estimated in each equation are jointly equal to zero. This tells us the statistical power of the instruments in explaining the variation in the endogenous variable. A general rule is that the F-statistic should be greater than or equal to 10 to reject the null hypothesis that all the parameters are jointly equal to zero.

We conduct the instrument power tests for the system GMM estimation of the overall impact of frailty on earnings that is reported in column (2) of Table 2 in the paper. The results of the tests are reported in Table 12. Notice that, across each result, the F-statistic is decreasing with the specification of further lags of the instrument set. Excluding the last row of the table, all the F-statistics are greater than 10 suggesting that the instruments have sufficient power in explaining the variation in the endogenous variables. Panel B of the table indicates that the lagged levels are relatively weak instruments for first-differences as compared to the strength of lagged differences as instruments for the levels. As we mentioned in Section 2.2 of the paper, this is not surprising given that both frailty and log earnings are highly persistent variables. It is also the reason we use the system GMM estimator as opposed to working only with the difference equation.

Table 5: Comparison with OLS and Fixed Effect Estimator, Frailty Effects by Education

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
Panel A. Earnings Regressions						
$\log(\text{earnings}_{t-1})$	0.560***	0.206***	0.370	0.544***	0.097***	1.371***
	(0.006)	(0.004)	(0.319)	(0.013)	(0.006)	(0.400)
$\log(\text{earnings}_{t-2})$	0.183***	-0.022***	0.318	0.233***	-0.031***	-0.569
	(0.006)	(0.005)	(0.259)	(0.011)	(0.006)	(0.356)
$\text{frailty}_t \times$ HSD	-6.143***	-8.533***	-6.269***	-1.340***	-0.742***	-1.846**
	(0.213)	(0.526)	(1.777)	(0.111)	(0.254)	(0.807)
$\text{frailty}_t \times$ HS	-5.215***	-9.586***	-5.591***	-0.762***	-0.712***	-1.239***
	(0.155)	(0.289)	(1.574)	(0.052)	(0.107)	(0.460)
$\text{frailty}_t \times$ CL	-3.003***	-6.900***	-2.519*	0.053	-0.014	-0.558
	(0.209)	(0.457)	(1.402)	(0.053)	(0.132)	(0.484)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.581	0.435		0.605	0.089	
Panel B. Hours Regressions						
$\log(\text{hours}_{t-1})$	0.550***	0.200***	0.383	0.331***	-0.027***	0.074
	(0.006)	(0.004)	(0.319)	(0.008)	(0.006)	(0.313)
$\log(\text{hours}_{t-2})$	0.176***	-0.028***	0.269	0.156***	-0.091***	0.168
	(0.006)	(0.004)	(0.253)	(0.007)	(0.006)	(0.221)
$\text{frailty}_t \times$ HSD	-4.433***	-6.526***	-4.770***	-0.403***	-0.942***	-0.533
	(0.157)	(0.385)	(1.320)	(0.078)	(0.169)	(0.356)
$\text{frailty}_t \times$ HS	-3.732***	-7.241***	-4.303***	-0.189***	-0.440***	-0.033
	(0.112)	(0.211)	(1.224)	(0.032)	(0.071)	(0.281)
$\text{frailty}_t \times$ CL	-2.380***	-5.119***	-2.219**	-0.092***	-0.311***	0.248
	(0.150)	(0.334)	(1.118)	(0.035)	(0.088)	(0.254)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.557	0.402		0.234	0.001	
Panel C. Wage Regressions						
$\log(\text{wage}_{t-1})$				0.514***	0.067***	0.122
				(0.010)	(0.006)	(0.368)
$\log(\text{wage}_{t-2})$				0.279***	-0.029***	0.600*
				(0.009)	(0.006)	(0.328)
$\text{frailty}_t \times$ HSD				-1.040***	0.191	-1.854***
				(0.102)	(0.222)	(0.616)
$\text{frailty}_t \times$ HS				-0.602***	-0.268***	-0.889***
				(0.043)	(0.094)	(0.307)
$\text{frailty}_t \times$ CL				0.123***	0.298***	-0.216
				(0.046)	(0.116)	(0.309)
Observations				34,170	34,170	34,170
R^2				0.596	0.063	

Notes: Panel A (B) [C] shows regression results for the effect of frailty on earnings (hours) [wages]. All regressions include controls (marital status, marital status interacted with gender, number of kids, number of kids interacted with gender, time dummies, and a quadratic in age). 'FE' is fixed effect (within groups) estimation. Standard errors are in parenthesis. R^2 is adjusted R-squared for OLS, and overall R-squared for FE. $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 6: Comparison with OLS and Fixed Effect Estimator, Frailty Effects by Health Status

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
Panel A. Earnings Regressions						
$\log(\text{earnings}_{t-1})$	0.564***	0.206***	0.220	0.555***	0.097***	1.293***
	(0.006)	(0.004)	(0.362)	(0.013)	(0.006)	(0.410)
$\log(\text{earnings}_{t-2})$	0.188***	-0.021***	0.444	0.240***	-0.031***	-0.498
	(0.006)	(0.005)	(0.297)	(0.012)	(0.006)	(0.377)
$\text{frailty}_t \times$ Good Health	-3.076***	-6.816***	-1.930	-0.610***	-0.230*	-1.765
	(0.305)	(0.499)	(4.816)	(0.082)	(0.135)	(1.775)
$\text{frailty}_t \times$ Bad Health	-4.818***	-8.607***	-5.207***	-0.522***	-0.446***	-0.963**
	(0.137)	(0.239)	(1.745)	(0.044)	(0.085)	(0.469)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.580	0.433		0.601	0.079	
Panel B. Hours Regressions						
$\log(\text{hours}_{t-1})$	0.553***	0.200***	0.386	0.332***	-0.027***	0.040
	(0.006)	(0.004)	(0.317)	(0.008)	(0.006)	(0.311)
$\log(\text{hours}_{t-2})$	0.180***	-0.028***	0.272	0.157***	-0.091***	0.282
	(0.006)	(0.004)	(0.253)	(0.007)	(0.006)	(0.219)
$\text{frailty}_t \times$ Good Health	-1.957***	-5.137***	-2.216	-0.046	-0.292***	-0.060
	(0.222)	(0.365)	(3.455)	(0.049)	(0.090)	(0.910)
$\text{frailty}_t \times$ Bad Health	-3.491***	-6.494***	-3.707***	-0.171***	-0.426***	0.026
	(0.099)	(0.175)	(1.242)	(0.028)	(0.056)	(0.258)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.556	0.402		0.234	0.001	
Panel C. Wage Regressions						
$\log(\text{wage}_{t-1})$				0.525***	0.067***	0.303
				(0.010)	(0.006)	(0.449)
$\log(\text{wage}_{t-2})$				0.288***	-0.028***	0.461
				(0.009)	(0.006)	(0.419)
$\text{frailty}_t \times$ Good Health				-0.561***	0.061	0.348
				(0.071)	(0.118)	(1.685)
$\text{frailty}_t \times$ Bad Health				-0.384***	-0.019	-0.581*
				(0.037)	(0.074)	(0.332)
Observations				34,170	34,170	34,170
R^2				0.592	0.055	

Notes: Panel A (B) [C] shows regression results for the effect of frailty on earnings (hours) [wages]. All regressions include controls (marital status, marital status interacted with gender, number of kids, number of kids interacted with gender, time dummies, and a quadratic in age). 'Good/Bad Health' is frailty below/above the 75th percentile. 'FE' is fixed effect (within groups) estimation. Standard errors are in parenthesis. R^2 is adjusted R-squared for OLS, and overall R-squared for FE. $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 7: Comparison with OLS and Fixed Effect Estimator, Frailty Effects by Age Group

	Everyone			Workers		
	OLS	FE	SYS-GMM	OLS	FE	SYS-GMM
Panel A. Earnings Regressions						
$\log(\text{earnings}_{t-1})$	0.564***	0.206***	0.628**	0.555***	0.098***	1.127***
	(0.006)	(0.004)	(0.291)	(0.013)	(0.006)	(0.302)
$\log(\text{earnings}_{t-2})$	0.188***	-0.021***	0.115	0.241***	-0.031***	-0.308
	(0.006)	(0.005)	(0.239)	(0.012)	(0.006)	(0.273)
$\text{frailty}_t \times$ Young	-4.870***	-8.547***	-4.992***	-0.660***	-0.483***	-1.650**
	(0.202)	(0.297)	(1.784)	(0.061)	(0.099)	(0.673)
$\text{frailty}_t \times$ Old	-5.034***	-8.943***	-4.030***	-0.376***	-0.463***	-0.293
	(0.161)	(0.249)	(1.317)	(0.054)	(0.091)	(0.365)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.580	0.433		0.601	0.080	
Panel B. Hours Regressions						
$\log(\text{hours}_{t-1})$	0.554***	0.200***	0.669***	0.332***	-0.027***	0.382
	(0.006)	(0.004)	(0.257)	(0.008)	(0.006)	(0.318)
$\log(\text{hours}_{t-2})$	0.180***	-0.028***	0.048	0.157***	-0.090***	0.254
	(0.006)	(0.004)	(0.206)	(0.007)	(0.006)	(0.246)
$\text{frailty}_t \times$ Young	-3.457***	-6.411***	-3.564***	-0.200***	-0.484***	-0.286
	(0.149)	(0.217)	(1.325)	(0.039)	(0.066)	(0.387)
$\text{frailty}_t \times$ Old	-3.726***	-6.767***	-3.131***	-0.151***	-0.414***	0.144
	(0.116)	(0.182)	(0.936)	(0.036)	(0.060)	(0.259)
Observations	64,965	64,965	64,965	34,274	34,274	34,274
R^2	0.556	0.401		0.234	0.001	
Panel C. Wage Regressions						
$\log(\text{wage}_{t-1})$				0.525***	0.067***	0.511
				(0.010)	(0.006)	(0.399)
$\log(\text{wage}_{t-2})$				0.289***	-0.029***	0.272
				(0.009)	(0.006)	(0.359)
$\text{frailty}_t \times$ Young				-0.481***	0.028	-1.106**
				(0.050)	(0.086)	(0.463)
$\text{frailty}_t \times$ Old				-0.274***	-0.064	-0.414
				(0.045)	(0.079)	(0.295)
Observations				34,170	34,170	34,170
R^2				0.592	0.055	

Notes: Panel A (B) [C] shows regression results for the effect of frailty on earnings (hours) [wages]. All regressions include controls (marital status, marital status interacted with gender, number of kids, number of kids interacted with gender, time dummies, and a quadratic in age). 'Young/Old' are individuals younger/older than 45 years of age. 'FE' is fixed effect (within groups) estimation. Standard errors are in parenthesis. R^2 is adjusted R-squared for OLS, and overall R-squared for FE. $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 8: Comparison With Different IV Lags, Average Frailty Effect

	Everyone			Workers		
IV Lags	3-4	4-5	5-6	3-4	4-5	5-6
Number of Instruments	20	20	20	20	20	20
Panel A. Earnings Regressions						
$\log(\text{earnings}_{t-1})$	0.689***	0.283	0.013	0.367***	-0.235	1.474***
	(0.105)	(0.364)	(0.545)	(0.120)	(0.446)	(0.509)
$\log(\text{earnings}_{t-2})$	0.046	0.396	0.684	0.089**	0.833**	-0.640
	(0.044)	(0.298)	(0.439)	(0.041)	(0.346)	(0.454)
frailty_t	-4.462***	-5.374***	-5.415**	-0.606**	-0.251	-0.978**
	(1.498)	(1.653)	(2.584)	(0.238)	(0.390)	(0.447)
AR(2) test (p-value)	0.115	0.380	0.233	0.494	0.051	0.130
Hansen test (p-value)	0.060	0.796	0.465	0.475	0.063	0.434
Diff-in-Hansen test (p-value)	0.063	0.652	0.440	0.297	0.027	0.255
Diff-in-Hansen test (p-value), Y-lag set	0.060	0.796	0.465	0.475	0.063	0.434
Panel B. Hours Regressions						
$\log(\text{hours}_{t-1})$	0.669***	0.399	0.292	-0.275	-0.208	0.003
	(0.119)	(0.322)	(0.387)	(0.379)	(0.288)	(0.345)
$\log(\text{hours}_{t-2})$	0.046	0.263	0.459	0.117**	0.448**	0.304
	(0.048)	(0.257)	(0.293)	(0.058)	(0.192)	(0.218)
frailty_t	-3.366***	-3.887***	-3.068*	-0.563***	-0.091	0.070
	(1.195)	(1.188)	(1.642)	(0.206)	(0.233)	(0.246)
AR(2) test (p-value)	0.158	0.596	0.302	0.219	0.060	0.273
Hansen test (p-value)	0.068	0.971	0.433	0.141	0.133	0.060
Diff-in-Hansen test (p-value)	0.073	0.944	0.450	0.453	0.083	0.080
Diff-in-Hansen test (p-value), Y-lag set	0.068	0.971	0.433	0.141	0.230	0.060
Panel C. Wage Regressions						
$\log(\text{wage}_{t-1})$				0.605***	0.603	0.212
				(0.086)	(0.865)	(0.541)
$\log(\text{wage}_{t-2})$				0.041	0.184	0.532
				(0.027)	(0.742)	(0.489)
frailty_t				-0.167	-0.302	-0.623**
				(0.197)	(0.266)	(0.263)
AR(2) test (p-value)				0.042	0.958	0.454
Hansen test (p-value)				0.335	0.056	0.085
Diff-in-Hansen test (p-value)				0.187	0.024	0.044
Diff-in-Hansen test (p-value), Y-lag set				0.335	0.056	0.085

Notes: Panel A (B) [C] shows regression results for the effect of frailty on earnings (hours) [wages]. All regressions include controls (marital status, marital status interacted with gender, number of kids, number of kids interacted with gender, time dummies, and a quadratic in age). Standard errors are in parenthesis. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 9: Comparison With Different IV Lags, Frailty Effects by Education

	Everyone			Workers		
IV Lags	3-4	4-5	5-6	3-4	4-5	5-6
Number of Instruments	26	26	26	26	26	26
Panel A. Earnings Regressions						
$\log(\text{earnings}_{t-1})$	0.676***	0.370	0.055	0.410***	0.077	1.371***
	(0.110)	(0.319)	(0.264)	(0.112)	(0.290)	(0.400)
$\log(\text{earnings}_{t-2})$	0.050	0.318	0.632***	0.070*	0.580**	-0.569
	(0.046)	(0.259)	(0.210)	(0.038)	(0.229)	(0.356)
$\text{frailty}_t \times$ HSD	-5.133***	-6.269***	-5.772***	-1.561***	-1.359**	-1.846**
	(1.809)	(1.777)	(2.050)	(0.540)	(0.692)	(0.807)
$\text{frailty}_t \times$ HS	-5.009***	-5.591***	-6.532***	-1.137***	-0.577	-1.239***
	(1.610)	(1.574)	(1.876)	(0.294)	(0.364)	(0.460)
$\text{frailty}_t \times$ CL	-3.237**	-2.519*	-3.125*	0.379	0.526	-0.558
	(1.313)	(1.402)	(1.743)	(0.252)	(0.402)	(0.484)
AR(2) test (p-value)	0.156	0.474	0.024	0.760	0.052	0.082
Hansen test (p-value)	0.022	0.132	0.116	0.681	0.050	0.826
Diff-in-Hansen test (p-value)	0.015	0.360	0.151	0.323	0.008	0.484
Diff-in-Hansen test (p-value), Y-lag set	0.053	0.516	0.516	0.219	0.005	0.388
Panel B. Hours Regressions						
$\log(\text{hours}_{t-1})$	0.657***	0.383	0.216	-0.366	-0.192	0.074
	(0.123)	(0.319)	(0.253)	(0.383)	(0.280)	(0.313)
$\log(\text{hours}_{t-2})$	0.049	0.269	0.495***	0.130**	0.433**	0.168
	(0.050)	(0.253)	(0.189)	(0.058)	(0.186)	(0.221)
$\text{frailty}_t \times$ HSD	-3.795***	-4.770***	-3.609**	-0.726*	-0.121	-0.533
	(1.412)	(1.320)	(1.580)	(0.380)	(0.342)	(0.356)
$\text{frailty}_t \times$ HS	-3.749***	-4.303***	-4.232***	-0.749***	-0.076	-0.033
	(1.256)	(1.224)	(1.422)	(0.248)	(0.255)	(0.281)
$\text{frailty}_t \times$ CL	-2.473**	-2.219**	-2.058	-0.334	-0.092	0.248
	(1.061)	(1.118)	(1.314)	(0.206)	(0.249)	(0.254)
AR(2) test (p-value)	0.196	0.569	0.071	0.149	0.062	0.572
Hansen test (p-value)	0.090	0.317	0.053	0.515	0.384	0.166
Diff-in-Hansen test (p-value)	0.050	0.597	0.108	0.618	0.582	0.062
Diff-in-Hansen test (p-value), Y-lag set	0.105	0.730	0.283	0.430	0.230	0.019
Panel C. Wage Regressions						
$\log(\text{wage}_{t-1})$				0.598***	0.564	0.122
				(0.087)	(0.481)	(0.368)
$\log(\text{wage}_{t-2})$				0.040	0.203	0.600*
				(0.027)	(0.409)	(0.328)
$\text{frailty}_t \times$ HSD				-0.792*	-1.104**	-1.854***
				(0.410)	(0.547)	(0.616)
$\text{frailty}_t \times$ HS				-0.516**	-0.566**	-0.889***
				(0.234)	(0.244)	(0.307)
$\text{frailty}_t \times$ CL				0.356	0.239	-0.216
				(0.241)	(0.356)	(0.309)
AR(2) test (p-value)				0.044	0.884	0.189
Hansen test (p-value)				0.446	0.104	0.374
Diff-in-Hansen test (p-value)				0.198	0.059	0.145
Diff-in-Hansen test (p-value), Y-lag set				0.181	0.038	0.097

Notes: Panel A (B) [C] shows regression results for the effect of frailty on earnings (hours) [wages]. All regressions include controls (marital status, marital status interacted with gender, number of kids, number of kids interacted with gender, time dummies, and a quadratic in age). Standard errors are in parenthesis. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 10: Comparison With Different IV Lags, Frailty Effects by Health Status

	Everyone			Workers		
IV Lags	3-4	4-5	5-6	3-4	4-5	5-6
Number of Instruments	23	23	23	23	23	23
Panel A. Earnings Regressions						
$\log(\text{earnings}_{t-1})$	0.799***	0.220	0.009	0.409***	-0.088	1.293***
	(0.106)	(0.362)	(0.492)	(0.114)	(0.387)	(0.410)
$\log(\text{earnings}_{t-2})$	0.001	0.444	0.695*	0.077*	0.734**	-0.498
	(0.045)	(0.297)	(0.396)	(0.039)	(0.304)	(0.377)
$\text{frailty}_t \times$ Good Health	-4.191	-1.930	-4.126	0.220	1.049	-1.765
	(3.587)	(4.816)	(7.067)	(0.763)	(1.326)	(1.775)
$\text{frailty}_t \times$ Bad Health	-2.963*	-5.207***	-4.941*	-0.621**	-0.191	-0.963**
	(1.570)	(1.745)	(2.665)	(0.255)	(0.408)	(0.469)
AR(2) test (p-value)	0.010	0.298	0.178	0.685	0.055	0.138
Hansen test (p-value)	0.014	0.826	0.544	0.345	0.067	0.543
Diff-in-Hansen test (p-value)	0.007	0.827	0.400	0.162	0.017	0.259
Diff-in-Hansen test (p-value), Y-lag set	0.004	0.960	0.451	0.262	0.019	0.283
Panel B. Hours Regressions						
$\log(\text{hours}_{t-1})$	0.819***	0.386	0.258	-0.274	-0.085	0.040
	(0.118)	(0.317)	(0.391)	(0.372)	(0.236)	(0.311)
$\log(\text{hours}_{t-2})$	-0.014	0.272	0.493*	0.118**	0.383**	0.282
	(0.049)	(0.253)	(0.296)	(0.057)	(0.160)	(0.219)
$\text{frailty}_t \times$ Good Health	-2.545	-2.216	-2.880	0.434	-0.262	-0.060
	(2.717)	(3.455)	(4.901)	(0.535)	(0.773)	(0.910)
$\text{frailty}_t \times$ Bad Health	-1.883	-3.707***	-2.900	-0.504**	-0.140	0.026
	(1.236)	(1.242)	(1.845)	(0.205)	(0.239)	(0.258)
AR(2) test (p-value)	0.007	0.565	0.259	0.208	0.064	0.312
Hansen test (p-value)	0.013	0.838	0.478	0.114	0.251	0.174
Diff-in-Hansen test (p-value)	0.007	0.713	0.340	0.250	0.235	0.108
Diff-in-Hansen test (p-value), Y-lag set	0.005	0.838	0.250	0.228	0.187	0.063
Panel C. Wage Regressions						
$\log(\text{wage}_{t-1})$				0.593***	0.151	0.303
				(0.087)	(0.410)	(0.449)
$\log(\text{wage}_{t-2})$				0.045	0.581*	0.461
				(0.027)	(0.351)	(0.419)
$\text{frailty}_t \times$ Good Health				-0.007	1.661*	0.348
				(0.649)	(0.986)	(1.685)
$\text{frailty}_t \times$ Bad Health				-0.229	-0.053	-0.581*
				(0.212)	(0.292)	(0.332)
AR(2) test (p-value)				0.059	0.244	0.474
Hansen test (p-value)				0.262	0.210	0.207
Diff-in-Hansen test (p-value)				0.600	0.168	0.082
Diff-in-Hansen test (p-value), Y-lag set				0.465	0.137	0.098

Notes: Panel A (B) [C] shows regression results for the effect of frailty on earnings (hours) [wages]. All regressions include controls (marital status, marital status interacted with gender, number of kids, number of kids interacted with gender, time dummies, and a quadratic in age). 'Good/Bad Health' is frailty below/above the 75th percentile. Standard errors are in parenthesis. $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 11: Comparison With Different IV Lags, Frailty Effects by Age Group

	Everyone			Workers		
IV Lags	3-4	4-5	5-6	3-4	4-5	5-6
Number of Instruments	23	23	23	23	23	23
Panel A. Earnings Regressions						
$\log(\text{earnings}_{t-1})$	0.754***	0.628**	0.356	0.334**	0.288	1.127***
	(0.105)	(0.291)	(0.403)	(0.130)	(0.218)	(0.302)
$\log(\text{earnings}_{t-2})$	0.019	0.115	0.408	0.099**	0.440**	-0.308
	(0.045)	(0.239)	(0.328)	(0.043)	(0.176)	(0.273)
$\text{frailty}_t \times$ Young	-5.068***	-4.992***	-4.360*	-0.545	-0.346	-1.650**
	(1.631)	(1.784)	(2.649)	(0.341)	(0.465)	(0.673)
$\text{frailty}_t \times$ Old	-3.265**	-4.030***	-4.238**	-0.861***	-0.472*	-0.293
	(1.422)	(1.317)	(1.802)	(0.232)	(0.262)	(0.365)
AR(2) test (p-value)	0.029	0.949	0.435	0.383	0.078	0.160
Hansen test (p-value)	0.342	0.752	0.414	0.163	0.000	0.465
Diff-in-Hansen test (p-value)	0.286	0.464	0.389	0.314	0.000	0.214
Diff-in-Hansen test (p-value), Y-lag set	0.204	0.479	0.195	0.766	0.000	0.249
Panel B. Hours Regressions						
$\log(\text{hours}_{t-1})$	0.739***	0.669***	0.467	0.281	0.245	0.382
	(0.115)	(0.257)	(0.286)	(0.231)	(0.310)	(0.318)
$\log(\text{hours}_{t-2})$	0.017	0.048	0.325	0.035	0.208	0.254
	(0.047)	(0.206)	(0.221)	(0.037)	(0.211)	(0.246)
$\text{frailty}_t \times$ Young	-3.640***	-3.564***	-2.511	-0.648***	-0.149	-0.286
	(1.286)	(1.325)	(1.871)	(0.235)	(0.321)	(0.387)
$\text{frailty}_t \times$ Old	-2.537**	-3.131***	-2.623**	-0.518***	-0.210	0.144
	(1.087)	(0.936)	(1.121)	(0.141)	(0.198)	(0.259)
AR(2) test (p-value)	0.039	0.706	0.438	0.741	0.642	0.642
Hansen test (p-value)	0.251	0.811	0.609	0.024	0.006	0.051
Diff-in-Hansen test (p-value)	0.185	0.545	0.485	0.007	0.002	0.037
Diff-in-Hansen test (p-value), Y-lag set	0.108	0.557	0.373	0.014	0.002	0.069
Panel C. Wage Regressions						
$\log(\text{wage}_{t-1})$				0.524***	0.306	0.511
				(0.096)	(0.382)	(0.399)
$\log(\text{wage}_{t-2})$				0.063**	0.434	0.272
				(0.029)	(0.325)	(0.359)
$\text{frailty}_t \times$ Young				-0.022	-0.227	-1.106**
				(0.295)	(0.379)	(0.463)
$\text{frailty}_t \times$ Old				-0.304*	-0.328	-0.414
				(0.174)	(0.211)	(0.295)
AR(2) test (p-value)				0.298	0.398	0.734
Hansen test (p-value)				0.202	0.024	0.170
Diff-in-Hansen test (p-value)				0.317	0.031	0.104
Diff-in-Hansen test (p-value), Y-lag set				0.147	0.036	0.065

Notes: Panel A (B) [C] shows regression results for the effect of frailty on earnings (hours) [wages]. All regressions include controls (marital status, marital status interacted with gender, number of kids, number of kids interacted with gender, time dummies, and a quadratic in age). 'Young/Old' are individuals younger/older than 45 years of age. Standard errors are in parenthesis. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 12: Results of instrument power tests for system GMM estimation of earnings on frailty

Dependent variable	Explanatory variables	F-statistic	R^2
Panel A. Dependent variables in levels			
y_t	Δy_{t-4}	175.0	0.099
y_t	$\Delta y_{t-4}, \Delta y_{t-5}$	93.71	0.10
f_t	Δf_{t-4}	135.5	0.078
f_t	$\Delta f_{t-4}, \Delta f_{t-5}$	68.55	0.075
Panel B. Dependent variables in first-differences			
Δy_t	y_{t-4}	40.63	0.003
Δy_t	y_{t-4}, y_{t-5}	13.62	0.003
Δf_t	f_{t-4}	23.18	0.002
Δf_t	f_{t-4}, f_{t-5}	3.10	0.000

Notes: F-statistics and R^2 values from OLS regressions of the endogenous variables in the main system GMM estimation (column (2) of Table 2 in the paper) on their instrument sets.

3 Additional Information about the Structural Model

3.1 Recursive competitive equilibrium

In this section we provide the definition of equilibrium we employ in the structural model economy. Let $\{\mu^E(x,i_s),\mu^N(x,n_a),\mu^D(x,n_d),\mu^R(x)\}$ represent the time-invariant measures of individuals. We assume that these are the population measures *after* the labor participation decisions and DI application decisions are made. The concept of a stationary recursive competitive equilibrium can be defined as follows.

Given a fiscal policy $\{G, Tr(\cdot), SS(\cdot), T(\cdot)\}$, a *stationary recursive competitive equilibrium* is a set of value functions $\{V^E(x,i_s),V^N(x,n_a),V^D(x,n_d),V^R(x)\}$, households' consumption decisions $\{c^E(x,i_s),c^N(x,n_a),c^D(x,n_d),c^R(x)\}$, saving decisions $\{a^E(x,i_s),a^N(x,n_a),$ $a^D(x,n_d),a^R(x)\}$, labor force participation decisions $I_E(x,i_s)$ and $I_N(x,n_a)$; prices of labor and capital $\{w,r\}$; and time-invariant measures of households $\{\mu^E(x,i_s),\mu^N(x,n_a),\mu^D(x,n_d)$ $,\mu^R(x)\}$ such that:

1. Given the fiscal policy and prices, households' decision rules solve households' decision problems in equations (6), (8), (10), (12), (13), (15), and (16) in the paper.

2. Rental rate r is exogenously given and the wage is given by equation (18) in the paper.

3. Aggregate labor and capital input satisfy:

$$N = \sum_{\{x,i_s\}} \eta(x)\,\mu^E(x,i_s),$$
$$r = (1-\tau_K)\left(\alpha A (K/N)^{\alpha-1} - \delta\right).$$

4. The government's budget constraint holds

$$\begin{aligned}\sum_{\{x,i_s\}} T(w\eta(x))\,\mu^E(x,i_s) + \tau_K\left(\alpha A (K/N)^{\alpha-1} - \delta\right) = G \\ + \sum_{\{x,n_d\}} \left(\mu^D(x,n_d)+\mu^R(x)\right) SS(\bar{e}) \\ + \sum_{\{x,i_s,n_d\}} \left(\mu^E(x,i_s)+\mu^D(x,n_d)+\mu^R(x)\right) Tr(x)\end{aligned}$$

5. The measures $\{\mu^E(x,i_s),\mu^N(x,n_a),\mu^D(x,n_d),\mu^R(x)\}$ are stationary

   (a) Employed:

$$\mu^E(x',0) = \frac{I_E(x',0)}{1+\nu} \sum_{\{x,i_s\}} (1-\sigma)\, p\,(j,f)\, \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^E(x,i_s)} \mu^E\left(x,i_s\right)$$

$$\mu^E(x',1) = \frac{I_E\left(x',1\right)}{1+\nu} \sum_{\{x,i_s\}} \sigma p\left(x\right) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^E(x,i_s)} \mu^E\left(x,i_s\right)$$
$$+ \frac{1}{1+\nu} \sum_{\{x,n_a\}} \left(1-\theta\left(f,n_a\right)\right) p\left(x\right) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^N(x,n_a)} I_N\left(x',n_a+1\right) \mu^N\left(x,n_a\right)$$

(b) Non-employed:

$$\mu^N(x',0) = \frac{1-I_E(x',0)}{1+\nu} \sum_{\{x,i_s\}} (1-\sigma)\, p\left(x\right) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^E(x,i_s)} \mu^E\left(x,i_s\right)$$
$$+ \frac{1-I_E(x',1)}{1+\nu} \sum_{\{x,i_s\}} \sigma p\left(x\right) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^E(x,i_s)} \mu^E\left(x,i_s\right)$$

$$\mu^N(x',n_a+1) = \frac{1-I_N(x',n_a+1)}{1+\nu} \sum_{\{x,n_a\}} p\left(x\right) \left(1-\theta\left(f,n_a\right)\right) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^N(x,n_a)} \mu^N\left(x,n_a\right)$$

(c) DI beneficiary:

$$\mu^D(x',0) = \frac{1}{1+\nu} \sum_{\{x,n_a\}} \theta\left(f,n_a\right) p(x) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^N(x,i_s)} \mu^N\left(x,n_a\right)$$

$$\mu^D(x',n_d+1) = \frac{1}{1+\nu} \sum_{\{x\}} p(x) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^D(x,n_d)} \mu^D\left(x,n_d\right)$$

(d) Retiree:
for $j = R-1$

$$\mu^R(x') = \frac{1}{1+\nu} \sum_{\{x,n_d\}} p(x) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^D(x,i_s)} \mu^D\left(x,n_d\right)$$
$$+ \frac{1-I_E(x',1)}{1+\nu} \sum_{\{x,i_s\}} (1-\sigma)\, p\left(x\right) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^E(x,i_s)} \mu^E\left(x,i_s\right)$$
$$+ \frac{1-I_E(x',0)}{1+\nu} \sum_{\{x,i_s\}} \sigma p\left(x\right) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^E(x,i_s)} \mu^E\left(x,i_s\right)$$
$$+ \frac{1}{1+\nu} \sum_{\{x,n_a\}} p\left(x\right) \pi^e\left(\epsilon'|x\right) \pi^f\left(f'|x\right) \mathbf{1}_{a'=a^N(x,i_s)} \left(1-I_N\left(x',n_a+1\right)\right) \mu^N\left(x,n_a\right)$$

for $j > R-1$

$$\mu^R(x') = \frac{1}{1+\nu}\sum_{\{x\}} p(x)\,\pi^e\left(\epsilon'|x\right)\pi^f\left(f'|x\right)\mathbf{1}_{a'=a^R(x)}\mu^R(x)$$
$$+\frac{1-I_E(x',1)}{1+\nu}\sum_{\{x,i_s\}}(1-\sigma)\,p(x)\,\pi^e\left(\epsilon'|x\right)\pi^f\left(f'|x\right)\mathbf{1}_{a'=a^E(x,i_s)}\mu^E(x,i_s)$$
$$+\frac{1-I_E(x',0)}{1+\nu}\sum_{\{x,i_s\}}\sigma p(x)\,\pi^e\left(\epsilon'|x\right)\pi^f\left(f'|x\right)\mathbf{1}_{a'=a^E(x,i_s)}\mu^E(x,i_s)$$
$$+\frac{1}{1+\nu}\sum_{\{x,n_a\}} p(x)\,\pi^e\left(\epsilon'|x\right)\pi^f\left(f'|x\right)\mathbf{1}_{a'=a^N(x,i_s)}\left(1-I_N\left(x',n_a+1\right)\right)\mu^N(x,n_a)$$

4 Additional Calibration Details

This section includes results of the estimations outlined in Section 4 of the paper. We use the results in these tables as input to our model.

Table 13: Estimation of mortality probits

	Mortality probit regression
frailty	3.184***
	(0.104)
frailty^2	-1.039***
	(0.126)
age	-0.001
	(0.005)
age^2	0.00025***
	(0.00004)
education (years)	-0.001
	(0.001)
male	0.288***
	(0.011)
constant	-3.725***
	(0.197)
year fixed effects	included
Observations	212,364
Pseudo R^2	0.218

Note: Standard errors are in parenthesis. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Mortality probits are estimated using 1998–2014 HRS data.

Table 14: Distribution (%) of 24–26 year-old males across employment states by education and frailty percentile group: model and data

	Frailty percentile group				
	0–50th	50–70th	70–90th	90–95th	95–100th
High-school dropouts					
Employed	76.2	76.5	72	63.6	57.7
Non-employed	23.7	23.3	26.4	33.0	33.3
DI beneficiary	0.1	0.2	1.6	3.3	9.0
High-school graduates					
Employed	91.4	91.7	91.3	91.5	83.3
Non-employed	8.3	8.2	8.4	5.8	13.8
DI beneficiary	0.3	0.2	0.2	2.7	2.9
College graduates					
Employed	95.6	95.9	95.8	91.7	93.6
Non-employed	4.1	3.9	3.3	5.3	0.0
DI beneficiary	0.3	0.2	0.9	3.0	6.4

Note: Percent breakdown of 25–26 year olds males by employment state for each education and frailty percentile group. Authors' calculations using PSID, MEPS, and SSA data.

Table 15: Estimation of the effect of frailty on labor productivity. Stage 1: Selection equation regression.

	Selection Equation Regression
frailty × HSD	-0.891
	(6.251)
frailty × HSG	-0.874
	(6.251)
frailty × CG	-0.535
	(6.250)
age	0.038***
	(0.003)
age^2	-0.0003***
	(0.00002)
exclusion restrictions	total of 436 combinations
joint p-value	0.000

Note: The left-hand-side variable is employment (1 if employed, 0 otherwise). Standard errors are in parenthesis. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 16: Estimating the effect of frailty on labor productivity. Stage 2: Bias correction.

	without bias correction	with bias correction
$\log(\text{wage}_{t-1})$	1.044***	1.034***
	(0.298)	(0.295)
$\log(\text{wage}_{t-2})$	-0.263	-0.262
	(0.270)	(0.262)
$\text{frailty}_t \times$ HSD	-1.128**	-1.201**
	(0.453)	(0.469)
$\text{frailty}_t \times$ HS	-0.662***	-0.741***
	(0.235)	(0.251)
$\text{frailty}_t \times$ CL	0.052	0.025
	(0.119)	(0.119)
selection term		0.076**
		(0.035)
Observations	23,874	23,755
AR(2) test (p-value)	0.182	0.163
Hansen test (p-value)	0.107	0.096
Diff-in-Hansen test (p-value)	0.307	0.417

Note: The left-hand-side variable is log wage. The selection term is the predicted fixed effects from the regression in stage 1. Standard errors are in parenthesis. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

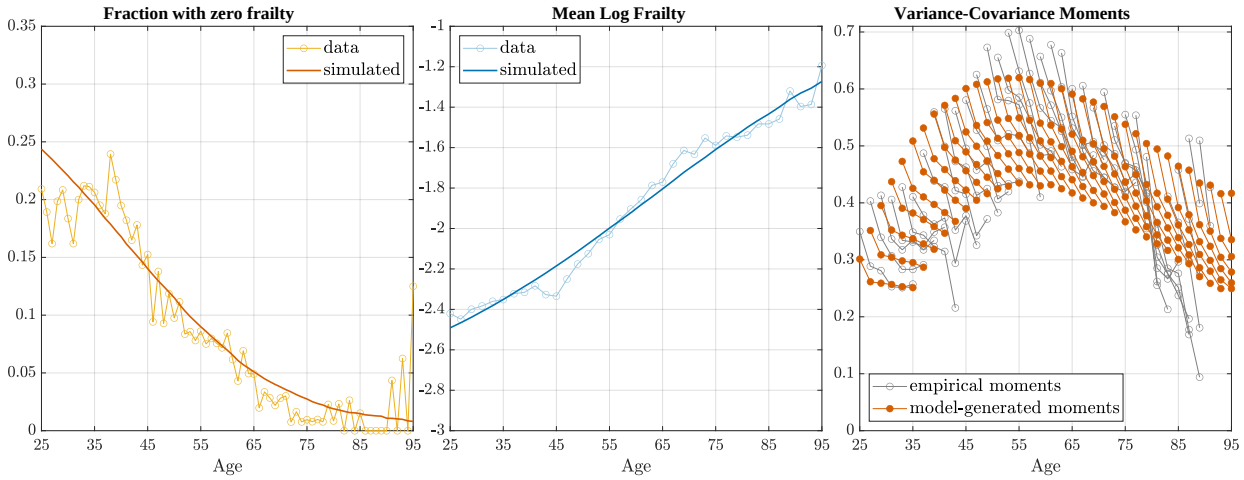


Figure 1: Estimation targets: auxiliary simulation model vs PSID data for high school dropouts. Left panel is the fraction with zero frailty by age, middle panel is mean log frailty by age for those with nonzero frailty, and right panel is the age-profile of the variance and covariances of log frailty residuals (the stochastic component of log frailty).

Table 17: Estimation of labor productivity process after bias correction and removal of frailty effect

(a) Estimation results for deterministic component of wages (net of frailty effect).

	Non-college	Col Graduates
age	0.0535	0.181
	(0.0194)	(0.0323)
age^2	-0.0005	-0.0027
	(0.0004)	(0.0007)
age^3	5.25e-7	1.19e-5
	(3.0e-6)	(4.9e-6)
constant	1.830	-0.0334
	(0.286)	(0.4808)

(b) Estimation results for stochastic component of wages.

	Non-college	Col Graduates
var. of transitory shock	0.0824	0.1033
	(0.0115)	(0.0180)
var. of permanent shock	0.0165	0.0181
	(0.0049)	(0.0070)
var. of fixed effect	0.0920	0.0636
	(0.0145)	(0.0291)
persistence	0.9218	0.9805
	(0.0231)	(0.0125)

Table 18: Estimation of zero frailty probits

	Zero frailty probit regression
age	0.0012
	(0.0027)
age^2	-0.0003***
	(0.00003)
high school grad dummy	-0.107***
	(0.017)
college grad dummy	0.295***
	(0.017)
constant	-0.534***
	(0.0620)
Observations	94,860
Pseudo R^2	0.082

Note: Standard errors are in parenthesis. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Zero frailty probits are estimated using PSID data.

Table 19: Estimation of nonzero frailty process

(a) First Stage: deterministic component

	HS Dropout	HS Graduates	Col Graduates
age	1.26	0.988	0.999
	(0.095)	(0.030)	(0.064)
age^2	2.19	1.40	2.04
	(0.492)	(0.146)	(0.305)
age^3	-0.607	-1.39	-0.838
	(0.951)	(0.380)	(0.585)
age^4	3.03	8.77	3.05
	(0.636)	(0.307)	(0.403)
const.	-2.50	-2.57	-2.83
	(0.006)	(0.003)	(0.004)

	HS Dropout	HS Graduates	Col Graduates
ρ	0.979	1.001	0.9690
	(0.002)	(0.001)	(0.002)
σ_α^2	0.2232	0.1542	0.1270
	(0.0107)	(0.005)	(0.0050)
σ_u^2	0.0368	0.0506	0.0357
	(0.0039)	(0.002)	(0.0023)
σ_ε^2	0.0286	0.0162	0.0250
	(0.0018)	(0.001)	(0.0012)

(b) Second stage: Stochastic component

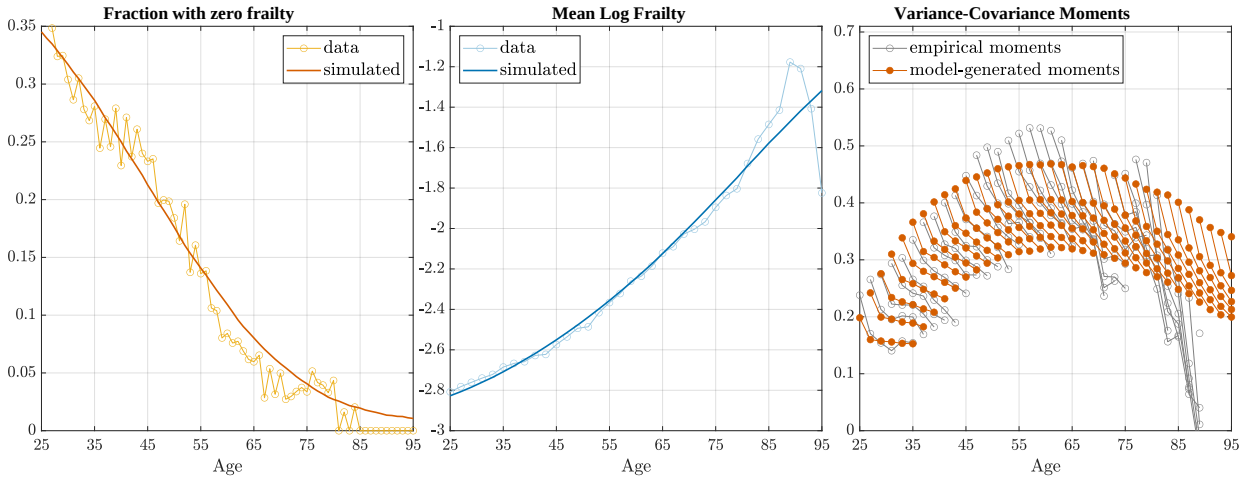


Figure 2: Estimation targets: auxiliary simulation model vs PSID data for college graduates. Left panel is the fraction with zero frailty by age, middle panel is mean log frailty by age for those with nonzero frailty, and right panel is the age-profile of the variance and covariances of log frailty residuals (the stochastic component of log frailty).

Table 20: Estimation of out of pocket medical expenditures

Estimation of log of out of pocket medical expenditures									
	High School Dropouts			High School Graduates			College Graduates		
	on medicare	working	not working	on medicare	working	not working	on medicare	working	not working
age	0.19	-0.23	0.42	-0.08	-0.03	-0.05	0.47	-0.11	-0.75
	(0.10)	(0.09)	(0.22)	(0.07)	(0.06)	(0.16)	(0.16)	(0.08)	(0.30)
age^2	-0.0024	0.00577	-0.00948	0.00238	0.00166	0.00165	-0.00717	0.00339	0.0163
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
age^3	0.0000114	-0.0000391	0.0000749	-0.0000149	-0.0000115	-0.00000646	0.0000359	-0.0000235	-0.000104
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
frailty	21.1	29.15	26.66	15.12	25.01	23.07	12.32	19.89	21.68
	(0.87)	(0.84)	(1.40)	(0.71)	(0.52)	(1.24)	(0.90)	(0.72)	(2.28)
$frailty^2$	-49.27	-71.78	-62.71	-35.9	-66.46	-55.72	-32.42	-49.45	-62.04
	(2.77)	(4.76)	(4.87)	(2.41)	(3.05)	(4.83)	(3.34)	(4.63)	(9.30)
$frailty^3$	35.86	55.31	47.43	27.32	54.53	42.95	26.16	37.55	51.05
	(2.45)	(6.36)	(4.56)	(2.27)	(4.28)	(5.03)	(3.33)	(6.77)	(9.67)
constant	-2.138	3.876	-5.45	3.535	1.525	1.232	-5.263	3.977	12.97
	(1.90)	(1.27)	(3.01)	(1.30)	(0.78)	(2.28)	(3.15)	(1.04)	(4.20)
Obs.	7160	17232	3068	10941	46641	5138	5182	24998	1456
R^2	0.162	0.205	0.312	0.113	0.181	0.278	0.0694	0.142	0.259

Table 21: Comparing estimated effect of frailty/disability with Low and Pistaferri (2015)

(a) Mean frailty for each work limitation group

	no work limitation ($d = 0$)	some work limitation ($d = 1$)	severe work limitation ($d = 2$)
mean frailty	0.068	0.177	0.285

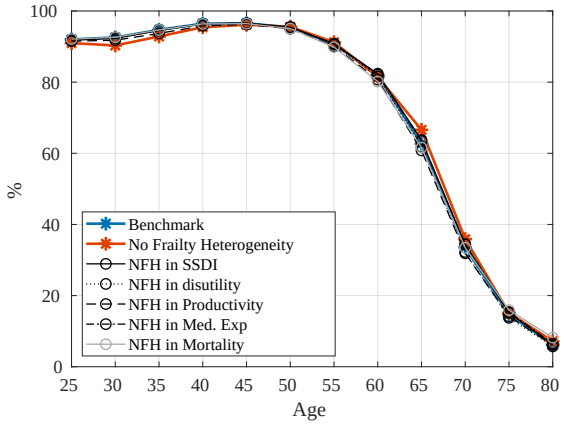
(b) Estimated effect of work limitations on log wage

	Low and Pistaferri (2015)	Our estimation
$d = 1$	-0.057	-0.110
$d = 2$	-0.177	-0.219

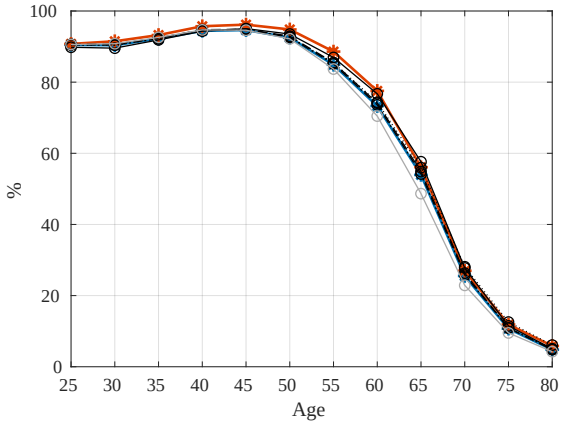
4.1 Comparing frailty effects on wages to Low and Pistaferri (2015)

Low and Pistaferri (2015) estimate the effect of *disability status* on wage. They use PSID to define three disability groups $d = 0, 1, 2$. Group $d = 0$ are those with no work limitations, group $d = 2$ are those with severe work limitations, and group $d = 1$ are the rest. In order to compare our estimation with theirs, we first calculation mean frailty for each of the disability groups defined above in our sample. Using these mean frailties we can calculate our counterpart of the effect of disability groups on wages. These estimations are reported in Table 21b. Note that our estimation imply stronger impact of work limitation on wages both for workers with some limitations ($d = 1$) and for those with severe limitations ($d = 2$). It is worth pointing out that Low and Pistaferri (2015) only include non-college educated workers in their sample whereas we included college educated as well as high school dropouts and high school graduates. The numbers reported in Table 21b are average effect among all education groups.

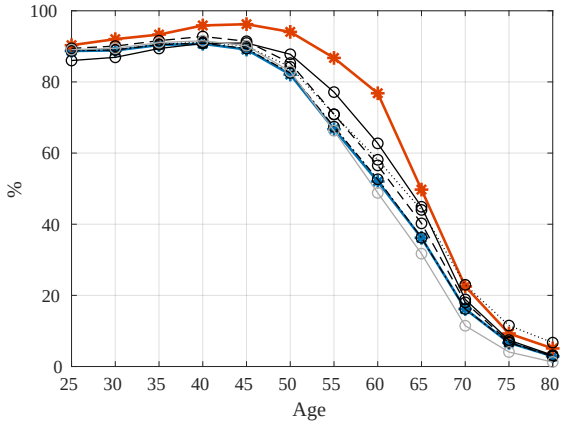
5 Additional Results



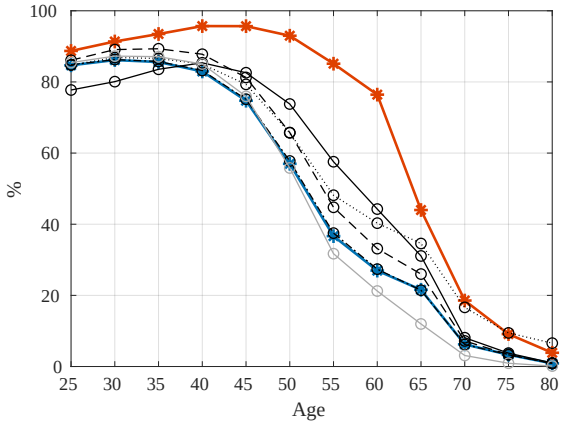
(a) Bottom half



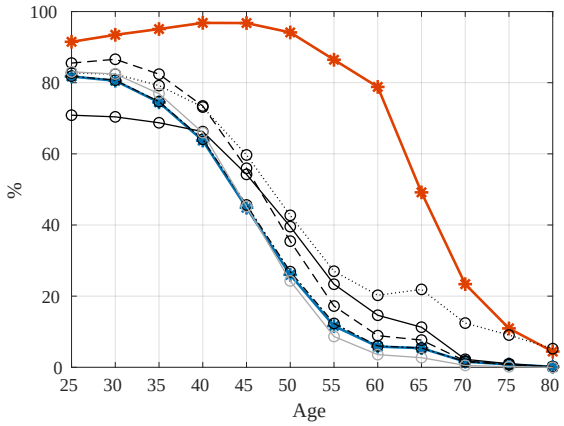
(b) 50th to 70th percentile



(c) 70th to 90th percentile

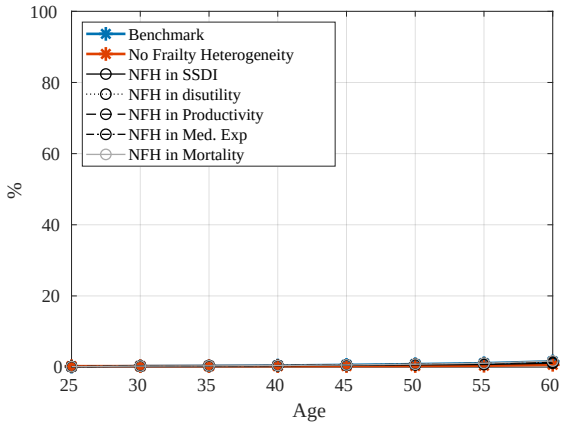


(d) 90th to 95th percentile

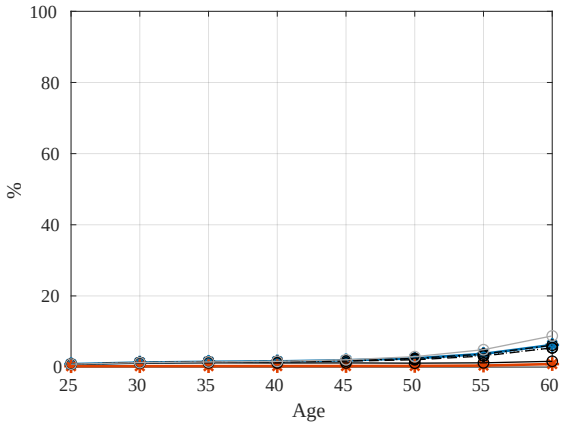


(e) 95th and above

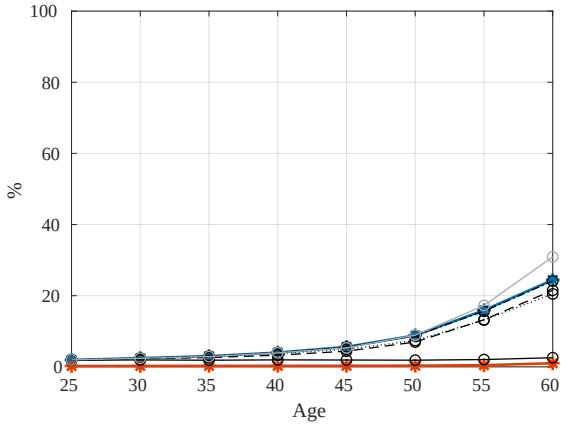
Figure 3: Labor force participation rates by age and frailty percentile groups: comparison between the benchmark (blue), No-Frailty-Heterogeneity (red), and additional five counterfactual (black and grey) economies.



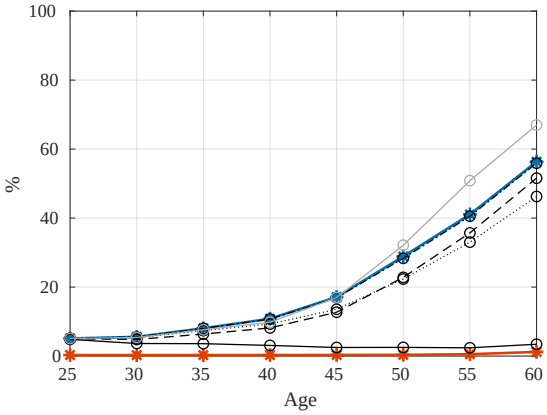
(a) Bottom half



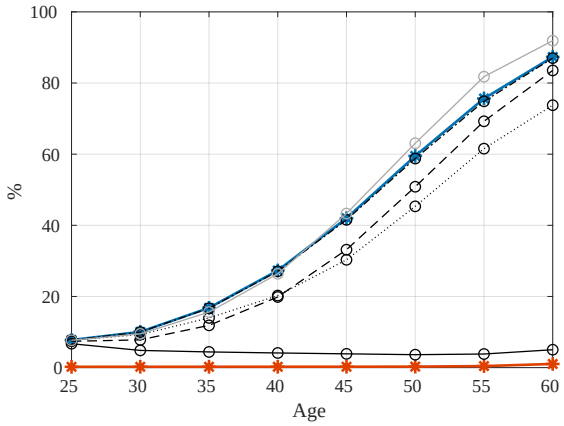
(b) 50th to 70th percentile



(c) 70th to 90th percentile

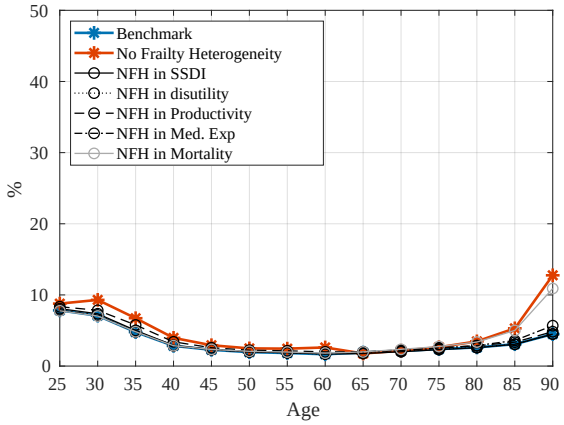


(d) 90th to 95th percentile

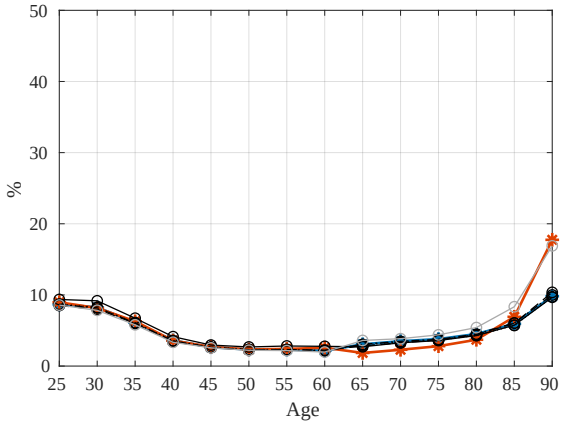


(e) 95th and above

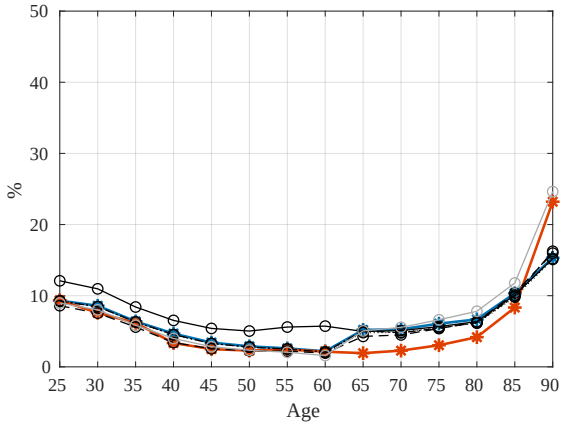
Figure 4: SSDI recipiency rates by age and frailty percentile groups: comparison between the benchmark (blue), No-Frailty-Heterogeneity (red), and additional five counterfactual (black and grey) economies.



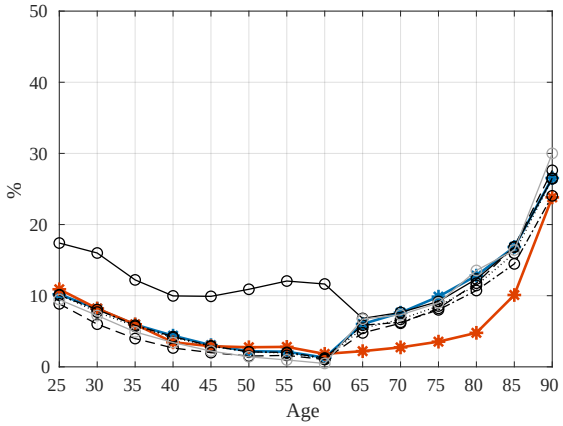
(a) Bottom half



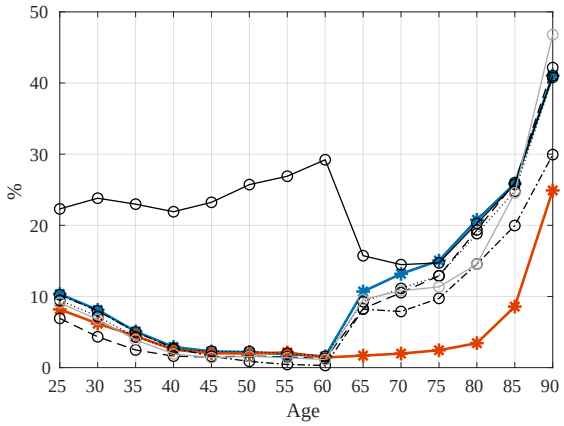
(b) 50th to 70th percentile



(c) 70th to 90th percentile



(d) 90th to 95th percentile



(e) 95th and above

Figure 5: Means-tested transfer recipiency rates by age and frailty percentile groups: comparison between the benchmark (blue), No-Frailty-Heterogeneity (red), and additional five counterfactual (black and grey) economies.

Table 22: Variance of log lifetime disposable income.

	Var. log lifetime disposable income			
	age 45	age 55	age 65	age 75
Benchmark	0.275	0.306	0.303	0.304
No frailty heterogeneity	0.244	0.256	0.259	0.254
% change relative to benchmark	-11.5	-16.1	-14.7	-16.5
Removing only frailty shocks	0.263	0.286	0.288	0.293
% change relative to benchmark	-4.5	-6.4	-4.9	-3.7
Removing only frailty fixed effect	0.269	0.296	0.292	0.294
% change relative to benchmark	-2.3	-3.1	-3.8	-3.4

Note: "No frailty heterogeneity" counterfactual removes all frailty shocks as well as cross-sectional (fixed effect) heterogeneity. "Removing only frailty shocks" removes only ex post uncertainty/shocks but retains all the initial fixed-effect heterogeneity. "Removing only frailty fixed effect" only removes initial fixed effect heterogeneity but retains all the shocks and uncertainty.

Table 22 shows the variance of log lifetime disposable income for the benchmark economy with no frailty heterogeneity, the economy with only individual fixed effect heterogeneity (and no shock), and the economy with only frailty shocks (and no fixed effect heterogeneity). Relative to the case of the variance of log lifetime earnings, initial fixed effect heterogeneity plays a larger role in accounting for decline in variance of log lifetime disposable income. This is for two reasons. First, individuals with a high initial fixed frailty component may never work. These individuals have positive disposable lifetime income but because they have zero lifetime earnings are not accounted for in the variance of log lifetime earnings calculations. Second, SSDI provides more insurance against frailty shocks than initial high and permanent frailty because benefits are based on past earnings.

5.1 Aggregate effects of health inequality

We report the aggregate implications of removing health inequality and removing its effect through each of the five channels through which health operates in the model in Table 24. Each column shows the change in GDP per capita, aggregate consumption, aggregate capital, aggregate labor services, aggregate hours, and labor productivity (GDP per hours) for each of our counterfactual economies relative to benchmark. The first column shows that removing all inequality in frailty raises GDP per capita by 2.03 percent and aggregate consumption by 0.95 percent. It also increases hours worked (employment) by 3.61 percent. As we explain in Section 6 of the paper, removing inequality in frailty mainly increases participation of workers at the bottom of the income/wage distribution. Since these are on average the less productive workers, the resulting GDP per hours (per employed worker)

Table 23: Variance of log consumption.

	Var. consumption			
	age 45	age 55	age 65	age 75
Benchmark	0.357	0.468	0.524	0.491
No frailty heterogeneity	0.285	0.360	0.378	0.382
% change relative to benchmark	-20.1	-23.0	-27.8	-22.2
Removing only frailty shocks	0.312	0.414	0.436	0.457
% change relative to benchmark	-12.6	-11.5	-16.8	-6.9
Removing only frailty fixed effect	0.339	0.450	0.487	0.466
% change relative to benchmark	-5.0	-3.9	-7.0	-5.0

Note: "No frailty heterogeneity" counterfactual removes all frailty shocks as well as cross-sectional (fixed effect) heterogeneity. "Removing only frailty shocks" removes only ex post uncertainty/shocks but retains all the initial fixed-effect heterogeneity. "Removing only frailty fixed effect" only removes initial fixed effect heterogeneity but retains all the shocks and uncertainty.

falls by 1.53 percent.

Columns 2 through 6 show that the main drivers of the GDP and consumption impact are the SSDI and disutility channel. For the aggregate effect on hours, labor productivity is almost as important as SSDI. Notice, also, that the effect of SSDI on consumption is almost half as much as the effect of GDP and hours. This is due to the fact that removing only the SSDI channel has opposite effects on labor supply at young and old ages. Moreover, while it reduces the aggregate disability benefit, it increases the fraction of individuals who are eligible for the means-tested welfare transfers. These opposing effects aggregate to a smaller impact on consumption and hours from the SSDI channel (relative to the impact of the disutility channel), even-though it is a significantly more important channel in terms of affecting individual labor supply and income inequality.

Finally, removing frailty inequality in mortality increases survival and tilts the age distribution of the model towards older (mostly retired) individuals. For this reason it has a negative impact on all aggregate measures.

Table 25 shows the SSDI recipiency rates (top panel), labor force participation rates (middle panel), and the share of people who receive means-tested transfers (bottom panel) in the benchmark economy, NFH economy and the five additional counterfactual economies. Looking at the first two columns, the effect of removing frailty inequality on SSDI recipiency is large for all three educations groups. Although, college graduates have very low SSDI usage in the benchmark so the increase in labor force participation is concentrated among high school dropouts and to a lesser extent high school graduates. Notice that the effect on the fraction receiving means-tested transfers is small. The effect of removing frailty inequality

Table 24: Aggregate Effect of Healthy Inequality

	NFH in model	NFH in SSDI	NFH in Disutility	NFH in Labor prod.	NFH in Med. Exp.	NFH in Mortality
	% change relative to benchmark					
GDP	2.03	1.06	1.12	0.33	0.14	−0.56
Consumption	0.95	0.50	0.90	0.10	0.10	−1.41
Capital	2.03	1.06	1.12	0.33	0.14	−0.56
Labor input	2.03	1.06	1.12	0.33	0.14	−0.56
Hours	3.61	0.98	1.41	0.81	0.19	−0.32
GDP per Hour	−1.53	0.08	−0.29	−0.47	−0.05	−0.24

Note: Each column shows the difference in aggregate measure between the respective counterfactual and benchmark. NFH: no frailty heterogeneity. NFH in SSDI: probability of SSDI acceptance is the same for all individuals at same age, NFH in Labor Prod.: there is no heterogeneous effect of frailty on wage, NFH in Disutility: there is no heterogeneous effect of frailty on disutility from work, NFH in Med. Exp.: no heterogeous effect of frailty on out of pocket medical expenditures, NFH in Mortality: no heterogeneous effect of frailty on mortality.

on means-tested program usage is due to a balance of two opposing forces. On the one hand, shutting down the SSDI channel pushes young frail workers out of the labor force and onto these programs. On the other hand, removing the labor productivity and disutility channels creates additional incentives to work at older ages reducing the usage of these programs.

Table 25: Effects of removing health inequality (overall and via different channels) on SSDI recipiency, labor force participation, and receipt of means-tested transfers

	Benchmark	NFH in model	NFH in SSDI	NFH in Disutility	NFH in Labor prod.	NFH in Med. Exp.	NFH in Mortality
SSDI Recipiency Rate (% of 25 to 65 year olds)							
ALL	4.58	0.33	1.24	3.89	3.94	4.54	4.96
HSD	10.28	0.77	2.83	9.05	8.28	10.23	11.14
HSG	5.77	0.41	1.59	4.89	4.99	5.71	6.22
CG	0.98	0.06	0.20	0.75	0.98	0.98	1.03
Labor-Force Participation Rate (% of 25 to 65 year olds)							
ALL	87.65	91.78	88.21	88.55	88.40	87.76	87.50
HSD	77.39	86.40	77.77	78.88	79.58	77.53	77.06
HSG	85.83	91.12	86.57	87.00	86.76	86.01	85.72
CG	93.68	94.58	94.06	93.99	93.68	93.69	93.64
Means-tested Transfers Recipiency Rate (%)							
ALL	4.77	4.93	6.43	4.70	4.67	4.68	4.62
HSD	8.95	9.00	13.73	8.88	8.79	8.86	8.58
HSG	5.03	5.14	7.06	4.91	4.87	4.87	4.76
CG	3.07	3.22	3.22	3.06	3.07	3.09	3.11

Note: The top (middle) [bottom] panel shows SSDI recipiency (labor-force participation) [means-tested transfers recipiency] rates in the benchmark and each counterfactual economy. HSD: high school dropout, HSG: high school graduate, CG: college graduate. NFH: no frailty heterogeneity. NFH in SSDI: probability of SSDI acceptance is the same for all individuals at same age and determined by the average frailty profile, NFH in Labor Prod.: effect of frailty on labor productivity is determined by the average frailty profile, NFH in Disutility: disutility from work is determined by average frailty profile, NFH in Med. Exp.: out-of-pocket medical expenditures are determined by the average frailty profile, NFH in Mortality: mortality is determined by the average frailty profile.

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