

LABOR MARKET SCREENING AND SOCIAL INSURANCE PROGRAM DESIGN FOR THE DISABLED *

Naoki Aizawa[†] Soojin Kim[‡] Serena Rhee[§]

February 4, 2018

Abstract

This paper studies how to optimally design subsidies for disabled workers, accounting for both the worker- and firm-side responses in the labor market. We first provide empirical evidence that firms design job characteristics, such as the flexibility of work hours, to screen out disabled workers. Then, we develop an equilibrium labor market model where firms post a screening contract which consists of wage and job characteristics; and workers with different levels of disability make labor supply decisions. We estimate the model using the Health and Retirement Study data, and identify the key model parameters by exploiting the exogenous policy variation on employment (hiring) subsidies for the disabled. Using the estimated model, we quantify the policy impacts on workers' labor supply and firms' employment contract design. Then, we characterize the optimal mix of the disability insurance and employment (hiring) subsidies for the disabled and study their implications on equilibrium labor market outcomes for workers of different health statuses.

JEL Codes: I38

Keywords: disability, screening, policy design

*Preliminary and incomplete. All comments are very welcome. This paper was written in part while Rhee was visiting the RAND Corporation. Rhee is grateful to them for their hospitality during her visit. Rhee thanks the National Institutes of Health under award number 2T32AG000244 for their support. The content of this paper is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

[†]Department of Economics, University of Wisconsin-Madison, 1180 Observatory Drive, Madison, WI 53706-1393, naizawa@wisc.edu.

[‡]Purdue University, 403 W. State Street, West Lafayette, Indiana 47907, soojink@purdue.edu.

[§]The University of Hawaii at Manoa, 2424 Maile Way, Honolulu, Hawaii 96822, rrees@hawaii.edu.

1 Introduction

Most advanced countries implement various social insurance programs to support individuals with disabilities. The public disability insurance program is one of the largest government expenditure programs in many countries and has been growing considerably in the last several decades.¹ Moreover, these countries introduced employment protection policies for the disabled to increase their work opportunities by mitigating firms' incentives to screen out those workers. These policies, such as the Americans with Disabilities Act (ADA) and the Work Opportunity Tax Credit (WOTC) in the U.S., prohibit firms from discriminating workers based on disability and give tax credits to firms hiring the disabled.

Because these policy interventions directly affect both workers and firms, understanding their *equilibrium* labor market effects is essential to evaluate the efficacy of these social insurance programs. Although there has been a large literature investigating the impact of disability insurance (DI) program on individual labor supply and welfare, only a handful of studies investigate the response of firms to the employment protection policies and the efficiency of those policies. Acemoglu and Angrist (2001) argue that the introduction of the ADA substantially raised the cost of hiring disabled workers, lowering the labor demand of these workers. However, to date, little is known about *how* firms screen disabled workers. More importantly, analysis of how the government should design subsidies for the disabled, through DI and employment (hiring) subsidies, when firms' incentives for recruiting disabled workers are endogenously adjusted is limited. Although additional spending on DI may distort labor supply incentives by encouraging applications to claim DI benefits, it may decrease the use of (inefficient) resources spent by employers to screen the disabled.

In this paper, we study the firms' incentives to screen workers with different disability statuses and the efficient subsidy design for the disabled in an equilibrium screening model of the labor market. We first start our analysis by providing empirical evidence that firms' design of job characteristics is responsive to the profitability from recruiting the disabled. Then, we develop an equilibrium screening model of the labor market for the disabled. We identify and estimate the model by exploiting the policy variation of employment subsidies for the disabled. An important advantage of our approach is that we can investigate the policy design for the disabled by fully accounting for endogenous responses of firms. Thus, finally, we analyze both theoretically and numerically the optimal combination of disability insurance and employment subsidies for the disabled.

We hypothesize that firms use job characteristics, such as the flexibility of working hours, to screen workers with different health (disability) statuses. Since the passage of the ADA, which mandates the provision of reasonable accommodations, it has become difficult for firms to explicitly discriminate workers by choosing different levels of accommodations (e.g., not providing physical equipment to support the disabled). However, the provision of flexible working hours can be ex-

¹In 2016, the U.S. government paid \$220 billion for insuring nearly nine million disabled through the public disability insurance.

empted from the ADA if it creates an undue hardship to firms or if workers cannot perform the essential function of a job. This creates room for firms to screen workers by designing non-wage benefits that are less appealing to disabled workers. To argue that these non-wage benefits are used as screening tools, one must show that (i) workers with different disability statuses have heterogeneous preferences from these job characteristics; and (ii) firms' choice of job characteristics are responsive to profitability from recruiting these workers. Our data from the Health and Retirement Study (HRS) suggest that workers with severe disabilities tend to select into jobs with more flexible working hours, which are consistent with the heterogeneity of worker preferences.² Then, we show empirical evidence that firms might be screening these workers using job characteristics, by exploiting WOTC Amendment as a policy variation shifting the firms profitability from hiring disabled workers.

Then, we develop and estimate an equilibrium labor market model with heterogeneous workers to investigate the implications of screening. The model builds on labor screening models such as Akerlof (1976), Guerrieri, Shimer and Wright (2010), and Stantcheva (2014). In the model, there is a continuum of workers with different disability statuses, who search for a job which consists of wage and non-wage job characteristics. Their preferences on job characteristics differ by their disability statuses. There is also a continuum of firms which decide to recruit workers. They choose wage and non-wage characteristics to maximize their profits. We assume that these contracts cannot explicitly depend on the worker's disability status. As a result, firms may adjust their contracts to screen workers with different degrees of disability in equilibrium. Following Guerrieri, Shimer and Wright (2010), we use a frictional labor market model, which leads to the following two desirable features. First, the model generates non-degenerate employment rates (the presence of non-employment), whereas frictionless screening models feature full employment among all workers. This feature is necessary because the policy instruments explicitly depend on employment statuses in our context. Second, we can show the existence and the uniqueness of equilibrium, which may not be guaranteed in frictionless screening models. Within this framework, we explicitly introduce the key features of disability insurance and employment subsidies: the former affects the worker's value of non-employment and the latter affects the profitability of firms.

We estimate the model using the HRS data. In doing so, the key identification challenge is that the degree of labor market screening is endogenously determined in equilibrium, affected by both the labor supply and labor demand side parameters: the worker's utility from job characteristics and the firm's resource cost of providing these benefits. To separately identify these parameters, we exploit the policy variation through WOTC, which mainly affected the labor demand side parameters.

With the estimated model, we examine the optimal design of subsidies for the disabled, by jointly determining the level of the public insurance and employment subsidies.

²In a related context, Ameriks et al. (2017) also show empirically that work incentives of older workers depend on whether the job offers flexible working hours.

Related Literature First of all, this paper contributes to the literature in disability insurance and labor market policies targeted for disabled workers. There has been a large literature that focuses on measuring the labor supply effects of disability insurance, that started with Bound (1989). Recent studies by Maestas, Mullen and Strand (2013) and French and Song (2014) have shown that the disincentive effects of DI on labor supply are large and heterogeneous across age groups and health conditions. There are a few studies investigating the labor market impacts of labor-demand-side policy interventions, including the ADA effects on employment rate (e.g., Acemoglu and Angrist (2001)) that discuss possible distortions in labor demand incentives.³ The main contribution of our paper is to study the firm’s screening incentives and their implication on policy designs. Specifically, We show that accounting for labor demand side responses is crucial to determine the optimal structure of subsidies design for the disabled.

Second, our paper is related to the literature analyzing screening problems in the labor market. A pioneering work in this literature is Akerlof (1976), who shows that there are distortions in employment contracts if firms cannot offer contracts contingent on worker types. More recently, Guerrieri, Shimer and Wright (2010) develop a general screening framework with search frictions. They show the existence of a separating equilibrium, in which worker of each type applies to a different submarket. An important advantage of this framework is its ability to endogenize both the extensive margin (whether a trade occur) and the intensive margin (the term of trade) effects of screening. Importantly, this literature is largely theoretical. Our paper contributes to this literature by applying this framework into the context of disability and empirically estimating the model. Moreover, we consider the optimal policy design in this context.

Finally, our paper is related to the public finance literature investigating the optimal disability insurance. Diamond and Sheshinski (1995) and Golosov and Tsyvinski (2006) analyze optimal disability insurance. The main departure of our paper from these papers is that we consider labor demand side incentives. Conceptually, our exercise is most closely related to Stantcheva (2014) who studies the optimal income taxation in an Akerlof (1976) labor market screening model. One of the important insights from her paper is that the optimal structure cannot be summarized by reduced-form sufficient statistics, mainly because it depends on the endogenous responses of the market equilibrium. Thus, in order to investigate the optimal policy design in our context, specifying and credibly recovering the full structure of the model is a crucial step. And our paper is the first to conduct such policy exercise.

In the next section, we first present the empirical analysis, which serves as suggestive evidence that firms utilize non-wage benefits in order to screen workers. Consistent with the empirical findings, we present a search frictional labor market model with screening in Section 3. The model is then estimated to match the key observations in the U.S. economy, whose description is detailed in Section 4. We use the estimated model to conduct quantitative policy analysis in Section 5, where we first analyze the impacts of the policies, then find optimal policies. We conclude in Section 6.

³Moreover, there are several papers examining the effectiveness of providing accommodations on labor supply (e.g., Hill, Maestas and Mullen (2014); Burkhauser, Butler and Kim (1995); and Burkhauser et al. (1999)).

2 Preliminary Analysis on Labor Market Screening of Disabled Workers

This section provides empirical evidence that firms may design jobs to offer a screening contract for workers with different disability status. We first describe in detail the Work Opportunity Tax Credit (WOTC) and its 2004 Amendments, which we utilize as an exogenous labor demand side shock, to infer the firm’s response to the policy change. We then discuss the data we use and describe the empirical specification and the results.

2.1 Work Opportunity Tax Credit and 2004 Amendments

The Work Opportunity Tax Credit (WOTC) Program provides tax credit to businesses when they employ economically disadvantaged workers. This target group includes individuals with disabilities who receive veterans or state-administered vocational rehabilitation services or Supplemental Security Income (SSI) benefits. According to the report of the US Government Accountability Office (GAO), about 1 out of 790 corporations and 1 out of 3,450 individuals with a business affiliation reported the work opportunity credit on their tax returns. The total tax credit claim was \$254 million.

Under the WOTC, employers can receive tax credit of up to \$2,400 per eligible employee. One of the WOTC studies conducted by GAO, included a survey of 225 employers participating in the WOTC program in California and Texas in 1999 and in 1997 or 1998 and found that most of the employers participating in the WOTC program reported changing their recruitment, hiring, or training practices to secure the credit and to better prepare the credit-eligible new hires. These changes may have helped employers to increase their pool of WOTC-eligible applicants and may thereby have increased their chances of hiring these workers. About 50% of these employers also reported training practices that may have increased the retention of WOTC-eligible hires, such as providing mentors or work readiness training and lengthening training times.

Expansion of the Program Workers with disabilities were qualified for WOTC benefits, only if they received vocational rehabilitation referrals or if they were SSI recipients. Due to the restrictions, individuals receiving Social Security Disability Insurance (SSDI) or privately funded vocational rehabilitation were not eligible to participate in the program.

In the early 2000s, provisions to expand the eligibility of disabled workers were made into a bill, which was signed into law in 2004. The act modified the definition of the WOTC’s vocational rehabilitation referral-eligible group in light of the Ticket to Work and Work Incentives Improvement Act of 1999. It effectively expanded the target group to include disabled individuals with individualized work plans who are referred to employers not only by a state vocational rehabilitation agency (as was the case under prior law), but also by “employment networks” that were created by the Ticket to Work legislation.

We utilize the passage of the Amendment to study how the policy supporting employment of

disabled workers affected their labor market outcomes as well as their employment contracts. In the latter, we distinguish between the effects on wages and non-wage benefits, such as flexibility in working hours and sick days. Moreover, we allow for a richer heterogeneity in the health statuses to distinguish between workers at the margin of entering the labor force and those who are not. In the next, we first describe our data, how we define different health groups, and provide descriptive statistics, before going into detail of the empirical specification.

2.2 Data

Our primary data source is the Health and Retirement Study (HRS). HRS is a biennial panel survey of individuals above the age of 50. It started in 1992, and provides detailed information on individual and job characteristics.

For measures of health, it asks “*Do you have any impairment of health problem that limits the kind or amount of paid work you can do?*” which we denote as a measure of work limitation (work disability). Moreover, it also asks the respondents to provide their self-reported health statuses in a 1 (Excellent) to 5 (Poor) scale. Other objective health measures, including difficulties in activities of daily life and specific diagnoses of disease (e.g., high blood pressure, diabetes, heart disease, etc) are also included in the data.

Figure 1: Work Limitation by Age

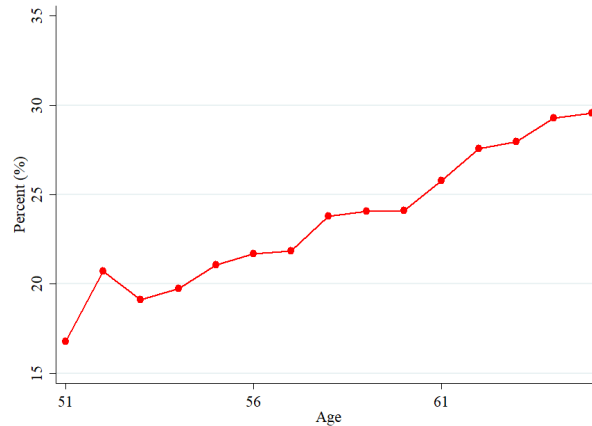


Figure 1 plots the share of workers with work limitation by age. As is evident from the figure, as workers age, they are more likely to have a work limitation. However, when we document the self-reported health status among those with and without work disability, there is a non-degenerate distribution of health statuses even among those who respond to have a work limitation as shown in Table 1. Thus, for the purpose of our empirical analysis, we use work disability and self-reported health status to categorize individuals into three health groups. We define workers to be non-disabled, if (s)he does not have a work limitation, and reports to have Good, Very Good, or Excellent health status. On the other hand, those with a work disability and have fair or poor health are defined to be severely disabled. All others, either who have work limitation but are

relatively healthy (Very Good or Excellent health), or who does not have a work limitation, but is relatively unhealthy (Fair, Poor, or Good health), are defined to be moderately disabled workers. According to our categorization, 15% of workers are severely disabled, 20%, moderately disabled, and the rest (64%), non-disabled.

Table 1: Health and Work Limitation

		Work Limitation		Total
		No	Yes	
Subjective Health	1 (Excellent)	6,338	266	6,604
	2 (Very Good)	12,878	1,283	14,161
	3 (Good)	10,630	3,248	13,878
	4 (Fair)	3,705	4,313	8,018
	5 (Poor)	529	3,133	3,662
Total		34,080	12,242	46,323

The benefit of using the HRS is that it not only reports standard labor market outcomes, such as employment, hours worked, and hourly wages, but also non-wage benefit (or job characteristics, which we will use interchangeably in the rest of the paper) measures from their employment. These measures include the availability of flexible working hours, whether part-time work is allowed, and the number of sick days available. Moreover, if a respondent is disabled, (s)he is also asked the types of accommodations that they receive from the government (which is enforced through a mandate under the Americans with Disabilities Act). These accommodation measures include special equipment, special transportation, helping learn new skills, changing jobs to something that they could do. In this analysis, however, our focus is on a broader set of non-wage benefits, that are applicable to not only disabled workers, but workers of all health statuses. Thus, we confine our definition of non-wage benefits to the kinds of benefits that all employees are subject to.

In Table 2, we provide some descriptive statistics of demographics, health conditions, labor market outcomes, and non-wage benefits by health statuses. While the average ages are similar across health statuses, those with severe disabilities, are on average, less-educated and more likely to be diagnosed with a disease. Their labor market performance, as measured by employment, hours worked, and hourly wage, are worse than their healthier counterparts. However, those who work despite their health conditions, receive more generous non-wage benefits as observed in the last parts of Table 2.

2.3 Preliminary Evidence

In order to examine the role of firms' screening incentives, it is important to detect their screening tools. We provide suggestive evidence on the potential screening tool, by looking at how employment contracts are adjusted when government provides tax credits for hiring disabled workers. For this purpose, we consider the following difference-in-differences regression:

Table 2: Descriptive Statistics

Health Status	Severely disabled	Moderately disabled	Non-disabled
<u>Demographics</u>			
Age	59.0	59.1	58.5
Female (%)	56.6	56.4	54.5
High school or less (%)	72.0	62.9	44.7
<u>Health Conditions</u>			
Work disability (%)	100	53.1	0
Self-reported health	4.4	3.3	2.1
Cardiovascular disease (%)	74.3	62.1	42.4
Psychiatric conditions (%)	38.3	19.1	8.1
<u>Labor Market Outcomes</u>			
Employment (%)	13.9	44.5	72.1
Hours per Week	34.5	38.6	40.2
Hourly wage (\$)	14.4	16.9	23.4
Missed work due to health (%)	70.3	55.3	40.6
Number of days missed	31.3	16.8	9.5
<u>Non-Wage Benefits</u>			
Flexible working hours (%)	39.7	32.7	32.7
Allow part-time (%)	70.5	65.3	57.3
Paid medical leaves (days)	14.7	10.5	10.5
Sick days available (days)	26.7	16.3	8.9

Note: Table is based on HRS 1996-2008 sample. The fraction of workers with work disability by health statuses are by construction 100% for the severely-disabled, and 0% for non-disabled. Refer to the main text for the description of the health status categories. For self-reported health, 1 refers to Excellent health, and 5 to Poor health.

$$y_{it} = \beta_1 \mathbb{I}_{\{t \geq 2004\}} + \sum_{h \in \{\text{mod}, \text{sev}\}} \beta_{2h} \mathbb{I}_h + \sum_{h \in \{\text{mod}, \text{sev}\}} \beta_{3h} \mathbb{I}_{\{t \geq 2004\}} \mathbb{I}_h + \gamma \mathbf{X}_{it} + \nu \mathbf{Z}_t + \varepsilon_{it}.$$

The dependent variables (y_{it}) include non-wage benefits and labor market outcomes of individual i in year t . The independent variables include \mathbf{X}_{it} , which are individual-level control variables (e.g., gender, education, polynomial in age, firm size, occupation, and industry) and \mathbf{Z}_t , which include macroeconomic controls (e.g., employment rates, GDP, and labor productivity).⁴

For non-wage benefits, we specifically consider flexibility of working hours, whether part-time job arrangement is offered, paid medical leaves, and sick days, as these can potentially be used as screening tools. As discussed in Section 2.2, people with adverse health conditions work in

⁴Annual output data are available at the Bureau of Economic Analysis (BEA) website. We use real GDP (all industry total) in millions of chained 2005 dollars. Employment data are taken from Current Employment Statistics program surveys of the Bureau of Labor Statistics (BLS). We define the measure of labor productivity as output per worker.

jobs with generous coverages (non-wage benefits), which may be consistent with the view that disabled individuals prefer these job characteristics more than their non-disabled counterparts. Moreover, importantly, these benefits are not necessarily mandated by the ADA. Specifically, firms do not need to offer these benefits if they hinder disabled individuals from performing the essential functions of the job or create issues for other workers. Thus, firms can potentially exploit this preference heterogeneity in non-wage benefits, in designing employment contracts to screen out disabled workers.

Table 3 summarizes our results on non-wage benefits and labor market outcomes. We find that the lump-sum transfer (tax credits) provided by the government for hiring disabled workers led to an increase in the provision of non-wage benefits, particularly the availability of flexible hours and part-time work, for moderately disabled workers. The effect, however, is insignificant for the severely disabled workers.

Table 3: Effects of the WOTC-Amendment on Non-Wage Benefits

		Flexible hours	Allow part-time	Paid sick days	Employment	Hourly wage
Post-Amendment		0.107***	0.038	4.736*	0.095***	0.993
(β_1)		(0.032)	(0.032)	(2.857)	(0.012)	(1.416)
Health Status (β_{2h})	Severe	0.037	0.068	5.378	-0.547***	-4.734*
		(0.030)	(0.052)	(3.433)	(0.013)	(2.663)
	Moderate	-0.039	0.049	1.536	-0.267***	-4.144***
		(0.16)	(0.027)	(1.907)	(0.011)	(1.477)
Health Status		0.009	0.007	2.085	-0.016	-3.569
\times Post-Amendment		(0.046)	(0.075)	(4.621)	(0.016)	(3.325)
(β_{3h})	Moderate	0.072***	0.082**	-2.765	0.023*	-0.969
		(0.025)	(0.037)	(2.464)	(0.014)	(1.815)

Thus, we find that severely disabled workers' contracts are not affected by the government intervention (lump-sum transfers), whereas it benefited those of the moderately disabled workers. As shown from our model, this evidence is consistent with the standard screening model: in the standard screening model, the lowest type workers (severely disabled workers in the data and model) are offered the efficient level of non-wage benefits, which is determined so as to equalize the marginal benefit to the marginal cost. Thus, the lump-sum transfer (which do not directly change the marginal costs of providing non-wage benefits) does not affect the magnitude of equilibrium non-wage benefits. However, it affects the non-wage benefit level for higher-type workers (moderately disabled or non-disabled workers), through the relaxation of the incentive compatibility constraints, mitigating some of the inefficiencies from firms' screening incentives.

We now introduce our model, which reflects the preliminary empirical evidence that we documented in this section.

3 An Equilibrium Labor Market Model with Screening

3.1 Model Environment

Workers There is a measure 1 of workers who value consumption and leisure. Workers are heterogeneous in their types (health statuses), which we denote by $i \in \mathbb{I} \equiv \{1, 2, \dots, I\}$.⁵ The share of each type i is denoted by $\pi_i > 0$, with $\sum_i \pi_i = 1$.

Each employed worker produces f_i , and we assume that high types produce (weakly) more than low types so that $f_{i+1} \geq f_i$. In the model, f_i represents the *net* productivity of workers. Thus, the heterogeneity in f_i might be either due to productivity differences driven by health status, or due to the accommodation costs for the disabled mandated under the ADA.

The workers' preferences are represented by the utility function $u_i(c, a) = c + \beta_i \varphi(a)$, where c denotes consumption and a , the job characteristics (or non-wage benefits, which we use interchangeably), such as the flexibility of work schedule.⁶ The non-wage benefits increase utility from work through function $\varphi(\cdot)$, which is strictly increasing ($\varphi' > 0$) and strictly concave ($\varphi'' < 0$). Furthermore, the type-specific preference is represented in β_i , where we assume $\beta_i > \beta_{i+1}$, so that unhealthy (low type) workers value a more than their healthier (high type) counterparts. Workers pay a proportional tax on wages, so that $c = (1 - t)w$.

Non-employed workers produce b at home and receive (in expectation) \tilde{d}_i from the government (we discuss this further below).

Firms There is a continuum of ex-ante homogeneous, risk-neutral firms in the economy. Firms are prohibited from posting type-dependent contracts.⁷ Firms post a contract, which consists of wage (w) and non-wage benefits (a), by paying a cost κ . When a worker type i is hired, the firm's payoff is $v_i(w, a) = f_i - w - \tilde{C}(a)$, where $\tilde{C}(a)$ denotes the (net) cost of non-wage benefits. The cost function is assumed to be strictly increasing ($\tilde{C}' > 0$) and convex ($\tilde{C}'' \geq 0$).

Labor Market Environment Labor market is subject to search frictions, and the match is bilateral, i.e., one firm and one worker form a match and produce. The labor market is indexed by a contract $y \equiv (w, a) \in Y$, where the set of feasible contract space Y is compact, nonempty. Firms and workers direct their search.

The market tightness, ratio of firms' vacancy to unemployed workers associated with a contract y is denoted by $\theta(y) \equiv v/u$. A worker who applies to a submarket indexed by a contract y find a job with probability $\mu(\theta(y))$ *regardless of* his type, and the job-finding rate $\mu : [0, \infty] \rightarrow [0, 1]$ is a strictly increasing and concave function of θ ($\mu'(\theta) > 0$ and $\mu''(\theta) \leq 0$). Similarly, a firm posting a vacancy characterized with a contract y , finds its employee with probability $\eta(\theta(y))$,

⁵While we only explicitly model the heterogeneity in health statuses, we can incorporate other dimensions (i.e., education, industry) by assuming that there are more submarkets, and that contracts can be posted based on the specific heterogeneity.

⁶Note that this section simply specifies the risk neutral individuals, mainly for simplifying the exposition. In the empirical section of the model, we consider that the workers are risk averse.

⁷We could alternatively assume that the worker type i is unobservable to firms.

where the worker-finding probability $\eta : [0, \infty] \rightarrow [0, 1]$ is a decreasing function of θ . Assuming a constant-returns-to-scale matching function, we have $\theta\eta(\theta) = \mu(\theta)$.

Let the share of type- i agent applying to a contract y -submarket be $g_i(y)$, with $g_i(y) \geq 0$ and $\sum_{i=1}^I g_i(y) = 1$. Thus, conditional on a match, the probability of hiring a type- i worker is $g_i(y)$. We normalize the payoff of firms not posting a vacancy to 0.

We denote \bar{Y}_i as the set of contracts that can generate non-negative profits in most favorable market tightness toward firms (i.e. $\theta = 0$) subject to type- i worker's participation.

$$\bar{Y}_i = \left\{ y \in Y \mid \eta(0) v_i(y) \geq \kappa \quad \text{and} \quad u_i(y) \geq u_i\left(\left(b + \tilde{d}_i, 0\right)\right) \right\},$$

and $\bar{Y} \equiv \cup_{i \in \mathbb{I}} \bar{Y}_i$. Contracts that are not included in this set cannot be in equilibrium. The second inequality ensures that the workers utility from participating in the labor market with contract y is greater than his outside option of consuming $b + \tilde{d}_i$ (and not receiving any non-wage benefits).

Assumption 1. (*Monotonicity*) For all $y \in \bar{Y}$, $v_1(y) \leq v_2(y) \leq \dots \leq v_I(y)$.

When we assume no productivity difference across types, then the firm is indifferent in terms of payoff and $v_i(y) = v_j(y)$ for $\forall i \neq j$. If there the productivity (weakly) increases with type index, then the monotonicity assumption also holds with (weak) inequality.

Government Policies Government collects income tax from the employed workers, using a proportional tax rate t , and allocates revenues between subsidizing the costs of non-wage benefits at rate s and paying disability insurance benefits of d . We assume that the government imperfectly verifies the true type of workers (similar to Low and Pistaferri (2015)) and denote the probability of identifying type i as disabled as ψ_i and assume $\psi_i \geq \psi_{i+1}$, i.e., the lower one's type is, the more likely it is for the government to verify that (s)he is disabled, and thus provides subsidies to the firm and pay disability insurance payment. According to the definition, the firm's net cost of providing non-wage benefits to type i is then $\tilde{C}_i(a) = (1 - \psi_i s) C(a)$, where $C(a)$ is the total cost of providing non-wage benefits of amount a . Moreover, worker type- i expects to receive DI benefit of $\tilde{d}_i = \psi_i d$, when (s)he is not working.

3.2 Competitive Search Equilibrium (Given Policy Parameters)

Given the tax rate, subsidy, and the disability insurance programs, competitive search equilibrium should satisfy that firms post profit maximizing contracts and earn zero profit, and that conditional on the contracts posted and search behaviors of others, each type- i workers maximize their expected utility by searching jobs at the optimal submarket. On top of these two conditions, we need to specify reasonable beliefs about the market tightness off the active submarkets (Y^p) in equilibrium. We formally define the equilibrium of the economy below.

Definition 1. A Competitive Search Equilibrium is a vector $\bar{U} = \{U\}_i \in \mathbb{R}$, a measure λ on Y with support Y^p , a function $\Theta : Y \rightarrow [0, \infty]$, and a function $\Gamma : Y \rightarrow \Delta^I$ that satisfy the following conditions

1. Firms' Profit Maximization and Free Entry: For any $y \in Y$,

$$\eta(\Theta(y)) \sum_i g_i(y) v_i(y) \leq \kappa,$$

with equality if $y \in Y^p$.

2. Workers' Optimal Job Search: Let

$$\bar{U}_i = \max \left\{ u(b + \tilde{d}_i, 0), \max_{y \in Y^p} \left\{ \mu(\Theta(y)) u_i(y) + (1 - \mu(\Theta(y))) u_i(b + \tilde{d}_i, 0) \right\} \right\}$$

and $\bar{U}_i = u_i(d)$ if $Y^p = \emptyset$. For any $y \in Y$ and i ,

$$\bar{U}_i \geq (b + \tilde{d}_i) + \mu(\theta(y)) \left\{ (1 - t)w + \beta_i \varphi(a) - (b + \tilde{d}_i) \right\},$$

with equality if $\Theta(y) < \infty$ and $g_i(y) > 0$. If $u_i(y) < u(b + \tilde{d}_i)$, either $\Theta(y) = \infty$ or $g_i(y) = 0$.

3. Market Clearing: For $\forall i \in \mathbb{I}$,

$$\int_{Y^p} \frac{g_i(y)}{\Theta(y)} d\lambda(\{y\}) \leq \pi_i$$

with equality if $\bar{U}_i > u(b + \tilde{d}_i)$.

Note that the market tightness function Θ is defined over the set of feasible contract space Y , unlike the distribution of active contracts λ over Y^p . This distinction comes from the fact that our equilibrium concept requires the workers to have reasonable beliefs about their potential deviation from the equilibrium outcome y_i^* . Following Guerrieri, Shimer and Wright (2010), one can prove the existence and the uniqueness of screening equilibrium, which is a fully separating equilibrium.

3.3 Characterizing Equilibrium Allocations

In this section, we first describe the efficient contract, i.e., the equilibrium contract when firms are allowed to post health-dependent contracts (or, firms have full information about the type of workers). This contract will serve as a benchmark allocation, allowing us to characterize the sources of inefficiencies and the potential role of government policies in the screening economy.

First-Best (Efficient) Contract Given the set of policy parameters, the equilibrium contract solves

$$\begin{aligned} & \max_{\theta, w, a} \quad \mu(\theta) \left\{ (1 - t)w + \beta_i \varphi(a) \right\} + (1 - \mu(\theta)) (b + \psi_i d) \\ \text{s.t. (FE)} \quad & \mu(\theta) \left\{ f_i - w - (1 - \psi_i s)C(a) \right\} = \theta \kappa \\ & \theta \in [0, \infty], w \in [0, f_i], a \in [0, C^{-1}(f_i / (1 - \psi_i s))] \end{aligned}$$

i.e., it maximizes the worker's utility subject to a free entry condition (FE), type-by-type. Substituting the free-entry condition for wage w , and by the first order condition (FOC) with respect to a , we get the equilibrium non-wage benefit level for type i represented by

$$a_i^{FB} = \varphi'^{-1} \left[\frac{(1-t)(1-\psi_i s)C'(a)}{\beta_i} \right].$$

With the assumption on the preference parameter β_i and by the concavity of φ , we have $a_{i+1}^{FB} < a_i^{FB}$. Since the marginal benefit of non-wage benefits is higher for the low types, they receive more of them. This effect is strengthened if the government provides more subsidies (so that $\psi_i s > \psi_{i+1} s$) to low types, lowering the marginal cost of non-wage benefits for them.

From the FOC with respect to θ , we obtain the equilibrium market tightness of workers of type- i :

$$\theta_i^{FB} = \mu'^{-1} \left[\frac{(1-t)\kappa}{(1-t)\{f_i - (1-\psi_i s)C(a_i^{FB})\} + \beta_i \varphi(a_i^{FB}) - (b + \psi_i d)} \right].$$

By strict concavity of $\mu(\cdot)$ and as long as the net productivity $(f_i - (1-\psi_i s)C(a_i^{FB}))$ of high types are higher, the equilibrium market tightness is increasing in type i , i.e., $\theta_{i+1}^{FB} > \theta_i^{FB}$.

Lastly, the wage rate is determined by the free-entry condition of firms as

$$w_i^{FB} = f_i - (1-\psi_i s)C(a_i^{FB}) - \frac{\theta_i^{FB}\kappa}{\mu(\theta_i^{FB})},$$

which is increasing in type i , so that $w_{i+1}^{FB} > w_i^{FB}$. This is driven by higher productivity and lower non-wage benefit costs of healthier workers.

Screening Contract Suppose firms are prohibited from posting type(health)-dependent contracts (or that they do not observe the health status of workers). Then, the firms offer screening contracts, to ensure that low types do not mimic the high types. Similar to the results in Guerrieri, Shimer and Wright (2010), the lowest type participating in the labor market receives the efficient contract. Let us denote his utility from entering his own submarket with efficient contract (w_1^{FB}, a_1^{FB}) as \bar{U}_1 , which is expressed as

$$\bar{U}_1 \equiv \mu(\theta_1^{FB}) \left((1-t)w_1^{FB} + \beta_1 \varphi(a_1^{FB}) \right) + (1 - \mu(\theta_1^{FB})) (b + \psi_1 d).$$

We can then solve for the equilibrium contracts sequentially by solving the following problem

for each type $i \geq 2$:

$$\begin{aligned}
& \max_{\theta, w, a} \quad \mu(\theta) \{(1-t)w + \beta_i \varphi(a)\} + (1 - \mu(\theta)) (b + \psi_i d) \\
\text{s.t. (FE)} \quad & \mu(\theta) \{f_i - w - (1 - \psi_i s) C(a)\} = \theta \kappa \\
\text{(IC)} \quad & \mu(\theta) \{(1-t)w + \beta_{i-1} \varphi(a)\} + (1 - \mu(\theta)) (b + \psi_i d) \leq \bar{U}_{i-1} \\
& \theta \in [0, \infty], w \in [0, f_i], a \in [0, C^{-1}(f_i / (1 - \psi_i s))]
\end{aligned} \tag{1}$$

In this case, we need to take into account the incentive compatibility (*IC*) constraint. It states that the utility of a type- i worker from entering the submarket of type- $i + 1$ should be less than or equal to the utility he receives from entering his own submarket. For types $i > 3$, \bar{U}_{i-1} is the utility from solving problem 1.

Using the optimality conditions, we can further show that if (*IC*) binds for type i , his non-wage benefits in the screening contract are inefficiently low, i.e., $a_i^{AS} < a_i^{FB}$. This is a standard result in the adverse selection models (even without search frictions), and it is designed to keep low types from entering the high types' submarkets. Another useful feature of search frictional labor market is the equilibrium determination of the market tightness, and thus the employment rates. In the screening economy, we can further show that $\theta_i^{AS} > \theta_i^{FB}$, if $\beta_i \varphi(a) - (b + \psi_i d) < 0$ holds, i.e., the worker prefers the outside option if the wage is 0, which is plausible.

Lastly, we emphasize that if the contract that satisfies zero-profit condition for firms is less attractive than the outside option (or, outside option value is relatively high), some types prefer to stay out of the labor force completely. This occurs if the value of staying out of the labor force, $b + \psi_i d$, is higher than $\mu(\theta) \{(1-t)w + \beta_i \varphi(a)\} + (1 - \mu(\theta)) (b + \psi_i d)$, or equivalently, $(1-t)w + \beta_i \varphi(a) < b + \psi_i d$ (this was part of the workers' optimal job search condition in the definition of competitive search equilibrium states in the previous section). If this occurs, then labor market participants with the lowest type receive the efficient contract, and all other (higher type) workers' contracts are distorted when the incentive constraints bind.

Discussion of the Effects of Policies Before setting up the governments' problem, we discuss the effects of the policies on labor market equilibrium with adverse selection. For now, assume that the government can perfectly detect whether a worker is disabled or not.

First, we consider the effects of an increase in d , disability insurance, which is paid only to disabled workers. The direct effect of the policy is that it increases the outside option of disabled workers. Thus, low types now prefer to stay out of the labor force, the well-known labor supply disincentive effects of DI. In this screening model, however, the low participation rate of disabled workers also affect the high types in the labor market. When the outside option increases, the low types now have less incentives to mimic the high types. This indirect effect relaxes the incentive compatibility constraint, therefore mitigating the distortions in the high types' non-wage benefits. Another interpretation is that firms' incentives to screen workers are now lower. At the extreme, it is possible that DI payments are so generous that there does not exist a contract satisfying

both the firms' zero-profit condition and the workers' participation condition. In this case, all disabled workers leave the labor force, with only the high types remaining in the market. Then, efficiency in the high types' contracts are restored, at the expense of high DI expenditures (driven by non-participation of all disabled workers) borne by the government.

Secondly, suppose the government increases the hiring (non-wage benefit) subsidy rate s . Since the low types receive the efficient contract in equilibrium, the subsidy leads to an over-provision of non-wage benefits for low types. This however, can induce them to work. At the same time, the firms' screening incentives increase, distorting the contracts of higher types.

The policy interaction becomes more important in an economy with workers who are at the margin of labor market entry. In the recent decades, the disability insurance program in the U.S. and other developed countries have financially suffered from the increased enrollment in DI programs. In particular, since the passage of the Social Security Disability Benefits Reform Act of 1984, the percentage of new beneficiaries with low-mortality diseases (e.g., mental disorders, endocrine system diseases, skin disorders) has been on a rise. A careful joint design of DI and employment subsidies can be used to provide sufficient consumption insurance for those who are severely disabled, while encouraging the marginal workers to come back to the labor force.

The next section first formally defines the government problem, and in the following sections, we will answer the question quantitatively.

3.4 Optimal Policy Design in the Screening Economy

Given welfare weights by type ω_i (and given his type-verification technology, ψ_i), the government maximizes social welfare subject to the budget constraint:

$$\begin{aligned} \max_{t,s,d} \sum_{i \in I} \omega_i & \left[(1 - \mu(\theta_i^*(t, s, d))) (b + \psi_i d) \right. \\ & \left. + \mu(\theta_i^*(t, s, d)) \{ (1 - t) w_i^*(t, s, d) + \beta_i \varphi(a_i^*(t, s, d)) \} \right] \\ \text{s.t.} \quad & \sum_{i \in I} \pi_i (1 - \mu(\theta_i^*(t, s, d))) \psi_i d \\ & = \sum_{i \in I} \pi_i \mu(\theta_i^*(t, s, d)) \{ t w_i^*(t, s, d) - \psi_i s C(a_i^*(t, s, d)) \} \end{aligned}$$

where $\{w_i^*(t, s, d), a_i^*(t, s, d), \mu_i^*(\theta_i^*(t, s, d))\}_{i=1}^I$ are derived from labor market equilibrium conditions.

Under full information benchmark, we can prove that $t^* = 0$ so that $s^* = 0$ and $d^* = 0$.

Proposition 2. *The optimal tax rate is zero under full information (no screening economy).*

Proof. See Appendix. □

This result is not surprising: given the linear utility function of workers, the decentralized

equilibrium outcome is the most efficient allocation and there is no welfare gain from either redistribution or insurance through disability benefits d or subsidy for non-wage benefits s .

We are also able to show that, under certain assumptions, optimal tax rate is positive in the screening economy.

4 Identification and Estimation (Preliminary)

In this section, we discuss our identification and estimation strategy.

4.1 Estimation Strategy

To empirically study the effects of firm's screening incentives and the optimal policy design problem, it is crucial to determine the relevant screening tools. As discussed in the previous section, the flexibility of working hours can be an important candidate. This instrument is rather difficult to be mandated under the ADA. Thus, we use this measure as the main source of screening, although in principle we can add other screening tools in the empirical framework.

The key challenge lies in separately identifying the cost of providing non-wage benefits and the utility value of these benefits to workers. To address this, we utilize the policy variation introduced in Section 2, the 2004 reform of WOTC. This can directly affect the firm's profit function but not worker's utility. This variation helps us to separately identify these key parameters. Using the actual data variation in HRS, we will estimate the model through indirect inference procedure.

For the benchmark model, we use the current policy parameters (some of which are derived from the literature), and find the equilibrium of the model, which are used as cross-sectional moments. Moreover, we find the equilibrium outcomes with WOTC, which we model as a lump-sum transfer to firms hiring disabled workers. The variations in the outcomes of the model before and after WOTC reform (as presented in Section 2) serve as additional targets of the model.

4.2 Functional Forms and Parameters

There are 3 types of workers, consistent with our empirical analysis, where $i = 1$ denotes severely disabled workers and $i = 3$, non-disabled workers. The value of home production (b) is 40% of average productivity. We assume that workers have linear utility in consumption (which we relax later), and concave utility in non-wage benefits,⁸ with non-wage benefit type-specific curvature parameter so that $\varphi(a_k) = a_k^{\delta_k}$ with $\delta_k \in (0, 1)$. Similarly, non-wage benefit cost function is convex with $C(a_k) = a_k^{c_k}$ and $c_k \geq 1$. We assume a Constant Elasticity of Substitution (CES) function for the job finding rate with parameter γ , so that $\mu(\theta) = \theta(1 + \theta^\gamma)^{-1/\gamma}$.

⁸While we currently focus on one measure of non-wage benefit, we write here, a generalized functional form specifications to potentially capture multiple measures of non-wage benefits. In general, we denote non-wage benefits to be a vector $\mathbf{a} \equiv \{a_k\}_{k=1}^K$, where a_k refers to one measure among many. We also allow for heterogeneity in the value and the cost of each type of non-wage benefit a_k by assuming $\varphi(\mathbf{a}) = \sum_{k=1}^K \varphi(a_k)$ and $C(\mathbf{a}) = \sum_{k=1}^K C(a_k)$.

Government’s disability verification probability (ψ_i) is assumed to be 0.62 for the severely disabled, 0.18 for the moderately disabled, and 0.075 for the non-disabled workers. These parameters are taken from Low and Pistaferri (2015), where they are taken to be the probability of receiving DI upon applying in their model. For the benchmark economy, the DI benefits are assumed to be 50% of average productivity. Thus, the implied outside option for the severely disabled worker is 71% of the average productivity of the economy ($b + \psi_i d = (0.4 + 0.62 \times 0.5) \bar{y}$). For the moderately disabled and non-disabled workers, these correspond to 49% and 44%, respectively. Our benchmark value for the non-wage benefit subsidy rate $s = 0$, as the current U.S. government does not implement policies that specifically subsidize the provision of non-wage benefits. In modeling WOTC, we set the lump-sum transfer to be 9.4% of the income of severely disabled workers, consistent with the actual amount of transfers allowed to firms.⁹

The parameters to be estimated within the model are type-specific productivities $\{f_i\}$; parameter governing the elasticity of job finding rate with respect to market tightness γ ; and the vacancy posting cost κ . Moreover, parameters related to non-wage benefits include the type-specific preferences $\{\beta_i\}$; curvature of the utility function $\{\delta_k\}$; and curvature of cost function $\{c_k\}$.

We find these parameters to match employment rates, wages, and non-wage benefits by type, vacancy cost-to-output ratio, as well as the effects of WOTC on worker outcomes.

In the current preliminary analysis, we use the availability of flexible hours, and use the cross-sectional moments as targets. The preliminary parameters are $f_i = \{1.5, 1.9, 2.1\}$; $\beta_i = \{1.04, 1.02, 1\}$; $\delta = 0.89$; $c = 1.06$; $\gamma = 0.68$; and $\kappa = 0.07$.

4.3 Model Fit

The preliminary model fit is presented in Table 4.

Table 4: Equilibrium Outcomes: Data vs. Screening Model

	Non-Wage Benefits		Wage (Ratio)		Employment	
	Data	Model	Data	Model	Data	Model
Severely Disabled	0.391	0.423	1	0.93 (1)	0.139	0.304
Moderately Disabled	0.333	0.267	1.212	1.02 (1.1)	0.459	0.682
Non-Disabled	0.333	0.008	1.762	1.30 (1.4)	0.717	0.734

In Table 5, we compare the outcomes of the model in the first-best (FB) and the screening (AS) economies. First, we note that as predicted by the model, in the screening economy, non-wage benefits are under-provided to moderately disabled and non-disabled workers. However, these workers are compensated with higher employment rates than in the first-best. The equilibrium wage depends both on the amount of non-wage benefits and the equilibrium market tightness, where the former has a positive effect, and the latter, a negative effect. Under the current parametrization,

⁹Firms can claim up to \$2,400 annually, and the average annual earning of the severely disabled workers are $\$13.70(\text{per hour}) \times 35.9(\text{hours per week}) \times 52(\text{weeks in a year}) = \$25,575.16$ (this is in line with CBO numbers \$25,452 in 2012 dollar).

the latter dominates and this leads to a compression of the wage ratios across health types in the screening economy, relative to the efficient outcomes. The combined effects in the screening economy, lowers the utility of healthier types, but not for the severely disabled workers, whose equilibrium outcomes in the screening economy is efficient.

Table 5: Equilibrium Outcomes: First-Best (FB) vs. Screening Model (AS)

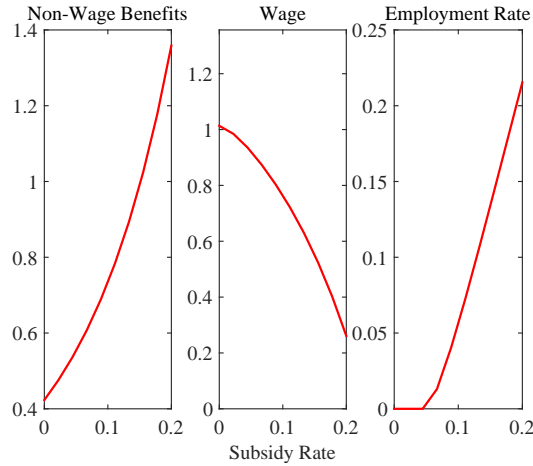
	Non-Wage Benefits		Wage		Employment		Utility	
	FB	AS	FB	AS	FB	AS	FB	AS
Severely Disabled	0.423	0.423	0.933	0.933	0.304	0.304	0.215	0.215
Moderately Disabled	0.387	0.267	1.152	1.022	0.554	0.682	0.250	0.234
Non-Disabled	0.353	0.008	1.351	1.298	0.594	0.734	0.881	0.757

5 Quantitative Policy Analysis (Preliminary)

In this section, we conduct a counterfactual analysis to study the joint effects of DI and hiring subsidies, and especially their interactions.

Proportional Subsidies to Non-Wage Benefits Suppose the government wants to provide more consumption insurance, especially for the severely disabled workers, and therefore increases the DI replacement rate to 70%. Given the imperfect verifiability of the health statuses, the policy reform results in the implied outside option of $\{0.83, 0.53, 0.45\}$ of average productivity for severely, moderately, and non-disable workers, respectively (compared to $\{0.71, 0.49, 0.44\}$ in the benchmark economy). To study the effects of the hiring subsidy rate, we now vary s from 0 to 0.2. We are interested in first, the labor market equilibrium effects of the policies; second, the aggregate costs to the government of implementing the policies; and third, their welfare consequences.

Figure 2: Severely Disabled Workers



In Figure 2, we plot the equilibrium non-wage benefits, wage, and employment rates of the

severely disabled workers, under varying subsidy rates. Notice that the lowest type of worker participating in the labor market receives the efficient contract even in the screening economy. At low s , the non-wage benefits provided are low, and severely disabled workers prefer to stay out of the labor force (as represented by 0 employment rate). However, as subsidy rate and thus the non-wage benefits increase, their incentives to work increase, despite generous DI benefits.

Figure 3: Moderately Disabled Workers

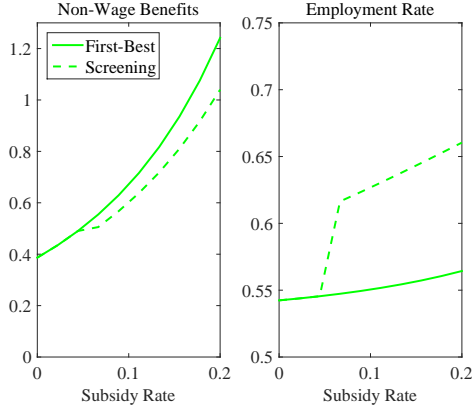
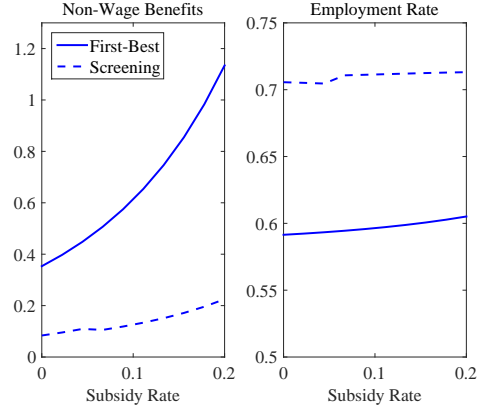


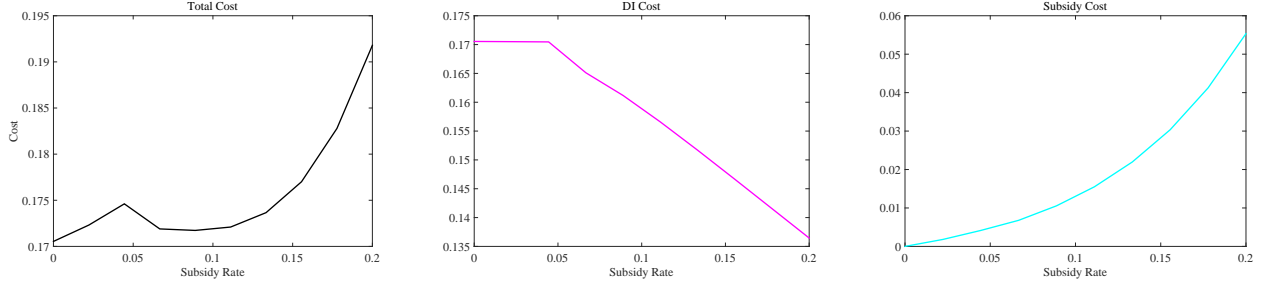
Figure 4: Non-Disabled Workers



In Figure 3, we have the results for moderately disabled workers. Note that when subsidy rate is low, moderately disabled workers receive first-best contracts. As severely disabled workers are out of the labor force, moderately disabled workers become the lowest type participating in the labor market. However, as the severely disabled workers start working, the firms' need to screen workers arise. This effect is captured by the gap in the non-wage benefits provided in the first-best and the screening economy; there is an under-provision of non-wage benefits to the moderately-disabled workers. This is offset by an increase in the equilibrium employment rates. Similar effects are present for non-disabled workers as shown in Figure 4. While their contracts are always distorted in the screening economy, the participation of severely disabled workers generates yet another kink in their equilibrium contracts.

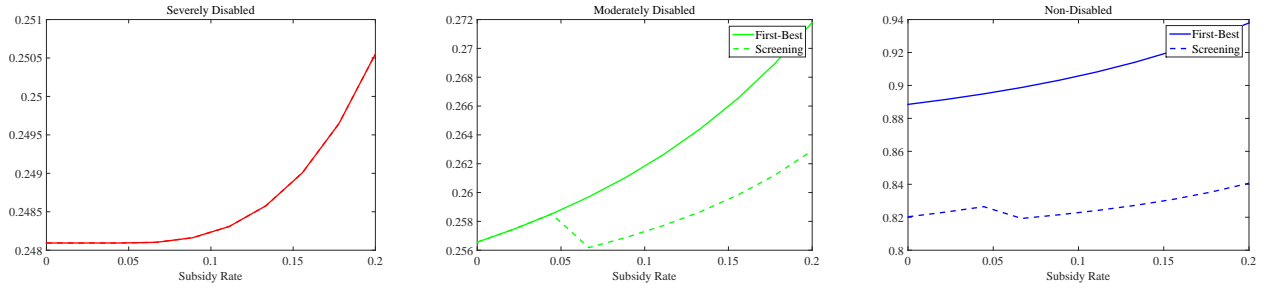
Next, we turn to the aggregate costs of implementing the policies. In Figure 5, we have the total costs of the policies, and separately by costs going to DI and subsidy program. While the subsidy costs are strictly increasing in the subsidy rates, the DI costs are not. In particular, there is a kink in the DI costs as the severely disabled workers start participating in the labor market. Combined effects yield non-monotonic total costs of increasing the subsidy rate, for a given DI replacement rate. When the subsidy rate exceeds 5%, the total cost decreases initially, as the cost of hiring subsidies provided to severely disabled workers is smaller than the cost of providing DI to them.

Figure 5: Total Expenditures by the Government



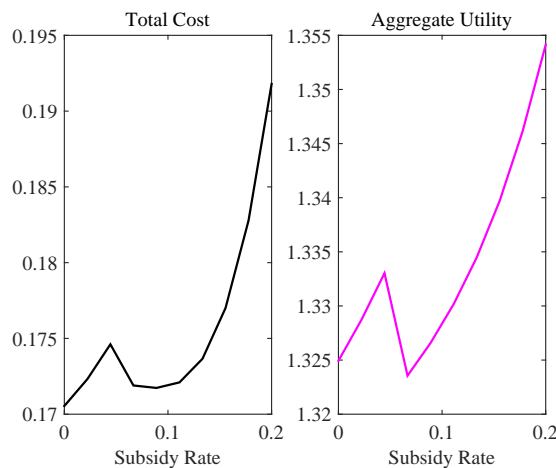
How do the policy combinations then affect the welfare of workers? We first plot the utility of workers by their health statuses in Figure 6. The utility of severely disabled workers at a low subsidy rate is their outside option, which is fixed by DI (thus a horizontal line up to 5% subsidy). Any further increase in the subsidy rate makes them better off. However, this is not the case for other types of workers in the labor market. While, in the first-best, both moderately-disabled and non-disabled workers benefit from the increase in the subsidy rate; the same is not true in the screening economy. The need for firms to screen workers when the labor market is populated by heterogeneous types lowers the utility of the (relatively) high types in the market.

Figure 6: Utility by Health Status



The aggregate utility (with utilitarian welfare weights) and the total costs are plotted side-by-side in Figure 7 for comparison. The aggregate utility reflects the pattern of the utilities by health statuses shown in the previous plots. An interesting policy combination occurs around the subsidy rates of 9%. Near the region, the total cost curve is relatively flat, while the aggregate utility is strictly increasing.

Figure 7: Cost vs. Aggregate Utility



This illustration shows that there exists a non-trivial interaction between DI and the hiring subsidies, for costs to the government and the aggregate utility in the economy. The key trade-offs that we capture are providing incentives of disabled workers to work (through subsidies), which can be costly as the firms' incentives to screen increase, distorting the equilibrium contracts in the labor market.

We also plan to consider direct wage subsidies, as another policy tool. Our goal is to use the fully estimated model to study the joint optimal design of the policies in the screening economy.

6 Conclusion

In this project, we explored how to optimally design policies for disabled workers. Rather than focusing only on social insurance policy (DI) or on labor market policy, we jointly model them to study their interactions in a labor market with heterogeneous workers. We empirically show the impact of the government's employment support program for disabled workers on their non-wage benefits, as well as other outcome variables. Then, we build a model that takes into account both the worker- and firm-side responses to government policies and that allows for the policies to impact all workers (not only disabled) in the labor market. The estimated model, using data from the HRS, is used to conduct quantitative policy analysis.

In the US, the expenditures on DI has been increasing dramatically in the past few decades, while the government spending to promote employment of disabled workers has been relatively small. According to projections by the Congressional Budget Office, DI trust fund is expected to be exhausted in 2022, and the government faces an imminent need of policy reforms for disabled workers. We propose that a more active utilization of labor market policies, to curb the increasing costs of the DI program, might be effective way of insuring disabled workers. This paper is an important step towards *(i)* understanding the interaction between DI and labor market policies for disabled workers; and thus *(ii)* devising policies, optimally and efficiently, to improve the welfare

of workers in the aggregate economy.

References

- Acemoglu, Daron, and Joshua D. Angrist.** 2001. “Consequences of Employment Protection? The Case of the Americans with Disability Act.” *Journal of Political Economy*, 109(5): 915–957.
- Akerlof, George.** 1976. “The Economics of Caste and of the Rat Race and Othe Woeful Tales.” *The Quartely Journal of Economics*, 90(4): 599–617.
- Ameriks, John, Joseph S. Briggs, Andrew Caplin, Minjoon Lee, Matthew D. Shapiro, and Christopher Tonetti.** 2017. “Older Americans Would Work Longer If Jobs Were Flexible.” *National Bureau of Economic Research Working Paper 24008*.
- Bound, John.** 1989. “The Health and Earnings of Rejected Disability Insurance Applicants.” *American Economic Review*, 79: 482–503.
- Burkhauser, Richard V., J.S. Butler, and Yang Woo Kim.** 1995. “The importance of employer accommodation on the job duration of workers with disabilities: A hazard model approach.” *Labour Economics*, 2(2): 109–130.
- Burkhauser, Richard V., J.S. Butler, Yang-Woo Kim, and Robert R. Weathers II.** 1999. “The Importance of Accommodation on the Timing of Disability Insurance Applications: Results from the Survey of Disability and Work and the Health and Retirement Study.” *The Journal of Human Resources*, 34(3): 589–611.
- Diamond, Peter, and Eytan Sheshinski.** 1995. “Economic aspects of optimal disability benefits.” *Journal of Public Economics*, 57(1): 1 – 23.
- French, Eric, and Jae Song.** 2014. “The Effect of Disability Insurance Receipt on Labor Supply.” *American Economic Journal: Policy*, 6(2): 291–337.
- Golosov, Mikhail, and Aleh Tsyvinski.** 2006. “Designing Optimal Disability Insurance: A Case for Asset Testing.” *Journal of Political Economy*, 114: 257–279.
- Guerrieri, Veronica, Robert Shimer, and Randall Wright.** 2010. “Adverse Selection in Competitive Search Equilibrium.” *Econometrica*, 78(6): 1823–1862.
- Hill, Matthew, Nicole Maestas, and Kathleen J. Mullen.** 2014. “Employer Accommodation and Labor Supply of Disabled Workers.” *RAND Working Paper*, 1047.
- Low, Hamish, and Luigi Pistaferri.** 2015. “Disability Insurance and the Dynamics of the Incentive-Insurance Tradeoff.” *American Economic Review*, 105(10): 2986–3029.
- Maestas, Nicole, Kathleen J. Mullen, and Alexander Strand.** 2013. “Does Disability Insurance Receipt Discourage Work? Using Examiner Assignment to Estimate Causal Effects of SSDI Receipt.” *American Economic Review*, 103(5): 1797–1829.

Stantcheva, Stefanie. 2014. “Optimal Income Taxation with Adverse Selection in the Labour Market.” *Review of Economic Studies*, 81: 1296–1329.

A Proofs

A.1 Equilibrium Contracts in the Screening Economy

We show properties of the equilibrium contracts under screening economy, in comparison with the first-best economy. Here, we also incorporate (for use in our quantitative analysis), F_i type-dependent fixed cost of work and tr_i , type-dependent lump-sum transfers from the government. Moreover, we allow for the incorporation of multiple non-wage benefit measures. We denote a_k , the non-wage benefit of type k , and $c(a_k)$, the cost function of the specific non-wage benefit. Thus, the total costs are now denoted as $\sum_k c(a_k)$, and utility, $\sum_k \varphi(a_k)$. The latter policy corresponds to the WOTC program that we use to identify the firm costs of providing non-wage benefits. The problem of the screening economy then reads,

$$\begin{aligned}
 & d_2 + \max_{\theta, w, a} \mu(\theta) \left[(1-t)w + \beta_2 \left(\sum_k \varphi(a_k) \right) - F_2 - d_2 \right] \\
 & \text{s.t.} \\
 & \text{(FE)} \quad \mu(\theta) \left\{ y_2 - w - (1 - \psi_i s) \sum_k c(a_k) + tr_2 \right\} \geq \theta \kappa \\
 & \text{(IC)} \quad \mu(\theta) \left\{ (1-t)w + \beta_1 \left(\sum_k \varphi(a_k) \right) - F_1 \right\} + (1 - \mu(\theta)) (b + \varphi_i d_1) \leq \bar{U}_1
 \end{aligned}$$

Let Lagrange multipliers with respect to (FE) and (IC) be ν and λ . Then, from the FOC with respect to the wage rate, we get

$$\begin{aligned}
 \mu(\theta) (1-t) - \nu \mu(\theta) - \lambda \mu(\theta) (1-t) &= 0 \\
 (1-t) (1-\lambda) &= \nu
 \end{aligned}$$

With $t < 1$, for ν to be positive, the multiplier $\lambda \in [0, 1)$. The FOC with respect to the non-wage benefit of type k , reads

$$\begin{aligned}
 \mu(\theta) \beta_2 \varphi'(a_k) - \nu \mu(\theta) (1 - \psi_i s) c'(a_k) - \lambda \mu(\theta) \beta_1 \varphi'(a_k) &= 0 \\
 (\beta_2 - \lambda \beta_1) \varphi'(a_k) &= (1-t) (1-\lambda) (1 - \psi_i s) c'(a_k)
 \end{aligned}$$

Rearranging,

$$\lambda = \frac{\beta_2 \varphi'(a_k) - (1-t) (1 - \psi_i s) c'(a_k)}{\beta_1 \varphi'(a_k) - (1-t) (1 - \psi_i s) c'(a_k)},$$

and combining with the FOC with respect to wage rate,

$$\nu = (1-t)(1-\lambda) = (1-t) \frac{\beta_1 \varphi'(a_k) - \beta_2 \varphi'(a_k)}{\beta_1 \varphi'(a_k) - (1-t)(1-\psi_i s) c'(a_k)}.$$

Since by assumption $\beta_1 > \beta_2$, numerator of ν is positive, thus, the denominator must be positive. This implies that for λ to be positive, the numerator must be positive, i.e., $\beta_2 \varphi'(a_k) > (1-t)(1-\psi_i s) c'(a_k)$. Note that in the first-best, the optimality condition for a_k reads $\beta_2 \varphi'(a_k^{FB}) = (1-t)(1-\psi_i s) c'(a_k^{FB})$. Thus, by concavity of ψ function (and convexity of $c(\cdot)$ function; holds with linear function too), $a_k^{AS} < a_k^{FB}$ when $\lambda > 0$ (i.e., when (IC) is binding).

Lastly, the FOC with respect to θ reads

$$\begin{aligned} & \mu'(\theta) \left[(1-t)w + \beta_2 \left(\sum_k \varphi(a_k) \right) - F_2 - d_2 \right] + \\ & \nu \mu'(\theta) \left\{ y_2 - w - (1-\psi_i s) \sum_k c(a_k) + tr_2 \right\} - \nu \kappa - \\ & \lambda \mu'(\theta) \left\{ (1-t)w + \beta_1 \left(\sum_k \varphi(a_k) \right) - F_1 - d_1 \right\} = 0 \\ & \left\{ \beta_2 \left(\sum_k \varphi(a_k) \right) - F_2 - d_2 \right\} - \lambda \left\{ \beta_1 \left(\sum_k \varphi(a_k) \right) - F_1 - d_1 \right\} \\ & + (1-t)(1-\lambda) \left\{ y_2 - (1-\psi_i s) \sum_k c(a_k) + tr_2 \right\} = (1-t)(1-\lambda) \frac{\kappa}{\mu'(\theta)} \end{aligned}$$

Denote $\varphi(a) \equiv \sum_k \varphi(a_k)$, $c(a) = \sum_k c(a_k)$ and $\tilde{d}_i \equiv F_i + d_i$. For now, assume no policy. Then, the last equation from FOC with respect to θ :

$$\begin{aligned} & \left\{ \beta_2 \varphi(a) - \tilde{d}_2 \right\} - \lambda \left\{ \beta_1 \varphi(a) - \tilde{d}_1 \right\} + (1-\lambda) \{y_2 - c(a)\} = (1-\lambda) \frac{\kappa}{\mu'(\theta)} \\ & \left\{ \beta_2 \varphi(a) - \tilde{d}_2 + y_2 - c(a) \right\} - \lambda \left\{ \beta_1 \varphi(a) - \tilde{d}_1 + y_2 - c(a) \right\} = (1-\lambda) \frac{\kappa}{\mu'(\theta)} \end{aligned}$$

Let $\beta_1 = \chi \beta_2$, and $\tilde{d}_2 = \xi \tilde{d}_1$. Note also that

$$\begin{aligned} 1 - \lambda &= \frac{(\beta_1 - \beta_2) \varphi'(a)}{\beta_1 \varphi'(a) - c'(a)} = \frac{(\chi - 1) \varphi'(a)}{\chi \beta_2 \varphi'(a) - c'(a)} \\ 1 - \lambda \chi &= \frac{\beta_1 \varphi'(a) - c'(a) - \chi \beta_2 \varphi'(a) + \chi c'(a)}{\beta_1 \varphi'(a) - c'(a)} = \frac{(\chi - 1) c'(a)}{\chi \beta_2 \varphi'(a) - c'(a)} \\ \frac{1 - \lambda \chi}{1 - \lambda} &= \frac{c'(a)}{\beta_2 \varphi'(a)} \end{aligned}$$

(similar calculations hold with ξ). So, simplifying, the FOC with respect to θ can be expressed as

$$\mu'(\theta) \left\{ y_2 - c(a) + \frac{c'(a)}{\beta_2 \varphi'(a)} (\beta_2 \varphi(a) - \tilde{d}_2) \right\} = \kappa. \quad (2)$$

In the FB, the following hold:

$$\begin{aligned}\mu'(\theta^{FB}) \left[y_2 - c(a^{FB}) + \beta_2 \varphi(a^{FB}) - \tilde{d}_2 \right] &= \kappa \\ \beta_2 \varphi'(a^{FB}) &= c'(a^{FB})\end{aligned}$$

which implies that the (a^{FB}, θ^{FB}) satisfies equation (2).

Since we know that $a^{FB} > a^{AS}$, then we need to know how θ^{AS} should adjust so that the equation (2) holds. So, we want to know the sign of $\frac{\partial}{\partial a} \left\{ y_2 - c(a) + \frac{c'(a)}{\beta_2 \varphi'(a)} (\beta_2 \varphi(a) - \tilde{d}_2) \right\}$.

$$\begin{aligned}\frac{\partial}{\partial a} \left\{ -c(a) + \frac{c'(a) \varphi(a)}{\varphi'(a)} - \frac{\tilde{d}_2 c'(a)}{\beta_2 \varphi'(a)} \right\} &= \left\{ \frac{c''(a)}{\varphi'(a)} - \frac{c'(a) \varphi''(a)}{(\varphi'(a))^2} \right\} \left\{ \varphi(a) - \frac{\tilde{d}_2}{\beta_2} \right\} \\ &= (+) \times \begin{cases} + & \text{if } \beta_2 \varphi(a) - \tilde{d}_2 > 0 \\ - & \text{if } \beta_2 \varphi(a) - \tilde{d}_2 < 0 \end{cases}\end{aligned}$$

The first term is positive with convex cost ($c''(a) > 0$) and concave utility (and $\varphi''(a) < 0$). The second term is positive if $\beta_2 \varphi(a) - \tilde{d}_2 > 0$. Think of a labor force participation constraint. Workers' utility from work is $w + \beta_2 \varphi(a)$ and utility from not working, \tilde{d}_2 . If $\beta_2 \varphi(a) - \tilde{d}_2 > 0$, utility from non-wage benefits is so high that even at wage rate of 0, the worker would be willing to work, which is unlikely. Thus, under reasonable parameters, it will be the case that $\beta_2 \varphi(a) - \tilde{d}_2 < 0$. If so, when a is lower ($a^{AS} < a^{FB}$), the term in the bracket is higher; to satisfy the FOC (given that the RHS is a constant, κ), it must be that $\mu'(\theta^{AS}) < \mu'(\theta^{FB})$, which implies with a concave matching function, $\theta^{AS} > \theta^{FB}$.

Lastly,

$$\begin{aligned}w &= y_2 - c(a) - \frac{\theta \kappa}{\mu(\theta)} \\ &= y_2 - c(a) - \frac{\theta \mu'(\theta)}{\mu(\theta)} \left\{ y_2 - c(a) + \frac{c'(a)}{\beta_2 \varphi'(a)} (\beta_2 \varphi(a) - \tilde{d}_2) \right\}\end{aligned}$$

If $(a, \theta) = (a^{FB}, \theta^{FB})$, then $w = w^{FB}$. If $a^{AS} < a^{FB}$, then from our assumption that $\beta_2 \varphi(a) - \tilde{d}_2 < 0$, $\left\{ y_2 - c(a) + \frac{c'(a)}{\beta_2 \varphi'(a)} (\beta_2 \varphi(a) - \tilde{d}_2) \right\}$ is higher. With $\theta^{AS} > \theta^{FB}$, $\frac{\theta \mu'(\theta)}{\mu(\theta)}$ is lower.

A.2 Optimal Policy under Full-Information Benchmark

From the governments' budget constraint,

$$d = \frac{\mu(\theta^*(t, s, d))}{1 - \mu(\theta^*(t, s, d))} \left[t \left\{ f_i - (1 - s) a^*(t, s) - \frac{\theta^*(t, s, d) \kappa}{\mu(\theta^*(t, s, d))} \right\} - s a^*(t, s) \right]$$

Substituting d ,

$$\begin{aligned}
G^F &= \max_{t,s,d} \mu(\theta^*(t,s,d)) \left[t \left\{ f_i - (1-s)a^*(t,s) - \frac{\theta^*(t,s,d)\kappa}{\mu(\theta^*(t,s,d))} \right\} - sa^*(t,s) \right] \\
&\quad + \mu(\theta^*(t,s,d)) \left[(1-t) \left\{ f_i - (1-s)a^*(t,s) - \frac{\theta^*(t,s,d)\kappa}{\mu(\theta^*(t,s,d))} \right\} + \beta_i \varphi(a^*(t,s)) \right] \\
&= \max_{t,s,d} \mu(\theta^*(t,s,d)) [f_i - a^*(t,s) + \beta_i \varphi(a^*(t,s))] - \theta^*(t,s,d)\kappa
\end{aligned}$$

The first-order condition with respect to d reads:

$$\frac{dG^F}{dd} = [\mu'(\theta^*) \{f_i - a^* + \beta_i \varphi(a^*)\} - \kappa] \frac{d\theta^*}{dd} = 0.$$

As $\frac{d\theta^*}{dd} < 0$, it must be the case that $\mu'(\theta^*) \{f_i - a^* + \beta_i \varphi(a^*)\} = \kappa$. Moreover,

$$\begin{aligned}
\frac{dG^F}{ds} &= \mu(\theta^*) [\beta_i \varphi'(a^*) - 1] \frac{da^*}{ds} \\
&\quad + [\mu'(\theta^*) \{f_i - a^* + \beta_i \varphi(a^*)\} - \kappa] \frac{d\theta^*}{ds} \\
&= \mu(\theta^*) [\beta_i \varphi'(a^*) - 1] \frac{da^*}{ds} = 0,
\end{aligned}$$

and

$$\begin{aligned}
\frac{dG^F}{dt} &= [\mu'(\theta^*) \{f_i - a^*(t,s) + \beta_i \varphi(a^*(t,s))\} - \kappa] \frac{d\theta^*}{dt} \\
&\quad + \mu(\theta^*) [\beta_i \varphi'(a^*) - 1] \frac{da^*}{dt} \\
&= \mu(\theta^*) [\beta_i \varphi'(a^*) - 1] \frac{da^*}{dt} = 0.
\end{aligned}$$

These two equations imply that

$$\begin{aligned}
\beta_i \varphi'(a^*) - 1 &= \beta_i \alpha \left[\left\{ \frac{\beta_i \alpha}{(1-t)(1-s)} \right\}^{\frac{1}{1-\alpha}} \right]^{\alpha-1} - 1 \\
&= \beta_i \alpha \left\{ \frac{\beta_i \alpha}{(1-t)(1-s)} \right\}^{-1} - 1 \\
&= (1-t)(1-s) - 1 = 0
\end{aligned}$$

or $t^* = s^* = d^* = 0$.