Understanding the Aggregate Effects of Disability Insurance

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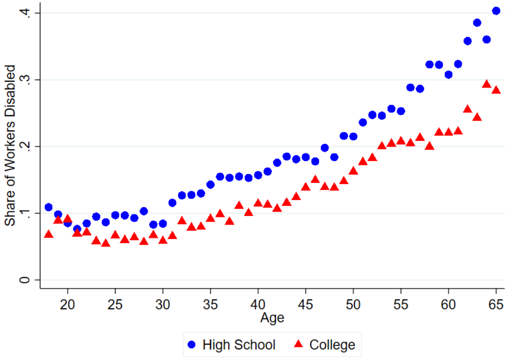
Disability Risk and Social Security Disability Insurance

Disability risk is real.

- One in four 20-yr-olds to experience a disability before 67.

Figure: Share of Disabled Workers by Age and Education



▸ OECD Statistics

Disability Risk and Social Security Disability Insurance

Disability risk is real.

- One in four 20-yr-olds to experience a disability before 67.

Social Security Disability Insurance in the United States

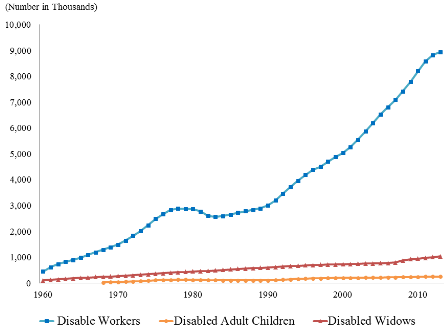
- Funded by payroll taxes
- Social insurance for disabled persons not able to work
- Replaces income of disabled individuals
- Beneficiaries also receive Medicare benefits

Rising Disability Insurance

In 2018, supported around 8.5M workers (≈4%, working-age pop.)

- 10M including dependents
- cf. manufacturing employment ≈ 13M
- growing number with low mortality diseases

Figure: Number of DI Recipients



Rising Disability Insurance

In 2018, supported around 8.5M workers ($\approx$4%, working-age pop.)

10M including dependents

cf. manufacturing employment $\approx$ 13M

growing number with low mortality diseases

In 2018, DI expenditures were $144B

15% of Social Security expenditures (OASDI, $977B)

3.5% of federal expenditures ($4,100B)

cf. unemployment insurance $\approx$ $33B-$100B

Social Security to face deficit in 2020.

OASDI Trust Fund to be depleted in 2035.

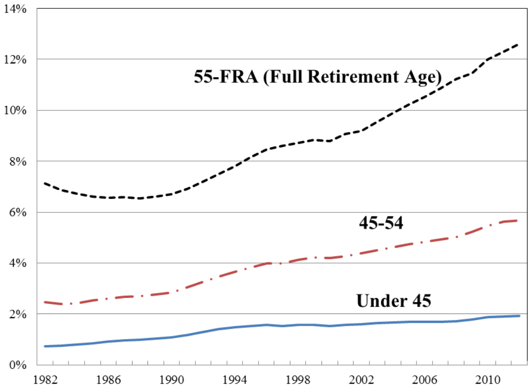
OECD Statistics

Demographic Composition of DI Recipients

More than 50% of recipients are older than 55.

Among those older than 55, 13% receives DI.

Figure: Share of DI Recipients by Age



Insurance vs. Incentive Tradeoff of DI

DI provides insurance against disability risks.

vs.

DI generates labor supply disincentive effects.

- Maestas et al. (2013): emp. $28pp$ higher w/o DI
- French and Song (2015): emp. $26pp$ higher w/o DI
- This might have large labor market impacts, especially given size and projected growth with aging workers.

Quantifying aggregate effects crucial for analyzing & reforming DI.

This Paper

What are the aggregate impacts of Disability Insurance?

To answer this question, we need to understand

- the productivity of workers over the life-cycle
  - Disabled workers are disproportionately older.
- the impact of disability on productivity of workers
  - How does disability affect the human capital of workers?
- the impact on aggregate productivity
  - Possible spillovers to young, non-disabled workers

Approach

Heterogeneous human capital framework

- Workers endowed with labor and experience (Katz/Murphy, 1992; Jeong/Kim/Manovskii, 2015)

Empirically estimate

- Workers' "efficiency" units of labor and experience
- Complementarity between inputs in aggregate production

Develop and calibrate a life-cycle model to analyze DI

- What happens if we remove DI?

Findings

How are workers' productivities determined over their life-cycle?

- Workers' effective experience increases over the life-cycle.
- Effect of disability is larger on labor than on experience.

How do workers (human capital) interact in aggregate production?

- Labor and experience are complementary inputs.

What are the labor market impacts of removing DI?

- Aggregate employment increases, more so for the old.
- Relative supply of experience increases.

Literature

Heterogeneous inputs in production

- Gruber/Milligan (2010); Munnell/Wu (2012); Katz/Murphy (1992); Card/Lemieux (2001); Krusell et al. (2000); Jeong/Kim/Manovskii (2015)

Disincentive effects of DI

- Empirical: Bound (1989); Maestas/Mullen/Strand (2013); French/Song (2015)
- Structural: Kitao (2014); Low/Pistaferri (2015)

This paper:

aggregate implications of DI with **heterogeneous human capital**

Today

Empirical Analysis

- Estimating the impacts of disability on human capital
- Estimating the aggregate production function

Quantitative Model

- Life-cycle model of heterogeneous workers

Quantitative Analysis

- Quantifying the aggregate impacts of DI

Conclusion

Empirical Analysis

1. Estimating the Individual-Level Productivities
2. Estimating the Aggregate Production Function

Overview: Empirical Analysis

Heterogeneous human capital à la Jeong, Kim, Manovskii (2015)

- Workers are endowed with "Labor" and "Experience."
  - A generalized version of Katz and Murphy (1992), in which young supplies only labor and old supplies only experience
- Workers' effective labor and experience vary over the life-cycle.
  - Determined by their ages, years of work, and disability statuses
- Aggregate production uses Labor and Experience.
  - Assume constant elasticity of substitution between two inputs.

Wage Equation

Wage rate w of an individual i in year t:

$$w_{it} = \left(R_{Lt}\hat{l}_{it} + R_{Et}\hat{e}_{it}\right) z_{it}$$

- $\hat{l}_{it}$: effective labor
- $\hat{e}_{it}$: effective experience
- R_{Lt}: price of effective labor
- R_{Et}: price of effective experience
- z_{it} : idiosyncratic productivity

Aggregate Production

Output Y in year t:

$$Y_t \quad = \quad A_t \left(L_t^{\rho} + \theta E_t^{\rho}\right)^{\frac{1}{\rho}}$$

- L_t: aggregate supply of effective labor
- E_t: aggregate supply of effective experience
- θ: relative efficiency of experience
- $(1-\rho)^{-1}$: elasticity of substitution between L and E
  - $\rho < 0$: gross complements ($\rho \to -\infty$: perfect complements)
  - $\rho > 0$: gross substitutes ($\rho = 1$: perfect substitutes)

Plan

Estimate individual-level effective labor $\hat{l}_{it}$ and experience $\hat{e}_{it}$

- Assume parametric functions
- Use micro-level data: age, years of work experience, disability

Construct the aggregate supply of labor $\hat{L}_t$ and experience $\hat{E}_t$

- $\hat{L}_t = \sum_i \hat{l}_{it} \times \text{hours}_{it}$
- $\hat{E}_t = \sum_i \hat{e}_{it} \times \text{hours}_{it}$

Estimate the elasticity of substitution $(1 - \hat{\rho})^{-1}$

- Use time-variation in relative supply of $\hat{L}_t$ and $\hat{E}_t$

Data: Panel Study of Income Dynamics

Panel dataset with detailed individual characteristics

Table: Summary Statistics

	Non-Disabled	Moderately Disabled	Severely Disabled
Population Share	86.4%	8.5%	5.1%
Age	41.2	46.7	49.9
Male	47.8%	42.0%	46.0%
Years of Schooling	13.7	13.1	12.2
Self-Reported Health Status	2.1	3.2	4.0
(1=Excellent, 5=Poor)			
Employed	80.4%	60%	23%
Hours Worked	1,743	1,251	459
Wage	\$23.5	\$20.6	\$20.2
Years of Work	12.0	12.8	13.7
Age $<$ 40	6.4	5.6	4.4
Age $\geq$ 40	17.7	16.2	15.9

Effective Labor: Specification

$$w_{it} = \left(R_{Lt}\hat{l}_{it} + R_{Et}\hat{e}_{it}\right) z_{it}$$

Let

- j: age
- $h_{it} \in \{N$on-Disabled, Moderately Disabled, Severely Disabled$\}$: disability status

Effective supply of labor $\hat{l}_{it} = \lambda_L(j_{it}, h_{it})$, where

$$\lambda_L(j_{it}, h_{it}) = \phi_L(h_{it}) \exp\left(\lambda_{L,0} + \lambda_{L,1} j_{it} + \lambda_{L,2} j_{it}^2\right)$$

- $\phi_L(h_{it})$: impact of disability on effective labor

All coefficients are education-specific:
High School (≤ 12 yrs. of schooling) vs. College.

Effective Experience: Specification

$$w_{it} = \left(R_{Lt}\hat{l}_{it} + R_{Et}\hat{e}_{it}\right) z_{it}$$

Let e_{it} denote the number of years worked.

Effective supply of experience, $\hat{e}_{it} = \lambda_E\left(j_{it}, h_{it}\right) g\left(e_{it}\right)$, where

$$\lambda_E\left(j_{it}, h_{it}\right) = \phi_E\left(h_{it}\right) \exp\left(\lambda_{E,0} + \lambda_{E,1} j_{it} + \lambda_{E,2} j_{it}^2\right)$$
$$g\left(e_{it}\right) = e_{it} + \zeta_1 e_{it}^2 + \zeta_2 e_{it}^3 + \zeta_3 e_{it}^4$$

- $g\left(e_{it}\right)$: accumulated experience as a function of years of work
- $\lambda_E\left(j_{it}, h_{it}\right)$: age efficiency schedule of experience
- $\phi_E\left(h_{it}\right)$: impact of disability on effective labor

All coefficients are education-specific $\left(s_{it}\right)$: HS vs. Col.

Estimating Equation

Wage equation again:

$$
\begin{aligned}
w_{it} &= \left(R_{Lt}\hat{l}_{it} + R_{Et}\hat{e}_{it}\right) z_{it} \\
&= \left(R_{Lt}\lambda_L\left(j_{it}, h_{it}\right) + R_{Et}\lambda_E\left(j_{it}, h_{it}\right) g\left(e_{it}\right)\right) z_{it} \\
&= R_{Lt}\lambda_L\left(j_{it}, h_{it}\right)\left(1 + \frac{R_{Et}}{R_{Lt}} \frac{\lambda_E\left(j_{it}, h_{it}\right)}{\lambda_L\left(j_{it}, h_{it}\right)} g\left(e_{it}\right)\right) z_{it}.
\end{aligned}
$$

Estimating Equation

Or,

$$
\begin{aligned}
\ln w_{it} \quad = \quad & \ln R_{L_t} + \ln \phi_L (h_{it}) + \left\{ \lambda_{L,0} + \lambda_{L,1} \cdot j_{it} + \lambda_{L,2} \cdot j_{it}^2 \right\} \\
& + \ln \left[1 + \Pi_{E_t} \frac{\phi_E (h_{it})}{\phi_L (h_{it})} \exp \left(\lambda_{E/L,0} + \lambda_{E/L,1} \cdot j_{it} + \lambda_{E/L,2} \cdot j_{it}^2 \right) g (e_{it}) \right] \\
& + \boldsymbol{\beta} \boldsymbol{X}_{it} + \varepsilon_{it}.
\end{aligned}
$$

- $\Pi_{Et} \equiv R_{Et} / R_{Lt}$: the relative price of experience
- $\lambda_{E/L,x} = \lambda_{E,x} / \lambda_{L,x}$ for $x \in \{0, 1, 2\}$
- $\boldsymbol{X}_{it}$: time-specific dummies for gender, region, and race
- $\varepsilon_{it} \sim N \left(0, \sigma_\varepsilon^2 \right)$: classical measurement error
- Normalize $\phi_E (ND) = \phi_L (ND) = 1$ for both education group

First: Controlling for Selection

Selection is important.

- Especially for estimating the impacts of disability.

Correct for selection using Heckman's two-stage estimation

Use as Instrumental Variables:

- *Potential* government transfers (Low and Pistaferri, 2017)
- *Potential* tax differentials (e.g., mortgage interest tax credit)
- *Potential* :
  transfers/tax a "representative" worker would receive/pay
  (not "actual" amounts that he receives/pays)

First-Stage Results

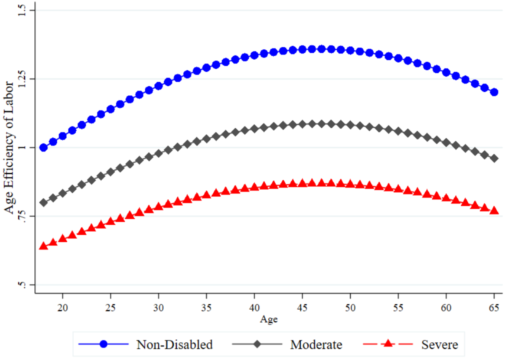
Effective Labor over the Life-Cycle

Effective units of labor is hump-shaped over the life-cycle.

(High School) Disability lowers effective labor by

- 20% for Moderate Disability
- 36% for Severe Disability

Figure: Effective Labor, $\hat{\lambda}_L(j_{it}, h_{it})$, for High School



Effective Experience over the Life-Cycle, by Component

Age efficiency of experience decreases:
experience early in life provides substantial benefit.

Disability lowers efficiency of experience by

- 12% for Moderate Disability
- 18% for Severe Disability

Years of work translates into increased stock of experience.

Figure: Age Eff. Exp., $\hat{\lambda}_E(j_{it}, h_{it})$, HS

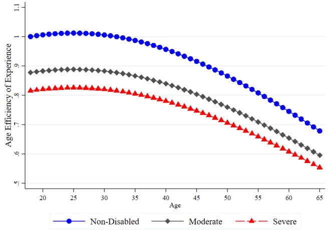
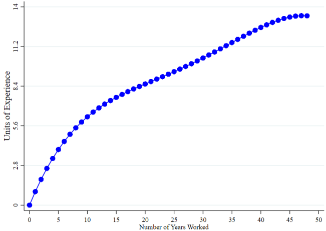


Figure: Units of Experience $\hat{g}(e_{it})$

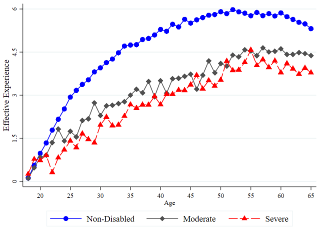


Effective Experience over the Life-Cycle

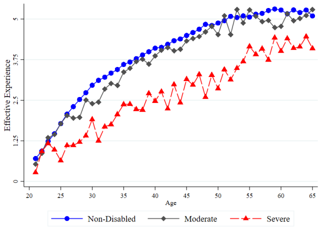
Effective supply of experience increases over the life-cycle.

Figure: Effective Experience, $\hat{\lambda}_E\left(j_{it}, h_{it}\right)\hat{g}\left(e_{it}\right)$, for High School

$\lambda_E \cdot g(e)$, High School



$\lambda_E \cdot g(e)$, College



College

Disability Effects on Labor and Experience

Disability lowers workers' productivities: labor and experience.

Disability effect is smaller on experience than it is on labor.

Older workers, rich in experience, are less-affected disability.

Table: Parameter Estimates: Effects of Disability

Individual characteristics		Relative Efficiency (Non-Disabled$\equiv 1$)			
Education	Disability Status	Labor $\phi_L(s,h)$		Experience $\phi_E(s,h)$	
High School	Moderate	0.80	[0.75, 0.86]	0.88	[0.73, 1.02]
	Severe	0.64	[0.54, 0.76]	0.82	[0.53, 1.11]
College	Moderate	0.66	[0.62, 0.71]	1.04	[0.87, 1.22]
	Severe	0.56	[0.48, 0.65]	0.85	[0.55, 1.15]

Robustness

Estimating the Aggregate Production

$$Y_t = A_t \left(L_t^{\rho} + \theta E_t^{\rho}\right)^{\frac{1}{\rho}},$$

implying

$$\Pi_{Et} \equiv \frac{R_{Et}}{R_{Lt}} = \theta \left(\frac{E_t}{L_t}\right)^{\rho - 1}.$$

From the micro-level estimation we obtain $\hat{\Pi}_{Et}$.

From the micro-level estimation we construct:

$$\hat{L}_t = \sum_i \hat{l}_{it} \times \text{hours}_{it}$$
$$\hat{E}_t = \sum_i \hat{e}_{it} \times \text{hours}_{it}$$

Estimate:

$$\ln \hat{\Pi}_{E_t} = \ln \theta + (\rho - 1) \ln \left(\frac{\hat{E}_t}{\hat{L}_t}\right)$$

Aggregate Production Technology

Labor and Experience are gross complements in production.

DI-induced exit of the old may impact aggregate labor productivity.

Figure: Relative Price and Supply

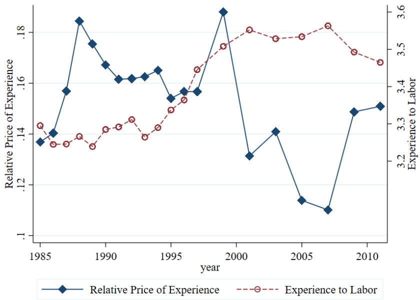


Table: Parameter Estimates

Parameters	Coefficient
ρ	-1.522
	(0.011)
$\ln\theta$	1.115
	(0.013)
Time periods	1985 to 2011
Adjusted R^2	0.352

Quantitative Model

Overview: Quantitative Analysis

Quantifying the aggregate impacts of DI

- given the estimated productivities and production technology

Need a model

- to understand the decision of households over their life-cycle
- to ask: What if there were no disability insurance?
  - Work decisions of young & old, disabled & non-disabled
  - Aggregate employment and labor productivity in the economy

Model: Households

Workers (born HS/Col) start at 18/22, retire at 65, live til 100.

Disability status
$h_j \in \{NonDisabled, ModeratelyDisabled, SeverelyDisabled\}$ at age j

- evolves stochastically following $\pi_j(h_{j+1}|h_j)$.
- affects productivity: effective labor and experience (est.)
- affects mortality δ_j^h and medical expenditure risks, $q_j^h(m)$

Decisions for working-age individuals

- If disabled: Whether to apply for DI or not
- If receive a job offer: Whether to work or not, after observing iid productivity shock ν
- How much to consume and save at return r

Decision for retirees: How much to consume and save

Model: Government

Disability Insurance

- If apply: earnings drop by 40%
- If apply: probabilistically accepted ($\pi^{DI,h}$)
- While a recipient: probabilistically re-examined (π^{RE})
- While a recipient: probabilistically qualify for Medicare (π^{M})
- DI amounts: function of previous earnings (progressive)

Other programs

- UI benefit: replace 23% of the annual earnings
- Social Security and Medicare for retirees
- Taxes: labor income, capital income, payroll
- Consumption floor: capturing other welfare programs

Parameterization

Technology: $Y = A\left(L^{\rho} + \theta E^{\rho}\right)^{\frac{1}{\rho}}$, with $\rho = -1.522$ and $\theta = 1.115$

Time discount factor: β

Period Utility: depends on consumption c, leisure l, and disability h

$$u(c,l;h) = \frac{\left(c \cdot \exp(\eta_h) \cdot l\right)^{1-\gamma}}{1-\gamma}$$

- CRRA with $\gamma = 2$
- Disability-specific disutility from work: $\boldsymbol{\eta} \equiv \{\eta_{SD}, \eta_{MD}, \eta_{ND}\}$
  - assume $\eta_{SD} < \eta_{MD} < \eta_{ND} < 0$
  - work reduces utility, and more so for the disabled
  - incur health-dependent monetary costs F_h when working

Job offer arrival rates by status: $\boldsymbol{\chi} \equiv \{\chi^W, \chi^U, \chi^A, \chi^D\}$

Calibration

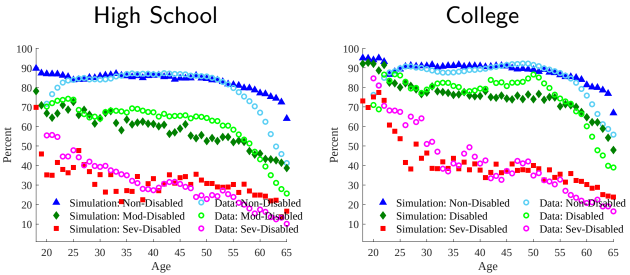
Use simulated method of moments to calibrate 34 remaining parameters: $\left\{A, \beta, \eta_{h,s}, F_{h,s}, \chi^W_{h,s}, \chi^U_{h,s}, \chi^A_{h,s}, \chi^B_s\right\}$ for $h \in \{ND, MD, SD\}$ and $s \in \{HS, Col\}$.

Parameters	Description	Value					
A	Aggregate productivity	0.650					
β	Time discount factor	0.953					
		High School			College		
		ND	MD	SD	ND	MD	SD
$\eta_{h,s}$	Disutility of work	-0.09	-0.16	-0.26	-0.12	-0.16	-0.20
$F_{h,s}$	Fixed cost of work	1142.53	1210.81	1295.12	783.91	830.68	1743.58
$\chi^W_{h,s}$	Offer arrival rate: E	0.90	0.77	0.42	0.94	0.91	0.55
$\chi^U_{h,s}$	Offer arrival rate: U	0.73	0.45	0.36	0.77	0.58	0.50
$\chi^A_{h,s}$	Offer arrival rate: A	0.69	0.45	0.18	0.94	0.64	0.26
χ^B_s	Offer arrival rate: DI	0.27	-		0.54	-	

Calibration

Moments: employment rates by health, education, and age group; share of DI recipients by age group; average labor income and consumption by education and health statuses (75 moments)

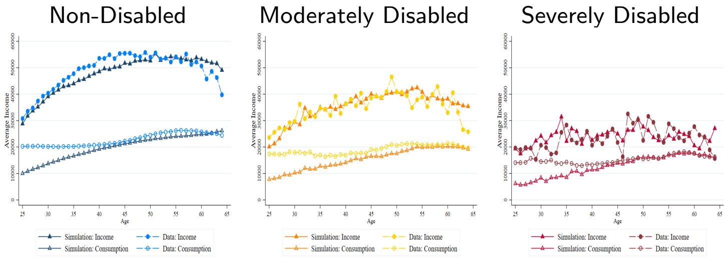
Figure: Employment Rates: Data vs. Model



Earnings and Consumption Over the Life Cycle

Moments: employment rates by health, education, and age group; share of DI recipients by age group; average labor income and consumption by education and health statuses (75 moments)

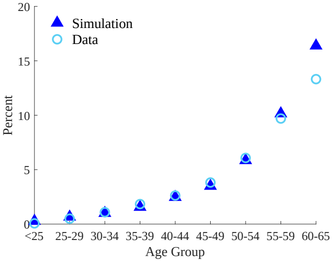
Figure: Earnings and Consumptions over the Life Cycle, Data vs. Model



Calibration

Moments: employment rates by health, education, and age group; share of DI recipients by age group; average labor income and consumption by education and health statuses (75 moments)

Figure: DI Recipient Share



Quantitative Results

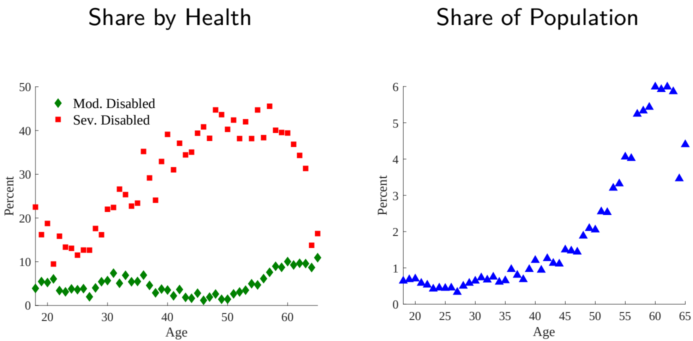
DI Decisions Over the Life Cycle

The model captures the characteristics of DI applicants:

- Large share of workers in the ages of 50-60 apply for DI.
  - DI recipients around 12% among older workers (as in data)

DI as a path to early retirement:

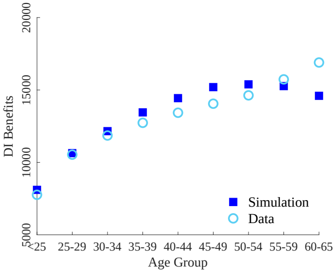
Figure: DI Applicant Share



DI Decisions Over the Life Cycle

The model captures the characteristics of DI applicants:

Figure: DI Benefit Amounts



Experience of DI Recipients Over the Life Cycle

The model captures the characteristics of DI recipients:

Figure: Agg. Average

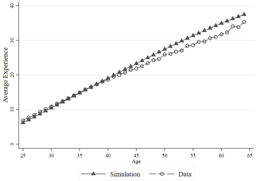
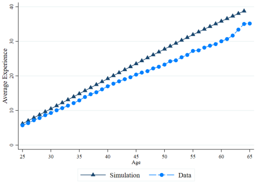
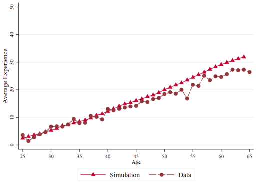


Figure: Average Experience by SSDI Status

Non-SSDI Recipients



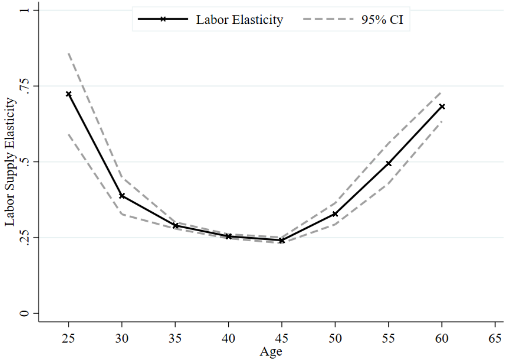
SSDI Recipients



Labor Supply Elasticity Over the Life Cycle

The average labor supply elasticity is 0.65 and U-shaped (consistent with recent findings in Erosa et al., 2016)

Figure: Labor Supply Elasticity



Suppose we remove DI.

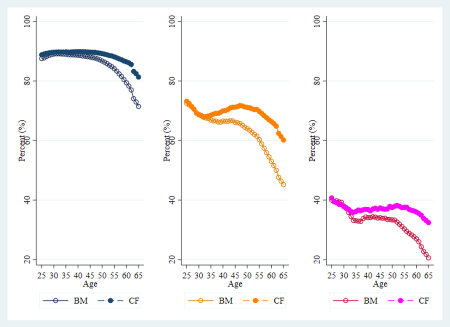
A budget-neutral reform: a lump-sum subsidy in exchange for DI

Labor Market Effects of DI

Aggregate employment increases by $3.22pp$.

- The increase is larger for older workers.
- Both non-disabled and disabled workers work more.

Figure: Employment Changes by Health



Labor Market Effects of DI

Aggregate employment increases by 3.22pp.

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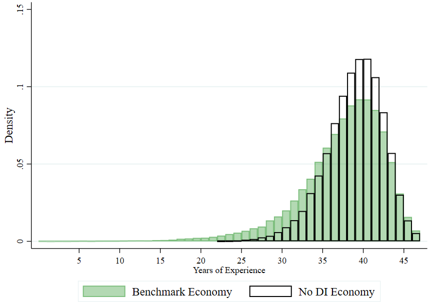
Figure: Distribution of Experience for Workers at Age 65

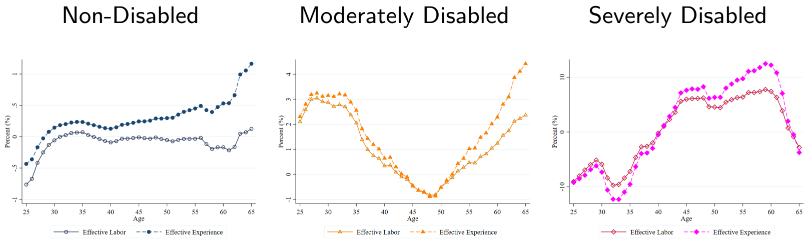


Labor Market Effects of DI

Output increases by 2.72%, but output per worker *falls* by 0.06%

- efficiency labor per worker: -0.27%
- efficiency experience per worker: +0.67%

Figure: Supply of L & E by Disability



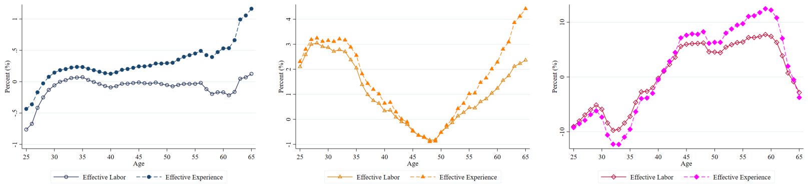
Labor Market Effects of DI

Relative supply of experience (E/L) increases by 0.94%

- price of labor increases: $+0.53\%$
- price experience decreases: -1.82%

Figure: Supply of L & E by Disability

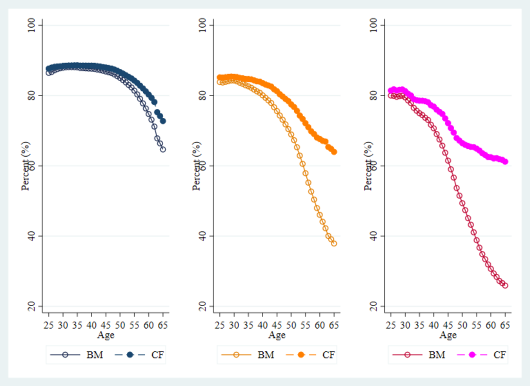
Non-Disabled | Moderately Disabled | Severely Disabled



Labor Market Effects of DI

Effects by *life-time* health:

- least healthy group: disabled ≥50% of working-age life
- healthy: disabled ≤ 30%

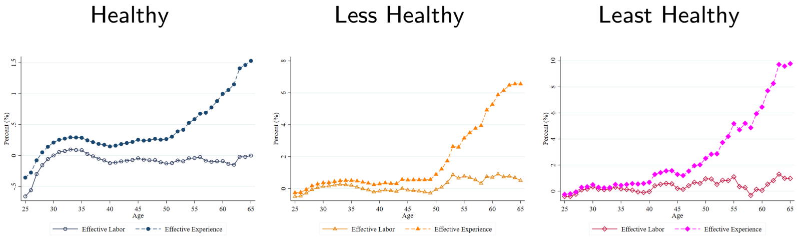


Labor Market Effects of DI

Effects by *life-time* health:

- least healthy group: disabled $\geq$50% of working-age life
- healthy: disabled $\leq$ 30%

Figure: Supply of L & E by Lifetime Health

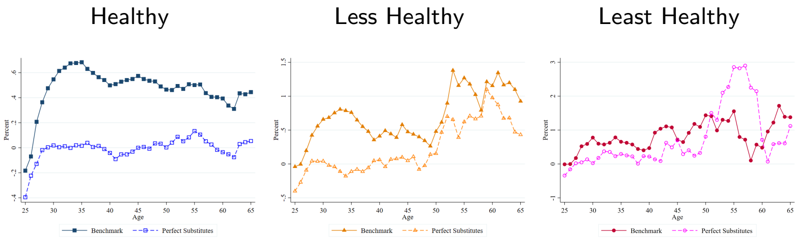


Labor Market Effects of DI

Assume $\rho = 1$. Removal of DI leads to

- Smaller changes of non-disabled & young workers' wage (b/c the increase in the price of labor is absent)

Figure: Value of L by Lifetime Health



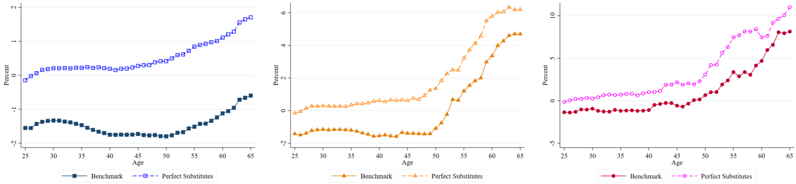
Labor Market Effects of DI

Assume $\rho = 1$. Removal of DI leads to

- Smaller changes of non-disabled & young workers' wage (b/c the increase in the price of labor is absent)

Figure: Value of E by Lifetime Health

Healthy | Less Healthy | Least Healthy



Labor Market Effects of DI

Assume $\rho = 1$. Removal of DI leads to

- Smaller changes of non-disabled & young workers' wage (b/c the increase in the price of labor is absent)

Table: Labor Market Effects of DI under Perfect Substitutability between Inputs

	Change from DI to No-DI	
	Benchmark	$\rho = 1$
Effective experience, E	+3.47%	+3.30%
Effective labor, L	+2.50%	+2.34%
Relative Price (R_E/R_L)	-2.34%	-
Price of experience,R_E	-1.82%	-
Price of laborR_L	+0.53%	-
Output	+2.72%	+2.52%
Employment	+3.22pp	+3.07pp
Wage	+0.79%	+0.58%

Labor Market Effects of DI

An approximation around the benchmark output:

$$
\begin{aligned}
Y_{CF} - Y_{BM} \quad \approx \quad & MPL \cdot (L_{CF} - L_{BM}) + MPE \cdot (E_{CF} - E_{BM}) \\
& + \frac{dMPL}{dL} \cdot (L_{CF} - L_{BM})^2 + \frac{dMPE}{dE} \cdot (E_{CF} - E_{BM})^2
\end{aligned}
$$

- The direct changes account for more than 90% of $(Y_{CF} - Y_{BM})$
- Given the set of parameters and $\left(\hat{L}, \hat{E}\right)$, the production function can be well explained with a linear approximation

If we disregarding the complementarity,

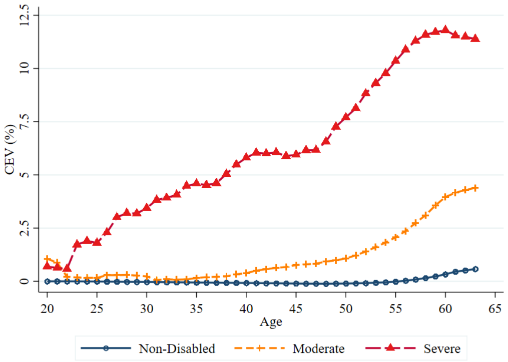
- (absent of price changes) the model with $\rho = 1$ underpredicts the role of labor by $4pp$

The Value of DI

Calculate the Consumption Equivalent Variation (CEV):

- For age j, we make the DI program unavailable for *one period*
  - Worker's labor market choices are restricted to $\{W, U\}$.

Figure: Value of DI by Disability



The Value of DI

Calculate the Consumption Equivalent Variation (CEV):

- The value is higher for older, less educated, disabled workers.

Table: CEV (%) by Subgroups

A. By health and education

Non-disabled		Moderate		Severe	
High School	College	High School	College	High School	College
0.11	-0.12	2.31	1.05	9.72	7.16

B. Disabled workers only: by labor market status at $t-1$

Health status	Employed	Unemployed	DI status	
			Applied	Received
Moderate	0.20	1.54	2.52	14.91
Severe	3.04	6.03	6.18	21.37

Conclusion

Here: Quantify the effects of DI on aggregate economy.

- Estimate the effects of disability on human capital
- Incorporate the imperfect substitutability of human capital

We learn:

- Yes, disability lowers the productivity
  - but the effect is less detrimental to the productivity of older workers (abundant in experience)
- Removal of DI has broad labor market effects
  - increases the price of labor but decreases return to experience

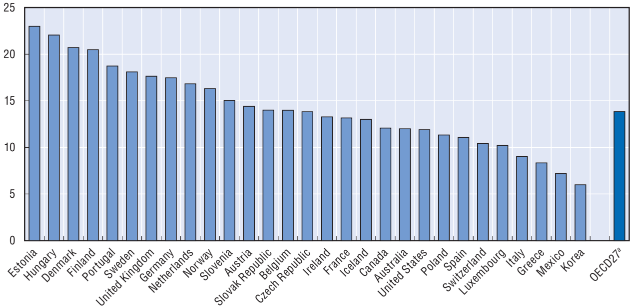
Later: Use the heterogeneous human capital framework to

- Study the alternative policies for the disabled (e.g., accommodation mandate)
- Joint design of retirement & disability insurance policies

Prevalence of DI

Across the OECD, 14% of people aged 20-64
report having a chronic health problem or disability, 6% in Korea.

Figure 1.1. **Disability prevalence at working age is high in most OECD countries**
Self-assessed disability prevalence, as a percentage of the population aged 20-64, late 2000s



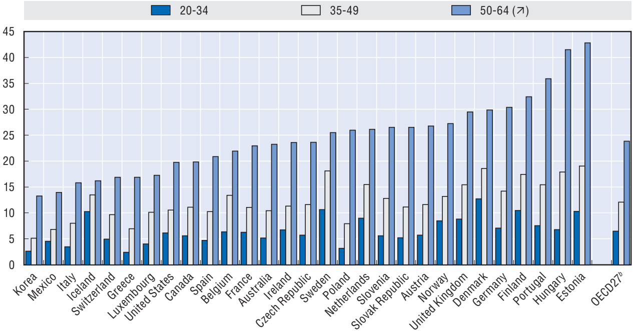
Korean Data Source: persons registered to the local government with their type of disability and level of severity as assessed by a medical doctor, from National Survey on Persons with Disabilities 2005

Prevalence of DI by Age

Disability prevalence increases sharply with age:
up to 24% for aged 50-64 across the OECD, 14% in Korea.

Figure 1.9. **Disability prevalence increases sharply with age which is critical in view of population ageing**

Self-assessed disability[a] prevalence, as a percentage of the population, by age group, late-2000s

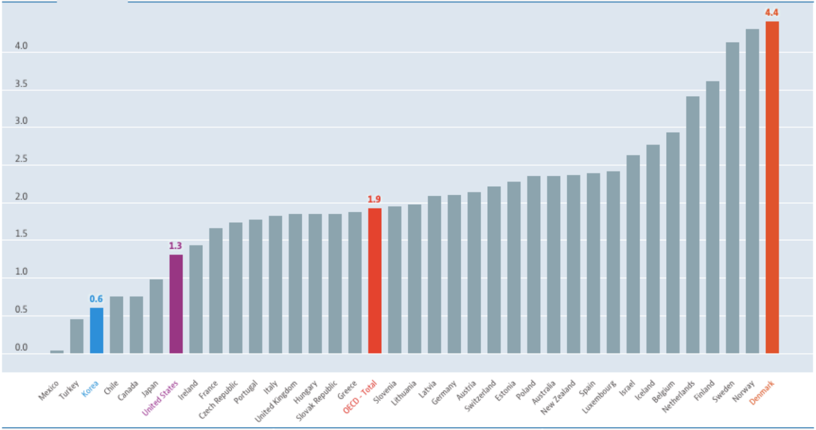


Korean Data Source: persons registered to the local government with their type of disability and level of severity as assessed by a medical doctor, from National Survey on Persons with Disabilities 2005

Public Spending on Incapacity

Across the OECD, spending on sickness, disability, and occupational injury is around 2%, 0.6% in Korea.

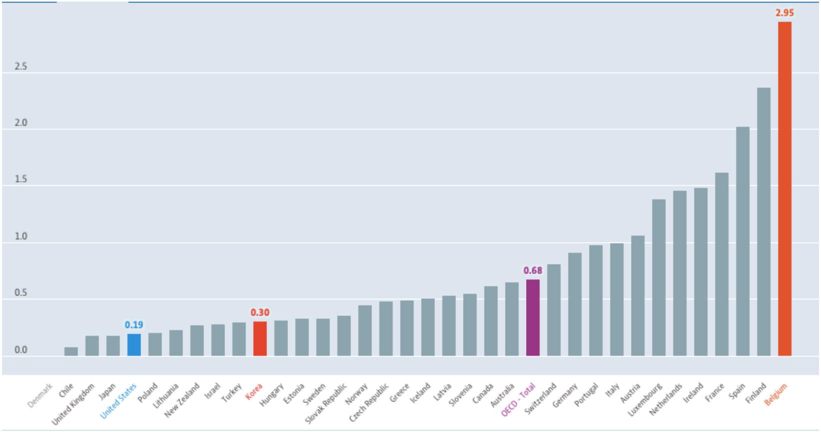
Figure: Public Spending on Incapacity, % GDP, 2017



Public Spending for the Unemployed

Across the OECD, expenditures on cash benefits for people to compensate for unemployment is around 0.7%, 0.3% in Korea.

Figure: Public Unemployment Spending, % GDP, 2017



OECD Definitions

Public spending on incapacity: Public spending on incapacity refers to spending due to sickness, disability and occupational injury. It includes disability cash benefits that are comprised of cash payments on account of complete or partial inability to participate gainfully in the labour market due to disability. The disability may be congenital, or the result of an accident or illness during the victim's lifetime. It also includes spending on occupational injury and disease, which records all cash payments such as paid sick leave, special allowances and disability related payments such as pensions, if they are related to specific occupational injuries and diseases. Sickness cash benefits related to loss of earnings because of a temporary inability to work due to illness are also recorded. This indicator excludes paid leave related to sickness or injury of a dependent child which is recorded under family cash benefits. Social expenditure on services for the disabled people encompasses services such as day care and rehabilitation services, home-help services and other benefits in kind. This indicator is measured in percentage of GDP.

Public unemployment spending: Public unemployment spending is defined as expenditure on cash benefits for people to compensate for unemployment. This includes redundancy payments from public funds, as well as the payment of pensions to beneficiaries before they reach the standard pensionable age, if these payments are made because the beneficiaries are out of work or for other labour market policy reasons. This indicator is measured in percentage of GDP.

First-Stage Probit

Independent Variables	Coefficients	Effects on Probability of Employment	
		Marginal Effects at the Means	Average Marginal Effects
Moderate Disability	-0.513 (0.036)	-0.148 (0.101)	-0.124 (0.008)
Severe Disability	-1.392 (0.050)	-0.395 (0.014)	-0.332 (0.012)
Number of Obs.	$101,335$	Pseudo R^2	0.237

Dependent variable: Employment status of an individual

Independent variables: age, experience, years of schooling, marital status, states, time-varying year dummies, male, race, potential government transfers, potential tax

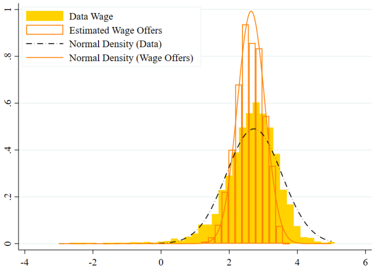
Role of Selection

Est. disability effects 6-18% lower than those w/o selection control.

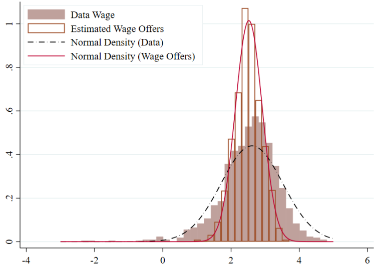
On avg., obs. wage is 10% higher than est. offers for the disabled.

Figure: Estimated Wage Offers vs. Data for Disabled

Moderately Disabled Workers



Severely Disabled Workers



Effective Labor over the Life-Cycle: College

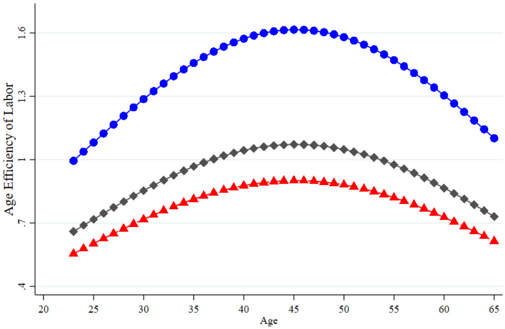
Effective units of labor is hump-shaped over the life-cycle.

Effective labor peaks later for Col than for HS.

Disability lowers effective labor by

- 34% for moderate disability
- 44% for severe disability

Figure: Effective Labor, $\hat{\lambda}_L(j_{it}, h_{it})$, for College



Effective Experience over the Life-Cycle: College

Severe Disability lowers efficiency of experience by 15%.

Years of work translates into increased stock of experience.

Figure: $\hat{\lambda}_E\left(j_{it}, h_{it}\right)$, for College

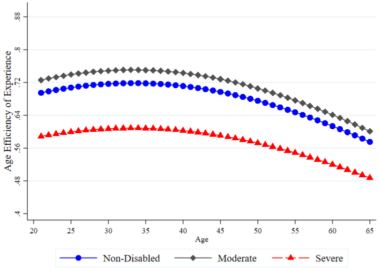
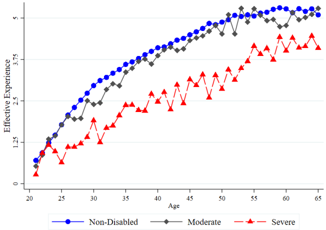


Figure: $\hat{\lambda}_E\left(j_{it}, h_{it}\right)\hat{g}\left(e_{it}\right)$, *Col*



Back

Alternative Specifications

Our benchmark allows for the education-dependence of ϕ_X and λ_X

The estimated effects of disability with alternative specifications are similar to the benchmark outcomes.

Coefficients			(1) $\phi_X(s) = \phi_X$	(2) $\lambda_X(s) = \lambda_X$	(3) Benchmark	(4) $g(e;s)$
Labor Profile	moderate	$\phi_L(HS)$	0.7095	0.7885	0.7994	0.8000
		$\phi_L(Col)$		0.6911	0.6637	0.6658
	severe	$\phi_L(HS)$	0.5830	0.6399	0.6388	0.6420
		$\phi_L(Col)$		0.6072	0.5577	0.5620
Experience Profile	moderate	$\phi_E(HS)$	0.9621	0.9568	0.8776	0.8776
		$\phi_E(Col)$		0.9844	1.0448	1.0469
	severe	$\phi_E(HS)$	0.8237	0.9459	0.8158	0.8145
		$\phi_E(Col)$		0.7949	0.8471	0.8450
Education-Specific	ϕ_L and ϕ_E			$\times$	$\times$	$\times$
Components	λ_L and λ_E		$\times$		$\times$	$\times$
	$g(e)$					$\times$

Quantitative Model: Households, Detail

Medical expenditures

- Age- and health-dependent
- Workers have health insurance
  - with premium HI_{prem} and coverage rate q_{HI}
- Retired workers and (some) DI recipients receive Medicare
  - with premium HI_{med} and coverage rate q_{med}
- Others do not have health insurance

Disability insurance applicants

- Only earn 50% of income (short-cut)

Back

Timing of Events

1. Starts period t with asset, $(1+(1-\tau_k)r)a_t + bequest$
2. Health status / medical expenditure (h,m) realized
3. DI recipients / application decisions revealed
4. Labor market opens: (λ,ν) revealed, work decisions made
5. SSA makes payments to retirees and existing DI recipients.
6. Pay medical / tax bills
7. Consume / save
8. Mortality shock realized / bequest received.

Back

Cash-On-Hand

Cash-on-hand is determined between timing 6 and 7:

$$
\begin{aligned}
x'_W\left(\upsilon', m' \middle| h'\right) &= (1+\tilde{r})a' + b + T\left(w\left(\upsilon'\right)\bar{l}\left(j+1,h'\right)\right) - \left\{HI_{prem} + (1-q_{HI})m'\right\} \\
x'_U\left(m' \middle| h'\right) &= (1+\tilde{r})a' + b - m' \\
x'_A\left(m' \middle| h'\right) &= (1+\tilde{r})a' + b + 0.5T\left(w\left(\upsilon'\right)\bar{l}\left(j+1,h'\right)\right) - m' \\
x'_{D,i_M}\left(m' \middle| h'\right) &= (1+\tilde{r})a' + b + d(\omega) - i_M\left\{HI_{med} + (1-q_{med})m'\right\} - (1-i_M)m' \\
x'_R\left(m' \middle| h'\right) &= (1+\tilde{r})a' + b + ss(\omega) - \left\{HI_{med} + (1-q_{med})m'\right\}
\end{aligned}
$$

- Worker (j,h) works exogenous number of hours $\bar{l}(j,h)$ (data)

Budget constraint:

$$
\begin{aligned}
x &= c + a' \\
tr &= \max\left\{\underline{c}_f - c, 0\right\} \\
a' &\geq \underline{A}
\end{aligned}
$$

Value Functions: Employed

$$
\begin{aligned}
W\left(\boldsymbol{x}_E\right) \quad = \quad & \max_{c\geq 0, a'\geq \underline{A}} u\left(c+tr,1;h\right) \\
& +\beta\delta_j^h \pi_j^{h,ND} \left[\begin{array}{c} \chi_{h'}^W \mathbb{E}_{m',\nu'} L\left(j+1,a',ND,e+1,m',\nu'\right) \\ +\left(1-\chi_{h'}^W\right)\mathbb{E}_{m'} U\left(j+1,a',ND,e+1,m'\right) \end{array} \right] \\
& +\beta\delta_j^h \sum_{h'\in\{MD,SD\}} \pi_j^{h,h'} \left[\chi_{h'}^W \max\left\{ \begin{array}{c} \mathbb{E}_{m',\nu'} L\left(j+1,a',h',e+1,m',\nu'\right), \\ \mathbb{E}_{m',\nu'} A\left(j+1,a',h',e+1,m',\nu'\right) \end{array} \right\} \right] \\
& +\beta\delta_j^h \sum_{h'\in\{MD,SD\}} \pi_j^{h,h'} \left[\left(1-\chi_{h'}^W\right) \max\left\{ \begin{array}{c} \mathbb{E}_{m'} U\left(j+1,a',h',e+1,m'\right), \\ \mathbb{E}_{m',\nu'} A\left(j+1,a',h',e+1,m',\nu'\right) \end{array} \right\} \right. \\
\text{s.t.} \quad & c+a'+F_h+p_{HI}+\left(1-q_{HI}\right)m = \tilde{y}\left(w\nu l_j^h;\boldsymbol{\tau}\right)+\left(1+\tilde{r}\right)a+beq,
\end{aligned}
$$

where $\boldsymbol{x}_E \equiv \left(j,a,h,e,m,\nu\right)$.

Today: work

Tomorrow:

If non-disabled & get an offer: choose btw Work, Not Work.

If disabled & get an offer: choose btw Apply, Work, Not Work.

Value Function: Non-Employed

$$
\begin{aligned}
U(\boldsymbol{x}_U) \quad = \quad & \max_{c \geq 0, a' \geq \underline{A}} u(c+tr, 0; h) \\
& + \beta \delta_j^h \pi_j^{h,ND} \left[\begin{array}{c} \chi_h^U \mathbb{E}_{m',v'} L(j+1, a', ND, e, m', v') \\ + \left(1 - \chi_{h'}^U\right) \mathbb{E}_{m'} U(j+1, a', ND, e, m') \end{array} \right] \\
& + \beta \delta_j^h \sum_{h' \in \{MD, SD\}} \pi_j^{h,h'} \left[\chi_{h'}^U \max \left\{ \begin{array}{c} \mathbb{E}_{m',v'} L(j+1, a', h', e, m', v'), \\ \mathbb{E}_{m',v'} A(j+1, a', h', e, m', v') \end{array} \right\} \right] \\
& + \beta \delta_j^h \sum_{h' \in \{MD, SD\}} \pi_j^{h,h'} \left[\left(1 - \chi_{h'}^U\right) \max \left\{ \begin{array}{c} \mathbb{E}_{m'} U(j+1, a', h', e, m'), \\ \mathbb{E}_{m',v'} A(j+1, a', h', e, m', v') \end{array} \right\} \right] \\
\text{s.t.} \quad & c + a' + m = UI(y) + (1+\tilde{r}) a + beq,
\end{aligned}
$$

where $\boldsymbol{x}_U \equiv (j, a, h, e, m)$.

Today: not work (no disutility from work)

Tomorrow:

If non-disabled & get an offer: choose btw Work, Not Work.

If disabled & get an offer: choose btw Apply, Work, Not Work.

Value Function: DI Applicants

$$
\begin{aligned}
A\left(\boldsymbol{x}_A\right) \quad = \quad & \max_{c\geq 0, a'\geq \underline{A}} u\left(c+tr,\kappa;h\right) \\
& +\beta\delta_j^h \sum_{h'} \pi_{j+1}^{hh'} \left[\begin{array}{c} \pi^{DI,h} DI^{i_M=0}\left(j+1,a',h',e,m'\right) \\ +\left(1-\pi^{DI,h}\right) \left[\begin{array}{c} \chi_{h'}^{A} \mathbb{E}_{m',\nu'} L\left(j+1,a',h',e,m',\nu'\right) \\ +\left(1-\chi_{h'}^{A}\right) \mathbb{E}_{m'} U\left(j+1,a',h',e,m'\right) \end{array} \right] \end{array} \right] \\
\text{s.t.} \quad & c+a'+\kappa\cdot F_h + p_{HI} + \left(1-q_{HI}\right) m = \tilde{y}\left(\kappa\cdot w\nu l_j^h;\boldsymbol{\tau}\right) + \left(1+\tilde{r}\right) a + beq,
\end{aligned}
$$

where $\boldsymbol{x}_A \equiv \left(j,a,h=MD \text{ or } SD,e,m,\nu\right)$.

Today: income penalty, i.e., only works half time
(in acc. with policy: need to have not worked before applying)

Tomorrow:

If successful: DI recipient w/o Medicare.

If not successful & get an offer: choose btw Work, Not Work.

If not successful & no offer: Not Work.

Value Function: DI Recipients

DI Beneficiaries with $(i_M = 1)$ and without Medicare $(i_M = 0)$:

$$
\begin{aligned}
B^{i_M}(\boldsymbol{x}_B) \quad = \quad & \max_{c\geq 0, a'\geq \underline{A}} u(c+tr, 0; h) \\
& +\beta\delta_j^h \left(\left(1-\pi^{RE}\right) + \pi^{RE}\left(\pi_{j+1}^{h,MD} + \pi_{j+1}^{h,SD}\right)\right) \ \mathbb{E}_{m'} \boldsymbol{E} B^{i_M}(j+1, a', h', e, m') \\
& +\beta\delta_j^h \pi^{RE} \ \ \pi_{j+1}^{h,ND} \left[\begin{array}{c} \chi^B \mathbb{E}_{m',\nu'} L(j+1, a', ND, e, m', \nu') \\ +\left(1-\chi^B\right) \mathbb{E}_{m'} U(j+1, a', ND, e, m') \end{array} \right]
\end{aligned}
$$

s.t. $\quad c + a' + i_M(p_M + (1-q_M)m) + (1-i_M)m = DI(\omega_{DI}) + (1+\tilde{r})a + beq,$

with $\boldsymbol{x}_B \equiv (j, a, h, e, m)$.

Today: DI recipient w/ or w/o Medicare

Tomorrow:

- If not re-examined or re-examined and disabled: DI recipient
- If re-examined, non-disabled & get an offer: choose btw Work, Not Work.

Value Functions: Retirees

$$R(\boldsymbol{x}_R) = \max_{c \geq 0, a' \geq \underline{A}} u(c + tr, 0; h) + \beta \delta_j^h \mathbb{E}_{h', m'} R\left(j+1, a', h', \omega, m'\right)$$

$$\text{s.t.} \quad c + a' + p_M + (1 - q_M) m = ss(\omega_{SS}) + \{1 + (1 - \tau_t^a) r\} a + beq$$

with $\boldsymbol{x}_R \equiv (j, a, h, \omega, m)$.

All individuals qualify for Social Security benefits and Medicare.

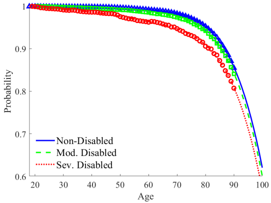
Benefit is determined by average earnings (ω) at retirement.

Back

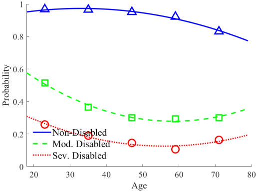
Parameters: Exogenously Calibrated

Note: Markers are data points from the PSID, which we use to estimate survival and transition probabilities by health and age.

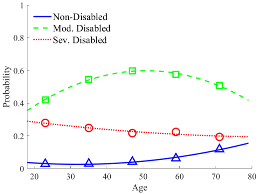
Figure: Survival Rate



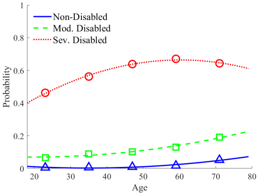
to Non-Disabled



to Mod. Disabled



to Sev. Disabled



Parameters: Disability Insurance and Social Security

DI and SS payments:

Determined by Average Indexed Monthly Earnings (AIME)

AIME(ω): average of the worker's 35 highest years of earning

Primary Insurance Amount (PIA) formula (2011\$):

$$PIA = \begin{cases} 0.90 \times \omega & \text{if } \omega < \$8,988 \\ \$8,089 + 0.32 \times (\omega - \$8,988) & \text{if } \$8,988 \leq \omega < \$54,204 \\ \$22,559 + 0.15 \times (\omega - \$54,204) & \text{if } \omega \geq \$54,204. \end{cases}$$

Approximation: use current income and experience to get ω

DI Medicare receipt probability: $\pi^{M} = 0.5$

DI re-examination probability: $\pi^{RE} = 0.06$

Parameters Chosen A Priori

Table: Parameters Calibrated Outside the Model

Parameters	Description	Values	Parameters	Description
Demographics, Preferences, Technology			Policies: UI, SS, Medicare, Tax, and DI	
$\{n_j\}$	Population share	Census Population Estimates	b	UI replacement rate
$\left\{\delta_j^h\right\}$	Survival rates	Fig. 28	τ_y	Labor income tax
γ	Risk aversion	2	τ_k	Capital income tax
r	Interest rate	0.03	τ_{SS}	SS tax
$\{\rho, \alpha\}$	Agg. production	-1.52; 3.05	y_{SS}	Max. taxable earnings
Wage and Hours			τ_M	Medicare tax
$w(j,h,s,e)$	Wage process coefficients	Estimation Results	$\{p_M, q_M\}$	Medicare prem., coverage
$\sigma^2_{\nu,\{ND,s\}}$	iid shock var., non-disabled	0.65; 0.71	$\underline{c}_f$	Consumption floor
$\sigma^2_{\nu,\{MD,s\}}$	iid shock var., mod. disabled	0.79; 0.78	κ	Application penalty
$\sigma^2_{\nu,\{SD,s\}}$	iid shock var., sev. disabled	1.06; 0.87	$\pi^{DI,MD}$	DI receipt prob., mod. di
l_j^h	Hours worked	PSID	$\pi^{DI,SD}$	DI receipt prob., sev. dis
Health, Medical Expenditures, and Health Insurance			π^M	Medicare benefit prob.
$\{p_{HI}, q_{HI}\}$	HI prem., coverage	\$2,500; 0.6	π^{RE}	Re-examination prob.

Parameters Chosen by Calibration

Parameter	Description	Value
A	TFP	3.148
β	Discount factor	0.963
Disutility of Work		
α_0	Non-Disabled, constant	0.564
α_1	Non-Disabled, coeff. on j	0.076
α_2	Non-Disabled, coeff. on j^2	-0.255
η_0	Disabled, constant	0.778
η_1	Disabled, coeff. on j	0.221
η_2	Disabled, coeff. on j^2	0.083
Job Offer Arrival Rates		
λ^W	Workers	0.973
λ^U	Non-workers	0.523
λ^D	DI recipients	0.098
λ^A	DI applicants	0.249

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