# Labor Market Screening and Social Insurance Program Design for the Disabled *

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**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 amenities, such as the option to reduce work hours, to screen disabled workers. Then, we develop an equilibrium labor market model where firms post a screening contract which consists of wage and job amenities; and workers with different levels of disability make labor supply decisions. In equilibrium, the firms' screening incentives depend on the job search efforts of disabled workers. 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 explore the optimal mix of the disability insurance and employment subsidies for the disabled and study their implications on equilibrium labor market outcomes for workers of different health statuses.

**JEL Codes**: I38
**Keywords:** disability, labor market screening, optimal policy design

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# 1 Introduction

Most advanced countries implement various social insurance programs to support individuals with disabilities. First of all, there are large-scale public disability insurance (DI) program, which provides income supports to disabled individuals who cannot work much.[1] Second, there are employment protection policies for the disabled, such as the Americans with Disabilities Act (ADA) and the Work Opportunity Tax Credit (WOTC) in the U.S. These policies aim to provide more job opportunities to the disabled by prohibiting firms from discriminating workers based on disability and giving tax credits to firms hiring the disabled. The key difference between these policies is whether the government provides support to the disabled outside or inside the labor market. DI provides insurance to individuals outside labor markets, while employment protection policies insures the disabled within the labor markets. There have been a number of active policy debates on how to choose this balance.[2]

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 the DI program on individual labor supply and welfare, only a handful of studies investigate the response of firms to either labor-supply or labor-demand side 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. Thus, firms have incentives to screen possibly costly disabled workers. However, to date, little is known about *whether* and *how* firms screen disabled workers when they cannot explicitly discriminate workers based on their disability statuses. Although it is possible for firms to screen disabled workers in many different ways, identifying the major screening tools will be a crucial step in evaluating the social cost of labor market screening. More importantly, there have been few studies analyzing how the government *should* design subsidies for the disabled when firms' incentives for recruiting disabled workers are endogenously adjusted. Although additional spending on DI or employment (or wage) subsidies may distort employment levels, they may, at the same time, reduce inefficiencies in the labor market created to screen out disabled workers.

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'

[1] In 2016, the U.S. government paid $220 billion for insuring nearly nine million disabled through the public disability insurance, and the size of this program has been growing substantially in the last several decades.

[2] For example, Autor and Duggan (2010) discuss the need for shifting the government spending toward employment protection policies, by proposing a private disability insurance program, which assists firms to accommodate disabled workers.

design of job amenities is responsive to the profitability from recruiting the disabled. Then, we develop an equilibrium screening model of the labor market. 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. Finally, we analyze the optimal combination of disability insurance and employment subsidies for the disabled.

We hypothesize that firms use job amenities, such as the option to reduce work 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 the option to reduce work hours (which we denote as "flexible working hours") can be exempted 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 job amenities that are less appealing to disabled workers. To argue that these job amenities are used as screening tools, one must show that (*i*) workers with different disability statuses have heterogeneous preferences from these job amenities; and (*ii*) firms' choice of job amenities are responsive to the differential profitability from recruiting workers with different disability statuses. Our data from the Health and Retirement Study (HRS) suggests that workers with severe disabilities tend to select into jobs with more flexible working hours, which are consistent with the heterogeneity of worker preferences.[3] Then, we show empirical evidence that firms might be screening these workers using job amenities, by exploiting WOTC Amendment as a policy variation shifting the firms' profitability from hiring workers with different disability statuses.

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. A worker's disability affects his preference on job characteristics, which consists of wage and non-wage components (job amenities), his productivity, and disutility from work. Workers optimally choose their job search activities, by deciding whether to search for a job (i.e., labor force participation decision is endogenous) and what type of jobs to search for (i.e., search process is directed). 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

[3]In 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.

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 introduce a labor market search friction, which leads to the following two desirable features. First, the model characterizes non-employment as an equilibrium object, which are now affected by both labor-supply (i.e. labor force participation/extensive job search) and labor demand (i.e. job vacancies) margins. This differs from standard frictionless screening models which feature full employment among all workers. This feature is necessary because the policy instruments explicitly depend on employment statuses and they directly intervene both workers and firms. Second, we can guarantee 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 firms' profits and workers' value from work.

The novel feature of our model is that it naturally links the degree of inefficiency in job amenities, arising due to the screening incentives, with the labor force participation margin (job search margin) of the disabled. As in the standard screening model, firms have incentives to offer inefficiently low amount of job amenities to non-disabled workers, to discourage disabled workers from applying to the job (screen disabled workers). However, such an incentive depends on whether those disabled workers prefer working to staying out of the labor force. If the disabled does not participate in the labor market, then firms no longer need to screen disabled workers. Thus, the inefficiency of job amenities for non-disabled workers can be mitigated. This dependence of screening incentives on labor force participation margin will create room for the government to choose both DI and various tax credit to firms (or employed workers) to improve the efficiency in the labor market allocation.

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 amenities and the firm's resource cost of providing these benefits. To separately identify these parameters, we exploit the policy variation after the WOTC Amendment, which mainly affected the labor demand side parameters. We then estimate our model through indirect inference procedure. Based on our estimates, we find that the inefficiencies in job amenities due to firm's screening can be sizable: for example, we find that the fraction of jobs providing the option of reducing work hours to moderately disabled workers can be 22% lower than the one in an economy without screening.

With the estimated model, we examine the efficiency and welfare impacts of policies for disabled workers, by jointly modeling public insurance program and employment subsidies.

We specifically consider the combination of two instruments: disability insurance and subsidies to workers and firms. These policies have three effects that are relevant for social welfare. First, as in the standard taxation problem, they create welfare gain by enhancing redistribution across workers with different disability statuses, i.e., providing better insurance against disability risk. Second, they affect the labor supply decisions of workers: e.g., more generous DI program lowers employment of the disabled. Third, which is new in the literature studying policies for the disabled, these policies also impact the distortions generated by information friction (adverse selection). Providing higher subsidies to low-wage jobs reduces the incentives of disabled workers to apply for high-wage jobs. Thus, firms do not need to screen out those disabled workers by offering inefficiently low amounts of job amenities.

The effectiveness of these policies depends on the firm's incentive to create job vacancies and recruit workers. If it is very difficult for disabled workers to find a job, then the labor market distortions in terms of employment and employment contract are less responsive to policy designs. Thus, the optimal structure will depend on the importance of each channel. We quantitatively assess how these forces shape the optimal subsidy structure for the disabled. For example, we find that providing more employment subsidies may be cost-effective and welfare-improving, and especially more so in the presence of a generous DI policy. These firm subsidies can be an effective tool for increasing the employment of disabled workers, despite the fact that it creates screening incentives for firms.

**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, including a pioneering work by Bound (1989).[4] Autor and Duggan (2003) find that the DI expansion lowers search intensities of the unemployed, increasing non-employment. 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.[5] The main contribution of our paper is to study the firm's screening incentives and their

[4]See Bound and Burkhauser (1999) and Autor and Duggan (2006) for an excellent survey of the development of this literature.

[5]Moreover, 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)).

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. Theoretically, our framework extends theirs by endogenizing the labor force participation/extensive job search margin of workers and allowing the value of being non-employed (i.e., the outside option of workers) are heterogeneous. With this structure, the model is able to capture how firm's screening incentives is affected by the worker's labor supply and their implications of policy designs. More importantly, our contribution is mainly empirical, as this literature has been largely theoretical. Specifically, we apply the labor market screening framework into the context of disability and empirically estimating the model. Moreover, we consider the optimal policy design in this context.[6]

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 theoretically 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 quantitatively characterize the optimal policy design in our context, specifying and credibly recovering the full structure of the model is a crucial step. To the best of our knowledge, our paper is the first to conduct such policy exercise. Our choice of policy instruments, i.e., subsidies which are dependent on employment status, is also related to Golosov, Maziero and Menzio (2013), which studies the optimal social insurance design in a frictional labor market model. The distinctive feature of our policy design problem is that we consider both search friction and information friction.

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

[6] Davoodalhosseini (2015) theoretically studies the efficiency property of the directed search equilibrium with adverse selection and the optimal sales tax in this context. Recently, Lester et al. (2017) propose a tractable framework which incorporates the screening problem into a random search model. Relative to theirs, one advantage of the current framework is that it endogenizes the employment rate and allows its dependence on firms' labor demand. This feature will be crucial in our application where we evaluate the impact of disability policies on equilibrium employment rate.

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.

# 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.

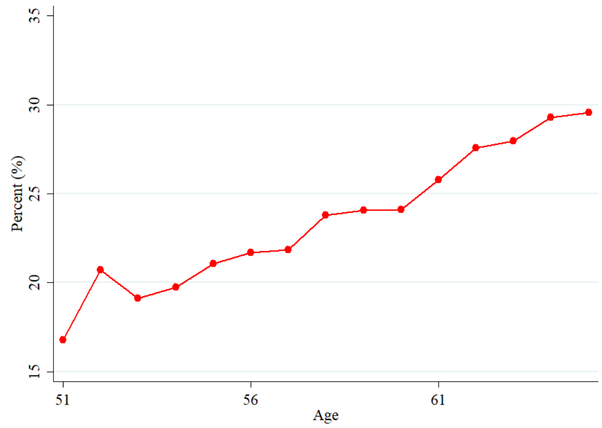
## 2.2 Data

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.

In our empirical analysis, we restrict the samples to individuals whose ages are between 51 and 65 as labor supply decisions of those older than 65 depend on their Medicare and Social Security benefits. Moreover, we exclude self-employed individuals and those working in public sector since they are less likely to be affected by the firm's screening incentives. Finally, we only consider years between 1996 and 2008, so that our results are not confounded by

Figure 1: Work Limitation by Age




the effects from the Great Recession. The overall sample size (individual-year combination) is 45,678.

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 limitation, 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 limitation 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 amenities, which we will use interchangeably in the rest of the paper) measures from their employment. These measures include the availability of the option to reduce work hours (or flexible working hours, which we will use interchangeably in the rest of the paper), 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 employer (which is enforced through a mandate under the Americans with Disabilities Act). These accommodation measures include, but are not limited to, 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, one of the robust patterns we observe is that 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. Our hypothesis is that if certain job amenities are used as a screening device, then they are responsive to changes in a government policy that differentially affects the profit of recruiting workers of different disability statuses. As discussed in 2.1, changes in Work Opportunity Tax Credit in 2004 can possibly be an important factor affecting these differential profits. For this purpose, we consider the following difference-in-differences regression:

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

Table 2: Descriptive Statistics

| Health Status | Severely disabled | Moderately disabled | Non-disabled |
|---|---|---|---|
| Demographics | | | |
| Age | 59.0 | 59.1 | 58.5 |
| Female (%) | 56.6 | 56.4 | 54.5 |
| High school or less (%) | 72.0 | 62.9 | 44.7 |
| Health Conditions | | | |
| 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 |
| Labor Market Outcomes | | | |
| 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 |
| Non-Wage Benefits | | | |
| 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.

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 $\boldsymbol{Z}_t$, which include macroeconomic controls (e.g., employment rates, GDP, and labor productivity).[7] Our parameter of interest is $\beta_{3h}$, which is the coefficient on the interaction term between the disability status dummy and the WOTC-amendment (post-WOTC) dummy. This coefficient captures the disability-specific effect of the WOTC-amendment.

For non-wage benefits, we specifically consider the option to reduce work hours and paid

[7] Annual 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.

sick days, as these can potentially be used as screening tools. As discussed in Section 2.2, people with adverse health conditions work in jobs with generous job amenities (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 disabled workers.

Table 3 summarizes our results on non-wage benefits. The other labor market outcomes from the analysis are reported in Table in Appendix. 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 for moderately disabled workers.[8] The effect, however, is insignificant for the severely disabled workers. Further, we find that the effect of the WOTC-expansion did not have significant effects on other labor market outcomes (employment or wage) as shown in Table 8 in Appendix.

Table 3: Effects of the WOTC-Amendment on Job Amenities

| | | Flexible hours | Paid sick days |
|---|---|---|---|
| Post-Amendment | | 0.057 | 4.736* |
| ($\beta_1$) | | (0.038) | (2.857) |
| Health Status | Severe | 0.242*** | 5.378 |
| ($\beta_{2h}$) | | (0.064) | (3.433) |
| | Moderate | 0.129*** | 1.536 |
| | | (0.038) | (1.907) |
| Health Status | Severe | 0.057 | 2.085 |
| $\times$ Post-Amendment | | (0.081) | (4.621) |
| ($\beta_{3h}$) | Moderate | 0.125*** | -2.765 |
| | | (0.046) | (2.464) |

*Note:* Sample in this regression analysis is restricted to high school graduates. The additional covariates used in the regression include age, age-squared, female dummy, self-reported health status dummy, firm-size categories dummy, union dummy, and annual growth rate of GDP. Standard error is clustered at individual-level.

Thus, we find that severely disabled workers' contracts are not affected by the WOTC expansion, which is a lump-sum transfer given to firms, whereas it benefited those of the moderately disabled workers. As it will be shown from our model in the next section,

[8] In the Appendix, we show that the parallel trend assumption holds for the flexible work hours.

this evidence is consistent with the standard screening model such as Akerlof (1976): 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 to equalize the marginal benefit to the marginal cost. Thus, the lump-sum transfer (which does not directly change the marginal costs of providing non-wage benefits) does not affect the magnitude of equilibrium non-wage benefits. However, by impacting the differential profit of recruiting disabled and non-disabled workers, it affects the non-wage benefit level for healthier workers (moderately disabled or non-disabled workers). As the incentive compatibility constraint on healthier workers' contract is relaxed (i.e., disabled workers have less incentive to enter the market designed for healthier workers), some of the inefficiencies from firms' screening incentives are mitigated. Importantly, the differential profit impacts the job characteristics only if it is used as a screening tool: if it is chosen competitively (i.e., competitive model without screening), then lump-sum transfers should not have any impact on job amenities of workers.

Although these predictions support that a certain job amenity might be used as a screening tool, there are several caveats. First, this result may be driven by the possibility that, within each disability category (under our definition), there is heterogeneity in health status and marginally unhealthy individuals in the "moderate" health group will start working in jobs with flexible work hours. If this is the driver of the above result, the prediction is consistent with a competitive labor market equilibrium without screening (or adverse selection). However, the result is robust to having additional controls on individual characteristics related to health status (e.g., income and gender), which alleviates this concern, as shown in Table 9 in Appendix.

Second, our conjecture that certain job characteristics are used as a screening tool is based on the strong responsiveness of moderately disabled workers' job amenities when firms received lump-sum transfers for hiring disabled workers. With risk-neutral workers, one can deterministically show that the empirical evidence is only consistent with the economies where firms screen workers. Under risk-averse workers, the predictions are not as robust since even under the efficient contract, job amenity levels can adjust due to the changes in marginal utility of consumption (wage). However, even under risk-aversion, we can further show that if WOTC is provided only to severely disabled workers, the empirical finding is consistent with the predictions of the screening model.[9]

[9]Moreover, if WOTC is provided upon hiring both severely and moderately disabled workers, as long as changes in wage of workers are not significant, then we again have the prediction that WOTC only affect moderately disabled' job amenities, but not for severely disabled, under the screening economy. On the other hand, the competitive economy without screening should predict that neither job amenities of severely disabled nor moderately disabled respond to WOTC. As reported in Appendix, wages are not responsive,

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** Labor market is populated by a continuum of workers and firms. There is a measure 1 of workers who value consumption and leisure. Workers are heterogeneous in their health statuses, which we denote by $h \in \mathcal{H} \equiv \{1, 2, \cdots, H\}$ and their *observed* skill types $x \in \mathcal{X}$. The share of each type $i = (h, x) \in \mathcal{I}$ is denoted by $\pi_i > 0$, with $\sum_i \pi_i = 1$. Given the menu of employment contracts offered, workers decide whether to look for a job (extensive margin) and which jobs to apply for (intensive margin).

Each employed worker produces $f_{h,x}$, and we assume that healthier individuals produce (weakly) more than less healthy individuals so that $f_{h+1,x} \geq f_{h,x}$. In the model, $f_{h,x}$ represents the *net* productivity of workers. Thus, the heterogeneity in $f_{h,x}$ in terms of $h$ might be either due to productivity differences driven by health status, or due to the expected accommodation costs which vary with $h$ mandated under the ADA.

The workers' preferences are represented by the utility function

$$\begin{aligned} U_{h,x}(c, a) &= u(c) - \tilde{\varphi}(a, h)\, 1(employed) \\ &= u(c) - (\eta_h - \beta_h \varphi(a))\, 1(employed) \end{aligned}$$

where $c$ denotes consumption and $\eta_h - \beta_h \varphi(a)$ represents the net disutility from work. The consumer derives utility from consumption through $u(c)$, which is strictly increasing ($u' > 0$) and concave ($u'' \leq 0$). The disutility from work consists of type-dependent fixed utility cost $\eta_h$, and utility from job amenities (or non-wage benefits, which we use interchangeably) such as the flexibility of work schedule $\beta_h \varphi(a)$. The non-wage benefits increase utility from work (or lowers disutility from work) through function $\varphi(a)$, which is strictly increasing ($\varphi' > 0$), strictly concave ($\varphi'' < 0$), and satisfies $\lim_{a \to 0} \varphi'(a) = 0$ and $\lim_{a \to 1} \varphi'(a) = 0$. Furthermore, the type-specific preference is represented in $\beta_h$, where we assume $\beta_h > \beta_{h+1}$, so that unhealthy (low type) workers value $a$ more than their healthier (high type) counterparts.[10] Workers pay taxes on wages, so that $c = w - t(w)$, where $t(w)$ represents a

supporting the screening economy.

[10]We only model health-specific preference heterogeneity. We could possibly add heterogeneity in prefer-

tax (or subsidy) function. If an individual does not work, his consumption consists of home production, denoted by $b$, and disability insurance amount $d$ from the government, which is awarded *probabilistically* (we discuss this further below).

**Firms** There is a continuum of ex-ante homogeneous, risk-neutral firms in the economy. Firms can observe worker's skill type $x$ and are allowed to post contracts based on it. However, firms cannot post contracts contingent on health type $h$, either due to information friction ($h$ is unobservable), or as they are prohibited from doing so by the ADA regulation. A firm's contract consists of wage ($w$) and job amenities ($a$) both of which can be skill ($x$)-dependent, by paying a cost $\kappa$. When a worker type $i = (h, x)$ 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 ($\tilde{C}'' \geq 0$). [11]

**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 $y_x \equiv (w, a) \in Y_x$, where the set of feasible contract space $Y_x$ is compact and nonempty. Note that these submarkets are indexed by $x$, which we assume is observable and contractible. Firms and workers direct their search.

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

Let the share of type-$h$ agent applying to a contract $y_x$-submarket be $g_h(y_x)$, with $g_h(y_x) \geq 0$ and $\sum_h g_h(y_x) = \sum_h \pi_{h,x}$. Thus, conditional on a match, the probability of

ences driven by other characteristics. However, if this multi-dimensional heterogeneity lead to violation of assumption 1 (introduced later), then it will create a number of complications in equilibrium analysis (see Azevedo and Gottlieb (2017) and Chang (2017) for their theoretical analyses). In our empirical analysis, we address the potential bias from this modeling assumption.

[11] It is plausible to consider that there are ex-ante heterogeneity among firms in terms of the efficiency in providing job amenities. In such case, one can characterize the heterogeneity of screening incentives across firms. For example, firms which are more efficient in providing job amenities (i.e., facing the lower cost of providing job amenities) may create jobs and attract any type of workers. As such, they screen disabled workers. However, firms which are less efficient in providing job amenities (i.e., facing the lower cost of providing job amenities) may create jobs which are only filled by non-disabled workers. Although these rich predictions will be useful, our main qulitative findings will remain as long as certain firms still have incentive to engage in screening. We leave this extension as an interesting future work.

hiring a type-$h$ worker is $g_h(y_x)$. We normalize the payoff of firms not posting a vacancy to 0.

We denote $\bar{Y}_{h,x}$ 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-$(h,x)$ worker's participation.

$$\bar{Y}_{h,x} = \left\{ y_x \in Y_x \middle| \eta(0) v_{h,x}(y_x) \geq \kappa \quad \text{and} \quad U_{h,x}(y_x) \geq U^N_{h,x}(b,d) \right\}$$

where $\bar{Y}_x \equiv \cup_{h \in \mathbb{H}} \bar{Y}_{h,x}$. 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 $U^N_i(b,d)$.

**Assumption 1.** *(Monotonicity) For all* $y_x \in \bar{Y}_x$, $v_{1,x}(y_x) \leq v_{2,x}(y_x) \leq \cdots \leq v_{H,x}(y_x)$.

When we assume no productivity difference across types, then the firm is indifferent in terms of payoff and $v_{h,x}(y_x) = v_{h',x}(y_x)$ for $\forall h \neq h'$. If the productivity (weakly) increases with health-type index, then the monotonicity assumption also holds with (weak) inequality.

**Government Policies** Government can set the following three sets of policy instruments: $(a)$ disability insurance; $(b)$ wage subsidies to the employed; and $(c)$ subsidies to firms. We assume that the government imperfectly verifies the true type of workers (similar to Low and Pistaferri (2015)) when providing disability insurance benefits, and denote the probability of identifying health type $h$ as disabled as $\psi_h$ and assume $\psi_h \geq \psi_{h+1}$, i.e., the lower one's type is, the more likely it is for the government to verify that (s)he is disabled. Although it is interesting to endogenize the government screening ability $\psi_h$, we assume that it is an exogenous technological constraint. For a given disability benefit level $d$, a type-$h$ individual's expected utility of not working is $U^N_{h,x}(b,d) = \psi_h u(b+d) + (1-\psi_h) u(b)$.

Moreover, the government provides wage subsidies (or income tax) which is denoted by $T_W(w)$, and it can also provide direct subsidies to firms hiring disabled workers. For the latter policy, we assume a direct subsidy can be a function of $(w,a)$, denoted by $T_F(w,a)$. As in the DI policy, we assume that they are still imperfectly verified: the employed with health status $h$ or firms hiring a worker with health status $h$ receive the subsidy with probability $\psi_h$. As a result, the expected transfer that the employed receives will be: $T_{W,h}(w) = \psi_h T_W(w)$ and the expected tax credit given to firms hiring a worker with health status $h$ is $T_{F,h}(w,a) = \psi_h T_F(w,a)$.

## 3.2 Competitive Search Equilibrium (Given Policy Parameters)

Given the disability insurance program, tax function, and subsidies to firms, a 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-$i$ worker maximizes the expected utility by searching for jobs in 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 following Guerrieri, Shimer and Wright (2010).

**Definition 1.** A Competitive Search Equilibrium is a vector $\bar{U} = \{U_{h,x}\} \in \mathbb{R}$, a measure $\lambda$ on $Y_x$ with support $Y_x^p$, a function $\Theta : Y_x \to [0, \infty]$, and a function $G : Y_x \to \Delta^H$ that satisfy the following conditions for all $x$:

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

$$\eta\left(\Theta\left(y_x\right)\right) \sum_h g_h\left(y_x\right) v_{h,x}\left(y_x\right) \quad \leq \quad \kappa,$$

   with equality if $y_x \in Y_x^p$.

2. Workers' Optimal Job Search: Let

$$\bar{U}_{h,x} \quad = \quad \max \left\{ U_{h,x}^N\left(b,d\right), \max_{(w,a) \in Y_x^p} \left\{ \mu\left(\Theta\left(y_x\right)\right) U_{h,x}^E\left(w,a\right) + \left(1 - \mu\left(\Theta\left(y_x\right)\right)\right) U_{h,x}^N\left(b,d\right) \right\} \right\}$$

   where $Y_x^p$ is the set of active submarkets for type-$x$ workers, $U_{h,x}^E\left(w,a\right)$ is the utility from working at job with $(w,a)$, given by

$$U_{h,x}^E\left(w,a\right) = u\left(w - T_{W,h}\left(w\right)\right) - \left(\eta_i - \beta_i \varphi\left(a\right)\right),$$

   and $U_{h,x}^N\left(b,d\right)$ is the utility from not working, given by

$$U_{h,x}^N\left(b,d\right) = \psi_h u\left(b+d\right) + \left(1 - \psi_h\right) u\left(b\right).$$

   If $Y_x^p = \emptyset$, $\bar{U}_{h,x} = U_{h,x}^N\left(b,d\right)$. For any contract $y_x^{'} = (w', a') \in Y_x$ and $(h,x)$,

$$\bar{U}_{h,x} \quad \geq \quad \max \left\{ U_{h,x}^N\left(b,d\right), \mu\left(\Theta\left(y_x^{'}\right)\right) U_{h,x}^E\left(w',a'\right) + \left(1 - \mu\left(\Theta\left(y_x^{'}\right)\right)\right) U_{h,x}^N\left(b,d\right) \right\},$$

   with equality if $\Theta\left(y_x\right) < \infty$ and $g_h\left(y_x\right) > 0$. If $U_{h,x}^E\left(w,a\right) < U_{h,x}^N\left(b,d\right)$, either $\Theta\left(y_x\right) = \infty$ or $g_h\left(y_x\right) = 0$.

3. Market Clearing: For $\forall (h,x) \in \mathcal{I}$,

$$\int_{Y_x^p} \frac{g_h(y_x)}{\Theta(y_x)} d\lambda(\{y_x\}) \quad \leq \quad \pi_{h,x}$$

with equality if $\bar{U}_{h,x} > U_{h,x}^N(b,d)$.

Note that the market tightness function $\Theta$ is defined over the set of feasible contract space for each type $x$, $Y_x$, unlike the distribution of active contracts $\lambda$ over $Y_x^p$. 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. We show the existence and the uniqueness of screening equilibrium, which is a fully separating equilibrium, following Guerrieri, Shimer and Wright (2010).

## 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. To simplify the notation, we assume in this section that $T_W(w) = 0$ and $T_F(w,a) = 0$, so that $\tilde{C}(a) = C(a)$. However, this restriction will be relaxed in our empirical and policy design analysis.

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

$$\max \quad \left\{ U_{h,x}^N(b,d), \max_{w,a,\theta} \left\{ \mu(\theta) U_{h,x}^E(w,a) + (1-\mu(\theta)) U_{h,x}^N(b,d) \right\} \right\}$$

$$\begin{aligned} \text{s.t.} \quad (\text{FE}) \quad & \mu(\theta)\{f_{h,x} - w - C(a)\} = \theta\kappa \\ & \theta \in [0,\infty],\ w \in [0, f_i],\ a \in \left[0, C^{-1}(f_i)\right], \end{aligned}$$

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 $i = (h,x)$ represented by

$$a_i^{FB} \quad = \quad \varphi'^{-1}\left[\frac{u\left(\mathit{\Delta}(a_i^{FB}, \theta_i^{FB})\right)}{\beta_i}\right]$$

where

$$\varDelta(a_i^{FB},\theta_i^{FB}) = C'\left(a_i^{FB}\right) - \theta_i^{FB}\kappa.$$

From the FOC with respect to $\theta$, we obtain the equilibrium market tightness of worker of type-$i$:

$$\mu'(\theta_i^{FB}) \quad \left[u\left(\varDelta(a_i^{FB},\theta_i^{FB})\right) - \left(\eta_i - \beta_i\varphi\left(a_i^{FB}\right)\right) - U_i^N(b,d)\right] = \mu(\theta_i^{FB})u'\left(\varDelta(a_i^{FB},\theta_i^{FB})\right)\frac{d\frac{\kappa\theta_i}{\mu(\theta_i)}}{d\theta_i}\bigg|_{\theta=\theta_i^{FB}}$$

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

$$w_i^{FB} \quad = \quad f_i - C\left(a_i^{FB}\right) - \frac{\theta_i^{FB}\kappa}{\mu\left(\theta_i^{FB}\right)}.$$

It is difficult to establish the theoretical properties of the first-best outcomes under general class of preferences. However, under risk-neutral individuals, one can establish monotonic relationships in equilibrium outcomes across health statuses. By assumption on the preference parameter $\beta_i$ and concavity of $\varphi$, we have $a_{(h+1,x)}^{FB} < a_{(h,x)}^{FB}$. Since the marginal benefit of non-wage benefits is higher for the low types, they receive more of them. By strict concavity of $\mu(\cdot)$, and as long as the net productivity $(f_i - C\left(a_i^{FB}\right))$ of high types are higher, the equilibrium market tightness is increasing in type $i$, i.e., $\theta_{(h+1,x)}^{FB} > \theta_{(h,x)}^{FB}$. Moreover, wages are higher for high types, i.e., $w_{(h+1,x)}^{FB} > w_{(h,x)}^{FB}$, which 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, firms offer screening contracts to ensure that unhealthy worker do not mimic healthy workers. 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 $\left(w_{1,x}^{FB}, a_{1,x}^{FB}\right)$ as $\bar{U_{1,x}}$, which is expressed as

$$\bar{U}_{1,x} \equiv U_{1,x}^N(b,d) + \mu\left(\theta_{1,x}^{FB}\right)\left\{u\left(w_{1,x}^{FB}\right) - \left(\eta_1 - \beta_1\varphi\left(a_{1,x}^{FB}\right)\right) - U_{1,x}^N(b,d)\right\}.$$

We can then solve for the equilibrium contracts sequentially by solving the following problem for each type $i \geq 2$:

$$\max_{\theta,w,a} \quad \left\{\mu(\theta) U^E_{h,x}(w,a) + (1-\mu(\theta)) U^N_{h,x}(b,d)\right\} \tag{1}$$

$$\begin{aligned} \text{s.t.} \quad (\text{FE}) \quad & \mu(\theta)\{f_{h,x} - w - C(a)\} = \theta\kappa \\ (\text{IC}) \quad & \mu(\theta) U^E_{h-1,x}(w,a) + (1-\mu(\theta)) U^N_{h-1,x}(b,d) \leq \bar{U}_{h-1,x} \\ & \theta \in [0,\infty],\ w \in [0, f_{h,x}],\ a \in \left[0, C^{-1}(f_{h,x})\right] \end{aligned}$$

In this case, we need to take into account the incentive compatibility $(IC)$ constraint. It states that the utility of a type-$(h-1,x)$ worker from entering the submarket for type-$(h,x)$ should be less than or equal to the utility he receives from entering his own submarket $(\bar{U}_{h-1,x})$. For types $h > 2$, $\bar{U}_{h-1,x}$ is the utility from solving problem 1, and thus we can solve the equilibrium sequentially.

One can establish various theoretical properties under the environment with risk-neutral workers. Using the optimality conditions, we can show that if $(IC)$ binds for type-$(h,x)$, his non-wage benefits in the screening contract are inefficiently low, i.e., $a^{AS}_{(h,x)} < a^{FB}_{(h,x)}$. This is a standard result in adverse selection models (even without search frictions), and it is designed to keep less healthy from entering healthy workers' submarkets. Another useful feature of search frictional labor market is the equilibrium determination of the market tightness, and thus the employment rates. We can further show that $\theta^{AS}_{(h,x)} > \theta^{FB}_{(h,x)}$, if $\beta_h\varphi(a) - U^N_{h,x}(b,d) < 0$ holds.[12]

Lastly, we emphasize that if the contract that satisfies the 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, $U^N_{h,x}(b,d)$, is higher than $\mu(\theta)\{u(w) - (\eta_h - \beta_h\varphi(a))\} + (1-\mu(\theta)) U^N_{h,x}(b,d)$, or equivalently, $u(w) - (\eta_h - \beta_h\varphi(a)) < U^N_{h,x}(b,d)$ (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 government's 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

[12] With linear utility, $\beta_h\varphi(a) - U^N_{h,x}(b,d) < 0$ implies that the worker prefers the outside option if his wage in the market is 0.

(i.e., $\psi_{disabled} = 1$ and $\psi_{non-disabled} = 0$).

First, we consider the effects of an increase in $d$, disability insurance, which is paid to non-working disabled workers. The direct effect of the policy is that it increases the outside option of disabled workers. Thus, disabled workers 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 non-disabled workers in the labor market. When the outside option increases, the disabled now has less incentives to mimic the non-disabled. This indirect effect relaxes the incentive compatibility constraint, therefore mitigating the distortions in the non-disabled workers' 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 disabled workers' participation condition. In this case, all disabled workers leave the labor force, with only the non-disabled workers remaining in the market. Then, efficiency in non-disabled workers' contracts are restored, at the expense of high DI expenditures (driven by non-participation of all disabled workers) borne by the government.

Second, we consider policies that impact workers who participate in the labor market. Specifically, we study the role of two types of subsidies: wage subsidies (to workers) through changes in the tax function $T_W(w)$, and hiring subsidies $T_F(w, a)$ given to firms. For the latter, the subsidy amounts can potentially be flexible enough to depend on both terms of the employment contract (wage and job amenities). Since the disabled workers already receive the efficient contract in equilibrium, providing more wage subsidies or firms subsidies to disabled workers would lead to either inefficiently high employment rate or over-provision of non-wage benefits for them. These subsidies, however, can also influence the adverse selection problem by affecting the disabled workers' incentives to mimic healthier workers. For instance, by providing higher subsidies to low-wage jobs, disabled workers may have less incentive to search in a submarket for non-disabled workers. This example suggests that there can be room of improving allocation by simultaneously using DI and subsidies. It is worth to notice that the impact of hiring subsidies to firms and wage subsidies to workers will have similar effects in terms of allocation. Importantly, however, the effects on welfare can be different, depending on the relative differences in the marginal utility gain from wages and job amenities, and also due to the presence of search friction. As the labor market is not perfectly competitive with search friction, the incidence of policies may differ depending on the actual party receiving the subsidies.

These discussions highlight that the optimal policy design requires the joint analysis of these policy instruments. The next section first formally defines the government problem, and in the following sections, we answer the question quantitatively.

## 3.4 Optimal Policy Design in the Screening Economy

Let government policies be denoted by $\boldsymbol{p} \equiv \{T_F, T_W, d\}$. Given welfare weights by type $\omega_i$ (and given the government's type-verification technology, $\psi_i$ for $i = (h, x)$, the government maximizes social welfare subject to the budget constraint:

$$\max_{T_F, T_W, d} \sum_{i \in I} \omega_i \left[ \mu\left(\theta_i^*\left(\boldsymbol{p}\right)\right) U_i^E\left(w_i^*\left(\boldsymbol{p}\right), a_i^*\left(\boldsymbol{p}\right)\right) + \left(1 - \mu\left(\theta_i^*\left(\boldsymbol{p}\right)\right)\right) U_i^N\left(b, d\right) \right]$$

$$\text{s.t.} \quad \sum_{i \in I} \pi_i \left( \left(1 - \mu\left(\theta_i^*\left(\boldsymbol{p}\right)\right)\right) \psi_i d + \mu\left(\theta_i^*\left(t_h, d\right)\right) \left(T_{F,h}\left(a_i^*\left(\boldsymbol{p}\right), w_i^*\left(\boldsymbol{p}\right)\right) + T_{W,h}\left(w_i^*\left(\boldsymbol{p}\right)\right)\right)\right)$$
$$= \sum_{i \in I} \pi_i \mu\left(\theta_i^*\left(\boldsymbol{p}\right)\right) t_w\left(w_i^*\left(\boldsymbol{p}\right)\right)$$

where $\{w_i^*\left(\boldsymbol{p}\right), a_i^*\left(\boldsymbol{p}\right), \mu_i^*\left(\theta_i^*\left(\boldsymbol{p}\right)\right)\}_{i=\mathcal{I}}$ are derived from labor market equilibrium conditions. We assume that the government sets and commits to the policies.[13]

In the full information benchmark with linear utilities and under restricted policies ($T_W = tw$ and $T_F = sC\left(a\right)$), we can prove that $T_W^* = 0$, so that $T_F^* = 0$ and $d^* = 0$.

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

*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 or subsidy to firms.

We are also able to show that, under certain assumptions, optimal tax rate is positive in the screening economy. Note that our assumption of linear tax and subsidies are imposed to obtain some benchmark analytical results. In our quantitative analysis, these assumptions are relaxed so that we consider nonlinear tax system (subsidies) and numerically characterize the optimal policies in our framework.

[13] It is important to note that, although the government commits to the policy ex-ante, the government can possibly learn the worker's health status ex-post, because employment contracts are perfectly separated by health types. We do not consider this possibility because we only characterize a one-shot (static) problem. In order to pursue this possibility, one must extend the framework to the dynamic environment where worker types are also changing over time. The government then imperfectly observes the worker type as in the current framework and therefore faces similar economic problem considered in this paper. The dynamic extension of the framework is left as a future research.

# 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 (the option to reduce work 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 Amendment of WOTC. This directly affects 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 the 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 expansion (as presented in Section 2) serve as additional targets of the model.[14]

## 4.2 Functional Forms and Parameters

The production function of a worker with health type $h$ and observed skill type $x$ is represented by $f_{h,x} = f_h \times f_x$, which assumes complementarity between health and skill type. We assume that there are three health types of workers consistent with our empirical analysis, where $h = 1$ denotes severely disabled workers and $h = 3$ denotes non-disabled workers. We consider that observed skill type $x$, is drawn from a log-Normal distribution with mean $-\sigma_h^2/2$ and health-dependent variance $\sigma_h^2$. We discretize the distribution into $N_z$ grids, implying that there are up to $3 \times N_z$ submarkets in the labor market.

[14] We identify the cost function of job amenities, by exploiting the effects of WOTC-expansion, which only affected the firms' differential profitability across health statuses. This relieves concerns on the potential bias from the estimating the model without multiple dimensions of worker heterogeneity.

The value of home production ($b$) is 40% of average productivity. We assume that workers' preferences on consumption is represented by a CRRA (constant relative risk aversion) utility function $u(c) = (c^{1-\sigma_c} - 1) / (1 - \sigma_c)$, with risk-aversion parameter of $\sigma_c$=2. Utility from job amenities is specified by $\varphi(a) = \left(1 - (a-1)^2\right)^\delta$ with $\delta \in (0.1)$. This function is concave as long as $\delta$ is less than one. Further, it satisfies $\lim_{a \to 0} \varphi'(a) = 0$ and $\lim_{a \to 1} \varphi'(a) = 0$, which is useful as the measure of job amenities used in estimation is the availability of flexible working hours. The cost function for non-wage benefits is represented by $C(a) = c_1 a^{c_2}$, which is convex with $c_2 \geq 1$. We assume a constant elasticity of substitution (CES) function for the job finding rate with parameter $\gamma$, so that $\mu(\theta) = \theta(1 + \theta^\gamma)^{-1/\gamma}$.

Government's disability verification probability ($\psi_h$) 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), which represent the probability of receiving DI upon applying for benefits in their model. For the benchmark economy, the DI benefits are assumed to be 50% of average productivity. Thus, the expected benefit of non-employment for the severely disabled worker is 71% of the average productivity of the economy ($b + \psi_h d = (0.4 + 0.62 \times 0.5)\bar{y}$). 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 job amenities. 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.[15] A firm hiring a worker of type-$h$ is expected to receive this lump-sum transfer with probability $\psi_h$.

The parameters to be estimated within the model are health-specific productivity $\{f_h\}$; health-specific preferences for job amenities $\{\beta_h\}$; curvature of the non-wage benefit utility function $\delta$; health-specific fixed disutility from work $\{\eta_h\}$; health-dependent variance of observed skill $x$ distribution $\{\sigma_h^2\}$; parameters governing the level and curvature of the cost of providing non-wage benefits $\{c_1, c_2\}$; parameter governing the elasticity of job finding rate with respect to market tightness $\gamma$; and the vacancy posting cost $\kappa$.

We find these parameters to match the average employment rates, wages, and job amenities by health status, the coefficient of variation of wages by health status, and the empirically estimated effects of WOTC on flexible hours (coefficients from the differences-in-differences estimation in Table 3).

The estimated parameters (preliminary) are summarized in Table 4[16], and the model fit

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

[16] Standard errors will be reported in the next version of the paper.

in Table 5.

Table 4: Parameter Estimates

| | Description | Value |
|---|---|---|
| $f_h$ | Productivity by health | $\{1.29, 1.63, 2.38\}$ |
| $\beta_h$ | Preference for job amenities | $\{2.98, 1.77, 1.38\}$ |
| $\delta$ | Curvature on utility from job amenities | 0.865 |
| $\eta_h$ | Fixed cost of work | $\{1.626, 0.774, 0\}$ |
| $\sigma_h^2$ | Variance of skill-distribution by health | $\{0.077, 0.070, 0.068\}$ |
| $\{c_1, c_2\}$ | Cost of job amenities | $\{4.593, 2.961\}$ |
| $\gamma$ | Matching function elasticity | 0.893 |
| $\kappa$ | Vacancy cost | 0.187 |

Our estimates indicate that disability has a significant effect on worker productivity. Specifically, a non-disabled worker's productivity is twice that of a severely disabled worker. Similarly, severely disabled workers value job amenities more have higher fixed cost of work than their healthier counter parts. Thus, in order for severely disabled workers to participate in the labor market, it is essential for them to receive sufficient amounts of job amenities. The model is able to fit the most salient qualitative features in both cross-sectional heterogeneity of wage, job amenities, and employment, and regression coefficients on job amenities documented in Table 3. Currently, however, the model somewhat underestimates the regression coefficients on post-WOTC and their interactions with health status.

Table 5: Model Fit

| | Data | Model |
|---|---|---|
| Job Amenities | | |
| Severely Disabled | 0.358 | 0.442 |
| Moderately Disabled | 0.328 | 0.321 |
| Non-Disabled | 0.326 | 0.188 |
| Wage | | |
| Severely Disabled | 1.000 | 0.958 |
| Moderately Disabled | 1.051 | 1.062 |
| Non-Disabled | 1.274 | 1.215 |
| Employment | | |
| Severely Disabled | 0.110 | 0.160 |
| Moderately Disabled | 0.450 | 0.538 |
| Non-Disabled | 0.670 | 0.773 |

| | Data | Model |
|---|---|---|
| Regression Coefficients on Job Amenities | | |
| Moderate | 0.130 | 0.113 |
| Severe | 0.240 | 0.222 |
| Post | 0.057 | 0.006 |
| Post×Moderate | 0.130 | 0.024 |
| Post × Severe | 0.057 | 0.016 |

## 4.3 Mechanisms

In Table 6, we compare the outcomes of the model in the first-best (FB) and the screening (AS) economies under the estimated parameters. First, we note that as predicted by the model, in the screening economy, job amenities 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 job amenities and the equilibrium market tightness, where the former has a positive effect, and the latter has a negative effect. Under the current parameterization, the former dominates for moderately disabled workers, and the latter dominates for non-disabled workers. 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 identical to the one in the first-best economy. Overall, our results show sizable distortions in labor market equilibrium due to adverse selection.[17]

Table 6: Equilibrium Outcomes: First-Best (FB) vs. Screening Model (AS)

| | Job Amenities | | Wage | | Employment | |
|---|---|---|---|---|---|---|
| | FB | AS | FB | AS | FB | AS |
| Severely Disabled | 0.454 | 0.454 | 0.996 | 0.996 | 0.154 | 0.154 |
| Moderately Disabled | 0.374 | 0.329 | 0.997 | 1.048 | 0.504 | 0.539 |
| Non-Disabled | 0.401 | 0.189 | 1.245 | 1.222 | 0.696 | 0.768 |

Next, we analyze whether the degree of distortions due to screening systematically varies with worker's observed skill levels. As skills and health statuses are complements in production ($f_{h,x} = f_h \cdot f_x$), firms might have more incentives to screen disabled workers among highly skilled workforce. In order to investigate this effect, in Table 7, we report job amenity levels by skill level under different economies. As is evident from comparing the differences in job amenities in the first-best and screening economies, the degree of distortions driven by screening differ across skill. The equilibrium amount of job amenities (or probability of receiving job amenities) provided to high-skilled, moderately disabled workers under screening contract is 12.7 percentage points (*pp*) lower; whereas the low-skilled, moderately disabled workers' amenities decrease by 4.1 *pp*. Similarly, non-disabled workers receive 22.4 *pp* and 27.4 *pp* lower amounts of job amenities for low-skilled and high-skilled workers respectively. These results suggest substantial heterogeneity in the extent of screening frictions across worker types.

[17]Job amenity levels in the first-best are monotonic in health statuses, if utility of consumption is linear. However, with risk-averse agents, which we assume, these may be non-monotonic in health statuses, due to differences in the marginal utilities of consumption.

Table 7: Skill Heterogeneity and Screening

| | Job Amenities | | | |
|---|---|---|---|---|
| | Low Skill | | High Skill | |
| | FB | AS | FB | AS |
| Severely Disabled | 0.382 | 0.382 | 0.567 | 0.567 |
| Moderately Disabled | 0.357 | 0.316 | 0.565 | 0.438 |
| Non-Disabled | 0.400 | 0.176 | 0.622 | 0.348 |

# 5 Quantitative Policy Analysis (Preliminary)

In this section, we conduct counterfactual analyses to study the effects of DI and tax subsidies to firms individually, and their joint effects. Our goal is to analyze the labor market equilibrium effects of the policies, their costs to the government, and lastly their welfare consequences.

## 5.1 Increase in the Generosity of DI

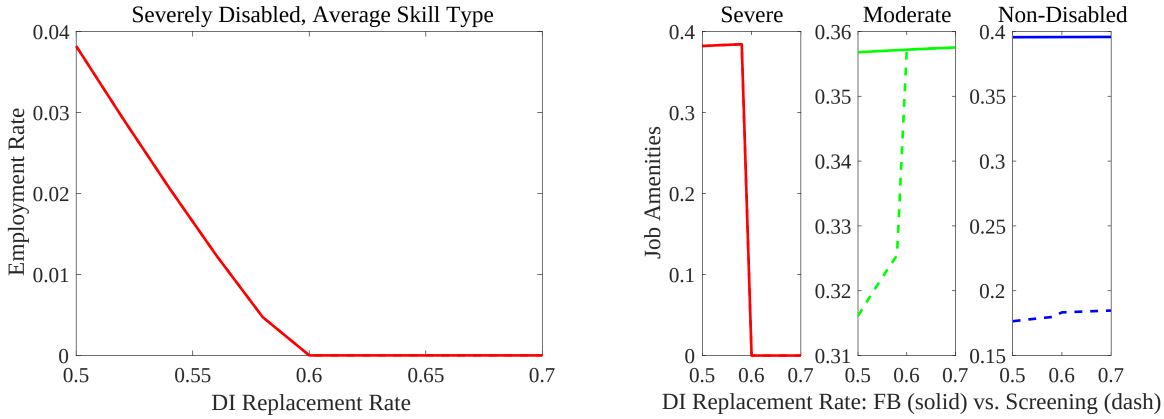
We first consider the effects of higher DI benefit replacement rates. For the analysis, we vary the replacement rate $d$ from 50% (benchmark policy) to 70%, while assuming that this is the only government policy implemented (no employment subsidies). Given the imperfect verifiability of health statuses ($\psi_h < 1$), a 70% DI replacement rate implies the expected outside option (which includes the value of home production) of $\{0.83, 0.53, 0.45\}$ of average productivity for severely, moderately, and non-disabled workers, respectively (compared to $\{0.71, 0.49, 0.44\}$ in the benchmark economy).

Before discussing the aggregate impacts of the policy changes, we first focus on the effects on workers with an average skill ($x$) type to better understand the results. In Figure 2(a), we plot the employment rate of severely disabled workers. As expected, a generous DI creates disincentive to work, and at around 60% replacement rate, severely disabled workers choose to stay out of the labor force completely. In Figure 2(b) are the equilibrium job amenities provided to severely disabled, moderately disabled, and non-disabled workers, under varying DI replacement rates. We plot the first-best (efficient) amounts of job amenities for a given $d$ (solid line), along with the amounts of job amenities in the screening equilibrium (dashed line).

Figure 2: Equilibrium with Varying DI, Average Skill Type

(a) Employment Rate of Severely Disabled

(b) Job Amenities by Health

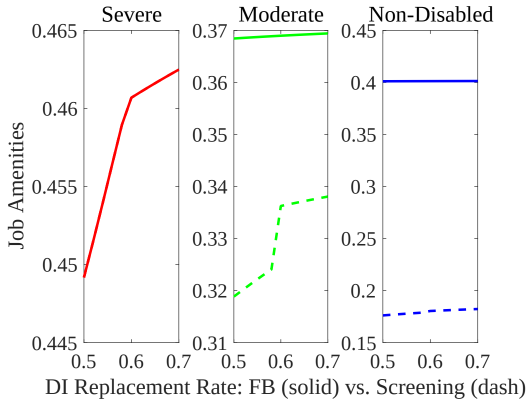



In the theoretical model, we showed that the worker type with the lowest health status in the labor market receives the efficient contract. Thus, at low DI replacement rates, contracts (wage and job amenities) for severely disabled workers are equivalent under first-best and screening economies (thus, solid and dashed lines overlap). On the other hand, moderately and severely disabled workers' job amenities in screening economy are inefficiently low, relative to their first-best outcomes: these distortions are caused by firms' screening incentives. Firms provide less job amenities in contracts for moderately disabled workers to ensure that severely disabled workers do not have the incentive to enter the labor market designed for moderately disabled workers. Same holds true between moderately disabled workers and non-disabled workers: non-disabled workers' contracts are distorted so that moderately disabled workers do not have the incentive to mimic non-disabled workers.

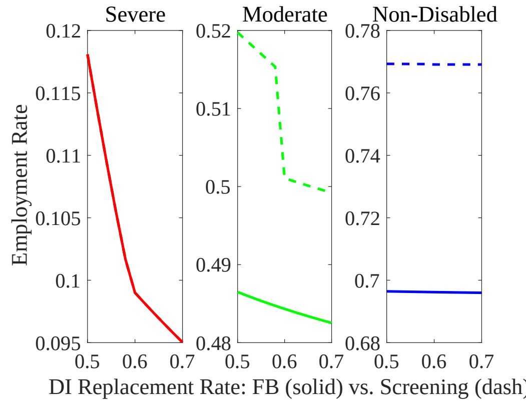
These screening incentives decrease, however, as the government makes DI benefits more generous. At around 60% replacement rate, moderately disabled workers become the least healthy type in the labor market, and now, they receive the first-best job amenities (solid and dashed lines overlap). The main reason is that, with this level of DI benefits, the severely disabled workers decide not to participate in the labor market. As a result, firms no longer need to screen severely disabled workers by offering inefficiently low job amenities to the moderately disabled workers. The inefficiency also decreases for non-disabled workers as seen by a small jump in the amount of job amenities provided to them. Thus, the key result is that, given the dependence of screening incentive on disabled's labor force participation margin, generous DI replacement can mitigate job amenities inefficiency at the expense of work disincentives of disabled worker.

Figure 3: Aggregate Effects of Generous DI

(a) Aggregate Job Amenities by Health




(b) Aggregate Employment by Health



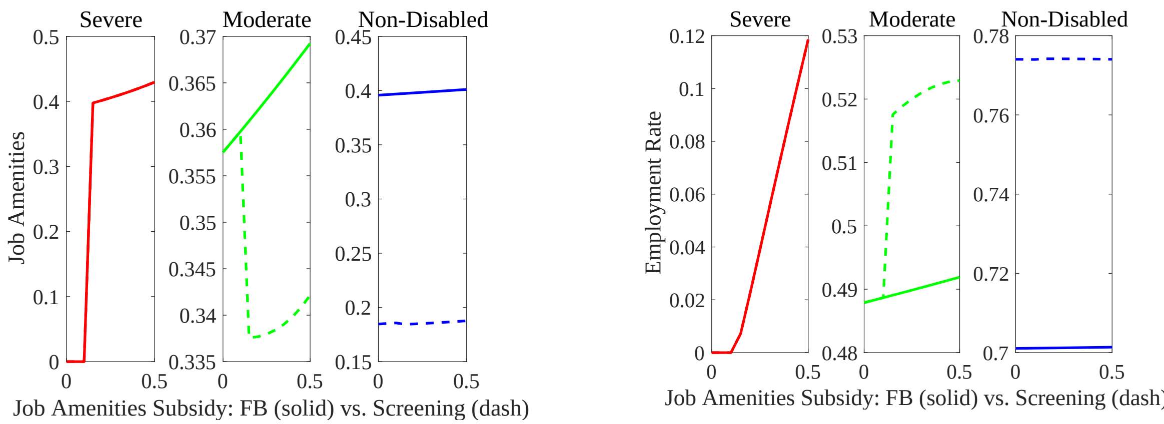

The aggregate impacts of DI (averages over skill types) are summarized in Figure 3, where the left panel plots the aggregate job amenities and the right panel, aggregate employment by health statuses. Overall, generous DI leads to higher job amenities provided to workers. The pronounced increase for severely disabled workers can be explained by two forces. First, as the value of outside option increases, firms are forced to make work more attractive. Second effect is through changes in the worker composition. Workers in our model differ in their health statuses and skills. When DI becomes more generous, low-skilled workers are more likely to leave the labor force, and this affects the average skill level of severely disabled workforce. As skilled workers receive more job amenities, conditional on health status, this composition effect leads to higher aggregate job amenities provided to severely disabled workers. Overall, the degree of inefficiencies in the labor market, as measured by the differences between the first-best outcomes (solid lines) and the outcomes in the screening economy (dashed lines), become smaller with higher replacement rates. This effect of DI on labor market is novel in our framework, where we specifically model and estimate the role of screening in equilibrium.

## 5.2 Firm Subsidies on Job Amenities

We now consider the effect of direct subsidies given specifically for the provision of job amenities, while fixing the DI replacement rate at 70%. In particular, we let $T_F(w, a) = sC(a)$, which is proportionately adjusted by the government's ability to verify health statuses, $\psi_h$. It is important to mention that while this policy and WOTC are both firm subsidies, they have different impacts on firm decisions. Since WOTC is a lump-sum transfer given to a firm hiring a disabled worker, it should not affect amenity provisions for workers of the lowest health type in the labor market. However, the proportional subsidy to the costs of job amenities directly lowers the marginal cost of job amenities. Thus, firms optimally decide to offer more job amenities even to the lowest health types in the labor market. In this counterfactual experiment, we vary the subsidy rate from 0% (benchmark policy) to 50%, and plot their labor market equilibrium effects for an average skill type worker in Figure 4.

Figure 4: Equilibrium with Varying Job Amenity Subsidies, Average Skill Type

(a) Job Amenities by Health (b) Employment by Health




The effects of direct subsidies for job amenity provision are the opposite of those of generous DI. When job amenity subsidies are low, severely disabled workers find it more attractive to stay out of the labor force, and thus their employment rate is zero. This leads to efficient labor market outcomes for moderately disabled workers, who end up being the lowest health type participating in the labor market. Thus, their job amenities and employment rates in the screening economy overlap with those in the first-best economy. However, as the job amenity subsidies increase and thus severely disabled workers start working, the firms' need to screen workers arise. This effect is captured by the gap in the amenities provided in the first-best and the screening economy: there is an under-provision of job amenities in moderately-disabled workers' equilibrium contracts. This is offset by an increase in the equilibrium employment rates as seen in Figure 4(b). Under the policies in consideration, moderately disabled workers always participate in the labor market, and thus non-disabled workers' labor market outcomes are always inefficient relative to the first-best.

## 5.3 Aggregate Costs and Utility Consequences

We now analyze the aggregate cost and utility implications of these policy scenarios. The nature of the policies we study in the previous sections differ in that DI are given to non-employed disabled workers and job amenity subsidies are given to employed disabled workers. Therefore, increase in DI generosity that disincentivizes employment unambiguously increases the cost associated with DI, while it decreases the government's expenditures on job amenity subsidies (if subsidy rate is strictly positive). We first show how the aggregate cost changes with varying job amenity subsidies, under the parameters discussed in Section 5.2: a proportional job amenity subsidy rate $s$ changes from 0% to 50%, with a fixed DI replacement rate of 70%. Then, we analyze the cost and utility consequences of the same varying job amenity subsidy rates under a less generous DI replacement rate of 50%.

Figure 5: Aggregate Policy Costs with Varying Job Amenity Subsidies

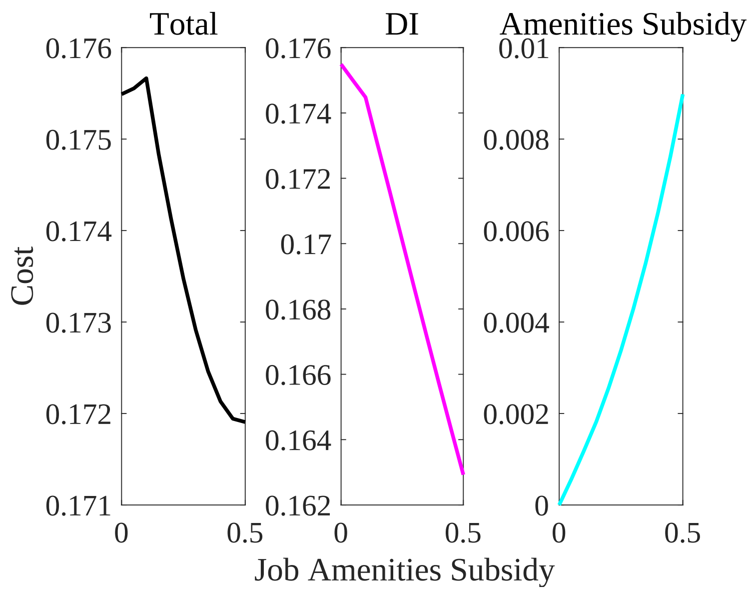
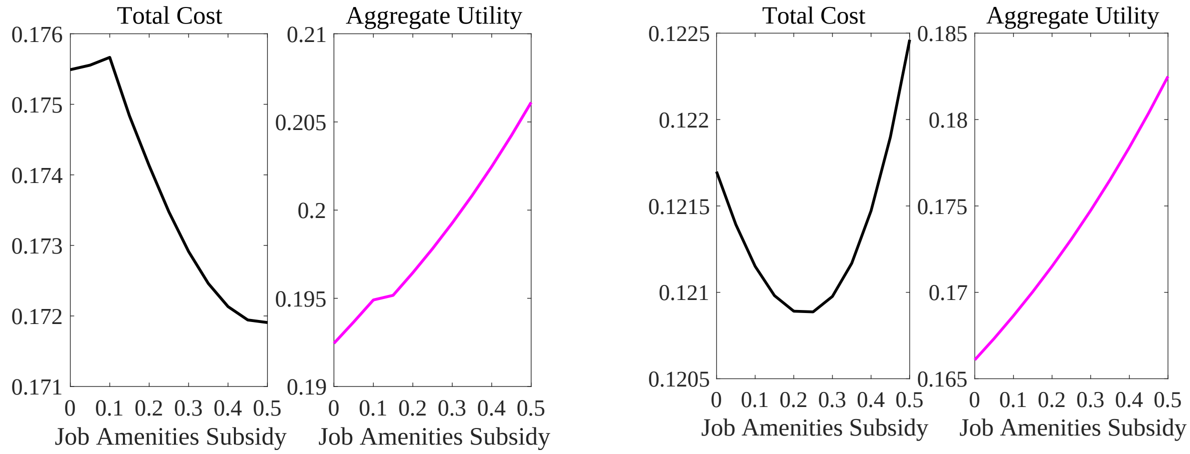



Figure 5 plots the total policy costs, and also separately, DI costs and amenity subsidy costs. Even though the government is increasing the job amenity subsidy rate, we see that the total cost is not monotonically increasing. While it increases initially, a more generous subsidy lowers the aggregate cost. In Figure 4, we showed workers' employment responses to job amenity subsidy rates. As subsidy rate increases, severely disabled workers start entering the labor market. Thus, the government now faces less expenditures on their DI benefits, and this is where the kink occurs in the total cost plot. At the kink, the aggregate DI cost decrease is steeper as seen in the middle panel of Figure 5, while amenity costs are increasing smoothly. As the former effect dominates, the total cost decreases beyond the kink point.

Figure 6: Cost and Utility Consequences with Varying Job Amenity Subsidies

(a) 70% DI Replacement Rate (b) 50% DI Replacement Rate




The natural question then is to understand the welfare consequence of this policy reform. In Figure 6(a), we plot the total costs along with aggregate utility (from a utilitarian social welfare). As is clear, we see that the aggregate utility increases over the whole region. These cost and utility consequences imply that it is not only more cost-effective, but also welfare-improving to increase the subsidy rate for job amenities. The increased employment of severely disabled workers driven by higher amenity subsidy increases welfare, while decreasing the costs of providing DI. However, the increased firms' incentive to screen disabled workers inevitably lowers the utility of moderately and non-disabled workers, as their contracts are distorted in equilibrium (screening incentives). Thus, the increased aggregate welfare masks higher utility for disabled workers which comes at the expense of healthier workers.

We now explore the role of job amenity subsidies in the presence of a less generous (50% replacement rate) DI policy. The total costs and aggregate utilities are plotted in Figure 6(b). The total cost consequences from job amenity subsidies differ by the generosity of DI benefits in place. While it is overall cheaper to implement a less generous DI program, we see that job amenity subsidies can further reduce costs while increasing aggregate utility. Interestingly, the job subsidy rate that yields the lowest cost is lower than that under a more generous DI program. When outside option is lower for the disabled (less generous DI), then it is easier (cheaper) to incentivize them to come back to the labor market. While this increases the firms' screening incentives, in the aggregate, welfare is increasing.[18] These comparisons show that there exists a non-trivial interaction between DI and amenity subsidies, and further that

[18]This may not always hold, as the utility loss experienced by moderately and non-disabled workers due to contract distortions might be higher than utility gain for severely disabled workers.

the efficient job amenity subsidies depend on DI generosity.

These counterfactual analyses show the role of employment subsidies, in the form of job amenity subsidy in this case, in designing policies for disabled workers. While these policies are not actively used relative to DI, they might prove to be cost-effective and welfare-improving in the aggregate economy.

### 5.4 Optimal Policy Design (to be updated)

We currently consider a very specific hiring subsidy policy, but it is important to consider other types of employment subsidies, like direct wage subsidies, for example which is widely used in Europe. We will also study the role of (potentially progressive or regressive) wage subsidy policies, and use the fully estimated model to study the joint optimal design of the policies in the screening economy.

## 6 Conclusion

In this paper, we study the equilibrium impacts of disability policies, focusing on the effects these policies have on firms' screening incentives. We first empirically show that certain job amenities (option to reduce work hours) are used to screen disabled workers, using the expansion of the Work Opportunity Tax Credit program in 2004. Then, we build a labor market screening model, consistent with the empirical findings. In the model, the government policy intended to encourage the employment of disabled workers increases the firms' incentive to screen, leading to inefficiencies in the contracts designed for non-disabled workers. On the other hand, disability insurance, which has well-known to labor supply disincentive effects, can mitigate the inefficiencies on non-disabled workers' equilibrium contracts. In order to evaluate and study optimal design of these policies, we estimate the model using the Health and Retirement Study data, and conduct quantitative policy analysis. Our preliminary findings suggest that a more active utilization of firm (employment) subsidies might be an effective way of insuring disabled workers, at lower government expenditures on disability insurance.

Our framework provides an important foundation for understanding the joint effects of social insurance and labor market policies for disabled workers in the presence of adverse selection. However, it is not without limitations. First of all, in order to focus on the firm-side responses to government policies, we made a very simplistic assumption on the worker side by assuming that workers solve a static labor supply problem. It is desirable to add life-cycle features in the model with consumption and savings margin to characterize the labor supply effects of DI. Second and relatedly, it is important to consider the firms' dynamic screening problem in an environment where worker's health status changes over time. We leave these interesting extensions for future research.

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# A Proofs

## A.1 Equilibrium Contracts in the Screening Economy (with Risk-Neutral Workers and Linear Policies)

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. Also assume, for simplicity, income taxes are proportionate at rate $t$, and firm subsidies are given specifically for the provision of job amenities with the amount $sC(a)$. 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,

$$d_2 + \max_{\theta,w,a} \mu(\theta)\left[(1-t)\,w + \beta_2\left(\sum_k \varphi(a_k)\right) - F_2 - d_2\right]$$

s.t.

$$\text{(FE)}\quad \mu(\theta)\left\{y_2 - w - (1-\psi_i s)\sum_k c(a_k) + tr_2\right\} \geq \theta\kappa$$

$$\text{(IC)}\quad \mu(\theta)\left\{(1-t)\,w + \beta_1\left(\sum_k \varphi(a_k)\right) - F_1\right\} + (1-\mu(\theta))(b + \varphi_i d_1) \leq \bar{U}_1$$

Let Lagrange multipliers with respect to (FE) and (IC) be $\nu$and $\lambda$. Then, from the FOC with respect to the wage rate, we get

$$\mu(\theta)(1-t) - \nu\mu(\theta) - \lambda\mu(\theta)(1-t) = 0$$
$$(1-t)(1-\lambda) = \nu$$

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

$$\mu(\theta)\,\beta_2\varphi'(a_k) - \nu\mu(\theta)(1-\psi_i s)\,c'(a_k) - \lambda\mu(\theta)\,\beta_1\varphi'(a_k) = 0$$
$$(\beta_2 - \lambda\beta_1)\,\varphi'(a_k) = (1-t)(1-\lambda)(1-\psi_i s)\,c'(a_k)$$

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 $\nu$ is positive, thus, the denominator must be positive. This implies that for $\lambda$ 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 $\beta_2 \varphi'\left(a_k^{FB}\right) = (1-t)(1-\psi_i s) c'\left(a_k^{FB}\right)$. Thus, by concavity of $\psi$ 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 $\theta$ 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 $\theta$:

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

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 $\xi$). So, simplifying, the FOC with respect to $\theta$ can be expressed as

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

In the FB, the following hold:

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

which implies that the $\left(a^{FB}, \theta^{FB}\right)$ satisfies equation (2).

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

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

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, $\kappa$), it must be that $\mu'\left(\theta^{AS}\right) < \mu'\left(\theta^{FB}\right)$, which implies with a concave matching function, $\theta^{AS} > \theta^{FB}$.

Lastly,

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

If $(a,\theta) = \left(a^{FB}, \theta^{FB}\right)$, then $w = w^{FB}$. If $a^{AS} < a^{FB}$, then from our assumption that $\beta_2\varphi(a) - \tilde{d}_2 < 0$, $\left\{ y_2 - c(a) + \frac{c'(a)}{\beta_2\varphi'(a)} \left(\beta_2\varphi(a) - \tilde{d}_2\right) \right\}$ 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 government's budget constraint,

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

Substituting $d$,

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

The first-order condition with respect to $d$ reads:

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

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

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

and

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

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

# B Empirical Analysis

## B.1 Testing for common-trend assumption

We test for the common-trend assumption for flexible hours using the following empirical specification:

$$y_{it} = \alpha_h + \sum_{j=1998}^{2008} \beta_t^h \mathbb{I}_{\{\text{health}=h\}} + \boldsymbol{\gamma}\mathbf{X_{it}} + \boldsymbol{\nu}\boldsymbol{Z_t} + \epsilon_{it}$$

| | | Severely disabled | Moderate disabled |
|---|---|---|---|
| Health status | | 0.191 (0.063)*** | 0.076 (0.034)** |
| Pre-WOCT expansion | $\beta_{1998}$ | -0.001 (0.072) | 0.01 (0.033) |
| | $\beta_{2000}$ | -0.04 (0.076) | 0.016 (0.037) |
| | $\beta_{2002}$ | 0.045 (0.093) | 0.059 (0.04) |
| Post-WOCT expansion | $\beta_{2004}$ | 0.008 (0.099) | 0.112 (0.048)** |
| | $\beta_{2006}$ | 0.004 (0.084) | 0.059 (0.043) |
| | $\beta_{2008}$ | 0.067 (0.093) | 0.109 (0.048)** |

## B.2 The Effects of WOTC on Labor Market Outcomes

The following table documents the empirical results from the diff-in-diff analysis on labor market outcomes.

Table 8: Effects of the WOTC-Amendment on Labor Market Outcomes

| | | Employment | Wage |
|---|---|---|---|
| Post-Amendment | | $0.026^{**}$ | $-0.650$ |
| ($\beta_1$) | | (0.013) | (0.652) |
| Health Status | Severe | $-0.894^{***}$ | $-1.450$ |
| ($\beta_{2h}$) | | (0.021) | (0.936) |
| | Moderate | $-0.407^{***}$ | $-1.201^{***}$ |
| | | (0.014) | (0.458) |
| Health Status | Severe | $-0.016$ | $-1.407$ |
| × Post-Amendment | | (0.017) | (1.000) |
| ($\beta_{3h}$) | Moderate | $-0.006$ | $-0.492$ |
| | | (0.019) | (0.723) |

*Note:* Sample in this regression analysis is restricted to high school graduates. The additional covariates used in the regression include age, age-squared, female dummy, self-reported health status dummy, firm-size categories dummy, union dummy, and annual growth rate of GDP. Standard error is clustered at individual-level.

## B.3 Robustness Analysis

We present results with some additional controls.

Table 9: Effects of the WOTC-Amendment on Job Amenities

| | | Flexible Hours | Flexible Hours |
|---|---|---|---|
| Health Status | Severe | $0.229^{***}$ | $0.229^{***}$ |
| ($\beta_{2h}$) | | (0.007) | (0.001) |
| | Moderate | $0.118^{***}$ | $0.118^{***}$ |
| | | (0.003) | (0.003) |
| Health Status | Severe | 0.021 | 0.021 |
| × Post-Amendment | | (0.792) | (0.797) |
| ($\beta_{3h}$) | Moderate | $0.107^{**}$ | $0.107^{**}$ |
| | | (0.025) | (0.026) |
| Additional Controls | | Wage, Wage×Post | Wage, Wage×Post<br>Gender×Post |

*Note:* Sample in this regression analysis is restricted to high school graduates. The additional covariates used in the regression include age, age-squared, female dummy, self-reported health status dummy, firm-size categories dummy, union dummy, and annual growth rate of GDP. Standard error is clustered at individual-level.