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

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Abstract

We evaluate social insurance program designs for the disabled by empirically implementing a frictional labor market model with screening employment contracts. In the model, firms post a screening contract consisting of wage and job amenities, and workers with different levels of disability make labor supply decisions. We first theoretically analyze the optimal structure of disability insurance (DI) and firm subsidies for hiring the disabled. Then, by exploiting policy variation in hiring subsidies for the disabled, we empirically examine which job amenities may be used by firms to screen out the disabled, and we structurally estimate our equilibrium model. Using the estimated model, we quantitatively explore the optimal *joint* design of DI and firm subsidies for employing disabled workers. We find a welfare improving role of firm subsidies that encourage firms to provide more job amenities, mitigating the labor supply disincentives of DI and labor market distortions induced by firms screening contracts. Finally, we show that the presence of a firm's screening incentive significantly affects the effectiveness of the policies: the optimal level of DI should be higher to ameliorate contract distortions caused by the firm's screening activities.

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1 Introduction

Most advanced countries implement various social insurance programs to support individuals with disabilities. First, there are large-scale public disability insurance (DI) programs, which provide income support to disabled individuals who cannot work much.[1] Second, there are labor market policies (or "integration" policies as in OECD (2010)) for the disabled, such as the Americans with Disabilities Act (ADA) in the U.S. These policies aim to provide better job opportunities for disabled workers by prohibiting firms from discriminating against workers based on disability and by subsidizing firms to hire the disabled. As surveyed by OECD (2010), many OECD countries have expanded labor market policies for the disabled to increase their employment rates. The need for reforming labor market policies for the disabled has also been widely discussed in the U.S.[2] Importantly, these two classes of policies—DI and labor market policies—interact with each other to determine the impacts on labor market outcomes, government expenditures, and social welfare. For example, labor market policies for the disabled could reduce spending on DI by increasing the employment rate of disabled workers. Then, how should the government *jointly* design DI and labor market policies for the disabled?

Towards that goal, it is essential to first understand how these policies affect both labor supply and labor demand of the disabled. Although there exists an extensive literature investigating the impact of the DI program on individual labor supply and welfare, only a few studies have investigated the response of firms to either labor-demand side or labor-supply side policies. DeLeire (2000) and Acemoglu and Angrist (2001) argue that the introduction of the ADA substantially raised the cost of hiring disabled workers, lowering the labor demand for these workers. These studies suggest that firms may have incentives to screen out (or avoid hiring) possibly costly disabled workers. However, to date, little is known about whether and how firms screen out disabled workers when they cannot explicitly discriminate against workers based on their disability statuses. Quantifying these behavioral responses is central to understanding how the government should design DI or firm subsidies.

This paper studies the efficient design of social insurance programs for disabled workers in an empirical equilibrium labor market model in which firms offer screening employment contracts. Consistent with a long-held theoretical view that firms may screen workers using employment contracts (Akerlof, 1976), we hypothesize that firms may design job amenities (or non-wage benefits) to avoid hiring disabled workers. We think that screening contract

[1] According to the recent OECD report, on average, its member countries spend 2.1% of their GDP for disability- and incapacity-related social policy programs (OECD, 2016).

[2] For example, Autor and Duggan (2010) propose to expand employer-based disability insurance to make more firms accommodate the disabled.

is a plausible screening mechanism under the presence of the ADA, which prohibits firms from explicitly discriminating workers based on disability and mandates provision of certain accommodations. In the first part of the paper, we develop an equilibrium screening model of the labor market with disability and disability policies and theoretically analyze the optimal design of disability policies. We then empirically examine which job amenity could be used for screening and structurally estimate the equilibrium model by exploiting policy variations that differentially affect firms' profits from recruiting disabled workers relative to the non-disabled. Using the estimated model, we quantitatively analyze the optimal combination of DI and hiring subsidies for the disabled.

Our model is based on screening labor contract models, such as those of Akerlof (1976), Guerrieri, Shimer and Wright (2010), and Stantcheva (2014). We depart from these papers by incorporating disability and disability policies. In our model, workers differ by their disability status and by observed skill levels. A worker's disability status affects his disutility from work, output, and preference for job characteristics. Workers optimally choose whether to search for a job (i.e., the labor force participation decision is endogenous) and what type of job to search for (i.e., the search process is directed). Similarly, once deciding to recruit workers, firms choose wage and job amenities to maximize their profits. We assume that these contracts cannot explicitly depend on a worker's disability status, although they can still depend on the observed skill levels. As a result, firms may adjust their contracts to screen workers with different degrees of disability. The model allows for the differences in the extent of screening contract distortions by worker's observed skill types.

Following Guerrieri, Shimer and Wright (2010), we introduce a labor market search friction, which leads to the following two desirable features. First, employment rates are determined endogenously in equilibrium and depend on the ex-post profitability of firms, which differs from standard frictionless screening models with full employment among all workers. This feature is necessary because the policy instruments explicitly depend on employment statuses. Second, we can guarantee the existence and the uniqueness of equilibrium, which may not be guaranteed in frictionless screening models. Within this framework, we introduce the key features of disability insurance and firm subsidies: the former affects the worker's value of non-employment and the latter affects the firm's profit.

Using this framework, we first analytically characterize the optimal structure of disability policies. We consider the government problem which maximizes the social welfare subject to a revenue requirement. We show that the optimal policies are essentially determined by three channels. First, the optimal policy must reflect the redistribution (or insurance) channel: the government wants to transfer resources from the non-disabled to the disabled. Importantly, DI provides income insurance for individuals who cannot work, while employment subsidies for disabled workers can smooth the value of employment across workers with different disability statuses. Second, the optimal policy depends on behavioral distortions, which consist of distortions in job amenities (intensive margins of contracts) and employment rates. Third, the optimal policy depends on the strength of firms' screening incentives. Firms in the model offer an inefficiently small amount of job amenities to the non-disabled to discourage the disabled from applying to the job. Importantly, firm subsidies can mitigate the screening distortion by increasing the value of employment for disabled workers, while DI can mitigate it by increasing the value of non-employment. Thus, the government designs these policies to account for their impacts on firms' screening incentives.

Next, we empirically implement the equilibrium model using the Health and Retirement Study (HRS). To begin with, we hypothesize that firms use flexibility in working hours, such as whether the job offers the option to reduce working hours, as a major screening tool. The provision of this job amenity is not necessarily mandated under the ADA. Compared with other job amenities such as employer-based health insurance, flexibility in working hours is often determined at each employee level, not at a firm level. Moreover, we find that the disabled tend to work at jobs that provide more flexibility in working hours, indicating their preference for this job amenity.[3] Then, we show a suggestive evidence that the option to reduce working hour is responsive to screening incentives (i.e., the relative profitability of hiring workers of different disability statuses) by exploiting two labor-demand side policy interventions for the disabled, the Amendment of the the Work Opportunity Tax Credit (WOTC) program in 2004 and the ADA Amendments Act of 2008.[4] This finding supports our hypothesis that the option to reduce working hours can be an important screening tool in the labor market for the disabled.

We then structurally estimate our equilibrium model using the option to reduce working hours as our job amenity measure, and we conduct an external validation of our estimated model. The main identification challenge in estimation is in that the degree of labor market screening is endogenously determined in equilibrium, affected by both the labor supply (resource cost of providing the amenity benefit) and labor demand side (worker utility from job amenities) parameters. To separately identify these parameters, we exploit the effects of the 2004 WOTC Amendment, which mainly affected the labor demand-side payoffs. We estimate our model through an indirect inference procedure. Then, we conduct a model validation exercise and show that the model is able to produce an empirically plausible employment

[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.

[4] The WOTC provides subsidies to firms employing workers in target groups; in 2004, the eligibility of qualified disability groups substantially expanded. The ADA was amended in 2008 to expand the eligibility of disabled workers for the ADA. The detailed description of the policies is discussed in Section 4.1.1.

effect of DI, similar to those in the literature exploiting quasi-experiments (Maestas, Mullen and Strand, 2013). From our estimates, we find that the inefficiencies in job amenities due to firm screening contract can be sizable: in the presence of screening, the share of employees with the option to reduce working hours can be on average 7% lower relative to the economy without screening contract.

With the estimated model, we conduct various counterfactual analyses, including deriving the optimal combination of disability insurance generosity and firm subsidies. We specifically consider subsidizing the costs of providing job amenities related to the flexibility of working hours, which is implemented in several European countries.[5] We find that introducing a job amenity subsidy is effective in increasing welfare for workers of all disability statuses: these subsidies provide better consumption insurance among the employed against disability status and also ameliorate screening distortions in the labor market. Therefore, our finding suggests a potential welfare gain from subsidizing firms, which does not currently occur in the U.S. to any meaningful degree, particularly relative to large expenditures on DI ($220 billion per year).

Interestingly, we also find that the optimal generosity of DI is higher when the government provides amenity subsidies, as the labor supply disincentive effects of DI can be mitigated by the use of amenity subsidies. Thus, the overall spending on DI may decrease despite an increase in its generosity. Overall, we find that the optimal structure can increase social welfare by equivalent to a 1.6% increase in consumption. Lastly, in order to isolate the effects of screening on optimal policies, we conduct counterfactual analysis in the absence of firms screening incentives (by assuming that firms can write health-dependent contracts). Because both DI and amenity subsidies are able to alleviate contract distortions in the screening economy, we find that the optimal DI benefit may be higher in the presence of screening than in its absence. This suggests the importance of incorporating firm screening incentives in optimal policy design analyses.

Related Literature. First of all, this paper contributes to the literature studying disability in the labor market and disability insurance. There exists an extensive literature that focuses on measuring the labor supply effects of disability insurance, early contributions of which are summarized in Bound and Burkhauser (1999). This literature has made substantial progress by utilizing rich worker-side data with cutting-edge empirical techniques, including French and Song (2014), Maestas, Mullen and Strand (2013), and Autor et al.

[5]Sweden, Norway, Great Britain, and Luxembourg provide financial incentives for employers to offer part-time positions to their disabled employees (OECD (2010)).

(2018).[6] The labor supply response is also the key ingredient in the literature theoretically analyzing the optimal disability insurance (e.g., Diamond and Sheshinski, 1995; and Golosov and Tsyvinski, 2006) and the literature quantitatively evaluating various DI designs (e.g., Low and Pistaferri, 2015; French and Song, 2017; Michaud and Wiczer, 2018). Compared with this huge literature, there are still only a handful of studies investigating firm-side regulations or the labor demand side responses (e.g., DeLeire (2000) and Acemoglu and Angrist (2001) that evaluate the impact of ADA on labor demand). To the best of our knowledge, this paper is the first paper providing a formal analysis of disability policy designs in an equilibrium labor market context. We substantially expand the scope of the analysis by incorporating intensive and extensive labor supply margins, by explicitly characterizing firms' decisions to create job positions using a richer employment contract space, and by modeling firms screening incentives motivated by labor market regulations. We show both theoretically and empirically that accounting for labor demand-side responses to screening incentives is crucial in determining the optimal structure of policies for the disabled.

Second, our paper contributes to the large literature analyzing screening problems in the labor market. A pioneering work in this literature is the rat-race model developed by Akerlof (1976), who shows that a distortion in employment contracts arises in equilibrium if firms cannot observe worker's ability. Guerrieri, Shimer and Wright (2010) and Auster and Gottardi (2018) develop a general screening framework with search frictions.[7] More recently, Stantcheva (2014) theoretically studies optimal income taxation in the labor market screening model of Akerlof (1976). The key premise of this literature is that firms screen workers through labor contracts, rather than through more direct means, such as ability tests. Despite the wealth of this theoretical literature, there are few studies providing empirical evidence of the presence and the characteristics of screening contracts in labor markets. A few exceptions are Landers, Rebitzer and Taylor (1996) and Autor (2001): Landers, Rebitzer and Taylor (1996) show that lawyers may work inefficiently long hours to reveal their ability in large law firms, and Autor (2001) shows the evidence that training may be used as as a screening tool for temporary help firms. This paper focuses on screening by disability statuses, where the firm's inability to write a type-dependent contract arises not only due to asymmetric information, but also due to the anti-discrimination laws. In this context, we

[6]See also Kostøl and Mogstad (2014) who study the employment effects of DI in Norway where DI benefit is also partially available to the employed.

[7]Davoodalhosseini (2015) theoretically studies the efficiency property of the directed search equilibrium with adverse selection and the optimal sales tax in the framework. Recently, Lester et al. (2017) propose a tractable framework that 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.

develop an empirical strategy to detect the potential screening tool. Moreover, we quantify the degree of distortion in contracts and explore the optimal policy design by developing an empirical equilibrium screening model, which endogenizes employment both through labor supply and demand margins and allows heterogeneity in the value of being non-employed (the outside option of workers). With this structure, the model is able to capture the dependence of screening distortions on employment rates.

Finally, our paper contributes to the large literature analyzing designs of labor market and social insurance policies within an equilibrium labor market model. From the theoretical perspective, Acemoglu and Shimer (1999), Blanchard and Tirole (2008), and Golosov, Maziero and Menzio (2013) emphasize the need of modeling labor demand sides to understand the determinants of the optimal unemployment insurance, employment protection policies, or income taxation. From the quantitative standpoint, Mitman and Rabinovich (2015), Landais, Michaillat and Saez (2018), Braxton, Herkenhoff and Phillips (2018), and Chodorow-Reich, Coglianese and Karabarbounis (2019) investigate equilibrium labor market implications of designs of unemployment insurance. The literature emphasizes the search frictions in the labor market as a source of welfare loss. Our paper substantially advances this literature by determining the joint optimal design of worker-side and firm-side social insurance policies in an environment where the information friction in the labor market is also a central ingredient.[8]

The rest of the paper is organized as follows. In Section 2, we present a search-frictional labor market model with screening and establish several theoretical results. Then, we discuss the main dataset in Section 3. Section 4 explains the main empirical strategies and findings. In section 5, we conduct counterfactual policy experiments. Finally, Section 6 concludes.

2 An Equilibrium Labor Market Model with Screening

This section develops an equilibrium labor market model. Our model is an extension of Guerrieri, Shimer and Wright (2010), which studies a search-frictional equilibrium model with asymmetric information.

2.1 Model Environment

Workers. Labor market is populated by a continuum of workers and firms. There is a measure one of workers who value consumption and leisure. Workers are heterogeneous in

[8]See also Corbae and Glover (2018) who study the impact of a policy that restricts pre-employment credit screening in a search-bargaining-matching model of the labor market with adverse selection.

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 $i \equiv (h, x) \in \mathcal{I}$ 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 job to apply for (intensive margin).

When workers are employed, they produce output denoted by $f_{h,x}$. 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* output of a worker *perceived by* firms. The heterogeneity in $f_{h,x}$ regarding h could be due to productivity differences driven by health, due to the expected costs of mandated accommodation under the ADA which vary with h, or due to firms' discrimination against the disabled for taste reasons as in Becker (1971). That is, firms may consider that there might be additional costs to hiring disabled workers which arises from their prejudice.

The workers' preferences are represented by the utility function

$$U_{h,x}(c, a) = u(c) - (\chi_h - \beta_h \varphi(a))\,\mathbb{I}(\text{employed}),$$

where c denotes consumption and $\chi_h - \beta_h \varphi(a)$ captures the disutility from work with a denoting the amount of job amenities provided by the firm.[9] The worker derives utility from consumption through $u(c)$, which satisfies $u' > 0$ and $u'' \leq 0$. The disutility from work consists of type-dependent fixed utility cost χ_h, and utility from job amenities $\beta_h \varphi(a)$. The job amenities increase utility from work (or lowers disutility from work) through function $\varphi(a)$, which satisfies $\varphi' > 0$, $\varphi'' < 0$, $\lim_{a \to 0} \varphi'(a) = \infty$, and $\lim_{a \to \infty} \varphi'(a) = 0$. Furthermore, the type-specific preference is represented by β_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 $c = w - \tau(w)$, where $\tau(w)$ represents a tax (or subsidy) function. If an individual does not work, his consumption consists of home production b_x and disability insurance amount d_x from the government, which is awarded *probabilistically* (we discuss this further below). We flexibly allow these variables to be dependent on skill x, and denote the utility from not working as $U^N_{h,x}(b_x, d_x)$.

[9]In our theoretical model, we consider job amenity a as a continuous variable with support $\mathbb{R}_+$. In our empirical specification, we consider it as the probability that firms offer a job amenity, so that it is restricted over the interval $[0, 1]$.

[10]Note that if there are multi-dimensional heterogeneity in individuals that are unobserved or not conditioned by firms and that leads to violation of assumption 1 (introduced later), then it creates 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. See footnote 45 in Section 4.2.2 for the detail.

Firms. There is a continuum of ex-ante homogeneous, risk-neutral firms that have a production technology translating a type-(h,x) worker into output $f_{h,x}$. To hire a worker, a firm posts a contract by paying κ. A contract consists of wage w and job amenity a. Firms can observe worker's skill x and are allowed to post contracts based on it. However, the contract cannot be contingent on a worker's health type h, either due to information friction (h is unobservable), or as they are prohibited from doing so under the ADA regulation.[11,12] When a worker type-(h,x) is hired, the firm's payoff is $v_{h,x}(w,a) = f_{h,x} - w - C(a)$, where $C(a)$ denotes the (net) cost of providing job amenities that satisfies $C' > 0$ and $C'' \geq 0$.[13]

Labor Market. Labor market is subject to search frictions, and firms and workers direct their search. 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 skill x because of our assumption that firms can directly offer the observed skill-dependent contracts.

Market tightness, the ratio of firm 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 $\mu : [0,\infty] \to [0,1]$ is a strictly increasing and concave function of θ ($\mu^{'}(\theta) > 0$ and $\mu^{''}(\theta) \leq 0$). Similarly, a firm posting a vacancy characterized by a contract y_x finds its employee with probability $\eta(\theta(y_x))$, where the worker-finding probability $\eta : [0,\infty] \to [0,1]$ is a decreasing function of θ. Assuming a constant-returns-to-scale matching function, we have $\theta\eta(\theta) = \mu(\theta)$.

Let the share of type-h workers among those who apply to a contract y_x-submarket be

[11] Strictly speaking, whether the ADA prohibits firms from offering health type-h dependent contracts depends on the interpretation of the monotonicity of $f_{h,x}$ in h. Specifically, the ADA does not strictly force firms to explicitly offer different employment contracts to workers with different disability statuses as long as their *true* productivity is different even after the workers are provided the mandated accommodations. In this case, one should consider such a productivity difference as an observed skill. However, firm's ability to offer these contracts became more limited after the ADA: there has been a significant increase in court cases, in which workers filed lawsuits claiming discrimination based on the ADA. Moreover, the ADA is strictly enforced if differential treatments among workers with different h are purely due to firm's misperception or discrimination (Acemoglu and Angrist, 2001). This indicates that $f_{h,x}$ itself may be endogenous to the ADA. In the rest of our analysis, we take the ADA as given and take $f_{h,x}$ as primitive of the model.

[12] In practice firms can, without violating the ADA, offer lower wages if individuals take leaves of absence due to the disability. We capture it with a in a reduced form way. Alternatively, we can interpret the contract as a combination of wages $\{w_N, w_X\}$, where w_N is the salary if the individual works without any absences and w_S, if he experiences absences. Firms may offer low w_S to screen disabled workers, yielding the same economic intuition as offering lower a.

[13] There might be ex-ante heterogeneity among firms in terms of the efficiency in providing job amenities. While this might lead to heterogeneity in the degree of screening incentives across firms, it will not eliminate all screening incentives. Although richer firm-level predictions will be useful, the main qualitative findings should be similar to our simple model. We leave this extension as a future work.

$g_h(y_x)$, with $g_h(y_x) \geq 0$. From firm's perspective, the probability of filling a vacant job in y_x-submarket with a type-h worker is $\eta(\theta(y_x))\, g_h(y_x)$. The payoff of firms not posting a vacancy is normalized to zero. 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:

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

where $\bar{Y}_x \equiv \cup_{h \in \mathbb{H}} \bar{Y}_{h,x}$. Contracts that are not included in this set cannot be an equilibrium. The second inequality ensures that the worker's utility from participating in the labor market with a contract y, $U_{h,x}(y_x)$, is greater than his outside option of $U^N_{h,x}(b_x, d_x)$.

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

For a given x, if we assume away the productivity difference across health 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: (i) disability insurance, (ii) subsidies to firms, and (iii) wage tax (subsidy). We assume that the government imperfectly verifies the true type of workers (similar to Low and Pistaferri, 2015) when providing disability insurance benefits and firm subsidies. The probability of identifying health type h as disabled is denoted by ψ_h. We assume $\psi_h \geq \psi_{h+1}$ so that the verification probability is increasing in one's severity of disability. This assumption of imperfect verification is empirically plausible and has been widely accepted in the disability literature. Moreover, this allows us to investigate an interesting policy design problem: if the government perfectly identifies the true disability type, it can undo all labor market distortions due to screening contracts by providing health-dependent lump-sum transfers. Although it is interesting to endogenize the government screening ability ψ_h, we assume that it is an exogenous technological constraint faced by the government.

Thus, for a given disability benefit level d_x, a type-(h,x) individual's expected utility from not working is $U^N_{h,x}(b_x, d_x) = \psi_h u(b_x + d_x) + (1 - \psi_h)\, u(b_x)$. Similarly, firms hiring a worker with health status h receive subsidy with probability ψ_h. As a result, the expected subsidy given to a firm hiring a worker with health status h is $T_h(w, a) = \psi_h T(w, a)$, which we flexibly denote as a function of both wage and job amenity. Firm's payoff from hiring a type-(h, x) worker is $v_{h,x}(w, a) = f_{h,x} - w - C(a) + T_h(w, a)$. Lastly, we denote the wage tax (subsidy) by $\tau(w)$.

2.2 Competitive Search Equilibrium (Given Policy Parameters)

Given the policy parameters, a competitive search equilibrium can be defined following Guerrieri, Shimer and Wright (2010).[14] In the equilibrium, firms maximize their profits and free entry condition, $\eta(\Theta(y_x))\sum_h g_h(y_x)\, v_{h,x}(y_x) \leq \kappa$, holds, with equality if $y_x \in Y_x^p$, where Y_x^p is the set of active submarkets for type-x workers. Second, conditional on the contracts posted and search behaviors of others, each type-i worker maximizes the expected utility by searching for a job in the optimal submarket by solving:

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

Note that this includes the possibility that if an active submarket does not exist, the worker chooses to stay out of the labor force. Lastly, the market clears, i.e., for $\forall(h,x)$, $\int_{Y_x^p} \frac{g_h(y_x)}{\Theta(y_x)} d\lambda(\{y_x\}) \leq \pi_{h,x}$ is satisfied, with equality if $\bar{U}_{h,x} > U_{h,x}^N(b_x,d_x)$.[15]

The equilibrium is a fully separating one, that is, given the same observed skill x, workers with different disability statuses apply to distinct submarkets that are characterized by a unique employment contract. There are two main issues in using this equilibrium concept in our context. First, in order to prove the existence and uniqueness of a separating equilibrium, we need to impose the monotonicity condition on firm's profit in worker's disability type, which is stated in Assumption 1. This constrains the range of hiring subsidies that can be considered as they directly affect the firm's profit from hiring disabled workers. However, as long as the government does not want to make disabled workers more profitable for firms than non-disabled workers, it will not impact our policy analyses.

Second, although the separating equilibrium is a standard feature in many screening models (e.g., Akerlof, 1976; Rothschild and Stiglitz, 1976), it has a very strong empirical implication in that workers with different disability levels receive different contracts. Our model is designed to address this concern by incorporating the skill heterogeneity x. It allows us to generate heterogeneity in observed employment contracts between workers of the same disability status while allowing for the possibility that workers of different disability statuses might receive the same employment contract. Thus, the model generates rich predictions that can be mapped to data for an empirical application. Moreover, as shown in Sections 3

[14] We relegate the formal definition of the equilibrium of the economy to Appendix A.1. The proof of existence and uniqueness of the equilibrium is a relatively straightforward extension of Guerrieri, Shimer and Wright (2010) and thus is omitted.

[15] In this model, we also need to specify reasonable beliefs about the market tightness off the active submarkets (Y^p) in equilibrium. Note that the market tightness function Θ is defined over Y_x, the set of feasible contract space for each type x, unlike the distribution of active contracts λ over Y_x^p. This distinction comes from the fact that our equilibrium concept requires the workers to have reasonable beliefs about their payoffs of potential deviations from the equilibrium outcome.

and 4, we observe that workers with different disability statuses tend to sort into jobs with distinctive features in their employment contracts, even after conditioning on many observed characteristics. Therefore, we think that the separating equilibrium is a plausible feature in our context.

2.3 Characterizing Equilibrium Allocations

In this section, we first describe the contract in the absence of screening, 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 $\tau(w) = 0$ and $T(w,a) = 0$. These restrictions will be relaxed later in our empirical and policy design analyses.

Equilibrium with Health-Dependent Contracts. Given the set of policy parameters, the no-screening equilibrium contract ("NS")[16] solves

$$\begin{aligned} (P1) \quad \max \quad & \left\{ U^N_{h,x}\left(b_x, d_x\right), \max_{w,a,\theta} \left\{ \mu\left(\theta\right) U^E_{h,x}\left(w,a\right) + \left(1-\mu\left(\theta\right)\right) U^N_{h,x}\left(b_x,d_x\right) \right\} \right\} \\ \text{s.t.} \quad & (\text{FE}) \quad \mu\left(\theta\right)\left\{f_{h,x} - w - C\left(a\right)\right\} = \theta\kappa \\ & \qquad\quad \theta \in [0,\infty], \; w \in [0, f_{h,x}], \; a \in \left[0, C^{-1}\left(f_{h,x}\right)\right], \end{aligned}$$

for each type-(h,x). That is, the equilibrium contract of type-(h,x) maximizes the worker's utility subject to a free entry condition (FE), independent from other types. By the first order condition (FOC) with respect to a, we get the equilibrium amenity level for type i determined by

$$\beta_h \varphi'\left(a^{NS}_{h,x}\right) = u'\left(w\left(a^{NS}_{h,x}, \theta^{NS}_{h,x}\right)\right) C'\left(a^{NS}_{h,x}\right), \tag{1}$$

where $w\left(a^{NS}_{h,x}, \theta^{NS}_{h,x}\right) \equiv f_{h,x} - C\left(a^{NS}_{h,x}\right) - \theta^{NS}_{h,x}\kappa/\mu\left(\theta^{NS}_{h,x}\right)$ from (FE). Using the FOC with respect to θ, we obtain the equilibrium market tightness of a type-i worker:

[16] In the remainder of the analysis, we denote the economy (contract) as a "no-screening economy (contract)" or "economy (contract) without screening", if firms can write health-dependent contracts. This terminology is meant to emphasize that when firms are not allowed to write health-dependent contracts (or workers have private information), firms strategically use contracts to "screen" certain type of workers. We acknowledge however, that in a broader sense, one can say that firms may screen workers at no cost (i.e., without using contracts as screening tools) under the "no-screening" economy.

$$\mu'\left(\theta_{h,x}^{NS}\right)\left[U_{h,x}^{E}\left(w_{h,x}^{NS},a_{h,x}^{NS}\right)-U_{h,x}^{N}\left(b_x,d_x\right)\right]=\mu\left(\theta_{h,x}^{NS}\right)u'\left(w(a_{h,x}^{NS},\theta_{h,x}^{NS})\right)\left.\frac{d\left(\theta\kappa/\mu\left(\theta\right)\right)}{d\theta}\right|_{\theta=\theta_{h,x}^{NS}}.$$

It is difficult to establish theoretical properties of the no-screening outcomes under general classes of preferences. However, with risk-neutral individuals, one can establish monotonic relationships in equilibrium outcomes across health statuses. By assumption on the preference parameter β_h and concavity of $\varphi(\cdot)$, we have $a_{h+1,x}^{NS} < a_{h,x}^{NS}$: since the marginal benefit of job amenities is higher for the low types, they receive more of them. By strict concavity of $\mu(\cdot)$, and as long as the term $f_{h,x} - C\left(a_{h,x}^{NS}\right)$ of healthier types is higher, the equilibrium market tightness is increasing in type h, i.e., $\theta_{h+1,x}^{NS} > \theta_{h,x}^{NS}$. Moreover, wages are higher for healthier types ($w_{h+1,x}^{NS} > w_{h,x}^{NS}$), which is driven by higher productivity and lower job amenity costs of healthier workers.

Equilibrium with Screening Contracts. Suppose firms are prohibited from posting health-dependent contracts (or that they do not observe the health status of workers). Then, firms offer screening contracts ("S") to ensure that unhealthy worker do not mimic healthy workers. Similar to the results in Guerrieri, Shimer and Wright (2010), the least healthy workers participating in the labor market receives the no-screening contract. Consider the least healthy worker and denote his utility from entering a submarket with contract $\left(w_{1,x}^{NS},a_{1,x}^{NS}\right)$ as $\bar{U}_{1,x}$, which is expressed as

$$\bar{U}_{1,x}\equiv U_{1,x}^{N}\left(b_x,d_x\right)+\mu\left(\theta_{1,x}^{NS}\right)\left\{u\left(w_{1,x}^{NS}\right)-\left(\chi_1-\beta_1\varphi\left(a_{1,x}^{NS}\right)\right)-U_{1,x}^{N}\left(b_x,d_x\right)\right\}.$$

We then solve for the equilibrium contracts sequentially for each health type $h \geq 2$ (given skill level x), by solving a similar problem as in Problem (P1) but taking into account the incentive compatibility (IC) constraint:

$$\text{(IC)}\qquad \mu\left(\theta\right)U_{h-1,x}^{E}\left(w,a\right)+\left(1-\mu\left(\theta\right)\right)U_{h-1,x}^{N}\left(b_x,d_x\right)\leq\bar{U}_{h-1,x}. \tag{2}$$

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 the optimization problem with the (IC) constraint, which is used to obtain the equilibrium sequentially.[17]

[17] It is important to note that the difference between equilibrium with and without screening contracts does not capture the effect of the ADA. As mentioned before, the ADA itself may affect $f_{h,x}$. For example, if the ADA decreases (increases) $f_{1,x}$, then it implies the employment rate of the most disabled may decrease

One can establish various theoretical properties in the environment with risk-neutral workers. Using the optimality conditions, we can show that if (IC) binds for type-(h,x), his job amenity in the screening contract is inefficiently low, i.e., $a_{h,x}^{S} < a_{h,x}^{NS}$. This is a standard result in adverse selection models (even without search frictions), and it is designed to keep the less healthy from entering the healthy workers' submarkets. A useful feature of a search-frictional labor market is the equilibrium determination of the market tightness, and thus the employment rates. Moreover, by imposing certain parametric assumptions, we can further show that $\theta_{h,x}^{S} > \theta_{h,x}^{NS}$ and $w_{h,x}^{S} > w_{h,x}^{NS}$ if (IC) binds for type-(h,x). These results are proved in Appendix A.2.

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, $U_{h,x}^{N}(b_x, d_x)$, is greater than $\mu(\theta)\{u(w) - (\chi_h - \beta_h \varphi(a))\} + (1-\mu(\theta)) U_{h,x}^{N}(b_x, d_x)$, or equivalently, $u(w) - (\chi_h - \beta_h \varphi(a)) < U_{h,x}^{N}(b_x, d_x)$. In this case, the worker type that receives the no-screening contract may not be the lowest type in the health status space.

2.4 Optimal Policy Design in a Simplified Model

Let government policies be denoted by $\boldsymbol{p} \equiv \{d_x, T(w,a), \tau(w)\}$. Given welfare weights for type ω_i and the government's type-verification technology ψ_i for $i = (h,x)$, the government maximizes social welfare subject to the budget constraint:

$$\max_{\boldsymbol{p}} \sum_{i \in I} \omega_i \left[\mu(\theta_i^*(\boldsymbol{p})) U_i^E(w_i^*(\boldsymbol{p}), a_i^*(\boldsymbol{p})) + (1-\mu(\theta_i^*(\boldsymbol{p}))) U_i^N(b_i, d_x) \right]$$
$$\text{s.t.} \quad \sum_{i \in I} \pi_i \left[(1-\mu(\theta_i^*(\boldsymbol{p}))) \psi_i d_x + \mu(\theta_i^*(\boldsymbol{p})) \psi_i T(w_i^*(\boldsymbol{p}), a_i^*(\boldsymbol{p})) \right] = \sum_{i \in I} \pi_i \mu(\theta_i^*(\boldsymbol{p})) \tau(w_i^*(\boldsymbol{p})),$$

where $\{w_i^*(\boldsymbol{p}), a_i^*(\boldsymbol{p}), \mu_i^*(\theta_i^*(\boldsymbol{p}))\}_{i=\mathcal{I}}$ are derived from labor market equilibrium conditions. We assume that the government sets and commits to the policies, after which workers and firms make their decisions.[18]

In order to understand the determinants of optimal policies, we first theoretically ana-

(increase) as well.

[18] Although the government commits to the policy ex-ante, it can possibly learn the worker's health status ex-post, because employment contracts are perfectly separated by health types in equilibrium. As the model is static, we do not consider such a case. However, even in a dynamic framework, if the workers' disability types change over time and the employment contract in the previous period does not fully predict the realization of disability status this period, the government cannot implement disability-dependent policies. This intuition is similar with the intuition in the dynamic public finance literature. The dynamic extension of the framework is left for future research.

lyze the optimal conditions for two specific policies: (i) a proportional job amenity subsidy to firms, i.e., $T^*(w,a) = sC(a)$ where s denotes the subsidy rate; and (ii) a disability insurance policy with benefit amounts of d, both of which are financed by lump-sum taxes on employed workers. To make the analysis tractable, we consider a simplified version of the model. We assume that workers are homogeneous in their skill levels (x) and all the workers choose to participate in the labor markets. Moreover, to find the optimal subsidy s, we also assume that the verification probability of the disability statuses of workers is binary, i.e., $\psi_h \in \{0,1\}$ with $\psi_h \geq \psi_{h+1}$. This assumption is not essential but allows us to simplify the mathematical expression. We show the determinants of the optimal policy in an economy without and with labor market screening, following the approach by Saez (2001) and Chetty (2006), with proofs relegated to Appendix A.3. This helps us understand the mechanisms determining the optimal policies using economically interpretable variables, before the numerical implementation of the model.

Proposition 1. ***Optimal Firm Subsidies.***
(a) The optimal amenity subsidy rate in an economy without labor market screening satisfies

$$\frac{s}{1-s} = \frac{1-\overline{C}(\boldsymbol{a},\boldsymbol{\theta})}{\widetilde{\epsilon}_{C(\boldsymbol{a}),1-s} + \widetilde{\epsilon}_{\mu(\boldsymbol{\theta}),1-s}},$$

where $\overline{C}(a,\theta) = \left[\frac{\sum_i \omega_i \mu(\theta_i) u'(c_{e,i}) \varphi_i C(a_i)}{\sum_i \omega_i \mu(\theta_i) u'(c_{e,i})}\right] / \left[\frac{\sum_i \pi_i \mu(\theta_i)\varphi_i C(a_i)}{\sum_i \pi_i \mu(\theta_i)}\right]$ *with* $c_{e,i}$ *denoting the consumption of employed workers of type-i; and* $\left(\widetilde{\epsilon}_{C(a),1-s}, \widetilde{\epsilon}_{\mu(\theta),1-s}\right) \equiv \left(\sum_i \alpha_i \epsilon_{C(a_i),1-s}, \sum_i \alpha_i \epsilon_{\mu(\theta_i),1-s}\right)$ *are the weighted averages of elasticities defined as* $\epsilon_{C(a_i),1-s} = \frac{d\log C(a_i)}{d\log(1-s)}$, $\epsilon_{\mu(\theta_i),1-s} = \frac{d\log\left(\frac{\pi_i\mu(\theta_i)}{\sum_k \pi_k \mu(\theta_k)}\right)}{d\log(1-s)}$, *and* $\alpha_i = \frac{\pi_i \mu(\theta_i)\psi_i C(a_i)}{\sum_k \pi_k \mu(\theta_k)\psi_k C(a_k)}$.
(b) The optimal subsidy rate in an economy with labor market screening satisfies

$$\frac{s}{1-s} = \frac{1-\overline{C}(\boldsymbol{a},\boldsymbol{\theta})}{\widetilde{\epsilon}_{C(\boldsymbol{a}),1-s} + \widetilde{\epsilon}_{\mu(\boldsymbol{\theta}),1-s}} + \frac{\sum_i \omega_i \mathbb{I}_i^{IC}\left(\left(\mu(\theta_i)\frac{da_i}{ds}\xi_{a,i}\right) + \frac{d\theta_i}{ds}\nu_{\theta,i}\right)}{\widetilde{C}(\boldsymbol{a},\boldsymbol{\theta})\sum_i \omega_i \mu(\theta_i) u'(c_{e,i})\left(\widetilde{\epsilon}_{C(\boldsymbol{a}),1-s} + \widetilde{\epsilon}_{\mu(\boldsymbol{\theta}),1-s}\right)}$$

where $\widetilde{C}(\boldsymbol{a},\boldsymbol{\theta}) = \frac{\sum_j \pi_j \mu(\theta_j)\varphi_j C(a_j)}{\sum_j \pi_j \mu(\theta_j)}$; *and* $\xi_{a,i}$, $\nu_{\theta,i}$, *and* $\mathbb{I}_i^{IC}$ *are defined as* $\xi_{a,i} = u'(c_{e,i})(1 - s\varphi_i)\frac{\partial C(a_i)}{\partial a_i} + \frac{\partial \beta_i \varphi(a_i)}{\partial a_i}$; $\nu_{\theta,i} = -\frac{\partial \mu(\theta_i)}{\partial \theta_i}\left(u(c_{e,i}) - u(c_{u,i})\right) - \mu(\theta_i) u'(c_{e,i})\frac{\partial \frac{\kappa\theta_i}{\mu(\theta_i)}}{\partial \theta_i}$; *and* $\mathbb{I}_i^{IC} = 1$ *if the (IC) binds, with* $c_{u,i}$ *denoting the consumption of non-employed workers of type-i.*

Proposition 1 (a) shows that the optimal subsidy in an economy without screening is determined by the usual two mechanisms. First, it depends on the redistributive motive and the insurance role of the government, which is captured by $\overline{C}(\boldsymbol{a},\boldsymbol{\theta})$.[19] This term measures the concentration of amenity spending per employed worker relative to the redistributive preference and insurance benefit captured by the welfare weight ω_i and the marginal utility of consumption of an type-i employed individual, $u'(c_{e,i})$. If the government is utilitarian and the individual is risk-neutral, then $\overline{C}(\boldsymbol{a},\boldsymbol{\theta}) = 1$ and the optimal subsidy should be zero. Second, the optimal subsidy depends on the magnitudes of its distortionary effects on behaviors, represented by the elasticities $\tilde{\epsilon}_{C(a),1-s}$ and $\tilde{\epsilon}_{\mu(\theta),1-s}$. The term $\tilde{\epsilon}_{C(a),1-s}$ is the average elasticity of costs of amenities $(C(a))$ with respect to the amenity's effective (net-of-subsidy) marginal cost $(1-s)$, weighted by the share of amenity costs on type-i (α_i). The term $\tilde{\epsilon}_{\mu(\theta),1-s}$ is the average elasticity of employment $(\mu(\theta))$ analogously defined. These two terms capture policy-driven changes in both the contract of employed workers and employment levels. Increasing the subsidy affects these terms, potentially more for severely disabled workers. However, as this is achieved by higher income tax on the employed, workers with low level of job amenities, such as non-disabled workers, may face a bigger burden from the policy. The government balances these two channels to optimally determine the subsidy rate. Thus, in an economy without screening, amenity subsidies play the role of redistributing resources from the non-disabled to the disabled.

Proposition 1 (b) then shows that the optimal subsidy in an economy with screening reflects an additional channel, which we call the screening effect. This effect is analogous to the "rate-race" effect in the environment of Stantcheva (2014). In our model, there are two margins to be considered—the amenity margin $(\xi_{a,i})$, and the employment margin $(\nu_{\theta,i})$—both of which are only operable if the incentive compatibility constraint is binding $(\mathbb{I}_i^{IC} = 1)$. The point is that a change in the subsidy rate also affects the firm's incentive to screen workers with worse disability conditions. Intuitively, higher subsidies make it more profitable for firms to hire severely disabled workers who value job amenities more. As a result, the incentive compatibility constraint can be relaxed as more subsidy is provided. This is also beneficial to healthier workers, whose job amenities tend to be under-provided. Thus, in general the presence of screening distortions generates an additional rationale for increasing subsidies.

Next, we characterize the optimal DI in a similar approach.

Proposition 2. ***Optimal Disability Insurance.***
(a) The optimal DI benefit in an economy without labor market screening satisfies $\overline{E}(\boldsymbol{\theta}) =$

[19] The relevant average cost is total expected (weighted by ψ_i) cost of amenities, $\sum_i \pi_i \mu(\theta_i) \varphi_i C(a_i)$, divided by the measure of employed workers, $\sum_i \pi_i \mu(\theta_i)$, reflecting that tax is only paid by employed workers. If taxes are paid regardless of employment statuses, the relevant average cost is $\sum_i \pi_i \mu(\theta_i) \varphi_i C(a_i)$. Similar effects are present in $\widetilde{C}(\boldsymbol{a},\boldsymbol{\theta})$.

$\widetilde{\epsilon}_{E,d} + 1$ *where* $\overline{E}\left(\boldsymbol{\theta}\right) = \left[\frac{\sum_i \omega_i (1-\mu(\theta_i)) u'(c_{u,i}) \psi_i}{\sum_i \omega_i \mu(\theta_i) u'(c_{e,i})}\right] / \left[\frac{\sum_j \pi_j (1-\mu(\theta_j)) \psi j}{\sum_j \pi_j \mu(\theta_j)}\right]$*; and* $\widetilde{\epsilon}_{E,d} = \frac{d \log \tilde{E}(\boldsymbol{\theta})}{d \log d}$ *with* $\widetilde{E}\left(\boldsymbol{\theta}\right) = \frac{\sum_j \pi_j (1-\mu(\theta_j)) \psi_j}{\sum_j \pi_j \mu(\theta_j)}$ *is the elasticity of the fraction of DI recipients over employed with respect to disability benefit.*

(b) The optimal DI benefit in an economy with labor market screening satisfies

$$\overline{E}\left(\boldsymbol{\theta}\right) + \frac{\sum_i \omega_i \mathbb{I}_i^{IC}\left(\left(\mu\left(\theta_i\right)\frac{da_i}{dd}\xi_{a,i}\right) + \frac{d\theta_i}{dd}\nu_{\theta,i}\right)}{\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \widetilde{E}\left(\boldsymbol{\theta}\right)\widetilde{\epsilon}_{E,d}} = \widetilde{\epsilon}_{E,d} + 1.$$

The basic intuition of Proposition 2 is similar to that of Proposition 1. Proposition 2 (a) states that optimal DI is set in order to balance the redistributional-insurance channel ($\overline{E}\left(\boldsymbol{\theta}\right)$) with the distortionary behavioral effect ($\widetilde{\epsilon}_{E,d}$). Essentially, the government wants to smooth the welfare-weighted marginal utility of consumption across individuals with different employment statuses and different disability types.[20] However, such incentives should be balanced by noting that it may distort the size of DI recipients: a higher DI benefit reduces the worker's utility gain from employment, which induces firms to offer either higher wages or job amenities, lowering their profits and posting fewer jobs. Proposition 2 (b) captures the additional screening channel. Higher DI increases the utility from non-employment for the disabled. Because, for the disabled, the employment probability is relatively lower in his own submarket, the net benefit from entering the non-disabled worker's submarket decreases. Moreover, higher DI increases wages in his own submarket for the disabled by increasing the outside option. These channels discourage the disabled to apply to other submarkets, relaxing the (IC) constraint and reducing screening distortions. Finally, it is important to note that these economic forces can be strengthened if we also endogenize the labor force participation decision of workers. Higher DI makes the disabled more likely to leave the labor market, amplifying the employment distortion. However, such effect may relieve the contract distortions on other workers, as they are less likely to enter the labor market intended for other types.[21]

It is important to point out the differential role of disability insurance and job amenity subsidies. First, they play different roles in redistribution: the disability insurance benefit redistributes resources from employed workers to "non-employed" disabled. On the other hand, job amenity subsidies induces redistribution from employed workers to "employed"

[20]Note that if there is no labor market response, i.e., $\widetilde{\epsilon}_{E,d} = 0$, then the optimal policy is designed so as to $\frac{\sum_i \omega_i (1-\mu(\theta_i)) u'(c_{u,i}) \psi_i}{\sum_i \omega_i \mu(\theta_i) u'(c_{e,i})} = \frac{\sum_j \pi_j (1-\mu(\theta_j)) \psi_j}{\sum_j \pi_j \mu(\theta_j)}$. Specifically, if there is only one type of worker, then the utilitarian preference implies that $u'(c_{u,i}) = u'(c_{e,i})$.

[21]Although we decide to leave out the endogenous labor force participation in our theoretical analysis for the simplification, it is still certainly possible to examine this margin by applying the generalized envelope theorem established by Milgrom and Segal (2002).

disabled. Second, they have differential employment effects: while job amenity subsidies may increase the employment of disabled workers, the disability insurance benefit may decrease it.[22] These considerations highlight the fact that optimal policy design requires the joint analysis of these two policy instruments. Moreover, these propositions highlight the need for recovering the full structure of the model for quantitative evaluations of the optimal policies. If screening is present, optimal policies depend not only on easily-measurable sufficient statistics, but also on other economic variables like (among others) the marginal utility from job amenities. Our goal in the remainder of the paper is to conduct such a joint quantitative analysis.

3 Data

Our primary data source is the Health and Retirement Study (HRS). The HRS is a biennial panel survey developed in 1992 and consists of more than 20,000 individuals representing the U.S. population over the age of 50. Among readily available data sets, the HRS is an appealing one for our purpose due to the following two reasons. First, it covers relatively older individuals, who are more likely to be disabled compared with younger individuals. Second, it provides a wealth of information on disability and job amenities that are offered to employed workers. This allows us to examine a number of robustness checks. In our main empirical analysis, we focus on individuals aged between 51 and 64 to focus on the population whose labor market outcomes are less affected by other social insurance programs such as Medicare and Social Security. For those who work, observations are limited to paid workers in private sectors. We also restrict the sample years from 1996 to 2008 so that our results are less confounded by the effects from the Great Recession. The overall sample size (individual-year combination) is 42,352.

Health Measures. We categorize the degree of disability based on two variables: self-reported work limitation and self-reported health evaluation. Interviewers ask respondents, "*Do you have any impairment of health problem that limits the kind or amount of paid work you can do?*," which we denote as the work limitation. While this binary variable is a commonly used measure of disability in the literature, we still find vast variation in health statuses among respondents within the same work limitation category. This observation leads us to define a finer measure of disability by combining the work limitation measure with the

[22] In an environment where verification probability of disability status φ_i is interior, subsidizing the firm can potentially be welfare enhancing compared to disability insurance. Because firms are risk-neutral, they can insure the risk of imperfect verification when they determine employment contracts. On the other hand, risk-averse workers face the full risk of verification errors when they are offered the disability benefit.

health evaluation, which records self-reported health status on a scale from 1 (excellent) to 5 (poor).[23]

We consider an individual to be *non-disabled* if he does not have a work limitation and reports to have either good, very good, or excellent health status. On the other hand, an individual is defined to be *severely disabled* if he has a work limitation and fair or poor health status. We define all others, either who have a work limitation but report to be healthy (good, very good or excellent), or who do not have a work limitation but report to be relatively unhealthy (fair or poor) to be *moderately disabled.* According to our categorization, 15% of workers are severely disabled, 18% are moderately disabled, and the rest (67%) are non-disabled.

Table 1: The Work Limitation and the Self-reported Health Evaluation

		Work limitation		Total
		No	Yes	
Self-reported health	1 (excellent)	5,881	244	6,125
	2 (very good)	11,872	1,141	13,013
	3 (good)	9,730	2,899	12,629
	4 (fair)	3,372	3,901	7,273
	5 (poor)	479	2,833	3,312
Total		31,334	11,018	42,352

Note: Table 1 reports the number of observations by the work limitation and the health evaluation variables. The sample is limited to individuals between ages 51 and 64 from 1996 to 2008.

Job Amenity Variables. Another benefit of using the HRS is that it provides detailed information on respondent labor market outcomes. It not only reports standard measures (such as employment status, working hours, and wages) but also non-wage benefits that we call "*job amenities*." This information is particularly important for our analysis because firms might be exploiting these amenities to screen workers with different disability statuses.

In this section, we document the job amenity variables that are available in the HRS and their summary statistics by the degree of disability. To begin with, we focus on job amenities which could be related to the work preferences of the disabled but not mandated under the ADA. We put such restrictions mainly because it is less plausible to assume that the accommodations mandated under the ADA could be used as screening tools. This

[23] One may concern that our disability measure is based on subjective measures, which rely on respondent self-evaluation. Using objective health variables available in the HRS, we evaluate their relationship with our disability measure and confirm that the severity of objective health is positively related to the degree of disability. Results are reported in Appendix C.1.

concern eliminates accommodation measures such as physical equipment for disabled from the possible data counterparts of job amenities within our model framework.[24]

Summary Statistics. Table 2 documents descriptive statistics for our sample by disability statuses. While the average ages are similar across disability statuses, those with severe disabilities are, on average, less-educated, and are more likely to live without a spouse or partner. Their labor market performance, as measured by employment, hours worked, and hourly wage, is worse than their healthier counterparts.

Table 2: Descriptive Statistics by Disability Status

Category	Variable	Disability status		
		Non-disabled	Moderately disabled	Severely disabled
Demographics	Age	58.1	58.6	58.6
	Female (%)	54.5	56.5	56.8
	Years of schooling	13.7	12.1	11.4
	Currently married/partnered (%)	72.0	60.3	54.3
Labor market	Employment rate (%)	73.6	47.9	14.3
	Working hours per week	40.6	39.2	37.0
	Hourly wage ($2014)	17.8	14.5	13.7
	Weekly Earnings ($2014)	744.1	582.8	524.7
Job amenities	Option to reduce working hours (%)	32.6	32.6	38.2
	Available sick leaves (days)	9.2	16.7	27.6
	Allow to change from full- to part-time (%)	57.5	69.2	67.2
	Employer-sponsored DI coverage (%)	53.2	42.0	42.2

Note: Table 2 reports the summary statistics by disability status, weighted by the individual-level survey weight. Observations are limited to individuals between ages 51 and 64 from 1996 to 2008, employed in private sector with a full-time position. The hourly wage rate is written in 2014 U.S. dollar using the CPI. Wage rate of lower than $4 are dropped and the top 5% of wage observations are truncated. Earnings are constructed using the individual-level information on hourly wage and working hours.

Importantly, we find workers with different disability statuses sort into jobs with different job amenities. In general, the disabled workers tend to work at jobs that provide more flexible working hour arrangements. For example, disabled workers are more likely to work at jobs that provide the option to reduce working hours, that allow changing from full- to part-time, or have more sick leaves. They are, however, less likely to work at jobs providing employer-sponsored DI (ESDI). Although these summary statistics do not condition on any worker or firm characteristics, we view the positive correlation between job amenities and

[24]The HRS asks employed respondents with a reported work limitation whether they receive any types of accommodations from their employers. These accommodation measures include, but are not limited to, access to special equipment, special transportation, help in learning new skills, and changes in job duties or tasks. However, they are not asked to individuals who do not report work limitation.

disability status as indicative of the preference heterogeneity between disabled and non-disabled workers.

4 Empirical Analysis

This section describes our approach for empirically implementing the model. In the first part of this section, we exploit policy variations and the theoretical properties of screening contracts to show suggestive evidence that firms use the option of reduce working hours to screen the disabled. Then, in the second part of the section, we discuss how to identify and estimate our equilibrium model.

4.1 Firm Screening Devices

To investigate how firms screen disabled workers, we hypothesize that firms may use the job amenity of providing flexible working hours as a major screening tool. As shown in Section 3, more severely disabled workers tend to work at a job that provides more flexibility in their working schedule. If this captures their preference heterogeneity relative to non-disabled workers, firms can possibly exploit this margin to screen disabled workers. Moreover, the provision of flexibility of working hour is often determined at each worker level, whereas the provisions of other job amenities such as employer based health insurance or employer based private DI are determined at the firm level. Therefore, compared to other amenities, firms may have more discretion in designing the job amenity to attract certain type of workers.

Importantly, this job amenity is not necessarily mandated under the ADA. Although the ADA requires employers to provide "reasonable" accommodations to their employees with disabilities, firms are exempted from this accommodation clause if the provision of the accommodation would impose undue hardship on their business operation (Equal Employment Opportunity Commission, 1992). The term "undue hardship" is an action that is "*requiring significant difficulty or expense*" determined based on factors including *"the type of operation ... including the composition, structure, and functions of the workforce."*[25] This definition indicates that the accommodation exemptions are based on factors beyond financial burden. According to the court cases, firms are not required to modify regular work schedules or to provide medical leaves if they can prove the nature of their business requires employees

[25]The Americans With Disabilities Act of 1990, Pub. L. No. 101-336, § 1, 104 Stat. 331, retrieved from the U.S. House Library (http://library.clerk.house.gov/) on November 2018.

to follow regular working hours or to avoid taking extensive sick leaves.[26,27] Thus, it is likely that compared to other mandated accommodations (like special equipment), there are less legal restrictions preventing firms from using the flexibility in working hours to screen disabled workers.

In our empirical analysis, we use the option to reduce working hours as the main outcome variable. While the HRS reports several measures related to working hour flexibility (e.g., option to change from full- to part-time, paid sick leaves), a particular attribute of the option to reduce working hours is that it is more broadly defined than other measures. Thus, this variable may capture different practices that firms use to engage in screening. Furthermore, in our dataset, the number of respondents who record a valid response to the survey question asking whether their job offers the option to reduce working hours is three to five times those of other amenities. Thus, using the option to reduce working hours as our candidate screening tool will allow for a more statistically precise estimation for testing the presence of screening. Although we still report the estimates from those variables in Appendix D.2, the rest of our analysis in the main text focuses on the option to reduce working hours. Finally, it is important to note that the provision of flexibility in working hour is affected by many other factors unrelated to screening the disability status of workers. As discussed in Section 4.1.2, we design our empirical strategy to address these concerns.

4.1.1 Policy Variations

To examine how firms screen workers, we utilize policy reforms that changed firms' relative profits from hiring a disabled worker compared to a non-disabled worker. Two main labor-demand side policy changes for the disabled we consider are the 2004 amendment of the Work Opportunity Tax Credit and the ADA Amendments Act of 2008.

Work Opportunity Tax Credit and Its 2004 Amendments. The Work Opportunity Tax Credit (WOTC) is a federal tax credit program that was implemented in 1996 in an effort to improve labor market outcomes of economically disadvantaged individuals (Scott, 2013). Firms earn tax credits for eligible hires from certain "target groups". The target groups cover

[26]The employees are guaranteed to take up to 12 weeks of unpaid medical leaves under the Family and Medical Leave Act (FMLA). However, the accommodation clause of the ADA requires a firm to provide (possibly longer than 12 weeks of) leaves to an employee without fixed date of return, unless the lack of a fixed return date causes an undue hardship (Equal Employment Opportunity Commission, 2002).

[27]Recently, there were several court decisions—*e.g., The Equal Employment Opportunity Commission v. Ford Motor Company* (2015); and *Williams v. AT&T Mobility Services LLC* (2017)—that ruled that *regular and in-person attendance* is an essential function for the jobs, and in those decisions, disabled workers' requests for additional breaks, flexible starting or ending time for medical reason, telecommunication, or medical leaves were not considered as reasonable accommodations under the ADA.

people with disabilities, including workers hired through state-run vocational rehabilitation agencies and former Social Security Income (SSI) recipients. For eligible hires of disabled workers, employers can get an annual tax credit, which usually amounts to $2,400. In 2004, the WOTC expanded the eligibility criteria for people with disabilities. Importantly, the WOTC certificates are issued to firms hiring the disabled through Employment Networks, non-government entities providing job training and referral services, instead of restricting qualification to those who receive job referrals through state-run vocational rehabilitation agency. We think that the WOTC Amendment has a meaningful impact on the utilization of hiring subsidies not only because of a direct effect that expanded the eligibility of the program[28], but also because of an indirect effect that increased the visibility of the program. Indeed, U.S. Government Accountability Office (2002) and Hamersma (2003) discussed a limited utilization of the WOTC between 1997 and 2001 and the need for increasing the awareness of this program to firms. Possibly due to these government efforts, we find that after 2004, the average number of WOTC certificates for the disabled increased by 35%.[29]

We consider the passage of the 2004 Amendment as a plausible exogenous shock affecting the firm's profit from hiring a disabled worker.[30] The size of the tax credit is comparable with the wage difference between the severely disabled and moderately disabled: if we assume that both work full-time, their annual wage difference is approximately $2,900 ($\approx$ ($582.8 $-$ $524.7) $\times$ 50), given the statistics reported in Table 2. Moreover, the expected employment duration of new hires with ages older than 50 tend to be very short, which is less than 3 years on average in our data. Thus, the expansion of eligibility of the WOTC can have a meaningful impact on firm's profit from hiring disabled workers.

[28]Those disabled who are newly qualified after the WOTC Amendment are essentially SSI or SSDI beneficiaries participating in the Ticket-to-Work (TtW) program. As discussed by Autor and Duggan (2006), the participant rate in the TtW Program was very low before 2003 at less than 1% among concurrent SSDI and SSI beneficiaries. However, it has gradually increased from 2004, reaching at about 6.4% in 2010 (Schimmel et al., 2013). Although whether the TtW program successfully increases the disabled workers' labor market attachment is still debated, we think that the direct effect of expanding the eligibility of WOTC increased the chance for firms receiving subsidies from hiring the disabled to some extent.

[29]The average number of WOTC certificates for the disabled remained stable in 2002 and 2003 (Levine, 2005). After the 2004 amendment, the issued certificates for vocational rehabilitation group increased by 35% (18,300 to 24,600 annually). Similarly, the number for the SSI recipients increased by 30% (25,900 to 33,800 annually). We compute the post-amendment average using years 2005 and 2007 because the data for years 2004 and 2006 do not reflect the accurate size of the program due to nine-month and 13-month hiatuses, respectively (source: the Employment and Training Administration, WOTC Certifications by Target Group 2002 to 2013).

[30]While the introduction of WOTC could serve an exogenous labor demand shock, in the same year, Personal Responsibility and Work Opportunity Reconciliation Act of 1996 was enacted, making it difficult to disentangle the impact of WOTC.

ADA Amendment Act of 2008. In 2008, the ADA Amendments Act (ADAAA) was passed to broaden and clarify the definition of disabilities. The ADAAA does not specifically name all of the impairments that are covered. Instead, under the ADAAA, a person is considered disabled if (s)he (i) has a physical or mental impairment that substantially limits one or more major life activities, (ii) has a history or record of such an impairment, or (iii) is perceived by others as having such an impairment. For instance, after 2008, individuals with health conditions such as mental illness, cancer, diabetes, and HIV/AIDS became eligible to claim protection under the ADAAA. This policy change can plausibly increase the firm's expected cost of hiring disabled workers, by allowing more disabled workers to be subject to labor market protection.

4.1.2 Empirical Specification and Findings

We now describe our approach for testing whether the option to reduce working hours is used to screen disabled workers. We hypothesize that if a certain job amenity is used to screen workers, then it would be responsive to the screening incentive, as is consistent with the predictions from screening models. We now explain our empirical design, which utilizes two policy variations discussed in Section 4.1.1.

The 2004 Amendments of WOTC. We first examine whether firms use the option to reduce working hours to screen the disabled by exploiting the WOTC amendment. We use the following empirical specification:

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

The dependent variables (y_{it}) is whether the job provides the option to reduce working hours for an individual i in year t, which is a binary variable in our data ($y_{it} \in \{0, 1\}$). The independent variables X_{it}, consist of individual-level control variables such as demographics (e.g., gender, education, age), employee's firm and occupation characteristics (e.g., firm size, occupation), and worker's objective health status (e.g., diagnosis type, like arthritis or diabetes; number of limitations in activities of daily living).[31] Moreover, the vector $\boldsymbol{Z}_t$ includes macroeconomic controls (e.g., the aggregate employment rates and the growth rates of GDP).[32] We control for many individual and firm characteristics to account for many factors affecting the variation in job amenities unrelated to disability. By including these

[31] Our specification does not include the individual-level fixed effect because disability status of an individual is a persistent variable with limited variation in data.

[32] We use the all industry total real GDP in chained 2005 dollars from the Bureau of Economic Analysis to compute the annual GDP growth rates. Employment data are from the Bureau of Labor Statistics.

health-related measures, we are able to control for the within-disability group heterogeneities. Our parameter of interest is β_{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.

The coefficients in this regression are informative in detecting relevant screening devices. We consider the impact of WOTC within the standard screening models (Akerlof, 1976 and Rothschild and Stiglitz, 1976), including ours. To begin with, we consider that the expansion of WOTC in 2004 particularly increases the chances for firms to receive lump-sum transfers when they hire severely disabled workers relative to moderately disabled workers. We view that this interpretation is plausible because the WOTC expansion is available to individuals who are already identified by the government as disabled, i.e, those who had experiences of receiving financial or medical supports from the government. If the expansion of WOTC in 2004 is mainly available for firms hiring severely disabled workers, then we should expect that the job amenities used as screening devices should increase for moderately disabled workers. The lump-sum transfer that firms receive for hiring severely disabled workers would increase the relative profitability of hiring the severely disabled. Thus, firms have less incentive to screen severely disabled workers; or severely disabled workers have less incentive to enter the market designed for healthier workers. The resulting relaxation of the incentive compatibility constraint for moderately disabled workers' contracts increases their equilibrium provision of job amenities.

Moreover, we should expect that the effect of WOTC on job amenities for severely disabled should be small, or even zero, i.e., $\beta_1 + \beta_{3,\text{severe}} \approx 0$, if these job amenities are used as screening tools. In this class of models, the amount of job amenity received by the lowest type (severely disabled workers) is chosen to equalize its marginal benefit (e.g., worker's marginal utility gain from the amenity) and marginal cost (e.g., firm's marginal cost of providing the amenity). Specifically, if workers are *risk-neutral*, the lump-sum transfer (which does not directly change the marginal costs of providing amenities) does not affect the magnitude of equilibrium job amenities for them ($\beta_1 + \beta_{3,\text{severe}} = 0$). If individuals are risk averse, the marginal benefit from additional job amenity depends on the marginal utility from consumption that may be affected by WOTC. As long as this effect is small, i.e., if individuals are not too risk averse or if consumption increase due to WOTC is small, the prediction still holds.

It is important to point out that these predictions are unique in screening models: in standard competitive equilibrium models in which firms can offer health-dependent employment contracts (i.e., an economy without screening contracts in Section 2.3), we expect that $\beta_1 + \beta_{3,\text{mod}} \approx 0$ because the incentive compatibility condition is no longer a determinant of job amenities. Specifically, these models predict that the WOTC should have no impact on job amenities for *any* type of workers if workers are risk-neutral.

Table 3: Effects of the WOTC-Amendment on the Option to Reduce Working Hours

Coefficients		Option to reduce working hours			
		(1) All employed		(2) New hires	
Post amendment (β_1)		-0.014	(0.058)	0.032	(0.069)
Disability status (β_{2h})	Severe	0.206***	(0.056)	0.215***	(0.082)
	Moderate	0.080***	(0.031)	0.048	(0.046)
Disability status	Severe	0.014	(0.064)	0.025	(0.103)
× Post amendment (β_{3h})	Moderate	0.068**	(0.034)	0.126**	(0.055)
Sample size		8,541		3,329	

Note: We estimate equation (3) with the linear probability model. The additional covariates used in the regression are age, age-squared, years of education, annual growth rate of GDP, annual employment rates, firm-size category dummies, and health outcomes. See the Online Appendix for the complete list of variables and their coefficient estimates. Standard errors are clustered at the individual-level. *** p<0.01, ** p<0.05, * p<0.1

Table 3 summarizes our main regression results on the option to reduce working hours.[33] Column (1) reports the main estimates from the linear probability model for equation (3) based on all employed workers.[34] First, there are significant differences in the provision of the option to reduce working hours across disability statuses (coefficient β_{2h}). This pattern is much more significant than that in Table 2 that documents the raw data. Thus, after controlling for various individual and firm characteristics, a worker's disability status seems to be an important determinant of the job amenity, consistent with preference heterogeneities. Second, we find that the lump-sum transfer (tax credit) provided by the government for hiring disabled workers led to an increase in the provision of the option to reduce working hours for moderately disabled workers (coefficient β_{3h}). The effect, however, is statistically insignificant for severely disabled workers. Column (2) reports the analysis by restricting the sample to newly employed workers, whose compensation packages may be more affected by firms' screening incentives. Interestingly, we find that change in job amenities among moderately disabled due to WOTC, is much larger among these newly hired workers.[35] Overall, these evidences are consistent with the possibility that the option to reduce working hours is used as a screening device.[36]

[33] In Appendix D.1, we show that the parallel trend assumption holds.

[34] See the Online Appendix D.6 for the complete list of variables and coefficient estimates.

[35] We define a subsample of newly hired workers using a binary variable indicating whether the respondent continuously worked with the same employer. As the HRS is a biennial dataset, this implies that the subsample includes workers with less than two years of employment tenure.

[36] In Appendix D.2, we report the results from the same regression analyses using other amenity measures. As discussed in Section 4.1, due to the small sample size problem, we do not obtain statistical significance

We conduct a number of robustness analyses with respect to these findings. First, to address the concern that the policy impact might be driven by compositional change within disability groups, we additionally allow the interaction between observable health and the post-amendment dummy. Second, we construct an alternative categorization of disability statuses to check the sensitivity of the results with respect to the definition of disability. Third, as the preferences for working hour flexibility might differ by gender, we additionally allow for the interaction of gender with disability, and WOTC amendment dummies. Fourth, we also examine whether the trend increase in DI enrollment over the years (Autor and Duggan, 2006 and Liebman, 2015) may explain the observed changes. We show in Appendix D.3 that our findings are robust to these analyses.

Although Table 3 only reports the effect on job amenities, we also examine the impact of WOTC on employment and wages, which are reported in Appendix D.5. We find that the WOTC itself has a statistically insignificant impact on employment; however, it increases the wage among severely disabled. Thus, the employer tax credit paid to employers hiring severely disabled workers made severely disabled workers' contracts more attractive, reducing their incentives to mimic moderately disabled workers.

The ADA Amendments Act of 2008. Unlike the 2004 amendment of the WOTC program, the expansion of the eligibility for the ADA can adversely affect firms' profit from hiring workers with disabilities, increasing firms' incentives to screen the disabled. In this case, one would expect that the job amenities for healthier workers after 2008 would decline to screen out the disabled workers in response to the policy change. Consistent with this view, we find that the option to reduce working hours decreases for moderately disabled and non-disabled workers after the policy implementation. We describe the details in Appendix D.4.

Overall, these findings suggest that screening might be present in the labor market, and that firms might be strategically using the option to reduce working hours as a screening tool. Given this suggestive evidence, we use the empirical measure of the option to reduce working hours as the model counterpart of job amenities (a) for the purpose of our estimation.

of our estimates for other job amenity measures related to flexible working hours (available part-time and available sick days). Moreover, for vacation days and ESDI coverage, even at the cross-section, we do not see the monotonicity of job amenities in disability statuses, captured by coefficients β_{2h}, after controlling for individual and firm characteristics.

4.2 Identification and Estimation of the Model

We now discuss the identification and estimation of our equilibrium screening model. As discussed in the previous section, we consider the option to reduce working hours as a measure of job amenity used for screening in our equilibrium model. The key challenge in our estimation lies in separately identifying the cost of providing the job amenity ($C(a)$) and the utility value of these benefits to workers ($\psi(a)$). To address this, we utilize the policy variation introduced in Section 4.1.1, the 2004 Amendment of WOTC. This policy change directly affects the firm's profit function but not worker's utility, and therefore helps us to separately identify these key parameters. Using the actual data variation in the HRS, we estimate the model through an indirect inference procedure.

4.2.1 Functional Forms and Parameters

Functional Forms. The production function of a worker with health type h and observed skill type x is represented by $f_{h,x} = f_h \times x$, 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 assume that observed skill type x, is drawn from a log-Normal distribution with mean $-\sigma_h^2/2$ and health-dependent variance σ_h^2. We discretize the distribution into the support with five grid points, $N_x = 5$, implying that there are up to $3 \times N_x$ submarkets in the labor market.

We assume that workers' preferences over consumption are represented by a log utility function $u(c) = \log c$. To specify the primitives related to job amenities, we first assume that each firm chooses a *probability* to offer an option to reduce working hours, implying $a \in [0, 1]$. This makes the moments from the model comparable to those in the data: while the model treats a as a continuous variable, the option to reduce working hours in the data is based on the respondent answers to a binary question. Utility from job amenities is specified by $\varphi(a) = \left(1 - (a-1)^2\right)^\delta$ with $\delta \in (0, 1)$, which is concave and satisfies $\lim_{a \to 0} \varphi'(a) = \infty$ and $\lim_{a \to 1} \varphi'(a) = 0$. The cost function for amenities is represented by $C(a) = c_0 + c_1 a \left(1/\left(1-a\right) - 1\right)^{c_2}$. The parameter c_0 represents the fixed cost of providing the job amenities,[37] c_1, the scale, and c_2, the convexity of the cost function. Under this parametric assumption, the marginal cost of amenities converges to 0 as a approaches 0 ($\lim_{a \to 0} C'(a) = 0$), and ∞ as a approaches 1 ($\lim_{a \to 1} C'(a) = \infty$). We assume a constant elasticity of substitution (CES) function for the job-finding rate with parameter γ, so that

[37]Note that the parameter c_0 can also be interpreted as a fixed hiring cost by imposing boundary conditions. We incorporate this parameter to improve the model fit, as discussed in footnote 44.

$\mu(\theta) = \theta(1+\theta^{\gamma})^{-1/\gamma}$.

Exogenously Calibrated Parameters. The health distribution in the economy (π_h) is 15%, 18%, and 67% for severely, moderately, and non-disabled workers respectively.[38] The health-skill type distribution of workers therefore is determined jointly by π_h and σ_h^2. We set the parameter γ in the job-finding rate to be 0.4 to produce an empirically reasonable job finding elasticity. In the CES matching function, the elasticity of the job-finding rate with respect to the market tightness depends on both γ and θ. Given our choice of γ, the weighted average of the elasticities across health types is around 0.2, which is within the range of values used in the literature.[39] The value of home production (b) is set at 10% of average productivity of the skill type x.

Following Low and Pistaferri (2015), we set the government's disability verification probability (ψ_h) to be 0.62 for the severely disabled, 0.18 for the moderately disabled, and 0.075 for the non-disabled workers. These parameters represent the probability of receiving DI upon applying for benefits for old population (as is consistent with our sample) in their paper. [40] For the benchmark economy, the DI benefits for each skill x are assumed to be 60% of average productivity among workers with the same observed skill, reflecting the fact that DI benefits are determined by the average of the worker's previous earnings.[41] Thus, the expected benefit of non-employment for the severely disabled worker is 47% of the average productivity of his skill level ($b + \psi_h d = 0.1 + 0.62 \times 0.6$). For the moderately disabled and

[38] These are weighted (by individual-level survey weights) distributions by health status categories reported in Table 1.

[39] Menzio and Shi (2011) adopt the same CES function in a directed search environment and calibrated the parameter γ by targeting the empirical elasticity of the unemployment-to-employment transition with respect to the vacancy-to-unemployment ratio (θ). In a model with no search by employed workers (which is a similar environment to ours, among the models considered in their paper), their calibrated value for γ is 0.25. Alternatively, using the Cobb-Douglas function, Shimer (2005) calibrates the elasticity parameter to the estimated coefficient 0.28 from a regression of (log) job-finding probability on (log) θ.

[40] Low and Pistaferri (2015) structurally estimates the DI receipt probability using the Panel Study of Income Dynamics, and we use their values estimated for old workers (between 45 and 62 in ages). They categorize disabled workers using work limitation and the degree of limitation, among which the latter is missing in the HRS. However, these are the most relevant estimates for the parameter in the literature. Further, using these probabilities, the model predicts that about 11% of workers receive DI. In 2016, the DI recipients in the U.S. ranged between 6.4% and 14.5% among workers aged between 50 and 64, according to a report by the Social Security Advisory Board. While we take these values exogenously as they yield empirically reasonable DI recipient rates, we are able to conduct robustness analysis with respect to ψ_h.

[41] We do not explicitly model that the DI benefits depend on the equilibrium wages determined within the model. Doing so requires solving a fixed point problem, as the DI benefit amounts are determined endogenously as equilibrium objects. It will be computationally demanding. By using the HRS survey years of 1992 through 2012, Khan, Rutledge and Sanzenbacher (2017) finds a large variation in effective replacement rates: the average replacement rate of SSDI is between 55-77% with the standard deviation between 17-57%, depending on whether to account for other sources of income. We use 60% as the benchmark replacement rate, but using a lower replacement rate does not affect our overall qualitative conclusions.

non-disabled workers, these correspond to 21% and 15%, respectively. In modeling WOTC for structural estimation, we assume that a firm hiring a severely disabled worker, after being qualified with probability ψ_h, receives a lump-sum transfer amounting to 30% of the income of severely disabled workers, consistent with the average amount of transfers allowed to firms.[42] This implies that any post-WOTC changes in job amenities of workers who are not severely disabled are driven solely by screening in our model.[43]

4.2.2 Identification

We now describe our strategy for identifying the rest of the model. Our identification strategy is parametric, making use of functional form assumptions. The parameters to be estimated within the model are worker's health effect on output perceived by firms $\{f_h\}$; health-specific preferences for job amenities $\{\beta_h\}$; curvature of the amenity utility function δ; health-specific fixed disutility from work $\{\chi_h\}$; health-dependent variance of the observed skill (x) distribution $\{\sigma_h^2\}$; parameters governing the level and curvature of the cost of providing job amenities $\{c_0, c_1, c_2\}$; and the vacancy posting cost κ. We normalize the non-disabled workers' fixed disutility from work to zero ($\eta_3 = 0$) and their preference for amenities to one ($\beta_3 = 1$), leaving 15 parameters to be estimated.

As seen in Section 2.3, the magnitude of job amenity is set to reflect the IC constraint if it binds (Equation (2)); and if not, it is determined by the marginal utility and the marginal cost of job amenities (Equation (1)). Note that the cross-sectional distribution of job amenities across disability statuses is not sufficient to separately identify the worker-side preference parameters on job amenities ($\{\beta_h\}$ and δ) and firm-side job amenity cost parameters ($\{c_0, c_1, c_2\}$). We exploit the policy variation induced by the 2004 WOTC amendment, as discussed in Section 4.1.1. Importantly, the lump-sum tax credit given to firms, tr, only affects the firm's profitability of hiring disabled workers, inducing labor demand-side driven changes in job amenities through a screening mechanism.[44] Thus, we separately identify these primitives via the cross-sectional and changes in job amenities induced by this policy

[42] The minimum hours worked to qualify for \$2,400 tax credit is 400 hours, and the average annual working hours in the U.S. is 1,780 hours. Given the hourly wage of severely disabled workers from the data, \$2,400 is between 10% and 40% of their income.

[43] Although this may be a stronger assumption on the policy than the one in Section 4.1.2, we make this assumption for the following reasons. First, we can avoid overestimating the role of screening in our counterfactual experiments. By explaining all the variation of amenities for these workers through screening mechanism, the estimated degree of preference heterogeneities, the key driver of screening contracts, are smaller. Thus, our counterfactual experiments will be implemented with a lower bound on the role of screening. Second, it makes the mapping between the model and data clearer, as elaborated in Section 4.2.2.

[44] Note that we can identify the constant parameter c_0 through this variation because changes in job amenities due to the WOTC in the model are affected by marginal utility of consumption (due to risk-aversion) and the incentive compatibility constraints.

across disability statuses.[45]

Next, we exploit the variation in wages and employment rates across workers with different disability statuses to identify the health-specific productivity (f_h) and fixed costs of work (χ_h). Our normalization of the fixed cost of work for the non-disabled allows us to identify the vacancy posting cost κ, the parameter that also affects employment rates. Lastly, we identify the variance of the observed skill $\{\sigma_h^2\}$ by fitting the variance of the wage conditional on disability type, as the skill heterogeneity is the only source of wage variation among workers with the same disability status.

4.2.3 Estimation Strategy

We estimate these parameters via indirect inference by considering the following set of moments in the auxiliary model: (i) mean and coefficient of variation of wages by disability status; (ii) employment rate by disability status; (iii) the proportion of individuals with the option to reduce work hours; and (iv) regression coefficients on the option to reduce working hours presented in Section 4.1 (i.e., coefficients reported in Table 3). These moments are chosen to reflect our identification discussion. We form the objective function for our estimation as

$$\hat{\boldsymbol{\omega}} = \arg\max_{\boldsymbol{\omega}} \left[\hat{\beta}\left(\boldsymbol{\omega}\right) - \overline{\beta}\right]' W \left[\hat{\beta}\left(\boldsymbol{\omega}\right) - \overline{\beta}\right],$$

where W is the weighting matrix, $\overline{\beta}$ is a vector of auxiliary model parameters computed from the data, and $\hat{\beta}\left(\boldsymbol{\omega}\right)$ is a vector of the corresponding auxiliary model parameters obtained from simulating datasets from the model (parameterized by a particular structural parameter vector $\boldsymbol{\omega}$).[46] We obtain the standard errors of our estimators based on the asymptotic variance, following Gourieroux, Monfort and Renault (1993). [47]

[45]Note also that some of the variation in job amenities in the data to identify the cost of job amenities are not related with worker-side preferences. This possibly relieves the concerns about the potential bias from estimating the model without multi-dimensional worker heterogeneity.

[46]Because of the small sample size concern, we do not use the optimal weighting matrix in our estimation (Altonji and Segal (1996)). Our weighting matrix on the estimators W is essentially based on the inverse of the variance-covariance matrix of empirical moments, assigning zero to all the off-diagonal elements. As we still have substantial differences in the weighting matrix between moments from the regression analysis and cross-sectional moments, we put additional weights on cross-sectional moments to ensure the similarity in their magnitudes. Finally, we assign the weight of one on coefficient of variation of earning.

[47]We calculate the variance-covariance moments of $\overline{\beta}$ through bootstrapping. Note that our equilibrium model is not necessarily *globally* smooth with respect to the structural parameters because of the discreteness of outcomes induced by labor force participation decisions and incentive compatibility constraints in the optimal employment contracts. We, however, find that our objective function is *locally* smooth near the estimated parameters and thus decide to obtain the standard errors by calculating the score function of $\hat{\beta}\left(\boldsymbol{\omega}\right)$ numerically.

4.2.4 Estimation Results

Our estimates of structural parameters are summarized in Table 4, and the model fit is presented in Table 5. Our estimates indicate that disability affects worker productivities and

Table 4: Parameters Estimated within the Model

	Estimate	(Std. Err.)	Estimate	(Std. Err.)	Estimate	(Std. Err.)
Panel A: Health (h) Dependent Worker-side Parameters						
	Severely Disabled		Moderately Disabled		Non-Disabled	
Effect of h on output: f_h	2.343	(0.016)	2.700	(0.035)	3.107	(0.043)
Preference for job amenities: β_h	8.712	(0.227)	2.892	(0.395)	1.0 (normalized)	
Fixed cost of work: χ_h	5.313	(0.139)	2.325	(0.226)	0.0 (normalized)	
Variance of skill-distribution: σ_h^2	1.773	(0.105)	0.361	(0.004)	0.417	(0.068)
Panel B: Other Worker-side Parameters						
Curvature in utility from job amenities: δ	0.762	(0.134)				
Panel C: Firm-side Parameters						
Const. in the cost $C(a)$: c_0	1.341	(0.128)				
Coeff. on a in the cost $C(a)$: c_1	1.115	(0.062)				
Curvature in the cost $C(a)$: c_2	2.031	(0.596)				
Vacancy cost: κ	0.001	(0.0003)				

their preferences for job amenities. For example, we find that there is a 25% $(1-\frac{2.343}{3.107})$ output loss perceived by firms for the severely disabled relative to the non-disabled, conditional on the observed skill x. Moreover, the severely disabled have a higher fixed cost of work and have more preference for job amenities compared to the non-disabled. Thus, in order for the 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 and employment, and the regression coefficients on job amenities documented in Table 3. Importantly, the model generates an insignificant effect of the WOTC amendment on severely disabled workers' job amenities (coefficient Post $\times$ Sev.), but a significant change in the provision of amenities for moderately disabled workers (coefficient Post $\times$ Mod), consistent with our auxiliary model. Other coefficients also lie within the ranges of the confidence intervals from the empirical analysis.

4.2.5 External Validation of the Model

While our model is able to match the targeted moments well, it is important to ensure that the model also generates an empirically plausible response to policy changes. In particular,

Table 5: Model Fit

(a) Labor market outcomes by disability

Statistics	Data	Model
Employment		
Severely Disabled	0.143	0.148
Moderately Disabled	0.479	0.508
Non-Disabled	0.736	0.740
Average wage		
Severely Disabled	1.000	0.916
Moderately Disabled	1.111	1.215
Non-Disabled	1.418	1.330
Coefficient of wage variation		
Severely Disabled	0.703	0.258
Moderately Disabled	0.646	0.366
Non-Disabled	0.611	0.530

(b) Job amenities

Statistics	Data	Model
Average job amenities		
All workers	0.329	0.338
WOTC coefficients on job amenities		
Post	-0.014	0.010
Severe	0.206	0.218
Moderate	0.080	0.092
Post × Severe	0.014	-0.010
Post × Moderate	0.068	0.046

Note: Table 5 compares the model-generated statistics to their empirical counterparts. We normalize the average wage of severely disabled as 1.

as one of our key policies of interest is the generosity of DI, we first evaluate employment effects of DI in the estimated model (which were not targeted) and compare the results to those in the empirical studies.

Recent developments in the DI literature have uncovered the labor supply effects of DI using exogenous variations in DI application processes. Among them, Maestas, Mullen and Strand (2013) finds a 28 percentage point (*pp*) decline in employment among marginal DI applicants. Further, these effects are heterogeneous across DI applicants, and range from no effect to 50*pp*. Given the estimated parameters, we simulate the economy without disability insurance and compare the employment effects of the model to empirical estimates from Maestas, Mullen and Strand (2013).

Our findings suggest that the removal of DI leads to an employment rate decline of 1.36*pp* overall. In Appendix B, we conduct a back-of-the-envelope calculation to estimate the overall employment effect of DI implied from the estimates of Maestas, Mullen and Strand (2013) and find that the average employment in the economy without DI is 2.68*pp* lower. Furthermore, depending on the skill and health statuses, the employment effects in our model also similarly range between 0.3*pp* and 47*pp*. This result thus shows the model's ability to generate empirically plausible DI impacts on employment rate.

4.2.6 Mechanisms

In the absence of screening, contracts are independently determined for each skill level and health type. However, this is not the case if firms have an incentive to screen. In Table 6, we compare the equilibrium outcomes in the economy without screening contracts and with screening under the estimated parameters. 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 and wages than in the economy without screening.

Table 6: Equilibrium in the Model without Screening (No-Scr.) vs. with Screening (Scr.)

	Job Amenities		Wage		Employment	
	No-Scr.	Scr.	No-Scr.	Scr.	No-Scr.	Scr.
Severely Disabled	0.506	0.506	0.916	0.916	0.148	0.148
Moderately Disabled	0.432	0.400	1.144	1.215	0.506	0.508
Non-Disabled	0.347	0.283	1.269	1.330	0.738	0.740

While Table 6 documents the outcomes by health statuses averaged over skill distribution within the health status, the degree of distortions may vary with a worker's skill level and participation decisions of disabled workers. In Table 7, we report job amenity levels by skill and health statuses. Given our estimates, we find that both severely and moderately disabled workers near the bottom tail of skill distribution (Low-Skilled workers in Table 7) choose not to participate in the labor market. In this case, non-disabled workers are the lowest type in the labor market. However, even in such case, they receive fewer job amenities to deter the moderately disabled workers from entering the non-disabled workers' labor market.

Table 7: Skill Heterogeneity and Screening

	Job Amenities					
	Low-Skilled Worker		Average Worker		High-Skilled Worker	
	No-Scr.	Scr.	No-Scr.	Scr.	No-Scr.	Scr.
Severely Disabled	-	-	0.460	0.460	0.523	0.523
Moderately Disabled	-	-	0.414	0.384	0.469	0.429
Non-Disabled	0.285	0.269	0.351	0.276	0.402	0.316

On the other hand, workers may decide to work regardless of their health statuses if their market productivities are high. For these skill groups (Average and High-Skilled workers), firms' incentives to screen disabled workers are higher, and thus contract distortions may be larger: moderately disabled workers receive between 3*pp* (7%) to 4*pp* (9%) fewer amenities relative to under the economy without screening. These heterogeneous effects on moderately disabled workers further trickle down to non-disabled workers. While low-skilled non-disabled workers received 1.6*pp* (5.5%) fewer amenities than under the no-screening contract, the distortionary effect is larger for workers with higher skills and range between 7.5*pp* (21%) and 8.6*pp* (21%). These results suggest heterogeneity in the labor market effects of screening frictions across worker types, which depends on the participation decisions of disabled workers.

5 Counterfactual Policy Experiments

Using the estimated structural model, we conduct counterfactual policy experiments. Given the exogenous disability verification technology (ψ_h) of the government, we consider the effects of both independently and jointly varying the generosity of disability insurance (d) and employment subsidy that proportionately subsidizes the firms' costs of providing amenities (s). We ensure that these policy reforms are budget-neutral (relative to the benchmark economy) within similar skill groups by allowing the government to use a proportional wage tax (subsidy). This approach better captures the role of policies in providing redistribution across workers of different disability statuses, rather than providing redistribution across disability statuses *and* skills.[48] In the following, we discuss the equilibrium and welfare effects of the policy reform, and the role of screening on optimal policy structure.

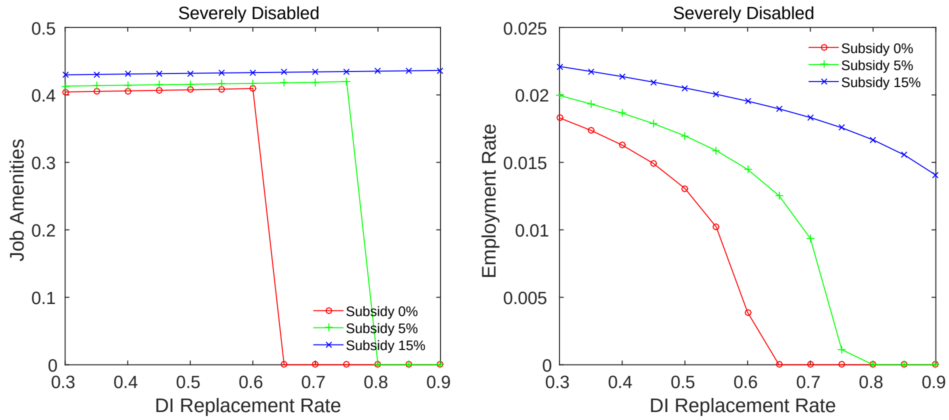
5.1 Equilibrium Effects of Policies

Allocative Effects. In Figure 1, we plot labor market equilibrium allocations for severely disabled workers under different policy combinations. The x-axis represents the DI replacement rate (d), and the three lines in each plot correspond to subsidy rates (s) of 0%, 5%, and 15%.[49] Under the amenity subsidy rate of s, the firm's net cost of providing amenities equals $(1 - s)\, C\,(a)$, effectively lowering the marginal cost of amenities. On the left panel of Figure 1, we plot the amount of job amenities provided to severely disabled workers under the joint policy parameters, and on the right panel, we plot the employment rates of severely disabled workers. We observe, first, that as the subsidy rate increases, severely disabled workers'

[48]We group the two lowest skill types (among five) together, totaling about 48% of workers in the model. We focus on the results from the low-skill groups as they are more likely to be affected by disabilities and related policies, which is often the approach taken in disability literature (e.g., Low and Pistaferri, 2015). The qualitative results are consistent with our benchmark findings, when we use all workers.

[49]In the current model under the benchmark policy, firms have the incentives to screen out disabled workers. If subsidies for disabled workers are very generous, however, it is possible that firms might prefer to hire disabled workers to non-disabled workers (monotonicity assumption discussed in Section 2.2). We restrict the employment subsidy parameter in the counterfactual analyses so that firms' incentives (to screen disabled workers) are similarly aligned with those in the benchmark economy.

Figure 1: Labor Market Equilibrium for Severely Disabled Workers



contracts feature higher job amenities, increasing their value of employment. Consequently, the employment rates of severely disabled workers increase as shown in the right panel of Figure 1. On the other hand, as DI becomes more generous, the labor supply disincentives increase, which reduces employment rates and sometimes drives severely disabled workers completely out of the labor force at high replacement rates. Importantly, the cutoff level of DI, above which severely disabled workers do not participate in the labor market is lower when the amenity subsidy rate is smaller.

Figure 2: Labor Market Equilibrium for Moderately and Non-Disabled Workers

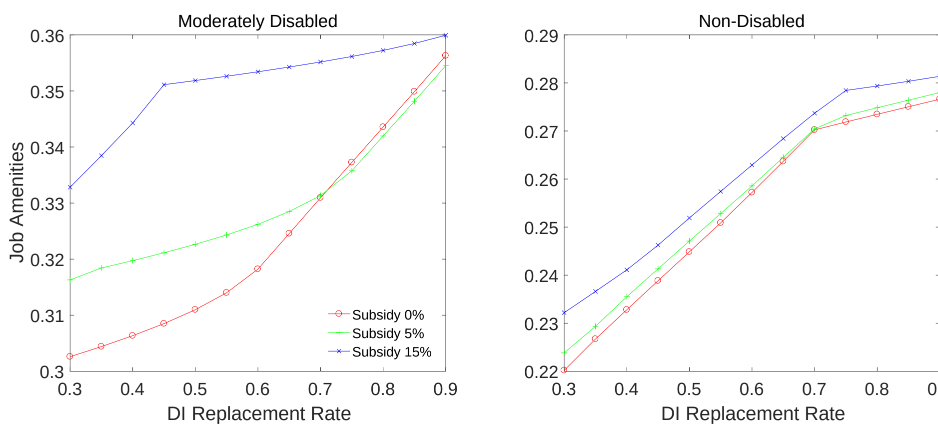


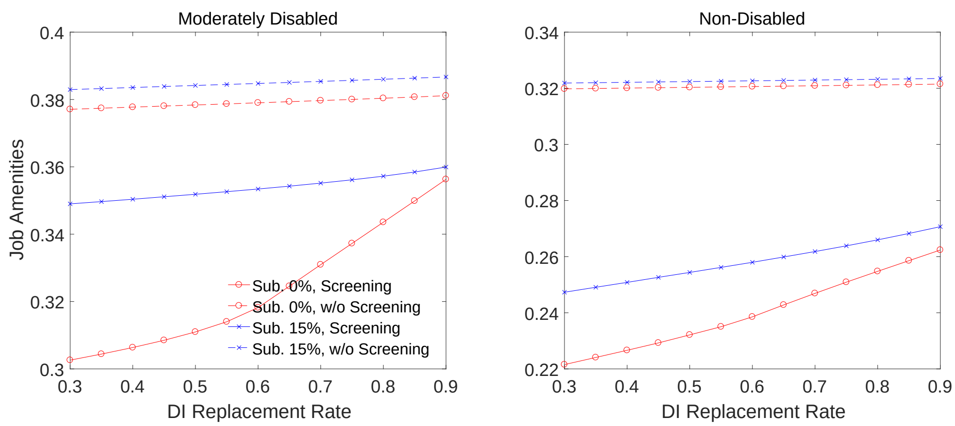
Figure 2 illustrates the equilibrium job amenities for moderately disabled (left panel) and non-disabled (right panel) workers. As the amenity subsidy directly lowers the marginal cost of amenities (albeit at lower expected rates due to verification probabilities), healthier workers in the labor market are also likely to benefit from higher amenities.[50] Further, as disability insurance becomes more generous, the combination of higher outside option and

[50]Note that the monotonic relationship between amenities and subsidy rates (for a fixed DI) may not hold for moderately disabled workers. There are several factors in play for the determination of the equilibrium

the relaxation of the IC constraint, induces an increase in the job amenities (for a fixed subsidy rate).

Effects on Screening Distortions. In the presence of screening, the decisions of disabled workers have effects on equilibrium outcomes of other workers in the labor market. Here, we discuss how policies affect the screening incentives of firms, and thus the degree of distortions in the contracts of moderately and non-disabled workers in equilibrium.

Figure 3: Labor Market Equilibrium: Without Screening vs. With Screening



In Figure 3, we plot the equilibrium job amenities in an economy without screening along with those in the screening economy, for moderately disabled workers (left) and non-disabled workers (right), both of the higher skill type.[51] The amenities without screening are plotted as a dashed line and with screening, a solid line. We observe that when the DI replacement rate is low, the contract distortions for moderately disabled workers are high: the difference between the level of amenity in an economy without screening and with screening is large. Fixing the subsidy rate, as DI becomes more generous, the distortionary effects on amenities decrease. While DI reduces the work incentives of severely disabled workers (as shown in Figure 1), it simultaneously relaxes the incentive compatibility constraint on moderately disabled workers' contracts. Putting it differently, severely disabled workers have less of an incentive to mimic healthier workers because they have higher outside option (DI). Thus, DI affects contracts for the moderately disabled, by not only increasing their own outside option, but through the change in the contracts and labor force participation incentives of

job amenity on top of its marginal cost, which include the marginal utility of consumption (due to risk aversion in the utility function) and the firm's incentives to screen (strength of the IC constraint). These combined effects lie behind the job amenities of workers in the economy.

[51]The labor market contracts of severely disabled workers are equivalent in the presence and absence of screening upon participation.

severely disabled workers.[52] This effect of DI on the labor market is novel in our framework, because we specifically incorporate and estimate the role of screening in equilibrium.

Now, we study the effect of increasing job amenity subsidies by setting the amenity subsidy rate to be 15%. In this case, the contract distortions on moderately disabled workers are smaller. For a fixed DI replacement rate (e.g., 30%), the difference between screening and no-screening lines is smaller under a 15% subsidy rate compared to no subsidy rate. When the amenity subsidy rate is high, the utility that the severely disabled obtain from working under their own contract increases, relaxing the incentive compatibility constraint in the moderately disabled worker's problem. From the firm's perspective, a generous amenity subsidy for disabled workers lowers its screening needs, resulting in fewer distortions in other workers' contracts. We observe similar effects on job amenity provision for non-disabled workers in the right panel of Figure 3: the size of distortions is smaller with higher DI (left to right) and higher subsidy rates ($\circ$-line to $\times$-line).

Overall, we observe two ways in which the screening distortions are affected by policies. First, if DI becomes more generous, severely disabled workers' outside option increases, lowering their labor force participation and reducing incentive to mimic healthier workers. Second, if the amenity subsidy is high, severely disabled workers' contracts are attractive enough that they have fewer incentives to enter the market designed for moderately disabled workers (firms' relative profits from hiring disabled workers increase). Both policy interventions therefore affect the degree of screening distortions in equilibrium, but through different mechanisms with heterogeneous equilibrium effects. In the next section, we analyze the welfare implications of these policy designs.

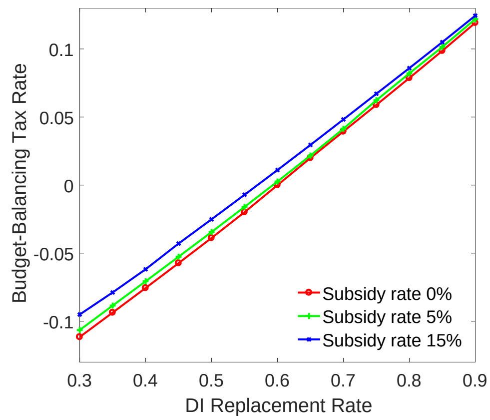
5.2 Optimal Joint Policy Design

In this section we consider the welfare effects of the joint policy reforms. To understand the quantitative results, we first show the equilibrium budget-balancing tax rate, the welfare effects by health statuses, and finally the average welfare implications of the reforms.

In Figure 4, we plot the equilibrium wage tax rate. As is evident, the tax rate is increasing in the generosity of DI and amenity subsidy. However, as DI becomes more generous, the expansion of amenity subsidy requires a smaller increase in the tax rate. Under a 30% DI replacement rate, the tax rate needs to increase by 2*pp* to introduce a 15% amenity subsidy, whereas an increase of 0.5*pp* is sufficient under a 90% replacement rate. The provision of amenity subsidies is costly as the government's expenditures on employed workers increase.

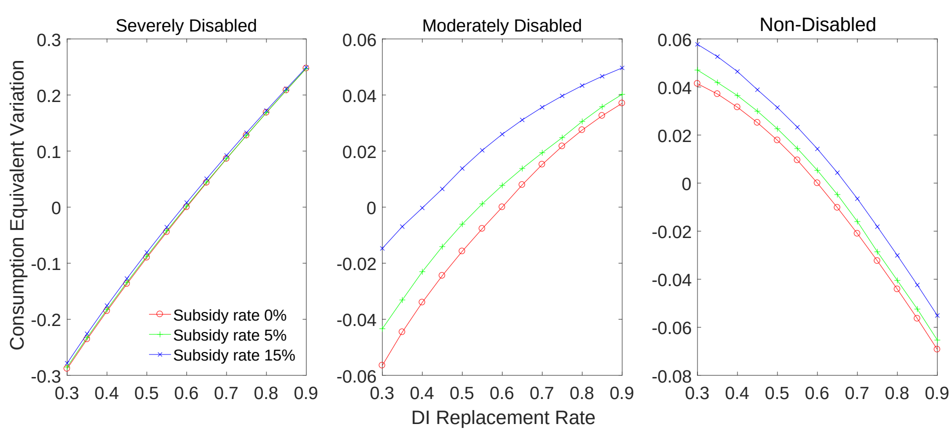
[52] For the lowest skill type, the effects of policies on screening distortions are larger. In the absence of amenity subsidies, even the moderately disabled workers drop out of the labor force as DI becomes more generous, removing all distortions on non-disabled workers' employment contracts within that skill group.

Figure 4: Fiscal Effects of Policy Reforms



At the same time, employment subsidies induce more disabled workers to participate in the labor force by increasing the value of work. This latter effect may add to subsidy expenditures, but it simultaneously lowers DI expenditures as there are fewer non-employed individuals. In the model, increasing the amenity subsidy in the presence of a generous DI has negligible fiscal consequences (or it may even reduce the financial burden of the government), as it attracts more workers thus alleviating the fiscal burden from the DI program.

Figure 5: Welfare Effects of Policy Reform by Health Status

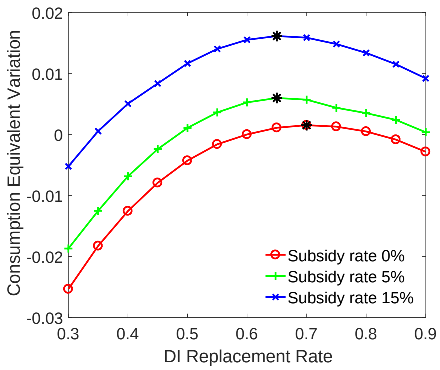


We now evaluate the welfare consequences measured by the consumption equivalent variation (CEV)—the percentage of consumption in the benchmark economy necessary for a worker to be indifferent between the benchmark[53] and the counterfactual economy—for each worker of a certain skill and health type. Figure 5 displays the CEVs by health statuses and Figure 6 displays the average CEVs.

First, we note that there are large differences in preferences for generous DI policy. While

[53]The benchmark policies are 0% amenity subsidy rate and 60% DI replacement rate.

Figure 6: Welfare Effects of Policy Reforms



Amenity Subsidy	0%	5%	15%
DI Rep. Rate	70%	65%	65%
Tax Rate	3.9%	2.2%	3.0%
Sev. Disabled	8.6	4.5	5.1
Mod. Disabled	1.5	1.4	3.1
Non-Disabled	-2.1	-0.5	0.4
Average	0.2	0.6	1.6

Note: For each amenity subsidy rate, the DI replacement rate is the average-welfare maximizing rate, and the tax rate, budget-balancing tax rate. The CEV's are expressed in percentages.

severely disabled workers are willing to give up 24% of their consumption in the benchmark economy for a 90% DI replacement rate, non-disabled workers need to receive around 7% of consumption to be indifferent. The welfare of moderately disabled workers is increasing in the DI replacement rate, although the magnitudes are smaller relative to those of severely disabled workers. Thus, the insurance benefit of DI, mostly enjoyed by severely disabled workers, is largely achieved at the expense of non-disabled workers who pay a higher tax rate. On the other hand, introducing job amenity subsidies benefits workers of all types. In particular, even though firms hiring moderately disabled or non-disabled workers receive amenity subsidies with a relatively low probability, worker welfare increases with amenity subsidies. This is driven by both a direct effect (from lower marginal cost of amenities) and an indirect effect through the relaxation of screening incentives (as shown in Figure 3).

The average welfare effects of the policy reforms are plotted and summarized in Figure 6. The CEV's range lies between -3%, when DI becomes less generous than the benchmark economy, to around 2%, when DI and amenity subsidies are more generous. In general, we observe that introducing amenity subsidies improves welfare on average as is consistent with the health-specific welfare results. Making DI more generous is also welfare-improving initially, but starts to become too costly at higher replacement rates. A noticeable feature is the interdependence between DI and amenity subsidies. We find that it is not necessarily the case that optimal DI is lower when the subsidy rate increases: with 5% or 15% amenity subsidy, optimal DI is constant at 65%.[54] The government finds it optimal to implement generous policies in both DI and amenity subsidies, as labor supply disincentive effects from DI are mitigated when the government simultaneously enacts the employment subsidies. As shown in the table, while these policies benefit disabled workers more, non-disabled workers

[54] When we conduct policy reforms with workers of all skill levels, the optimal DI replacement rate is higher, as the government uses DI as a means of redistributing resources across workers of heterogeneous skills as well as health statuses. Further, we find that the optimal DI is higher when subsidy rate is higher.

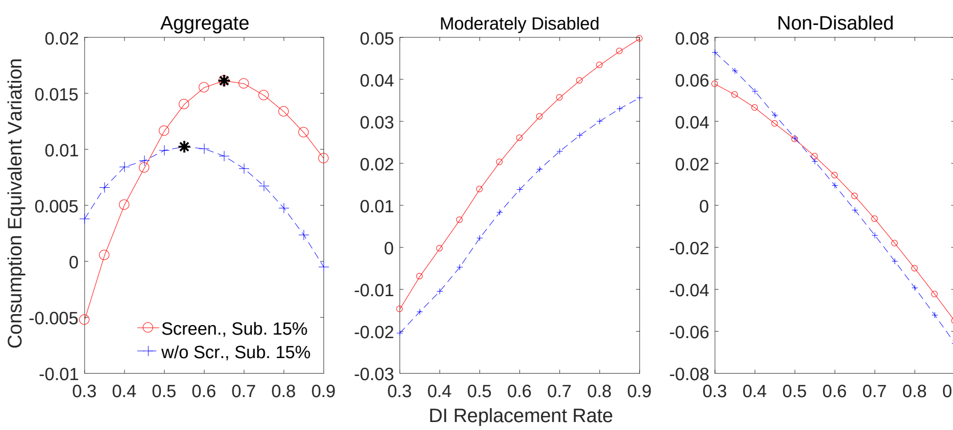
may also be better off when policies are jointly implemented. Under a 15% amenity subsidy rate and 65% replacement rate, the average CEV can be up to 1.6%, which indicates a significant welfare gain.

Overall, our counterfactual results show that the amenity subsidy is effective in improving welfare not only on average, but also for workers of all health statuses. It encourages more workers to supply labor by lowering their disutility of work, and directly lowers the contract distortions driven by firm screening incentives. Thus, with a higher amenity subsidy mitigating the labor supply disincentive effects of DI, the government gains the ability to implement a generous DI, providing more insurance during employment (using amenity subsidies) and across employment statuses (using DI). Thus, the two policies when used jointly are effective in increasing welfare and allocative efficiencies in the labor market with disabled workers.

5.3 Effects of Screening on Optimal Policy Design

Lastly, we discuss how the presence of screening contracts affects the optimal policy structure in the economy. To do so, we conduct the same counterfactual analyses, now assuming that firms can offer health-dependent contracts, and we compare the welfare effects under the two economies.

Figure 7: Welfare Effects of Policy Reform in Economics with vs. without Screening



In Figure 7, we plot welfare consequences of policy reforms when subsidy rate is 15% for varying generosity of DI, on average (left), for moderately disabled workers (middle), and non-disabled workers (right).[55] The welfare effects for severely disabled workers are similar under the two screening regimes, as their contracts in the screening economy are

[55] For brevity, we only report results under 15% subsidy rate, but the results are qualitatively similar when the government implements 0% or 5% subsidy rates.

the same as those in the no-screening economy.[56] The optimal DI replacement in the no-screening economy is 55%, 10*pp* lower than the optimal DI replacement rate in the screening economy.[57] This difference mostly stems from the welfare benefits enjoyed by moderately disabled workers. As discussed, moderately disabled workers are those whose contracts are most affected by firm screening incentives. In the screening economy, a generous DI provides more insurance, just as in the no-screening economy, and reduces screening incentives, giving more benefits to healthier workers. These factors make a "more" generous DI optimal in the presence of screening relative to the economy without screening contracts as shown in the left panel of Figure 7. This result, therefore, suggests the importance of taking into account the firm screening incentives in the labor market for optimal policy analyses.

6 Conclusion

In this paper, we have studied designs of social insurance programs for the disabled by developing an equilibrium labor market model in which firms offer screening contracts. We empirically examine which job amenity is used for screening and then structurally estimate the model by exploiting policy variations that subsidize firms hiring disabled workers. Our counterfactual policy experiments suggest a potential need to expand firm subsidies that support the hiring of disabled workers in the U.S., which are currently very small compared with expenditure of DI. In light of our model, subsidies to promote a more generous provision of job amenities to reduce disabled workers' disutility from work, which have been implemented in several European countries recently (OECD, 2010), may be effective in improving efficiency in the labor market and increasing welfare.

There are several promising avenues for future work. First of all, it is worth to explore the effectiveness of other disability policies, such as regulating or mandating certain employment contracts, in our framework. Second, the model could be also extended considerably. One interesting area is to consider a firm's dynamic employment contract problem in an environment where workers' health statuses change over time and workers choose consumption and savings over their life-cycle. We leave these interesting extensions for future research.

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[56] They are not equal, as the budget-neutral tax rates differ across the two economies, but the differences are almost negligible in magnitude.

[57] We also find the similar magnitude of differences in optimal policies in the no-screening and screening economy in counterfactual analyses with all skill-level workers.

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Online Appendix (Not For Publication)

A Theoretical Appendix

A.1 Competitive Search Equilibrium

We formally define the equilibrium of the economy below following Guerrieri, Shimer and Wright (2010).

Definition 3. A Competitive Search Equilibrium is a vector $\bar{U} = \{U_{h,x}\} \in \mathbb{R}$, a measure λ 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

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

   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

$$U_{h,x}^E\left(w, a\right) = u\left(w - \tau\left(w\right)\right) - \left(\chi_h - \beta_h \varphi\left(a\right)\right),$$

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

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

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

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

   with equality if $\Theta\left(y_x\right) < \infty$ and $g_h\left(y_x\right) > 0$. If $U_{h,x}^E\left(w, a\right) < U_{h,x}^N\left(b_x, d_x\right)$, 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 $\bar{U}_{h,x} > U_{h,x}^N(b_x, d_x)$.

A.2 Equilibrium Characterizations under Risk-Neutral Preference

We compare properties of the equilibrium contracts with and without screening. To simplify notation, without loss of generality, we assume that the number of observable types $x = 1$. For simplicity, we also assume $\tau(w) = 0$ and $T(w,a) = 0$ and denote the expected DI benefits by $\tilde{d}_i = \psi_i d$. We show the main result for type $h = 2$, but the result can be generalized for $h > 2$. The problem of the screening economy then reads,

$$\begin{aligned} &\max_{\theta,w,a} && \left\{\mu(\theta)\left[c - (\chi_2 - \beta_2\varphi(a))\right] + (1-\mu(\theta))\,\tilde{d}_2\right\} \\ \text{s.t.} \quad &\text{(FE)} && \mu(\theta)\left\{f_2 - w - C(a)\right\} = \theta\kappa \\ &\text{(IC)} && \mu(\theta)\left[c - (\chi_1 - \beta_1\varphi(a))\right] + (1-\mu(\theta))\,\tilde{d}_1 \leq \bar{U}_1. \end{aligned}$$

Let Lagrange multipliers with respect to (FE) and (IC) be ν and λ. Then, from the FOC with respect to the wage rate (w), we get $1 - \lambda = \nu$. From the FOC with respect to amenity a, we also obtain $\lambda = \dfrac{\beta_2\varphi'(a) - C'(a)}{\beta_1\varphi'(a) - C'(a)}$. Combining the two optimality conditions,

$$\nu = \frac{\beta_1\varphi'(a) - \beta_2\varphi'(a)}{\beta_1\varphi'(a) - C'(a)}.$$

Since $\beta_1 > \beta_2$, the numerator of ν is always positive. Thus, for ν to be positive, the denominator must be positive too. This implies that for λ to be positive, the numerator must be positive: $\beta_2\varphi'(a) > C'(a)$. Note that in the no-screening economy, the optimality condition for a^{NS} reads $\beta_2\varphi'\left(a^{NS}\right) = C'\left(a^{NS}\right)$. Thus, by concavity of φ function (and weak convexity of $C(\cdot)$ function), $a_2^S < a_2^{NS}$ when $\lambda > 0$ (that is, when (IC) is binding).

Lastly, we take the FOC with respect to θ. In the no-screening economy, the following optimality condition holds:

$$\left\{f_2 - C\left(a_2^{NS}\right) + \beta_2\varphi\left(a_2^{NS}\right) - \chi_2 - \tilde{d}_2\right\} = \frac{\kappa}{\mu'\left(\theta_2^{NS}\right)}. \tag{4}$$

Note that the expression within the bracket is equivalent to the standard definition of match surplus, where the level of job amenity is determined by the FOC, $\beta_2\varphi'\left(a^{NS}\right) = C'\left(a^{NS}\right)$, so that the match surplus can be maximized. In this no-screening economy, the equilibrium market tightness θ_2^{NS} is determined in socially efficient level in the sense that the expected gain of additional vacancy is equivalent to its cost, κ. In contrast, the FOC in the economy with screening reads

$$\frac{\kappa}{\mu'\left(\theta_2^S\right)} = f_2 - C\left(a_2^S\right) + \frac{C'\left(a_2^S\right)}{\beta_2\varphi'\left(a_2^S\right)}\left(\beta_2\varphi\left(a_2^S\right) - \beta_2\frac{\Delta\tilde{d}}{\Delta\beta}\right) - \tilde{d}_2\left(1 - \frac{\beta_2}{\tilde{d}_2}\frac{\Delta\tilde{d}}{\Delta\beta}\right), \quad (5)$$

where $\Delta\beta \equiv \beta_1 - \beta_2$ and $\Delta\tilde{d} \equiv \tilde{d}_1 - \tilde{d}_2$. The difference between the two FOC illustrates that there exist opposite forces on the match surplus with the presence of screening effectively shifts down the utility from amenity by $\beta_2\frac{\Delta\tilde{d}}{\Delta\beta}$, and the marginal utility is also rescaled with $\frac{C'\left(a_2^S\right)}{\beta_2\varphi'\left(a_2^S\right)} < 1$. On the other hand, reduction in costs for providing $a_2^S < a_2^{NS}$ increases the surplus.

To know how θ_2^S should adjust in the economy with screening in net, we apply the implicit function theorem on Equation (5) and find the relationship between θ_2^S and of a_2^S. Since $a^{NS} > a^S$ when $\lambda > 0$, $\theta_2^{NS} < \theta_2^S$ if $\frac{d\theta_2^S}{da_2^S} < 0$:

$$\frac{d\theta_2^S}{da_2^S} = -\left\{\varphi\left(a_2^S\right) - \frac{\Delta\tilde{d}}{\Delta\beta}\right\}\left(\frac{C''\left(a_2^S\right)\varphi'\left(a_2^S\right) - C'\left(a_2^S\right)\varphi''\left(a_2^S\right)}{\left\{\varphi'\left(a_2^S\right)\right\}^2}\right) \times \frac{\left\{\mu'\left(\theta_2^S\right)\right\}^2}{\kappa\mu''\left(\theta_2^S\right)} < 0.$$

This inequality holds when $\varphi\left(a_2^S\right) < \frac{\Delta\tilde{d}}{\Delta\beta}$. We solve for the equilibrium wage using the (FE):

$$\begin{aligned}
w_2^S &= f_2 - C\left(a_2^S\right) - \frac{\theta_2^S\kappa}{\mu\left(\theta_2^S\right)} \\
&= \left(1 - \frac{\theta_2^S\mu'\left(\theta_2^S\right)}{\mu\left(\theta_2^S\right)}\right)\frac{\kappa}{\mu'\left(\theta_2^S\right)} - \frac{C'\left(a_2^S\right)}{\varphi'\left(a_2^S\right)}\left(\varphi\left(a_2^S\right) - \frac{\Delta\tilde{d}}{\Delta\beta}\right) + \tilde{d}_2\left(1 - \frac{\beta_2}{\tilde{d}_2}\frac{\Delta\tilde{d}}{\Delta\beta}\right) \\
&\equiv \frac{\left(1-\varepsilon_{\mu,\theta}\right)\kappa}{\mu'\left(\theta_2^S\right)} + \frac{C'\left(a_2^S\right)}{\varphi'\left(a_2^S\right)}\left(\frac{\Delta\tilde{d}}{\Delta\beta} - \varphi\left(a_2^S\right)\right) + \tilde{d}_2\left(1 - \frac{\beta_2}{\tilde{d}_2}\frac{\Delta\tilde{d}}{\Delta\beta}\right).
\end{aligned}$$

Note that the wage compensates the decline in amenity (second term). If $\theta_2^S > \theta_2^{NS}$, then $w_2^S > w_2^{NS}$ as long as the matching function elasticity ($\varepsilon_{\mu,\theta}$) is non-increasing in θ.

A.3 Proof of Proposition 1

A.3.1 Proof of (a): Optimal Firm Subsidies without Labor Market Screening

To begin with, we first specify the government's problem:

$$\max_{s} \sum_{i} \omega_i \left((1 - \mu(\theta_i)) U_i^N (b, d) + \mu(\theta_i) (u(w_i - T) - (\chi_i - \beta_i \varphi(a_i))) \right)$$

$$s.t. \; \frac{\mu(\theta_i)}{\theta_i} (f_i - w_i - (1 - s\psi_i) C(a_i)) = \kappa$$

$$T = \frac{\sum_i \pi_i \mu(\theta_i) s\psi_i C(a_i)}{\sum_i \pi_i \mu(\theta_i)}.$$

Now, we incorporate these two constraints into the objective function:

$$\sum_{i} \omega_i \left((1 - \mu(\theta_i)) U_i^N (b, d) + \mu(\theta_i) \left(u \left(f_i - (1 - s\psi_i) C(a_i) - \frac{\kappa \theta_i}{\mu(\theta_i)} - \frac{\sum_j \pi_j \mu(\theta_j) s\psi_j C(a_j)}{\sum_j \pi_j \mu(\theta_j)} \right) - (\chi_i - \beta_i \varphi(a_i)) \right) \right).$$

We can apply the first-order condition and characterize the optimal policy, exploiting the envelope condition (Chetty, 2006). To provide intuition, we apply the perturbation approach following (Saez, 2001), to decompose the optimal policy into three components. First, the government takes into account the standard mechanical revenue effect from a Δs change in the subsidy rate, which is determined as

$$\Delta M = -\sum_{i} \omega_i \mu(\theta_i) u'(c_{e,i}) \frac{\sum_j \pi_j \mu(\theta_j) \psi_j C(a_j)}{\sum_j \pi_j \mu(\theta_j)} \Delta s = -\sum_{i} \omega_i \mu(\theta_i) u'(c_{e,i}) \widetilde{C}(a, \theta) \Delta s,$$

where $c_{e,i}$ is the consumption of the employed worker, and $\widetilde{C}(\boldsymbol{a}, \boldsymbol{\theta})$ is the average expected (i.e., incorporating eligibility probabilities, ψ_j) job amenity spendings per employed worker (total expected job amenity spendings divided by the measure of employed workers):

$$\widetilde{C}(\boldsymbol{a}, \boldsymbol{\theta}) = \frac{\sum_j \pi_j \mu(\theta_j) \psi_j C(a_j)}{\sum_j \pi_j \mu(\theta_j)}.$$

The term in the denominator reflects that the tax is imposed only on employed workers. If for example, all workers are subject to the tax regardless of their employment statuses, the value of denominator would be 1.

Second, an increase in subsidy rate has a welfare effect, which is expressed as

$$\Delta W = \sum_{i} \omega_i \mu(\theta_i) u'(c_{e,i}) \psi_i C(a_i) \Delta s = \sum_{i} \omega_i \mu(\theta_i) u'(c_{e,i}) \widetilde{C}(\boldsymbol{a}, \boldsymbol{\theta}) \overline{C}(\boldsymbol{a}, \boldsymbol{\theta}) \Delta s,$$

where $\overline{C}(\boldsymbol{a}, \boldsymbol{\theta})$ is the concentration of job amenity (subsidy) spending among the subsidy-eligible disabled population relative to the redistributive preference, captured by the welfare weights and the marginal utility of consumption:

$$\overline{C}(\boldsymbol{a},\boldsymbol{\theta}) = \frac{\frac{\sum_i \omega_i u'(c_{e,i})\mu(\theta_i)\psi_i C(a_i)}{\sum_i \omega_i u'(c_{e,i})\mu(\theta_i)}}{\frac{\sum_i \pi_i \mu(\theta_i)\psi_i C(a_i)}{\sum_i \pi_i \mu(\theta_i)}}.$$

Note that if $\pi_i = \omega_i u'(c_{e,i})$, which is the case under the utilitarian social welfare function and risk-neutral individuals, $\overline{C}(\boldsymbol{a},\boldsymbol{\theta}) = 1$.

Finally, we have the behavioral effect:

$$\begin{aligned}
\Delta B =& -\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \sum \pi_j \psi_j s \frac{\partial \frac{C(a_j)\mu(\theta_j)}{\sum_k \pi_k \mu(\theta_k)}}{\partial s} \Delta s \\
=& \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \sum_j \mathbf{1}_{(\varphi_{\mathbf{j}}=\mathbf{1})} \left(\frac{\frac{sC(a_j)\pi_j\mu(\theta_j)}{\sum_k \pi_k\mu(\theta_k)}}{1-s} \frac{\frac{\partial C(a_j)}{\partial(1-s)}}{\frac{C(a_j)}{1-s}} + \frac{\frac{sC(a_j)\pi_j\mu(\theta_j)}{\sum_k \pi_k\mu(\theta_k)}}{1-s} \frac{\frac{\partial \frac{\pi_j\mu\left(\theta_j\right)}{\sum_k \pi_k\mu(\theta_k)}}{\partial(1-s)}}{\frac{\frac{\pi_j\mu\left(\theta_j\right)}{\sum_k \pi_k\mu(\theta_k)}}{1-s}} \right) \Delta s \\
=& \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) 1_{(\varphi_j=1)} \frac{\frac{sC(a_j)\pi_j\mu(\theta_j)}{\sum_k \pi_k\mu(\theta_k)}}{1-s} \left(\epsilon_{C(a_j),1-s} + \epsilon_{\mu(\theta_j),1-s}\right) \Delta s \\
=& \frac{s}{1-s} \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \widetilde{C}(\boldsymbol{a},\boldsymbol{\theta}) \sum_j \frac{1_{(\varphi_j=1)} \frac{C(a_j)\pi_j\mu(\theta_j)}{\sum_k \pi_k\mu(\theta_k)}}{\widetilde{C}(a,\theta)} \left(\epsilon_{C(a_j),1-s} + \epsilon_{\mu(\theta_j),1-s}\right) \Delta s \\
=& \frac{s}{1-s} \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \widetilde{C}(\boldsymbol{a},\boldsymbol{\theta}) \sum_j \alpha_j \left(\epsilon_{C(a_j),1-s} + \epsilon_{\mu(\theta_j),1-s}\right) \Delta s \\
=& \frac{s}{1-s} \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \widetilde{C}(\boldsymbol{a},\boldsymbol{\theta}) \left(\widetilde{\epsilon}_{C(a),1-s} + \widetilde{\epsilon}_{\mu(\theta),1-s}\right) \Delta s,
\end{aligned}$$

where α_j is the contribution of amenities costs by type j:

$$\alpha_j = \frac{1_{(\varphi_j=1)} \frac{C(a_j)\pi_j\mu(\theta_j)}{\sum_k \pi_k\mu(\theta_k)}}{\widetilde{C}(\boldsymbol{a},\boldsymbol{\theta})} = \frac{\pi_j \mu\left(\theta_j\right)\psi_j C(a_j)}{\sum_k \pi_k \mu\left(\theta_k\right)\psi_k C(a_k)};$$

$\epsilon_{C(a_j),1-s}$ and $\epsilon_{\mu(\theta_j),1-s}$ are elasticities of total cost of amenities and employment with respect to the net-of-subsidy marginal cost of amenities, $(1-s)$:

$$\epsilon_{C(a_j),1-s} = \frac{d\log C(a_j)}{d\log(1-s)} \quad \text{and} \quad \epsilon_{\mu(\theta_j),1-s} = \frac{d\log\left(\frac{\pi_j\mu(\theta_j)}{\sum_k \pi_k\mu(\theta_k)}\right)}{d\log(1-s)};$$

and $\left(\widetilde{\epsilon}_{C(a),1-s}, \widetilde{\epsilon}_{\mu(\theta_j),1-s}\right)$ are the α_j-weighted sums of these elasticities. Note that this channel clarifies the two margins in which the subsidy rate can affect the equilibrium outcomes: its effect on the provision of amenities in the employment contract, and on the employment level of workers.

The optimal policy is determined by the sum of these three effects: importantly, we do not need to consider any changes in other endogenous variables, such as labor market tightness or job amenities due to the envelope condition (Saez, 2001). Then, the optimal policy is:

$$\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \left(-\widetilde{C}(\boldsymbol{a},\boldsymbol{\theta}) + \widetilde{C}(\boldsymbol{a},\boldsymbol{\theta})\overline{C}(\boldsymbol{a},\boldsymbol{\theta}) + \frac{s}{1-s}\widetilde{C}(\boldsymbol{a},\boldsymbol{\theta})\left(\widetilde{\epsilon}_{C(a),1-s} + \widetilde{\epsilon}_{\mu(\theta),1-s}\right)\right) \mathit{\Delta} s = 0,$$

or

$$\frac{s}{1-s} = \frac{1-\overline{C}(\boldsymbol{a},\boldsymbol{\theta})}{\widetilde{\epsilon}_{C(a),1-s} + \widetilde{\epsilon}_{\mu(\theta),1-s}}.$$

This completes the proof. Note that if the government is utilitarian and workers are risk neutral, one can easily show that the optimal subsidy should be zero. □

A.3.2 Proof of (b): Optimal Firm Subsidies with Labor Market Screening

Importantly, we now need to consider the incentive compatibility constraint in the firm's problem which affects the optimal employment contracts. An immediate implication is that the envelope theorem no longer applies: that is, the optimal contract must not only to maximize the worker's utility subject to free-entry condition, but also to satisfy the incentive compatibility constraint. This requires some modification in the perturbation argument.

First, we have the identical mechanical revenue effect and behavioral effects as in the case in the absence of labor market screening (a). The mechanical revenue effect is denoted by $\Delta M = -\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i})\widetilde{C}(a,\theta)\mathit{\Delta} s$, and the behavioral effect is denoted by

$$\Delta B = \frac{s}{1-s}\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i})\widetilde{C}(\boldsymbol{a},\boldsymbol{\theta})\left(\widetilde{\epsilon}_{C(a),1-s} + \widetilde{\epsilon}_{\mu(\theta),1-s}\right)\mathit{\Delta} s.$$

Now, the inability to apply the envelope condition leads to a different form of welfare effect:

$$\begin{aligned}\Delta W =& \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i})\overline{C}(\boldsymbol{a},\boldsymbol{\theta})\widetilde{C}(\boldsymbol{a},\boldsymbol{\theta})\mathit{\Delta} s \\ &+ \sum_i \omega_i \mathbb{I}_i^{IC}\left(\mu\left(\theta_i\right)\frac{\partial a_i}{\partial s}\left(-u'(c_{e,i})(1-s\psi_i)\frac{\partial C(a_i)}{\partial a_i} + \frac{\partial \beta_i \varphi\left(a_i\right)}{\partial a_i}\right)\right)\mathit{\Delta} s \\ &+ \sum_i \omega_i \mathbb{I}_i^{IC}\frac{\partial \theta_i}{\partial s}\left(\frac{\partial \mu\left(\theta_i\right)}{\partial \theta_i}\left(u(c_{e,i}) - u(c_{u,i})\right) - \mu\left(\theta_i\right) u'(c_{e,i})\frac{\partial \frac{\kappa\theta_i}{\mu(\theta_i)}}{\partial \theta_i}\right)\mathit{\Delta} s.\end{aligned}$$

Screening effects on worker utility are given by

$$\xi_{a,i} = -\left(-u'(c_{e,i})(1 - s\psi_i)\frac{\partial C(a_i)}{\partial a_i} + \frac{\partial \beta_i \varphi(a_i)}{\partial a_i}\right);$$

$$\nu_{\theta,i} = -\frac{\partial \mu(\theta_i)}{\partial \theta_i}\left(u(c_{e,i}) - u(c_{u,i})\right) - \mu(\theta_i)\, u'(c_{e,i})\frac{\partial \frac{\kappa\theta_i}{\mu(\theta_i)}}{\partial \theta_i},$$

both of which are zero in an equilibrium without screening. They are non-zero when firms incentive compatibility constraint $\mathbb{I}_i^{IC}$ is binding, that is,

$$\mathbb{I}_i^{IC} = 1 \quad \text{if} \quad \mu(\theta_i)\, U_{i-1}^{E}(w_i, a_i) + (1 - \mu(\theta_i))\, U_{i-1,x}^{N}(b, d) = \bar{U}_{i-1}.$$

The optimal subsidy is now determined by summing these three effects and can be expressed as:

$$\frac{s}{1-s} = \frac{1 - \overline{C}(\boldsymbol{a}, \boldsymbol{\theta})}{\widetilde{\epsilon}_{C(a),s} + \widetilde{\epsilon}_{\mu(\theta),s}} + \frac{\sum_i \omega_i \mathbb{I}_i^{IC}\left(\left(\mu(\theta_i)\frac{da_i}{ds}\xi_{a,i}\right) + \frac{d\theta_i}{ds}\nu_{\theta,i}\right)}{\widetilde{C}(\boldsymbol{a}, \boldsymbol{\theta})\sum_i \omega_i \mu(\theta_i)\, u'(c_{e,i})\left(\widetilde{\epsilon}_{C(a),1-s} + \widetilde{\epsilon}_{\mu(\theta),1-s}\right)}. \quad \square$$

A.4 Proof of Proposition 2

A.4.1 Proof of (a): Optimal Disability Insurance without Labor Market Screening

To begin with, we specify the government's optimal disability benefit problem as (assume $s = 0$ for simplicity)

$$\max_{d} \sum_i \omega_i \left((1 - \mu(\theta_i))\left(\psi_i u(d + b) + (1 - \psi_i)\, u(b)\right) + \mu(\theta_i)\left(u(w_i - T) - (\chi_i - \beta_i \varphi(a_i))\right)\right)$$

$$s.t.\ \frac{\mu(\theta_i)}{\theta_i}\left(y_i - w_i - C(a_i)\right) = \kappa$$

$$T = \frac{\sum_i \pi_i (1 - \mu(\theta_i))\, \psi_i d}{\sum_i \pi_i \mu(\theta_i)}$$

Now, we plug these constrains into the objective function:

$$\sum_i \omega_i \left(\begin{array}{c} (1 - \mu(\theta_i))\left(\psi_i u(d + b) + (1 - \psi_i)\, u(b)\right) \\ +\mu(\theta_i)\left(u\left(y_i - C(a_i) - \frac{\kappa\theta_i}{\mu(\theta_i)} - \frac{\sum_j \pi_j (1-\mu(\theta_j))\psi_j d}{\sum_j \pi_j \mu(\theta_j)}\right) - \chi_i - \beta_i \varphi(a_i)\right) \end{array}\right).$$

Following the proof in A.3, we can characterize the optimal policy by introducing (i) mechanical revenue effect; (ii) welfare effect; and (iii) behavioral effect:

First, the mechanical effect is

$$\Delta M = -\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \frac{\sum_j \pi_j \left(1-\mu\left(\theta_j\right)\right) \psi_j}{\sum_j \pi_j \mu\left(\theta_j\right)} \Delta d = -\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \widetilde{E}\left(\boldsymbol{\theta}\right) \Delta d,$$

where

$$\widetilde{E}\left(\boldsymbol{\theta}\right) = \frac{\sum_j \pi_j \left(1-\mu\left(\theta_j\right)\right) \psi_j}{\sum_j \pi_j \mu\left(\theta_j\right)}$$

is the ratio of DI enrollees over the employed.

Second, the welfare effect is

$$\begin{aligned}
\Delta W &= \sum_i \omega_i \left(1-\mu\left(\theta_i\right)\right) u'(c_{u,i}) \psi_i \Delta d \\
&= \frac{\frac{\sum_i \omega_i (1-\mu(\theta_i)) u'(c_{u,i}) \psi_i}{\sum_i \omega_i \mu(\theta_i) u'(c_{e,i})}}{\frac{\sum_j \pi_j (1-\mu(\theta_j)) \psi_j}{\sum_j \pi_j \mu(\theta_j)}} \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \frac{\sum_j \pi_j \left(1-\mu\left(\theta_j\right)\right) \psi_j}{\sum_j \pi_j \mu\left(\theta_j\right)} \Delta d \\
&= \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \overline{E}\left(\boldsymbol{\theta}\right) \widetilde{E}\left(\boldsymbol{\theta}\right) \Delta d
\end{aligned}$$

where

$$\overline{E}\left(\boldsymbol{\theta}\right) = \frac{\frac{\sum_i \omega_i (1-\mu(\theta_i)) u'(c_{u,i}) \psi_i}{\sum_i \omega_i \mu(\theta_i) u'(c_{e,i})}}{\frac{\sum_j \pi_j (1-\mu(\theta_j)) \psi_j}{\sum_j \pi_j \mu(\theta_j)}}$$

is the concentration of DI spending relative to the redistribution preference of the government.

Finally, the behavioral effect is

$$\begin{aligned}
\Delta B &= -d \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \frac{\partial \frac{\sum_j \pi_j (1-\mu(\theta_j)) \psi_j}{\sum_j \pi_j \mu(\theta_j)}}{\partial d} \Delta d \\
&= -\widetilde{\epsilon}_{E,d} \widetilde{E}\left(\boldsymbol{\theta}\right) \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \Delta d
\end{aligned}$$

where $\widetilde{\epsilon}_{E,d}$ is the elasticity of employment ratio with respect to disability benefit.

The optimal disability benefit is such that the sum of these three effects equals zero:

$$\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \left(-\widetilde{E}\left(\boldsymbol{\theta}\right) + \overline{E}\left(\boldsymbol{\theta}\right) \widetilde{E}\left(\boldsymbol{\theta}\right) - \widetilde{\epsilon}_{E,d} \widetilde{E}\left(\boldsymbol{\theta}\right)\right) \Delta d = 0,$$

or

$$\overline{E}\left(\boldsymbol{\theta}\right) = \widetilde{\epsilon}_{E,d} + 1$$

This completes the proof. □

A.4.2 Proof of (b): Optimal Disability Insurance with Labor Market Screening

As discussed in the proof of Proposition A.3, we have the identical mechanical revenue effect and behavioral effect as those in (a); however, the welfare effect now includes a screening effect.

The welfare effect is now expressed as

$$\begin{aligned}\Delta W = & \sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \overline{E}\left(\boldsymbol{\theta}\right) \widetilde{E}\left(\boldsymbol{\theta}\right) \Delta d \\ & + \sum_i \omega_i \mathbb{I}_i^{IC} \mu\left(\theta_i\right) \frac{\partial a_i}{\partial s} \left(-u'(c_{e,i})(1 - s\psi_i) \frac{\partial C(a_i)}{\partial a_i} + \frac{\partial \beta_i \varphi\left(a_i\right)}{\partial a_i} \right) \Delta d \\ & + \sum_i \omega_i \mathbb{I}_i^{IC} \frac{\partial \theta_i}{\partial s} \left(\frac{\partial \mu\left(\theta_i\right)}{\partial \theta_i} \left(u(c_{e,i}) - u(c_{u,i})\right) - \mu\left(\theta_i\right) u'(c_{e,i}) \frac{\partial \frac{\kappa \theta_i}{\mu(\theta_i)}}{\partial \theta_i} \right) \Delta d\end{aligned}$$

where $\mathbb{I}_i^{IC}$ is defined as in A.3.

So the optimal policy is determined by

$$\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \left(-\widetilde{E}\left(\boldsymbol{\theta}\right) + \overline{E}\left(\boldsymbol{\theta}\right) \widetilde{E}\left(\boldsymbol{\theta}\right) - \widetilde{\epsilon}_{E,d} \widetilde{E}\left(\boldsymbol{\theta}\right) \right) - \sum_i \omega_i \mathbb{I}_{i \neq 1} \left(\left(\mu\left(\theta_i\right) \frac{da_i}{ds} \xi_{a,i} \right) + \frac{d\theta_i}{ds} \nu_{\theta,i} \right) \Delta d = 0$$

where $(\xi_{a,i}, \nu_{\theta,i})$ is defined in section A.3 and $\widetilde{E}\left(\boldsymbol{\theta}\right) = \frac{\sum_j \pi_j (1-\mu(\theta_j))\psi_j}{\sum_j \pi_j \mu(\theta_j)}$. By rearranging terms, we have

$$\overline{E}\left(\boldsymbol{\theta}\right) + \frac{\sum_i \omega_i \mathbb{I}_i^{IC} \left(\left(\mu\left(\theta_i\right) \frac{da_i}{ds} \xi_{a,i} \right) + \frac{d\theta_i}{ds} \nu_{\theta,i} \right)}{\sum_i \omega_i \mu\left(\theta_i\right) u'(c_{e,i}) \widetilde{E}\left(\boldsymbol{\theta}\right) \widetilde{\epsilon}_{E,d}} = \widetilde{\epsilon}_{E,d} + 1,$$

which completes the proof. □

B A Back-of-the-Envelope Calculation: DI Removal and Employment Changes

Ideally, we would like to compare labor market statistics from our counter-factual experiment without DI to real-world equivalent measures. While we cannot directly observe labor market outcomes without DI, recent empirical analysis sheds lights on labor supply changes caused by DI (Maestas, Mullen and Strand, 2013; French and Song, 2014). In this section, we explain how we use these empirical estimates to compute the effects of DI removal on employment for individuals ages between 50-64.

According to Maestas, Mullen and Strand (2013), DI applicants can be characterized into three groups: 57% of *truly disabled* applicants who receive DI for sure, 20% of applicants are *always rejected*, and the remaining 23% of applicants are classified as *marginal cases*, as their outcomes may vary depending on the judge's leniency. These findings indicate that, roughly speaking, the current DI recipients can be either truly disabled or marginal, and their shares are given by 71.25%(=57/80) and 28.75%(=23/80), respectively.[58]

According to Social Security Administration (2018), there are 6.18 million DI recipients ages between 50 and 64. Using the decomposition explained above, we expect that 4.4 million of them are truly disabled recipients and that the remaining 1.78 million are marginal cases. Among the 59 million of U.S. population ages between 50-64 (Census Population Estimates), approximately 37.17 million are employed, yielding an employment rate of 63%.[59]

From the estimation results in Maestas, Mullen and Strand (2013), the employment rate for DI applicants declines after the rejection of application, and the magnitude of this decline varies by the applicant's type; 57% of marginal case applicants return to work once their application is rejected, however for the truly disabled only 12% return to work after rejection. Using these numbers, we compute that without DI, we would expect 12% of 4.4 million and 56.6% of 1.78 million DI recipients (or 1.54 million) to return to work. This would result an increase in employment from 37.17 to 38.71 million out of 59 million workers between 50 and 64, or a 2.6pp increase in the employment rate of this group.

[58] These DI recipient shares are broad estimates because we ignore possibilities of appeals and re-appeals of DI application process. Our approach does not take into account heterogeneity of rejection rates within the marginal cases either.

[59] The number is calculated as the 10-year average of employment rates for 50-64 from 2008 to 2010. Data source: Data source: BLS statistics, the number of employment for ages in 50-54 (LNU02024937Q) and 55-64 (LNU02000095Q).

C Data Appendix: Health and Retirement Study

C.1 Summary Statistics by the Disability Measure

Because the degree of disability status is constructed based on the two subjective measures relying on the respondent self-evaluation, one may worry that our disability measure may not correctly captures the respondent health conditions. To examine how accurately our disability measure reflects the health status of an individual, we looked into the relationship between the disability measure with other objective health variables available in the HRS, as listed in Table 8. We confirm that our disability measure indeed is positively correlated with the severity of health conditions in various types of health outcomes.

Table 8: Other Measures of Health: Sample Means

Objective health measures	Non-disabled	Moderately disabled	Severely disabled
Body Mass Index	27.6	29.4	30.4
Missed work due to health issues (days)	3.9	9.3	21.7
Hospital utilization during the past 12 months			
Out-of-pocket medical spending ($2014)	1,819	3,142	4,367
Any doctor's visit (%)	88.2	91.1	96.2
Any overnight stay in hospital (%)	11.9	24.3	44.2
Doctor's diagnoses (%)			
Experiencing back problems	23.4	46.7	65.4
Arthritis or rheumatism	37.8	63.5	75.8
High blood pressure or hypertension	37.7	55.2	65.7
Emotional, nervous, or psychiatric problems	10.3	23.3	44.9
Diabetes or high blood sugar	8.9	22.3	33.1
Heart attack, congestive heart failure, or other heart problems	8.9	20.1	37.4
Cancer or a malignant tumor of any kind (except skin cancer)	6.5	10.5	13.8
Chronic lung disease (except asthma)	3.5	10.5	24.1
Stroke or transient ischemic attack (TIA)	1.3	4.7	12.2

Note: Table 8 documents the sample mean of objective health measures by the degree of disability. The nominal out-of-pocket medical expenditure is adjusted using the Consumer Price Index (CPI) in 2014 U.S. dollar.

D Additional Empirical Results

We documents additional results of our empirical analysis reported in Section 4.1.

D.1 Testing for the Common-Trend Assumption

We test for the common-trend assumption for the option to reduce working hours by introducing time-specific dummies of disability status:

$$y_{it} \;=\; \alpha_h + \sum_{j=1998}^{2008} \beta_t^h \mathbb{I}_{\{\text{health}=h\}} + \boldsymbol{\gamma} \mathbf{X_{it}} + \boldsymbol{\nu} \boldsymbol{Z_t} + \epsilon_{it}. \tag{6}$$

Table 9 summarizes the estimated coefficients. We find that the moderately disabled workers show significant increases in receiving the option to reduce working hours after the WOTC amendment: the share of the moderately disabled with the access to the option used to range in between 10.7% and 16.5% prior to the amendment but increased to 16.5% to 29.1% after the amendment. During the same timeframe, however, severely disabled workers exhibit no significant changes in receiving this job amenity.

Table 9: Testing for the Common-Trend Assumption

Dependent variable: Option to reduce working hours

		Severely disabled	Moderately disabled
Disability status		0.160	-0.044
		(0.101)	(0.060)
Pre-WOTC expansion	β_{1998}	-0.022	0.107*
		(0.113)	(0.064)
	β_{2000}	0.015	0.140**
		(0.109)	(0.064)
	β_{2002}	0.238	0.165**
		(0.159)	(0.085)
Post-WOTC expansion	β_{2004}	0.445***	0.268**
		(0.119)	(0.110)
	β_{2006}	0.055	0.291***
		(0.136)	(0.083)
	β_{2008}	0.032	0.165**
		(0.112)	(0.065)
# of observations		7,653	

Note: Table 9 reports the coefficient estimates of a regression equation (6). The sample is individuals in age between 50 and 64 from 1996-2008 and is weighted by individual-level survey weight. The additional covariates used in the regression include age, age-squared, years of education, annual growth rate of GDP, annual employment rates, firm-size categories, and health outcomes. Standard errors are clustered at individual-level. *** p<0.01, ** p<0.05, * p<0.1

D.2 The Effects of the 2004 WOTC Amendment on Other Measures of Job Amenities

We estimate Equation (3) in Section 4.1 on other job amenity variables available from the HRS: availability to switch to a part-time position, the number of paid sick days per year, the number of vacation weeks per year, and the availability of ESDI converge. Results are reported in Table 10. It is important to note that the sample sizes in regressions for the availability of part-time and the availability of sick days are much smaller than that for the option to reduce working hours. As a result, we may not have enough statistical power to credibly estimate our regression models. Moreover, we also find that the coefficients for disability dummies (β_{2h}) are not monotonic in disability status in regressions for vacation days and ESDI coverage, in addition to the lack of the significance of the effect of the WOTC Amendment. One possibility is that the provision of these job amenities, especially ESDI, are determined at the firm level. Thus, it may be very difficult for firms to exploit them to screen a particular worker.

Table 10: Effects of the WOTC Amendment on Other Job Amenities

Coefficients		Dependent variable			
		Available part-time	Available paid sick days	Available vacations (week)	ESDI coverage
Post amendment (β_1)		-0.015	0.933	-0.348	-0.063
		(0.113)	(3.874)	(0.804)	(0.056)
Disability status (β_{2h})	Severe	0.030	13.496***	-0.833	-0.082
		(0.109)	(4.855)	(0.750)	(0.056)
	Moderate	0.038	9.378***	0.377	0.071**
		(0.058)	(3.107)	(0.558)	(0.035)
Disability status	Severe	-0.076	-2.161	0.183	-0.002
× Post amendment (β_{3h})		(0.132)	(6.160)	(0.510)	(0.064)
	Moderate	0.004	-4.035	-0.232	0.034
		(0.064)	(2.774)	(0.458)	(0.037)
# of observations		1,950	3,280	6,331	6,200

Note: The additional covariates used in the regression include age, age-squared, years of education, annual growth rate of GDP, annual employment rates, firm-size categories, and health outcomes. Standard errors are clustered at individual-level. *** p<0.01, ** p<0.05, * p<0.1

D.3 Robustness Analyses

This section describes the robustness analyses and their estimation results.

D.3.1 Interaction of Health Outcomes with the 2004 WOTC Amendment

One potential concern with our analysis is that our results may be driven by changes in worker composition in each disability category. That is, there may be heterogeneity in health status within each disability category, and marginally disabled individuals (with more preference for the option to reduce working hours) in the moderate group started working in jobs with the amenity after the expansion of WOTC in 2004. If this is the driver of the above result, the prediction is consistent with a competitive labor market equilibrium without screening contracts (or equilibrium with health-dependent contracts). We include interaction terms of health outcomes with the 2004 WOTC amendment as additional covariates to the benchmark analysis. With this, we can check whether our findings of changes in job amenities after the 2004 WOTC Amendment is explained by health heterogeneity within each disability group. As reported in Table 12, the main findings reported in the benchmark analysis are not affected, including the significant increase of the the option to reduce working hours among the moderately disabled after the 2004 WOTC amendment. Thus, this finding indicates the robustness of our results with respect to the potential compositional effects induced by heterogeneity in health status within each disability.

D.3.2 Results with an Alternative Categorization of Workers

Another potential concern is whether our main finding is robust to alternative choices of disability measures. In this section, we introduce an alternative measure of disability and examine how sensitive our estimation results are with respect to the classification of disability. We construct our alternative disability measure by combining the work limitation measures with the number of reported diagnoses. In HRS, "respondents are asked if they have been diagnosed with any of eight major disease categories since the last survey: (i) arthritis or rheumatism, (ii) high blood pressure or hypertension, (iii) emotional, nervous, or psychiatric problems, (iv) diabetes or high blood sugar, (v) heart attack, congestive heart failure, or other heart problems, (vi) cancer or a malignant tumor of any kind (except skin cancer), (vii) chronic lung disease, and (viii) strokes or transient ischemic attacks. Based on these variables, we construct the number of diagnoses as an index ranging from zero to eight.

Table 11: Summary Statistics: The Number of Diagnoses

Share (%)		Number of diagnoses								
		0	1	2	3	4	5	6	7	8
Work limitation	no limitation	19.0	23.9	17.6	9.2	3.3	1.0	0.2	0.0	0.0
	limitation	0.9	3.4	5.9	6.3	4.6	2.8	1.3	0.5	0.1

Note: Table 11 reports the share of observations by the number of reported diagnoses and the work limitation measure. The statistics are computed using the individual-level survey weight.

Similar to the benchmark case, non-disabled workers are those who report less than four diagnoses and no work-limitation. We define severely disabled workers as those who have more than four diagnoses and have work limitations. The rest are labeled as moderately disabled. Under this specification, 4% are severely disabled, 25% are moderately disabled, and 71% are non-disabled. Thus, we are applying tighter criteria for being severely disabled compared to the benchmark case. Table 12 documents the results. Results suggest that the estimation outcomes are robust to the choice of disability measures.[60]

Table 12: Results: Robustness Analyses

Dependent variable: Option to reduce working hours

Coefficients		Benchmark	Type of robustness exercise (1) Health outcomes ×post-WOTC	(2) Measure with # of diagnoses	(3) Gender ×post-WOTC
Post amendment (β_1)		-0.014	0.014	0.038**	-0.025
		(0.058)	(0.098)	(0.019)	(0.060)
Disability status (β_{2h})	Severe	0.206***	0.145***	0.134*	0.204***
		(0.056)	(0.054)	(0.082)	(0.056)
	Moderate	0.080***	0.050**	0.053**	0.078**
		(0.031)	(0.029)	(0.024)	(0.031)
Disability status	Severe	0.014	0.079	-0.003	0.012
× Post amendment (β_{3h})		(0.064)	(0.082)	(0.127)	(0.063)
	Moderate	0.068***	0.118**	0.072**	0.068**
		(0.034)	(0.048)	(0.037)	(0.034)
# of observations		8,541	8,280	8,258	8,541

Note: Robustness (1) and (3) contain the covariates with that of the benchmark, and also include interaction terms with dummy variables for health outcomes and gender, respectively. Robustness (2) uses the same covariates of the benchmark which include age, age-squared, years of education, annual growth rate of GDP, annual employment rates, firm-size categories, and health outcomes. For all analyses, standard errors are clustered at individual-level. *** p<0.01, ** p<0.05, * p<0.1

[60]We find that regression analyses on other amenity measures and labor market outcomes also deliver similar coefficients when we apply the disability measure instead of the benchmark measure. These results are available upon request.

D.3.3 Including a Gender-Specific Time Dummy

One might worry that the increase in amenities among the moderately disabled after the 2004 WOTC amendment could be driven by certain characteristics of workers that are independent from their disability status. In particular, it has been often argued that female workers may have different preference for work schedule compared to male counterparts. If the changes in the option to reduce working hours were mainly driven by the compositional change of female workers among the moderately disabled, our result would not be relevant to firms' response in screening the disabled. To address this concern, we introduce a gender-specific time dummy as an additional regressor and estimate Equation (3). We find that there is no significant differences on the effects of the WOTC amendment by gender group (Table 12).

D.3.4 The Trend increase in DI enrollment

As Autor and Duggan (2006) and Liebman (2015) argue, there has been a steady increase in DI enrollment since the early 1990s. One may wonder whether our results may be partially explained by this trend. First, one potential concern is that this change in DI enrollment may lead to changes in worker composition within each disability category. If workers with less job amenities among moderately disabled stop working and receive DI, it may drive our estimate of the interaction term of moderately disabled and WOTC amendment dummy. This is essentially the composition effect: as discussed in Appendix D.3.1, our findings are robust with respect to controlling for compositional effects.

Another potential effect is that an increase in DI enrollment may actually increase job amenities received by the moderately disabled precisely due to the screening mechanism as discussed in Section 2.4. If an increase in DI enrollment is concentrated on severely disabled workers, then firms hiring moderately disabled workers no longer need to reduce job amenities to screen the severely disabled. Because this channel is consistent with screening mechanism, we view that whether changes in job amenities are induced by the WOTC Amendment or changes in DI enrollment do not matter for detecting screening tools. However, as seen in Table 14, we find a statistically insignificant effect of employment in the interaction between the severely disabled and WOTC amendment dummy. Thus, at least in our sample, we think that it is unlikely that this channel drives our findings.

D.4 The ADA Amendments Act of 2008

We describe our empirical specification to examine the effects of labor market screening using the ADA Amendments Act in 2008 (ADAAA). The empirical specification is similar to our specification for the WOTC Amendment in 2004:

$$y_{it} = \beta_1 \mathbb{I}_{\{t>2008\}} + \sum_{h\in\{\text{mod, sev}\}} \beta_{2h}\mathbb{I}_h + \sum_{h\in\{\text{mod, sev}\}} \beta_{3h}\mathbb{I}_{\{t>2008\}}\mathbb{I}_h + \boldsymbol{\gamma}\mathbf{X_{it}} + \boldsymbol{\nu}\boldsymbol{Z_t} + \varepsilon_{it}.$$

The dependent variable y_{it} indicates whether an individual i in time t has an option to reduce working hours or not. The definition of other regressors remains the same as those described in Equation (3). It is worth mentioning that even though we control for the aggregate economic conditions by including macroeconomic variables in Z_t, our results could be confounded by the Great Recession whose impact was unprecedented. Table 13 summarizes the regression results.

For moderately disabled workers, the expansion of the ADA-eligible workers led to a *decrease* in the provision of option to reduce working hours. However, we find that there was no significant change among the severely disabled workers' amenity level after 2008. Again, these findings are consistent with the standard screening model's predictions as described in Section 4.1. While the severely disabled workers' contracts are unaffected, the employment contract for the moderately disabled depends on firms' screening incentives. These observations are suggestive evidence for our hypothesis that the option to reduce working hours can serve as a firm's screening device against workers with disabilities.

Table 13: Effects of the ADA Amendment on the Option to Reduce Working Hours

Coefficients		Sample period 2004 to 2014
Post amendment (β_1)		-0.035
		(0.036)
Disability status (β_{2h})	Severe	0.280***
		(0.108)
	Moderate	0.240***
		(0.064)
Disability status	Severe	0.073
× Post amendment (β_{3h})		(0.110)
	Moderate	-0.105*
		(0.062)
# of observations		3,458

Note: Table 13 reports the coefficient estimates based on years 2004-2014. The sample includes individuals between ages 50 and 64 and is weighted with individual-level survey weight. The additional covariates used in the regression include age, age-squared, years of education, annual growth rate of GDP, annual employment rates, firm-size categories, and health outcomes. Standard errors are clustered at individual-level. *** p<0.01, ** p<0.05, * p<0.1

D.5 The Effects of WOTC on Employment and Wages

Table 14 documents the empirical results on employment and wage rates by disability status.

Table 14: Effects of the WOTC-Amendment on the Labor Market Outcomes

Coefficients		Dependent variable	
		Employment	(log) Hourly wage
Post amendment (β_1)		0.109***	-0.011
		(0.014)	(0.072)
Disability status (β_{2h})	Severe	-0.876***	-0.118**
		(0.019)	(0.056)
	Moderate	-0.398***	-0.088**
		(0.013)	(0.035)
Disability status	Severe	-0.012	0.087*
× Post amendment (β_{3h})		(0.015)	(0.051)
	Moderate	-0.002	0.050
		(0.015)	(0.037)
# of observations		34,141	8,890

Note: Table 14 reports the coefficient estimates of regression on employment and hourly wage rate. The sample includes individuals between ages 50 and 64 from 1996-2008. The wage regression sample is further restricted to those who recorded hourly rate less than $43.75, which is equivalent to the 95 percentile among the observations. The additional covariates used in the regression include age, age-squared, years of education, annual growth rate of GDP, annual employment rates, firm-size categories, and health outcomes. The sample is weighted by individual-level survey weight. Standard errors are clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1

D.6 Coefficient Estimation Results

We present the regressors and their coefficient estimates that are included in our empirical analysis but omitted to report in the main text due to space limitations.

Aggregate Variables. At the aggregate level, we use two variables, the growth rate of GDP and the average annual employment rates, to control for macroeconomic conditions. We use the all industry total real GDP in millions of chained 2005 dollars from the Bureau of Economic Analysis (BEA) to compute the annual GDP growth rates. For annual employment rates, we use data from the Current Employment Statistics program surveys of the Bureau of Labor Statistics (BLS). We convert seasonally adjusted monthly total employment in non-farm sectors into annual data by taking the average of twelve months. Then, we compute the employment rate by dividing this number by the size of the U.S. working-age population (defined as ages between 18 and 65). We obtained population estimates from the U.S. Census Bureau's Population Estimates. All of these data series are public and available online.

The Size of Employment. On the labor demand side, we control for the size of employer. HRS offers two kinds of variables for employment size, the size of an establishment ("*the number of employees at location*") and the size of a firm ("*the number of employees at all locations*"). We choose the establishment size as the main index for the size of an employer and substitute with the firm size variable if the establishment size is missing.[61] As the range of the employment size vastly varies between zero and 999,999, we introduced five category dummies instead of directly introducing the employer size as a regressor. Employers with fewer than 10 employees are considered as the base group, and we introduce four dummies representing the employment size for 11 to 50, 51 to 200, 201 to 600, and 600 or more. Each category represents 26%, 29%, 23%, 12% and 10% of the sample observations.

Individual Characteristics. On the labor supply side, we control for age, age-square, education and health outcomes. In our benchmark analysis, we categorize the years of schooling into five subcategories: (i) less than high school, (ii) high school graduates, (iii) some college, (iv) college graduates, (v) and individuals with advanced degrees. Each category represents 21%, 33%, 23%, 11% and 12%. In our regressions, individuals with less than high school are set as a base group.

For health outcomes, we use the number of reported major diagnoses and include the types of diagnoses as dummy variables. The list of major diagnoses is (i) arthritis or rheumatism, (ii) diabetes or high blood sugar, (iii) heart attack, congestive heart failure, or other heart problems (iv) stroke or transient ischemic attack, (v) emotional, nervous, or psychiatric problems, (vi) and high blood pressure or hypertension. We also include annual medical expenditures and the Body Mass Index (BMI).[62] The summary statistics associated with these objective health measures are reported in Table 8 of Section C.1.

Along with these regressors, we also add two subjective health measures, difficulties with Activities of Daily Living (ADL) and the subjective health evaluation. The ADL asks whether respondents have difficulties with performing the five basic tasks: bathing, eating, dressing, walking across a room, and getting in or out of bed. We define the number of reported difficult tasks as an ADL index and introduce a dummy variable for each category. In our sample, 87.4% of respondents have no difficulties in performing ADLs, and the share of each category diminishes to 6.3%, 2.9%, 1.7%, 1.1% and 0.6% along with the index. Due to smaller sample size for indices 4 and 5, we merge the last two categories into one. Similarly,

[61] 2.4% of the observations in our sample falls into this category. Our results are unaffected when we exclude these observations from the analysis.

[62] Instead of directly taking BMI as a regressor, one can introduce dummy variables for being overweight ($\text{BMI} \geq 27$) and underweight ($\text{BMI} \leq 18$) to capture nonlinear effects of BMI on one's health. We find that our results are not affected.

the health evaluation score varies from 1 to 5, and we introduce it as a dummy variable.

Table 15: Effects of the WOTC-Amendment: Other Covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Sensitivity analysis			
Type of exercise	Using different dependent variables				New hires	2004-14 ADAAA	Gender× WOTC	Health× WOTC
Dependent variable	Option to reduce hours	Available sick days	(log) wage	Employment	Option to reduce working hours			
Panel A. Firm-side characteristics and macro variables								
GDP growth rate	0.00006	-0.002	0.00004	-0.00008***	-0.00002	-0.00001	0.0004	0.00007*
	(0.00005)	(0.003)	(0.00006)	(0.00001)	(0.00005)	(0.00004)	(0.00004)	(0.00004)
Employment rate	-0.00002**	0.0006	4.47e-6	0.00002***	3.93e-7	-2.20e-6	-0.00001**	-0.00002**
	(7.92e-6)	(0.0006)	(0.00001)	(2.16e-6)	(9.94e-6)	(4.64e-6)	(7.47e-6)	(6.46e-6)
Firm size category								
$11 \leq$ size ≤ 50	-0.071***	-0.128	0.079***		-0.049*	-0.075***	-0.071***	-0.051***
	(0.018)	(1.080)	(0.023)		(0.025)	(0.025)	(0.017)	(0.015)
$51 \leq$ size ≤ 200	-0.125***	4.315***	0.159***		-0.093***	-0.141***	-0.120***	-0.105***
	(0.019)	(1.513)	(0.025)		(0.029)	(0.026)	(0.018)	(0.016)
$201 \leq$ size ≤ 600	-0.121***	1.758	0.185***		-0.162***	-0.095***	-0.118***	-0.107***
	(0.023)	(1.532)	(0.027)		(0.036)	(0.034)	(0.022)	(0.020)
size ≥ 601	-0.142***	1.680	0.293***		-0.082*	-0.089*	-0.141***	-0.133***
	(0.024)	(1.343)	(0.030)		(0.048)	(0.036)	(0.023)	(0.021)
Panel B. Individual characteristics								
Age	-0.144**	4.289	-0.073	0.276**	-0.132	-0.131**	-0.134**	0.024**
	(0.059)	(3.696)	(0.070)	(0.025)	(0.090)	(0.001)	(0.056)	(0.011)
Age^2	0.001***	-0.038	0.0005	-0.003***	0.001*	0.001***	0.001***	-0.00009
	(0.0005)	(0.032)	(0.0006)	(0.0002)	(0.0008)	(0.0005)	(0.0005)	(0.00008)
Female	0.010	-1.254	-0.185***	-0.094***	-0.004	0.041**	0.014	0.010
	(0.012)	(0.950)	(0.019)	(0.008)	(0.020)	(0.019)	(0.016)	(0.012)
Female×WOTC							0.034	
							(0.025)	
Education category								
high school	-0.004	-2.205	0.138***	0.056***	0.102***	0.021	0.012	0.003
	(0.024)	(1.981)	(0.026)	(0.012)	(0.034)	(0.036)	(0.023)	(0.019)
some college	0.007	-4.448**	0.269***	0.092***	0.055	0.029	0.020	0.015
	(0.025)	(1.963)	(0.028)	(0.013)	(0.035)	(0.036)	(0.024)	(0.021)
college	0.005	-5.588***	0.408***	0.091***	0.080*	-0.0006	0.014	-0.002
	(0.029)	(2.117)	(0.034)	(0.016)	(0.042)	(0.039)	(0.027)	(0.024)
advanced	0.008	-7.573***	0.539***	0.123***	0.123***	0.061	0.023	0.008
	(0.029)	(1.951)	(0.036)	(0.015)	(0.042)	(0.040)	(0.027)	(0.024)
Sample size	8,541	3,280	8,890	34,141	3,329	3,458	8,541	8,280

Table 16: Effects of the WOTC-Amendment: Other Covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Panel C. Health-related characteristics								as a regressor	Interaction with WOTC
# of diagnoses	-0.011	1.186	-0.006	-0.001	-0.019	0.012	-0.006	-0.008	0.003
	(0.010)	(0.751)	(0.012)	(0.005)	(0.016)	(0.016)	(0.009)	(0.009)	(0.014)
Diagnosed disease type									
arthritis	0.020**	-0.942	-0.011	0.010	0.013	0.003	0.010	0.009	0.001
	(0.018)	(1.297)	(0.023)	(0.010)	(0.030)	(0.027)	(0.018)	(0.018)	(0.031)
diabetes	-0.005	-4.205**	-0.025	-0.004	0.034	-0.014	-0.011	-0.008	-0.016
	(0.024)	(1.651)	(0.028)	(0.012)	(0.042)	(0.031)	(0.024)	(0.026)	(0.039)
heart	0.058**	-1.034	-0.006	-0.015	0.099**	0.047	0.057**	0.052**	-0.018
disease	(0.026)	(1.783)	(0.028)	(0.013)	(0.044)	(0.037)	(0.026)	(0.024)	(0.039)
strokes	-0.046	9.168*	0.048	-0.018	-0.088	-0.029	-0.044	-0.004	-0.028
	(0.044)	(5.166)	(0.056)	(0.020)	(0.063)	(0.066)	(0.044)	(0.044)	(0.068)
psychiatric	-0.002	-0.819	0.038	-0.057***	0.018	-0.061	-0.002	0.017	-0.049
problems	(0.025)	(1.557)	(0.029)	(0.013)	(0.039)	(0.032)	(0.025)	(0.031)	(0.044)
high blood	0.014	0.903	0.006	0.010	0.050*	-0.019	0.012	0.019	-0.016
pressure	(0.017)	(1.157)	(0.021)	(0.009)	(0.029)	(0.025)	(0.017)	(0.017)	(0.029)
# of Difficulties with Activities of Daily Living (ADL)									
1	-0.002	3.937	-0.043	-0.024*	0.080	0.0006	0.008	0.004	0.056
	(0.034)	(3.659)	(0.043)	(0.013)	(0.055)	(0.055)	(0.033)	(0.036)	(0.061)
2	0.066	8.944	-0.139***	-0.058***	0.104	0.023	0.051	0.071	0.083
	(0.069)	(9.238)	(0.051)	(0.019)	(0.101)	(0.101)	(0.066)	(0.076)	(0.126)
3	-0.080	20.999	-0.116*	-0.053**	-0.157	0.115	-0.095	-0.243***	0.312
	(0.092)	(15.102)	(0.061)	(0.023)	(0.113)	(0.169)	(0.089)	(0.056)	(0.173)
4	0.009	-5.027	-0.033	-0.086***	-0.027	-0.223	-0.062	0.228	-0.242
	(0.133)	(5.192)	(0.139)	(0.030)	(0.151)	(0.139)	(0.112)	(0.177)	(0.233)
Health evaluation									
2	-0.013	-0.949	-0.055**	0.016	0.048	0.016	-0.00008	-0.001	-0.043
	(0.019)	(1.228)	(0.025)	(0.011)	(0.031)	(0.028)	(0.018)	(0.020)	(0.035)
3	-0.071***	0.842	-0.125***	0.019	-0.028	-0.023	-0.056***	-0.069***	-0.019
	(0.022)	(1.433)	(0.027)	(0.012)	(0.035)	(0.031)	(0.020)	(0.021)	(0.037)
4	-0.191***	-3.804	-0.066	0.429***	-0.216***	-0.140**	-0.161***	-0.126***	-0.130**
	(0.041)	(3.370)	(0.048)	(0.019)	(0.061)	(0.058)	(0.039)	(0.040)	(0.066)
5	-0.288***	2.240	-0.174***	0.345***	-0.259***	-0.203**	-0.250***	-0.204***	-0.100
	(0.056)	(4.967)	(0.061)	(0.022)	(0.095)	(0.081)	(0.054)	(0.055)	(0.095)
BMI	-0.001	-0.022	0.003**	0.001**	-0.001	-0.001	-0.002	-0.001	-0.002
	(0.001)	(0.099)	(0.002)	(0.0007)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
(ln) medical	0.003	2.185***	0.019***	-0.003	0.005	-2.07e-6	0.001	0.006	0.004
spending	(0.005)	(0.405)	(0.006)	(0.002)	(0.008)	(186e-6)	(0.005)	(0.005)	(0.007)