Take it or Leave it: Take-up, Optimal Transfer Programs, and Monitoring

Laurence Jacquet

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Abstract

This paper studies the optimal income redistribution and optimal monitoring when disability benefits are intended for disabled people but when some able agents with high distaste for work mimic them (type II errors). Labor supply responses are at the extensive margin and endogenous take-up costs may burden disabled recipients (because of either a reputational externality caused by cheaters or a snowball effect). Under paternalistic utilitarian preferences that do not compensate for distaste for work, inactive disabled recipients should obtain strictly lower consumption than disabled workers. The cost of monitoring supports adoption of an Earned Income Tax Credit. However, and surprisingly, with or without take-up costs, even if perfect monitoring is costless, it proves optimal to have type II errors. These results are robust to a utilitarian criterion. The paper provides numerical simulations calibrated on U.S. data.

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1　Introduction

This paper examines the optimal redistributive structure and the optimal accuracy of monitoring when disability benefits are intended for disabled people but where some able agents who have a high distaste for work mimic them. It suggests the shape of the optimal tax-transfer system when the government operates a costly monitoring program financed by taxation of labor income.

The standard optimal taxation model assumes that individuals are distributed over some private characteristic, such as their individual productivity, the distribution of which is common knowledge. Redistribution policy is limited by incentive constraints that must be satisfied if individuals are to reveal their true productivity types (Mirrlees, 1971). These incentive compatibility constraints are relaxed and redistribution is enhanced when some characteristics correlated with low productivity (or 'tag' to use the terminology introduced by Akerlof, 1978), like disability status, are monitored for a subset of the disabled population.[1]

This paper differs from the existing literature by endogenizing the monitoring technology[2] and all of the behavioral responses (participation to the labor market and to disability programs), which allows us to cast light on three important redistributive issues.

First, who gets the largest consumption level? The tagging literature shows that tagged disabled agents obtain a larger consumption level than untagged disabled people (e.g., Akerlof, 1978; Salanié, 2002). This result relies on the assumption that eligible people do not work whether they are tagged or untagged. However, some disabled people work, and others do not work and receive disability benefits in the real world.[3] This paper models behavioral responses such as labor supply responses and take-up responses as accurately as possible and shows that the optimal ranking of consumption bundles is then reversed to give work incentives to some disabled.

Secondly, who gets the largest transfer? By definition, an Earned Income Tax Credit (EITC) provides the largest transfer to disabled or low-productivity workers. This contrasts with a Negative Income Tax (NIT), whereby nonemployed agents receive the largest transfer. As usual in the literature, let us define the ratio of social marginal utility to the marginal value of public funds as the marginal social welfare weight. Neglecting monitoring, the literature has well established that when labor supply responses are modeled along the extensive margin (i.e., the agent decides whether or not to participate in the labor force), a marginal social welfare weight lower (larger) than one on disabled workers implies a NIT (EITC) (Diamond, 1980; Saez, 2002). Contrastingly, this paper shows that, with a costly monitoring technology, a marginal social welfare weight lower than one on disabled workers does not preclude an EITC.

Third, relaxing the standard assumption that monitoring, and therefore the probability of

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[1]In this paper, the tag (disability) is perfectly correlated with low productivity, which is the basis for redistribution. However, the tag is not perfectly observable; hence, tagging is not perfect. Contrastingly, in the seminal paper of Akerlof (1978), the tag is perfectly observable but correlated more or less perfectly with low productivity. Tagging is also not perfect.

[2]An exception is Boadway *et al.* (1999), where the accuracy of monitoring depends on the effort level of social workers. Boadway *et al.* (1999) characterize the optimal payment and monitoring of social workers who shirk. Shirking induces errors in screening between disabled and low-ability claimants (the latter are the able in our model). Contrastingly, the endogenous monitoring of our model depends upon the resources devoted to it and there is no agency problem involved in the tagging process. We also relax Boadway et al.'s assumption that government policy is designed such that all low-ability and disabled people apply for welfare assistance. The other differences between our model and that of Boadway *et al.* (1999) will become apparent as we proceed.

[3]In EU countries, about 30% of people who report severe disability do not get disability benefits and work (Eurostat, 2001).

errors, is taken as given, this paper shows that there should always remain some type II errors (i.e., able people who falsely claim to be disabled and receive disability benefits). When the marginal cost of monitoring is very high, no monitoring (hence a type II error probability of one) is optimal. More surprising, even when monitoring is perfect and costless, it is optimal that some type II errors prevail. Since labor supply is restricted to be binary, the direct truthful mechanism that implements the optimal allocation is never fully revealing. Therefore, to reach the ideal full information allocation, the tax authority needs to not only observe the correct health status of claimants by its monitoring, but must also observe their precise disutility if they worked. Since perfect monitoring provides correct information on the health status of claimants but not on their disutility from work, having some people who commit fraud is optimal, under asymmetric information.

In this paper, optimal tax formulas are derived to provide a clear understanding of the key economic effects underlying them. This allows better analysis of the new effects that monitoring and take-up imply for standard formulas. To ease the comparison with the existing literature, these formulas are presented as functions of the behavioral elasticities.

Non-take-up may exist because of the costs of learning about and applying for the program or because of stigma costs (e.g., Sen, 1995; Currie, 2006). This paper emphasizes the endogenous stigma à la Besley and Coate (1992) as an explanation of the non-take-up phenomenon. Given the imperfect observability of disability,[4] there are recipients whose decision to claim benefits can be directly attributed to laziness and not to disability. When one is truly disabled, being considered as an undeserving (i.e., lazy) recipient is demeaning and stigmatizing. This stigma increases with the number of cheaters. Although no empirical papers have studied this endogenous stigma, anecdotal evidence about people who cheat in welfare programs and then create doubts or social resentment against their peers seems persistent enough to open the path to more investigation. To the best of our knowledge, the endogenous stigma à la Besley and Coate has never been studied in the optimal income tax and tagging literature. Our optimal tax formula then includes all effects that arise from the stigma externality. Moreover, this paper also studies the robustness of the optimal tax formula to an alternative take-up cost function. Importantly, all of our results are also valid without any take-up cost.

The analysis is realized under a normative criterion corrected for features that individuals are responsible for (Bossert *et al.*, 1999; Schokkaert *et al.*, 2004). According to this paternalistic approach, income should not be transferred as compensation for distaste for work because individuals are responsible for their own taste for work. Moreover, disabled workers, contrary to the lazy ones, ought to be compensated for their handicap. The validity of our main results is examined and confirmed under a utilitarian criterion.

We proceed in the following section by setting up the basic model. Assuming the paternalistic criterion, Sections 3 and 4 derive the optimal tax-transfer and monitoring programs under full information and asymmetric information, respectively. Section 5 studies the robustness of the results under a utilitarian criterion. Section 6 presents some numerical results.

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[4]In 2005, about 80% of disability recipients suffer from mental disorders and musculoskeletal diseases (e.g., back pain) (Social Security Administration, 2006). Generally, most of these disabilities are neither easily observed nor perfectly monitored, even with a deep medical examination (Campioleti, 2002). Therefore, disability transfer systems are always imperfect. Benitez-Silva *et al.* (2004b) estimate that approximately 20% of applicants who are ultimately awarded benefits are not disabled.

2 The model

2.1 Individual's behavior

Agents are either able or disabled. Productivities take two values, $w_H > w_L > 0$, which correspond with the gross wages in two types of jobs (low and high skilled). N_d is the proportion of disabled people in the population. Their productivity is w_L. $N_a \equiv 1 - N_d$ is the proportion of able people in the population whose productivity is w_H. There is a perfect correlation between disability and lower productivity. This assumption is in the vein of the statutory definition of disabled people who are eligible for disability benefits. The applicant is considered to be disabled not just because of the existence of a medical impairment, but because the impairment drastically reduces his or her productivity and precludes any substantial and gainful work (Hu *et al.*, 2001). A disabled worker in a wheelchair who has the functional capability to engage in a substantial gainful job is not considered disabled either by the U.S. Social Security Act or in this model.

Assume that agents decide whether or not to work. This assumption seems natural since the empirical literature has shown that the extensive margin of labor responses is important, especially at the low income end (e.g., Meghir and Phillips, 2008) while most estimates of hours of work elasticities conditional on working are small (Blundell and MaCurdy, 1999). Utility is quasilinear and represented by:

$$v(x) - \delta \text{ if they work,}$$

$$v(x) - \sigma \mathbb{I} \text{ if they do not work,}$$

where x is consumption, $v(x) : \mathbb{R}^+ \rightarrow \mathbb{R} : x \rightarrow v(x)$ with $v' > 0 \geq v''$ and $\lim_{x \to \infty} v'(x) = 0$, δ is a parameter measuring disutility when working, $\mathbb{I}$ is an indicator function that takes the value of 1 if inactive agents take-up disability benefits and 0 otherwise, and σ denotes the (endogenous) take-up cost.

The disutility of work δ is denoted δ_d for the w_L-agents and δ_a for the w_H-agents. δ_d is distributed according to the cumulative distribution function $F(\delta_d) : \mathbb{R}^+ \rightarrow [0,1] : \delta_d \rightarrow F(\delta_d)$ and the corresponding density function $f(\delta_d)$. The latter is continuous and positive over its domain. δ_a is distributed according to the cumulative distribution function $G(\delta_a) : \mathbb{R}^+ \rightarrow [0,1] : \delta_a \rightarrow G(\delta_a)$ and the corresponding (continuous and positive) density function $g(\delta_a)$.[5] Individual characteristics are private information to each person while the distribution thereof is assumed to be public information.

The rest of this section defines the endogenous take-up cost σ in the utility function. Let us already emphasize that all results of this paper are still valid when those take-up costs are neglected, i.e., $\sigma = 0$, which is the standard assumption in the optimal taxation and tagging literature.

Stigma and snowball take-up costs

We now define the take-up cost $\sigma(.)$ that can be stigma or the take-up cost of snowball.

The phenomenon that disabled recipients are viewed with some suspicion and are vulnerable to accusations of laziness has largely been documented by psychologists and sociologists since Goffman

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[5]We want to see whether an EITC or a NIT is optimal. This requires us to describe only the participation tax rates. Therefore, it is appropriate to assume a discrete support for skills, like in Saez (2002). For simplicity, we assume two productivity levels, but increasing the number of productivities would not modify our main results. Continuity of δ is assumed for simplicity.

(1963). However, to the best of our knowledge, the economics literature has largely neglected that being considered as an undeserving (i.e., lazy) recipient when one truly is disabled is demeaning and stigmatizing. This motivates our focus on the reputational stigma à la Besley and Coate (1992). The undeserving (able) recipients impose a "reputational externality" (Besley and Coate, 1992) on the deserving (disabled) ones.[6] When it is known that an individual is receiving disability benefits, other individuals infer that this individual is probably lazy.[7] This creates the reputational stigma that reduces the recipients' utility. Stigma is an increasing function of the proportion of undeserving recipients in the economy, denoted by π_a^u. The undeserving beneficiaries are able agents who do not work, i.e., they are "voluntarily unemployed"; hence, the subscripts a and u are used. It seems realistic to assume that reputational stigma hurts deserving people more than the undeserving because the former face a limited choice set. The cost of being perceived as a cheater is lower for someone who does commit fraud (i.e., an able recipient) than for someone who does not (i.e., a disabled recipient). Without affecting the qualitative nature of the results but to later ease the notations and intuitions, we assume zero stigma effect for the able recipients. However, our results are still valid when able people also face positive stigma and the optimal tax formulas could easily be written with larger stigma on the cheaters than on the deserving.[8]

The definition of stigma of Besley and Coate (1992) is relevant if we consider a society where people who do their best abiding by the rules are respected and admired (even if they are quasi-unproductive) and where people who do not comply with the rules (even in a cunning way) are despised. If we want to model a society where cheats and "old foxes" are admired, stigma should be a decreasing function of π_a^u. The take-up by undeserving people then has a snowball effect on take-up by the deserving.[9]

The type of take-up cost then depends on the first derivative: Stigma (snowball take-up cost) prevails when $\sigma'(\pi_a^u) > 0$ $(\sigma'(\pi_a^u) < 0)$. The rest of the paper will mainly focus on the general form $\sigma'(\pi_a^u)$, letting the reader choose the type of take-up cost she/he prefers.

2.2 The government's decisions

A feature of disability systems is that the eligibility of applicants is assessed on the basis of the disability status rather than being solely dependent on reported incomes. The process of

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[6] Society is deemed to value certain individual characteristics, such as willingness to earn one's income from work when one is able to do so (e.g., Sen, 1995; Lindbeck *et al.*, 1999). A social norm claiming that disabled, low-productivity people should get transfers also prevails (e.g., Wolff, 2004). Given the imperfect observability of disability, there are (lazy) able agents who do not deserve benefits but receive them.

[7] Anecdotal evidence about this reputational stigma effect also exists in politics or sport. For instance, during the 2006 Tour de France, when several exceptional cyclists were revealed to have taken drugs to improve their performances, the entire profession lost its credibility and all cyclists were suspected of being cheats.

[8] Introducing larger stigma on the able applicants than on the disabled ones implies that take-up costs are an ordeal associated with desirable screening (e.g., Nichols and Zeckhauser (1982) and Cuff (2000)).

[9] Rather than explaining the snowball effect with a society where cheats and old foxes are admired, alternative empirical explanations can prevail. In the vein of recent empirical studies that look at endogenous social interactions and peer effects (e.g., Aizer and Currie, 2004), it can become less embarrassing to live on transfers when more individuals do likewise (Lindbeck *et al.*, 1999). Alternatively, the snowball effect can be explained by complexity or the rigor of the monitoring technology, see Kleven and Kopczuk (2010) for a model of transfer program complexity (however, without tax revenue and without administrative costs). Complexity is an instrument used by program administrators to increase the intensity of screening, hence to reduce errors. Higher complexity requires larger governmental expenditure per applicant, e.g., because of the increased number of tests and interviews with doctors. Larger monitoring expenditure per applicant reduces π_a^u, as it will be made explicit in Section 2.2. A reduction of π_a^u could then be viewed as resulting from an increase in complexity, the latter inducing a higher cost to the applicant $\sigma(.)$ (e.g., the time spent applying or a cognitive cost of having a lot of testing). Complexity is then allowed for in our model when $\sigma'(\pi_a^u) < 0$ is assumed.

determining individual eligibility has been called "tagging" by Akerlof (1978). In Akerlof (1978), tagging allows perfect identification of a given subset of disabled people. In this paper, it is assumed that the accuracy of tagging is limited by the non-take-up phenomenon. Even if disabled people are aware of their eligibility, some of them might not claim disability benefits depending on the level of benefit and the associated stigma or take-up cost. Moreover, it is assumed that disability agencies are unable perfectly to detect able claimants.

Differing from the existing literature (Stern, 1982; Diamond and Sheshisnki, 1995; Parsons, 1996), the monitoring (tagging) technology is not exogenous in this model. The accuracy of monitoring depends on the per capita resources, M, devoted to it. The higher is M, the lower is the probability of type II error μ ("false positive"), i.e., the higher the precision with which an able agent claiming disability benefits is detected. This model analyzes the choice of monitoring expenditures, (M), that is equivalent to choosing the level of type II errors (μ). Formally, the per capita cost of monitoring, $M(\mu)$, depends on the precision of the monitoring technology with $\partial M/\partial\mu < 0$, $\partial^2 M/\partial\mu^2 \geqslant 0$, $\lim_{\mu\to 0} M(\mu) = +\infty$, and $M(1) = 0$.[10]

Under full information (so-called first-best), the disability agencies have no role to play, there is no monitoring and no type II error. Therefore, there is no stigma effect: $\sigma(\pi_a^u) = 0$. The government implements a tax policy depending on δ and w_Y $(Y = L, H)$, hence it also assigns individuals to low-skilled jobs (where the gross wage is w_L), to high-skilled jobs (where the gross wage is w_H) or to inactivity (activity u). Activity assignment is captured through the functions $\ell_L(\delta_d) : \mathbb{R}^+ \to \{0,1\} : \ell_L(\delta_d) = 1$ $(\ell_L(\delta_d) = 0)$ if w_L-agents with this value for δ_d are employed (inactive) and $\delta_H(\delta_a) : \mathbb{R}^+ \to \{0,1\} : \delta_H(\delta_a) = 1$ $(\delta_H(\delta_a) = 0)$ if w_H-agents with this value for δ_a are employed (inactive). w_L-agents cannot get access to high-skilled jobs and, since efficiency matters, it will never be optimal that w_H-agents work in low-skilled jobs. By putting these people in high-skilled jobs instead of low-skilled jobs, they produce more and that increase can be used to rise consumption bundles. Hence, formally, the government determines four consumption functions: $x_L^w(\delta_d)$ for the w_L-workers, $x_H^w(\delta_a)$ for the w_H-workers, $x_L^u(\delta_d)$ for the w_L-inactive agents, and $x_H^u(\delta_a)$ for the w_H-inactive. All of these functions go from $\mathbb{R}^+$ to $\mathbb{R}^+$.

We define the government's budget constraint as

$$N_d \left[\int_0^\infty \left[\ell_L(\delta_d)(w_L - x_L^w(\delta_d)) - (1 - \ell_L(\delta_d)) x_L^u(\delta_d) \right] dF(\delta_d) \right]$$
$$+ N_a \left[\int_0^\infty \left[\ell_H(\delta_a)(w_H - x_H^w(\delta_a)) - (1 - \ell_H(\delta_a))) x_H^u(\delta_a) \right] dG(\delta_a) \right] = -R,$$

where $R(\gtrless 0)$ is the exogenous revenue available to the economy.

This model highlights the effects of errors in distributing disability benefits. Therefore a clear boundary between eligible and noneligible people is needed. This suggests the following distinction between disutility of the disabled δ_d and the able δ_a. We assume that δ_d measures disutility when working as a result of disability, i.e., the intensity of the physical or mental pain associated with work as a result of disability if relevant (Harkness, 1993; Cuff, 2000; Marchand *et al.*, 2003). Contrastingly, δ_a is disutility when working as a result of distaste for work or work aversion. Following Arneson (1990) and Roemer (1998), people are held responsible for their taste for work δ_a

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[10]In summary, disability agencies do not observe either δ_d or δ_a. They perfectly observe the disability status of w_L-agents (and hence their lower productivity). However, they tag some able as disabled, hence type II errors prevail.

while δ_d stems from luck; hence, those people are not responsible for it. Therefore, able (disabled) people are unambiguously noneligible (eligible) for disability benefits.[11]

Our first social objective function uses a paternalistic view for the valuation of distaste for work. The government has a reference distaste for work equal to zero, i.e., it attaches a weight of zero to the distaste for work δ_a. The paternalistic utilitarian objective states

$$S^P \equiv N_d \left[\int_0^\infty \left[\ell(\delta_d) \left(v(x_L^w(\delta_d)) - \delta_d \right) + (1 - \ell_L(\delta_d)) v(x_L^u(\delta_d)) \right] dF(\delta_d) \right]$$
$$+ N_a \left[\int_0^\infty \left[\ell_H(\delta_a) v(x_H^w(\delta_a)) + (1 - \ell_H(\delta_a)) v(x_H^u(\delta_a)) \right] dG(\delta_\alpha) \right]$$

This normative criterion is a sum (weighted by the share in the population) of utility functions corrected for the features that individuals are responsible for. Implicit in this approach is the idea that income should not be transferred as compensation for distaste for work (δ_a) because individuals are responsible for their own taste for work, and disabled workers contrary to the lazy ones ought to be compensated for their handicap. Schokkaert *et al.* (2004) and Cremer *et al.* (2007), for instance, consider this type of social objective function, but alternative paternalistic objectives are possible. Marchand *et al.* (2003) and Pestieau and Racionero (2009) consider another paternalistic approach in which the government attaches a larger weight to the labor disutility of disabled individuals. Our approach is also close to that used in behavioral economics when social planners does not use, in their objective function, individual preferences but their own preferences (O'Donoghue and Rabin, 2003; Kanbur *et al.*, 2006). Maximization of paternalistic social preferences typically selects allocations that are not Pareto efficient.

Our second normative criterion is a standard utilitarian one, i.e.

$$S^U \equiv N_d \left[\int_0^\infty \left[\ell(\delta_d) \left(v(x_L^w(\delta_d)) - \delta_d \right) + (1 - \ell_L(\delta_d)) v(x_L^u(\delta_d)) \right] dF(\delta_d) \right]$$
$$+ N_a \left[\int_0^\infty \left[\ell_H(\delta_a) \left(v(x_H^w(\delta_a)) - \delta_a \right) + (1 - \ell_H(\delta_a)) \left(v(x_H^u(\delta_a)) \right) \right] dG(\delta_\alpha) \right]$$

The only differences with the paternalist criterion are in the terms $v(x_H^w(\delta_a))$, which are substituted by $v(x_H^w(\delta_a)) - \delta_a$. It can be seen as contradictory to use both a utilitarian criterion and a costly monitoring technology. One screens people with high distaste for work, δ_a, on the one hand, and compensates for distaste for work, δ_a, by including δ_a in the utilitarian preferences, on the other hand. However, this is a standard objective in the optimal tax and tagging literature.

The results derived under utilitarian preferences will be given in Section 5 and compared to the ones obtained under the paternalistic utilitarian criterion. We use the superscripts U and P for the utilitarian and paternalistic criteria, respectively, and we drop these superscripts from the different variables for notational simplicity.

3 Full information

Proposition 1 *In full information, everyone gets the same consumption ($\overline{x}$) under paternalistic utilitarian preferences, and a Negative Income Tax (NIT) is optimal. All able people work while only disabled agents with $\delta_d \leq v'(\overline{x})w_L$ do work.*

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[11]It is possible to follow the suggestion by Pestieau and Racionero (2009) to disentangle the disabled's parameter into two components: $\delta = \delta_a + \delta_d$ and again to hold people responsible for their taste parameter δ_a but not for their disability parameter δ_d. However this complicates the model without bringing further analytical gains.

A proof is given in Appendix A and the intuition is as follows. Suppose all able individuals are working. The social benefit of having the able individuals with the highest δ_a stop working is zero. The cost of having an able individual who stops working is $w_H(>0)$. Therefore, it is optimal that all able agents work. The same exercise can be done for disabled people. Suppose all disabled individuals are working. The social benefit of having a disabled agent endowed with δ_d to stop working is $\delta_d \in [0, \infty)$ and the social cost is $w_L(>0)$, which is constant. Therefore, there is a threshold value $\widehat{\delta_d}$ such that those with $\delta_d > \widehat{\delta_d}$ do not work and those with $\delta_d \leq \widehat{\delta_d}$ do work. $\widehat{\delta_d}$ is such that the net loss of utility when the marginal disabled individuals are shifted from the disability assistance to the low-skilled job is equal to the gain of resources (w_L) valued according to their common marginal utility, i.e., $\widehat{\delta_d} = v'(\overline{x})w_L$ with $\overline{x}$ denoting the consumption level. Consumption levels are the same for all individuals ($\overline{x}$) since the first-order conditions require identical marginal utility of consumption for all individuals with additively separable utility functions. Therefore, the transfer (or tax) toward the disabled workers, $\overline{x} - w_L$, is lower than the transfer toward the inactive disabled, $\overline{x}$. This is the definition of a Negative Income Tax (NIT), which is then optimal.

4   Asymmetric Information

Under asymmetric information, the tax authority is only able to observe income levels and thus can condition taxation only on income. However, when monitoring is introduced, disability agencies have access to more information than the tax authority. The optimization problem for the government takes place over three consumption bundles x^u, x_L, x_H (in doing so, it also assigns people to work or inactivity)[12] and the optimal level of type II errors $\mu \in (0, 1]$.

The government needs to take into account the set of incentive compatibility constraints (hereafter ICC) to prevent individuals from a given type from taking the tax-treatment designed for individuals of other types.

Since our objective functions are increasing in individuals' consumption, it will, just like in the first-best, never be optimal that able people work in low-skilled jobs. By putting these people in high-skilled jobs instead, they produce more that can be used to increase everyone's consumption in a way that respects the ICC and hence increases social objective value. Consequently, to induce high-skilled people to work in high-skilled jobs,

$$x_H \geq x_L, \tag{1}$$

since the individual aversion to work δ_a is the same in both jobs. A formal proof is given in Appendix B. Therefore, no able individuals mimic disabled workers at the optimum.[13] The remaining incentive problem consists in able individuals who mimic disabled recipients.

Recall that with a probability μ, able individuals who claim disability benefits are accepted. With a probability $1 - \mu$, they are caught and therefore go back to work. Having all detected able

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[12]In the literature on optimal redistributive taxation initiated by Mirrlees (1971), nonemployment, if any, is synonymous with nonparticipation. There is no job search; hence, people who do not work make the choice of being inactive, i.e., there is no (so-called) involuntary unemployment. Similarly, there is no involuntary unemployment in this model. However, since disabled people face real physical or mental pain at work, they are eligible for disability benefits (x^u).

[13]Equation (1) implies that only disabled people work in unskilled jobs at the optimum. Therefore, they are perfectly tagged as disabled. Being recognized as disabled is not a characteristic that implies stigma, contrarily.

claimants who go back to work can be assumed but it can also be the result of the optimal tax program where able agents who claim disability benefits and are detected choose either to receive a welfare benefit or to go back to work. Appendix C states the proof.

We introduce the threshold value $\widetilde{\delta}_a$. It characterizes able agents who are indifferent between choosing either $v(x_H) - \delta_a$ or, with a probability μ, $v(x^u)$ and with a probability $1 - \mu$, $v(x_H) - \delta_a$. The ICC[14] on agents of w_H-type can be written as:

$$v(x_H) - \widetilde{\delta}_a = \mu v(x^u) + (1 - \mu) \left[v(x_H) - \widetilde{\delta}_a \right]$$
$$\Leftrightarrow \widetilde{\delta}_a = v(x_H) - v(x^u) \tag{2}$$

such that a high-skilled agent with taste parameter δ_a prefers high-skilled employment to claiming benefits if and only if $\delta_a \leq \widetilde{\delta}_a$. Equation (2) emphasizes that the decision of able people to apply or not for disability benefits does not depend on the probability μ.[15]

Disabled agents choose between $v(x_L) - \delta_d$ and $v(x^u) - \sigma (.)$. Disabled agents characterized by $\delta_d \leq \widetilde{\delta}_d$ $(\delta_d > \widetilde{\delta}_d)$ choose to work (to apply for disability benefits). Hence, the ICC on disabled states:

$$\widetilde{\delta}_d = v(x_L) - v(x^u) - \sigma \left(\pi_a^u \left(\widetilde{\delta}_a, \mu \right) \right) \tag{3}$$

with $\pi_a^u \left(\widetilde{\delta}_a, \mu \right) = N_a \mu \left(1 - G \left(\widetilde{\delta}_a \right) \right)$, the share of population that is able and unduly collect disability benefits. Recall that we can consider either that $\sigma(.)$ represents stigma (hence, $\sigma'(\pi_a^u) > 0$ and $\sigma (.) \to 0$ if either $\widetilde{\delta}_a \to \infty$ or $\mu \to 0$), or that $\sigma (.)$ represents snowball take-up costs (hence, $\sigma'(\pi_a^u) < 0$ and $\sigma (.)$ reaches its minimum value if either $\widetilde{\delta}_a \to 0$ or $\mu \to 1$), or there is no take-up cost and $\sigma(\pi_a^u) = 0$. From (2) and the definition of π_a^u:

$$\frac{\partial \sigma}{\partial x^u} = -\frac{\partial \sigma}{\partial \pi_a^u} \frac{\partial \pi_a^u}{\partial \widetilde{\delta}_a} v'(x^u) = \sigma'(\pi_a^u) N_a \mu g \left(\widetilde{\delta}_a \right) v'(x^u) \tag{4}$$

Combining these results with (3), and totally differentiating gives:

$$\frac{\partial \widetilde{\delta}_d}{\partial x^u} = -v'(x^u) \left(1 + \frac{\partial \sigma}{\partial \widetilde{\delta}_a} \right)$$

Following an increase in x^u, the global effect on $\widetilde{\delta}_d$ can be decomposed into a positive direct effect and a negative indirect effect with stigma (or a positive indirect effect with the snowball take-up cost). The increase in the proportion of disabled people claiming assistance (or equivalently, the diminishing level of $\widetilde{\delta}_d$) is the direct effect. The indirect effect stems from the enlargement of stigma (the decrease of snowball take-up cost) that follows the fall in $\widetilde{\delta}_a$, which in turn leads to a decrease (increase) in the proportion of disabled recipients or, equivalently, to an increase (decrease) in $\widetilde{\delta}_d$.

Lemma 1 *Active and inactive people in both ability groups coexist under asymmetric information (i.e., $\infty > \widetilde{\delta}_d > 0$ and $\infty > \widetilde{\delta}_a > 0$).*

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[14]It can easily be checked that the set of ICC for each agent of type (w_Y, δ_y) (with $\delta_y \in \mathbb{R}^+$, $Y = L, H$ and $y = d, a$) can be rewritten as constraints (1)-(3).

[15]For agents whose $\delta_a \in \left(\widetilde{\delta}_a, \infty \right)$, the worst utility outcome when taking the lottery (i.e., when applying for benefits) is identical to the utility reached when not taking the lottery. Therefore, μ does not drive the decision to apply or not for benefits.

Appendix D provides the proof.

From (2) and $\widetilde{\delta}_a > 0$, we know that

$$x_H > x^u$$

The government budget constraint becomes

$$\pi_d^w (w_L - x_L) - (\pi_d^u + \pi_a^w) x^u + \pi_a^w (w_H - x_H) - \left(\pi_d^u + \frac{\pi_a^u}{\mu} \right) M(\mu) = -R, \qquad (5)$$

where π_d^w is the share of population that is disabled and works, π_d^u is the share of population that is disabled and receives disability benefits, π_a^u is the share of population that is able but unjustifiably collects disability benefits, π_a^w is the proportion of the population that is able and works (it includes the refused undeserving claimants). Table 1 displays the proportion of individuals in each position. The per capita cost of monitoring $M(\mu)$ appears ex ante and for any individual who has applied for disability assistance, i.e., for the proportion $N_d \left(1 - F \left(\widetilde{\delta}_d \right) \right) + N_a \left(1 - G \left(\widetilde{\delta}_a \right) \right) = \pi_d^u + \pi_a^u / \mu$. Thus, the total cost of monitoring is increasing in the proportion of monitored individuals.

	recipients of disability benefits	workers
disabled (w_L, δ_d)	$\pi_d^u = N_d \left(1 - F \left(\widetilde{\delta}_d \right) \right)$	$\pi_d^w = N_d F \left(\widetilde{\delta}_d \right)$
able (w_H, δ_a)	$\pi_a^u = N_a \mu \left(1 - G \left(\widetilde{\delta}_a \right) \right)$	$\pi_a^w = N_a \left[G \left(\widetilde{\delta}_a \right) + (1 - \mu) \left(1 - G \left(\widetilde{\delta}_a \right) \right) \right]$

Table 1: Distribution of individuals in the population

To simplify the optimal tax formulas, we can introduce more definitions. Let $T_L = w_L - x_L$, $T_H = w_H - x_H$, and $T^u = -x^u$, be the tax paid by disabled workers, able workers, and people on disability assistance, respectively. Hence, $-T^u$ is the disability benefit. Let us define the elasticity of participation of the disabled workers with respect to x_L and the elasticity of the able workers with respect to x_H, respectively, as

$$\eta \left(x_L, \widetilde{\delta}_d \right) \equiv \frac{x_L}{\pi_d^w} \frac{\partial \pi_d^w}{\partial x_L} \qquad (6)$$

$$\eta \left(x_H, \widetilde{\delta}_a \right) \equiv \frac{x_H}{\pi_a^w} \frac{\partial \pi_a^w}{\partial x_H} \qquad (7)$$

where $\partial \pi_d^w / \partial x_L = N_d f \left(\widetilde{\delta}_d \right) v'(x_L)$ from (3) and where $\partial \pi_a^w / \partial x_H = N_a \mu g \left(\widetilde{\delta}_a \right) v'(x_H)$ from (2). These elasticities measure the percentages of disabled (able) workers in low-skilled (high-skilled) jobs who decide to leave the labor force when x_L (x_H) decreases by 1 percent.

Next, we define the marginal social welfare weight for working agents whose consumption is x_L and x_H, respectively, as the ratio of the social marginal utility of consumption and the shadow price of the public funds:

$$g_L \equiv \frac{v'(x_L)}{\lambda} \qquad (8)$$

$$g_H \equiv \frac{v'(x_H)}{\lambda} \qquad (9)$$

Disabled individuals are not responsible for the stigmatization (or snowball) phenomenon. One can then argue that they are not responsible for the impact of σ on their well being. Therefore,

there are good reasons to integrate it in the paternalistic utilitarian preferences $\widetilde{S}^P$,

$$\widetilde{S}^P \equiv N_d \left[\int_0^{\widetilde{\delta}_d} (v(x_L) - \delta_d) \, dF(\delta_d) + \left(1 - F\left(\widetilde{\delta}_d\right)\right) (v(x^u) - \sigma(\pi_a^u)) \right] + \pi_a^w v(x_H) + \pi_a^u v(x^u)$$

The Lagrangian states as

$$\mathcal{L}^P \equiv \widetilde{S}^P + \lambda \left[\pi_d^w (w_L - x_L) - (\pi_d^u + \pi_a^u) x^u + \pi_a^w (w_H - x_H) - (\pi_d^u + \pi_a^u/\mu) M(\mu) + R \right]$$

, where $\widetilde{\delta}_a$ $(\widetilde{\delta}_d)$ is given by (2) ((3)).

Next, observe that the average of the inverse of the private marginal utility of consumption is given by

$$g_A \equiv \frac{\pi_d^w}{v'(x_L)} + \frac{\pi_d^u + \pi_a^u}{v'(x^u)} + \frac{\pi_a^w}{v'(x_H)}. \tag{10}$$

Let subscripts to the function $\widetilde{S}^P$ denote the partial derivative of $\widetilde{S}^P$ with respect to the argument in the subscript and note that the effect of a uniform increase in private utilities on $\widetilde{S}^P$ is given by

$$D \equiv \frac{\widetilde{S}^P_{x_L}}{v'(x_L)} + \frac{\widetilde{S}^P_{x_H}}{v'(x_H)} + \frac{\widetilde{S}^P_{x^u}}{v'(x^u)}. \tag{11}$$

The following theorem states the solution for the second-best problem.

Proposition 2 *Under asymmetric information, the optimal consumption levels and type II errors satisfy the budget constraint (5) and the following four equations:*

$$\frac{T_L - T^u}{x_L} = \frac{1}{\eta\left(x_L, \widetilde{\delta}_d\right)} (g_L - 1) + \frac{M(\mu)}{x_L} \tag{12}$$

$$\frac{T_H - T^u}{x_H} = \frac{1}{\eta\left(x_H, \widetilde{\delta}_a\right)} \left[(g_H - 1) + \frac{\Omega(x_H, x_L, x^u, \mu)}{\pi_a^w} \right] + \frac{\widetilde{\delta}_a}{\lambda x_H} + \frac{M(\mu)}{\mu x_H} \tag{13}$$

, where $\Omega(x_H, x_L, x^u, \mu) = (x_L - w_L + x^u + M(\mu)) \frac{\partial \pi_d^w}{\partial x_H} - \frac{\pi_d^u}{\lambda} \frac{\partial \sigma}{\partial x_H}$ *applies to the indirect behavioral responses and indirect welfare change that arise from the endogenous take-up cost,*

$$\lambda^{-1} = g_A/D \tag{14}$$

and

$$(1 - \mu) \frac{\partial \mathcal{L}^P}{\partial \mu} = 0 \text{ and } \frac{\partial \mathcal{L}^P}{\partial \mu} \geq 0 \tag{15}$$

The proof as well as a simple heuristic interpretation in the spirit of Saez (2002) is provided in Appendix E.

Substituting $M(\mu) = 0$ in (12) yields the standard optimal tax schedule with extensive responses (Diamond, 1980; Saez, 2002). The financial incentive to enter the labor force, i.e., $T_L - T^u$, is inversely related to the participation elasticity $\eta\left(x_L, \widetilde{\delta}_d\right)$ in the vein of the inverse elasticity rule of Ramsey. Similarly, the financial incentive to enter the labor force increases with the marginal social welfare weight of (disabled) workers (g_L).[16] With costly monitoring $(M(\mu) > 0)$, our formula

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[16] From (12), an optimal replacement rate formula can also be derived, as done in Kroft (2008). This implies following Kroft's assumption of zero taxation in unskilled jobs, i.e., $x_L = w_L$, to neglect monitoring costs and to define the elasticity of participation by $[(x_L - x^u)/\pi_d^w] (\partial \pi_d^w/\partial x_L)$. Then it can easily be shown that (12) becomes an optimal replacement rate formula as a function of the elasticity of participation.

emphasizes that the financial incentive to enter the labor force also increases with the per capita cost of monitoring. Intuitively, monitoring costs make inactivity more expensive, hence financial incentives are needed to reduce inactivity. Corollary 1 will discuss the optimal tax formula (12) in more detail.

Compared with (12), the optimal formula (13) has two key changes given the stigma externality and the paternalistic criterion.

First, the term $\widetilde{\delta}_a / (\lambda x_H)$ is a result of the fact that the marginal disutility $\widetilde{\delta}_a$ is not included in the paternalistic criterion. This term appears since the effect of an infinitesimal change in the consumption bundle of able workers (dx_H) induces the pivotal able agents to start working, which has a first-order effect on paternalistic evaluation of their well-being equal to $v(x_H) - v(x^u)$, which by virtue of (2) reduces to $\widetilde{\delta}_a$. The denominator in (13) converts this effect in terms of public funds and makes it relative to x_H. This term is sometimes called the paternalistic or first-best motive for taxation since it arises from differences between social and private preferences (Kanbur *et al.*, 2006). It corrects the labor supply of able people to correspond more closely to social preferences. The term $\widetilde{\delta}_a / (\lambda x_H)$ increases their financial incentive to enter the labor force, i.e., $T_H - T^u$.

Second, $\Omega(x_H, x_L, x^u, \mu)$ includes all of the effects from the externality created by stigma or snowball take-up costs. An infinitesimal change dx_H modifies the proportion of able recipients. This modifies $\sigma\left(\pi_a^u\left(\widetilde{\delta}_a, \mu\right)\right)$, which indirectly induces $\partial \pi_d^w / \partial x_H$ pivotal disabled recipients to change their occupational choice as a result of stigma (snowball take-up cost) effects. Using the envelope theorem and (2) and (3), $\partial \pi_d^w / \partial x_H > 0 \ (< 0)$ if $\partial \sigma / \partial \widetilde{\delta}_a > 0 \ (< 0)$. Each disabled recipient entering the labor force induces a revenue gain of $w_L - x_L + x^u + M(\mu)$, i.e., the tax paid by each new disabled worker $(w_L - x_L)$ and the benefit that stops being paid to him/her. There is also a gain in monitoring expenditures $(M(\mu))$ for the disabled who stop applying for disability benefits. Hence, the total gain is $(w_L - x_L + x^u + M(\mu)) \left(\partial \pi_d^w / \partial x_H\right) dx_H$. The change dx_H also affects welfare through a change in the stigma intensity of the π_d^u disabled recipients. This change in terms of public funds is valued $-\pi_d^u \left(\partial \sigma / \partial x_H / \lambda\right) dx_H$ by the government. Then, all of the indirect effects implied by the stigma (take-up cost) externality when $dx_H > 0$ are denoted by $\Omega(x_H, x_L, x^u, \mu)$ defined in Proposition 2.

Equation (14) is similar to Diamond and Sheshinski (1995)'s equation (6), p. 6. It yields an important redistributive principle of the optimal redistributive programs, which prevails independently of stigma effects. It is associated with an equal marginal change of the consumption of everyone in the economy. Consider a uniform increase in all private utilities of one unit. This does not change activity decisions. To accomplish this uniform increase, we need per w_Y-worker $1/v'(x_Y)$ extra units of consumption $(Y = L, H)$, and per inactive person we need $1/v'(x^u)$ extra units of consumption. Weighting this by the frequencies of these groups in the population, we find that we need an additional $g_A\left(x^u, x_L, x_H, \widetilde{\delta}_d, \widetilde{\delta}_a\right)$ units of public revenue to finance this operation. In terms of social welfare, this is worth $\lambda g_A\left(x^u, x_L, x_H, \widetilde{\delta}_d, \widetilde{\delta}_a\right)$. This has to be equal to the increase in the social objective function caused by the uniform increase in utilities, which is equal to D. Remarkably, under paternalistic utilitarian preferences, $D = 1$ from (11). Equation (14) thus equates the inverse of the marginal cost of public funds to the ratio of the average of the inverse of the private utilities and the marginal social utility of a uniform increase in all individual utilities, the latter being equal to one under paternalism. Multiplying both sides of (14) by λ, this

principle can be rephrased as: the average (using population proportions) value of the inverses of the marginal welfare weights is one.

Equation (15) is developed in Appendix E (see Equation (23)). In case of an interior solution ($\mu < 1$), the optimal amount of monitoring is such that the impact of a small increase in the probability of type II errors $d\mu > 0$ cancels out the mechanical and behavioral effects (detailed in Appendix E) such that $\partial \pounds / \partial \mu = 0$.[17] When the marginal cost of monitoring $|\partial M / \partial \mu|$ is not huge, monitoring is always optimal (i.e., $\mu < 1$) because it reduces the number of undeserving recipients, thereby improving efficiency. It also reduces stigmatization (with $\partial \sigma / \partial \mu > 0$). However, when $|\partial M / \partial \mu|$ is very high, $\mu = 1$ prevails at the optimum. No monitoring is optimal, as whoever applies for disability benefits obtains them. From simulations, Section 6 shows when monitoring becomes suboptimal (i.e., $\mu = 1$).

It is well known (Diamond 1980) that subsidizing low-paid workers more than inactive people (i.e., $T_L < T_u$) can be optimal when labor supply is modeled along the extensive margin. Using the definition of Saez (2002), an Earned Income Tax Credit (EITC) is then optimal. On the other hand, when $T_L > T_u$, a Negative Income Tax (NIT) is optimal. With labor supply modeled along the extensive margin, Saez (2002) shows that an EITC or NIT prevails depending on whether $g_L \geq 1$ or $g_L < 1$. The following corollary emphasizes that the sufficient condition for an EITC is still valid with costly monitoring, but not under NIT. Costly monitoring supports the use of an EITC since it makes inactivity more expensive.

Corollary 1 *With costless monitoring, an EITC or a NIT is optimal depending on $g_L \geq 1$ ($g_L < 1$) (Saez, 2002). With costly monitoring, $g_L \geq 1$ implies an EITC, and the EITC result can also carry through with $g_L < 1$.*

Proof. From (12), $g_L \geq 1 \Leftrightarrow T_L - T^u \geq M(\mu)$; hence, an EITC is optimal. This result prevails with $M(\mu) \geq 0$. Moreover, from (12), $g_L < 1 \Leftrightarrow T_L - T^u < M(\mu)$. Therefore, $M(\mu) = 0$ implies that a NIT is optimal. When $M(\mu) > 0$ (i.e., $\mu < 1$), the previous inequality does not imply $T_L < T_u$ (i.e., a NIT) anymore. ∎

At this stage of the analysis, it becomes obvious that Lemma 1, Proposition 2, and Corollary 1 may easily be extended to a more general utility function, but at the cost of more extensive notation and derivations without bringing further economic intuitions and results, so we prefer to stick to the simple quasilinear form.

Interestingly, Corollary 1 and the next proposition highlight that the government should offer particularly strong financial incentives to the disabled and not trap all of them into inactivity. This supports adoption of an EITC (Corollary 1) and, in addition, because the consumption then received by disabled workers is necessarily larger than that of those who are non-employed:

Proposition 3 *Consumption of workers in low-skilled jobs is strictly larger than the disability benefit, $x_L > x^u$.*

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[17]In a model with a perfect (i.e., without any error) but costly monitoring technology, Cremer *et al.* (2007) show that the optimal number of monitored people is determined by the trade-off between the negative effect of monitoring on public expenditures (i.e., the mechanical loss in monitoring expenditures) and its positive effect via the welfare gain stemming from less stringent ICC. Similarly, in our model, decreasing μ implies a mechanical loss in monitoring expenditures and gains on government revenue as a result of behavioral responses. In our model, modifying monitoring also affects the stigma (snowball take-up cost). This externality modifies welfare and implies behavioral responses from disabled agents.

Appendix F states the proof. The result $x_L > x^u$ can seem counterintuitive at first sight for two reasons. First, those who get the lowest consumption are also those who suffer from stigma. Second, our result contrasts with those of Akerlof (1978) and Salanié (2002). They show analytically that tagged disabled people obtain larger consumption than untagged ones, i.e., $x_L > x^u$. In this literature, tagging improves equity by giving higher transfers to some of the more needy. At the same time, tagging also improves efficiency by circumventing the ICC that normally limits the extent of redistribution.

The reverse ranking of consumption levels obtained in Proposition 3 can intuitively be explained by a new efficiency effect. The latter appears when the tagged population includes a proportion of disabled who are ready to work, and it is not optimal to release that proportion from work activity. It implies that disabled workers should receive higher consumption than is provided to those disabled persons who do not work, $x_L > x^u$. In standard tagging models, since the disabled are by assumption always inactive, no efficiency effect will push the consumption of untagged disabled above that of the tagged disabled.[18]

The next proposition points out that when perfect monitoring can be realized without any governmental spending, using it is, however, not optimal.

Proposition 4 *With costless monitoring, perfect monitoring (i.e., $\mu = 0$) is not optimal under paternalistic utilitarian preferences. This result holds with or without stigma.*

Appendix G gives the proof. This quite surprising result relies on the fact that, since the labor supply is restricted to be binary, the directly truthful mechanism that implements the optimal allocations is never fully revealing (see Equations (2)-(3)). Workers fully reveal their w_Y ($Y = L, H$) information but not their δ value, and they announce only that their δ is larger than $\widetilde{\delta}_y$ with $y = d$ ($y = a$) for $w_L(w_H)$-workers. Moreover, inactive agents do not reveal either their exact w_Y or their δ_y. In this context, monitoring improves information on the inactive but full revelation never occurs. In other words, even when $\mu = 0$ is feasible without any cost, an instrument is still missing to reach the first-best. To implement the first-best allocation, the tax authority would need to observe not only the health status (through perfect monitoring) but also the precise δ level.

We have emphasized that costless and perfect monitoring does not imply full information. Now, let us recall that the full information optimum is characterized by all able agents who work (Proposition 1). In the second-best, perfect monitoring allows that all able agents work (hence, stigma is zero, if any). However, even when this does not cost anything, it is always optimal to have imperfect monitoring. This can be intuitively explained as follows. In the second-best with costless and perfect monitoring ($\mu = 0$), equalizing the consumption levels such that we tend toward the first-best optimum, all disabled agents stop working and create a considerable loss of tax revenue. This sharply contrasts with the first-best allocation where the disabled with δ_d below some threshold do work. Using financial incentives, $x_L > x^u$, is the only way to guarantee that some disabled agents work in the second-best (since we do not observe their individual disutility). Moreover, financial incentives for able agents are also required to avoid that they all only work in low-skilled jobs. The lowest financial incentive such that they all work in high-skilled jobs is

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[18]This result is in the vein of a "dual-NIT system' (Parsons, 1996), where some able people who get disability benefits (type II errors) also receive incentives to work.

13

$x_H = x_L$, μ being equal to zero. In other words, $\mu = 0$ yields $\lambda = v'(x_H) = v'(x_L) < v'(x^u)$ (as also emphasized in the proof in Appendix G). This has a welfare cost for the disabled that implies that $\mu > 0$ (hence, $v'(x_H) < \lambda$) is preferred.

Interestingly, this result holds with stigma, with snowball take-up cost, or without either of them. Our model does not require take-up costs to show that no type II error is suboptimal.

We believe that this result may be of some use for policy recommendations. In Norway for instance, several economists and politicians have recently proposed strengthening controls in disability programs to eliminate those able people who abuse the system. In the current budgetary, demographic, and economic contexts, to cut unnecessary costs may be a good idea. However, a government that, roughly speaking, wants to help the disabled but not lazy able persons should allow some cheating, according to Proposition 4. This occurs because to reach the ideal first-best optimum requires not only perfect information on the health status of claimants (able versus disabled) but also their precise disutility of work given their handicap. Since this is not feasible, perfect monitoring would be welfare-reducing.

5   The utilitarian criterion

This section emphasizes that most of the results we have derived under paternalistic utilitarian preferences are still valid under the utilitarian criterion, S^U.

Proposition 5 *In full information, everyone receives the same consumption $\overline{x}$ under utilitarian preferences and a NIT prevails. Disabled and able agents with $\delta_y > \widehat{\delta}_y = v'(\overline{x})w_Y$ $(y, Y) = (d, L)$ or (a, H), do not work.*

The proof is provided in Appendix A. Under full information, it is optimal to have able people who do not work and receive disability benefits, under utilitarian preferences. This result contrasts with the full information optimum under the paternalistic utilitarian criterion (Proposition 1).

In the second-best, because of the ICC, the utilitarian preferences become

$$
\widetilde{S}^U \equiv N_d \left[\int_0^{\widetilde{\delta}_d} (v(x_L) - \delta_d)\, dF(\delta_d) + \left(1 - F\left(\widetilde{\delta}_d\right)\right) (v(x^u) - \sigma(\pi_a^u)) \right]
$$

$$
+ N_a \left[\left(G\left(\widetilde{\delta}_a\right) + (1 - \mu)\left(1 - G\left(\widetilde{\delta}_a\right)\right)\right) v(x_H) - \int_0^{\widetilde{\delta}_a} \delta_a\, dG(\delta_a) \right.
$$

$$
\left. - (1 - \mu) \int_{\widetilde{\delta}_a}^{\infty} \delta_a\, dG(\delta_a) + \mu \left(1 - G\left(\widetilde{\delta}_a\right)\right) v(x^u) \right]
$$

The following proposition gives the optimal second-best allocation.

Proposition 6 *In asymmetric information, the utilitarian optimal consumption levels and type II errors satisfy the budget constraint (5), Equations (12), (14), and (15), and*

$$
\frac{T_H - T^u}{x_H} = \frac{1}{\eta\left(x_H, \widetilde{\delta}_a\right)} \left[(g_H - 1) + \frac{\Omega(x_H, x_L, x^u, \mu)}{\pi_a^w} \right] + \frac{M(\mu)}{\mu x_H}
$$

Since the proof is identical to the one in Proposition 2, it is skipped here. There is no more change in welfare (directly) due to the behavioral response of the pivotal able workers leaving the labor

force, characterized by $\delta_a = \widetilde{\delta}_a$. Their well-being weight is now the same, in the social preferences, whether they are recipients or workers. Therefore, compared with Equation (13) in Proposition 2, the paternalistic term $\widetilde{\delta}_a / (\lambda x_H)$ does not appear in the above equation.

From Equation (12) in Proposition 6, it is straightforward to see that Corollary 1 is still valid under utilitarianism. Again, monitoring supports an EITC.

Proposition 7 *Under utilitarianism, the consumption of workers in low-skilled jobs is strictly larger than the disability benefit, $x_L > x^u$.*

Since the proof is identical to the one of Proposition 3, it is skipped here. The intuition is identical to the one we provided for Proposition 3.

Proposition 8 *With costless monitoring, perfect monitoring (i.e., $\mu = 0$) is not optimal under utilitarianism. This result holds with or without stigma.*

The proof is identical to the one of Proposition 4 (in Appendix G). Under utilitarianism, as with the paternalistic utilitarian criterion, $\mu = 0$ coexists with $x_H = x_L > x^u$. Moreover, perfect monitoring implies that all able never obtain disability benefits. Contrastingly, in the first-best utilitarian optimum, disabled but also able agents (with δ above some threshold values) do not work (Proposition 5). This is never reached with $\mu = 0$. Hence, even if costless, $\mu = 0$ is not optimal in the second-best.

6   An illustration

This section implements our optimal tax formulas to check when monitoring becomes suboptimal, as expected from the discussion of Equation (15) in Proposition 2.

6.1   Calibration

To calibrate the model, we specify a logarithmic utility function, $v(.) \equiv \ln(.)$ and a linear take-up cost function, $\sigma(\pi_a^u) = s\pi_a^u$ with $s \in \mathbb{R}$. There is no empirical evidence concerning the disutility of work as a result of disability or aversion to work. Therefore, δ_d and δ_a are distributed according to Gamma distributions since those distributions take a very large variety of shapes by perturbing only its r parameter.[19] Let r_{δ_d}, r_{δ_a} be the parameters characterizing Gamma distributions, respectively, for δ_d and δ_a. In 1998, almost 20% of people in the U.S. reported some level of disability (Stoddard *et al.*, 1998). In 2001, almost 15% of the population of working age from EU countries reported severe and moderate disability (Eurostat, 2001). Following Benitez-Silva *et al.* (2004a), who show that the hypothesis that self-reported disability is an unbiased indicator that cannot be rejected,

---

[19]The density of a Gamma is given by:

$$f(y) = \frac{1}{\Gamma(r)} \exp(-y) y^{r-1}$$

, where $\Gamma(r)$ is a Gamma law of parameter and the latter is equal to the mean and the variance of the distribution. We have checked that our conclusions are maintained with other continuous distributions defined on the infinite support $[0, +\infty)$.

we take $N_d = 0.15$ as a benchmark. Here, with two levels of skills, assumptions about w_H and w_L cannot be based on actual earnings distributions. The base setting for the parameters is

$$s = 3, \; r_{\delta_d} = 5, \; r_{\delta_a} = 1, \; w_L = 50, \; w_H = 100 \text{ and } R = 0.$$

In all of our simulations, we consider R strictly larger than $-[N_d w_H + N_a w_L] = -92.5$; otherwise, the budget constraint (5) is violated. The specification of the monitoring function is

$$M(\mu) = m(1/\mu - 1) \quad \text{with } m > 0. \tag{16}$$

The value of m is given by (16), where μ and $M(\mu)$ are replaced by empirical estimates as follows. Benitez-Silva *et al.* (2004b) estimate that approximately 20% of applicants who are ultimately awarded benefits are not disabled; hence, $\mu = 0.2$. The (average) monthly disability benefit is \$786, about the (average) labor earnings of disabled people w_L (however, the variance is large), and the average cost of running the Social Security Administration (Disability Insurance) bureaucracy, which determines eligibility for disability benefits, is about \$2000 per application in the U.S. (Benitez-Silva *et al.*, 2004b). The claims are typically reviewed every year. Hence, the monthly average per capita cost of monitoring is \$166.7. Therefore, $w_L = 4.7M$. Since $w_L = 50$, $M = 10.6$. $M(\mu) \in [7.5; 15]$ is considered to get a range of empirically relevant parameters. Substituting $\mu = 0.2$ and $M \in [7.5; 15]$ into (16) gives an interval of plausible values for m, i.e., $m \in [1.8; 3.8]$.

Simulations were performed with Mathematica software and our programs are available upon request. Technical details of the simulations are described in Appendix H.

6.2   Simulations

A first exercise gives the threshold values of m in (16) beyond which monitoring is suboptimal (i.e., $\mu = 1$). With the paternalistic utilitarian criterion, monitoring is suboptimal when $m \geq 73$. With the utilitarian criterion, monitoring is suboptimal ($\mu = 1$) when $m \geq 50.3$. Those threshold values are large relative to labor earnings in low-skilled jobs ($w_L = 50$) or relative to (per capita) governmental exogenous resources ($R = 0$). These thresholds also seem unrealistically high compared with the interval of empirically plausible values, $1.8 \leq m \leq 3.8$. All our unreported simulations give unrealistic high threshold values.

Simulations also allow the emphasis of another situation where monitoring is suboptimal and cannot be captured by the first-order conditions. Under the utilitarian criterion, when the exogenous resources R become very high (and larger than m and w_H according to all of our simulations), monitoring becomes suboptimal. Figure 1 illustrates this with $m = 2$. Under utilitarianism, monitoring becomes suboptimal when $R \geq 130.96$. At $R = 130.96$, there is a discontinuity in the probability of type II errors μ, which jumps up to 1. The proportion of able workers, π_a^w, then sharply shrinks. And there is a discontinuity in π_a^w at $R = 130.96$ (see Figure 1). Intuitively, since the disutility terms δ_a reduces the utilitarian welfare level, it is optimal that more and more able workers stop working when R increases. Under paternalistic utilitarianism, our simulations never report a threshold R beyond which monitoring is suboptimal. Taking large ranges of (s, R, w_L, w_H, N_d, m) (such that monitoring is optimal), we varied R but never found any case where monitoring became suboptimal. Intuitively, able people who stop working reduce efficiency without improving equity under the paternalistic criterion. Therefore, under paternalism, the proportion of able people who
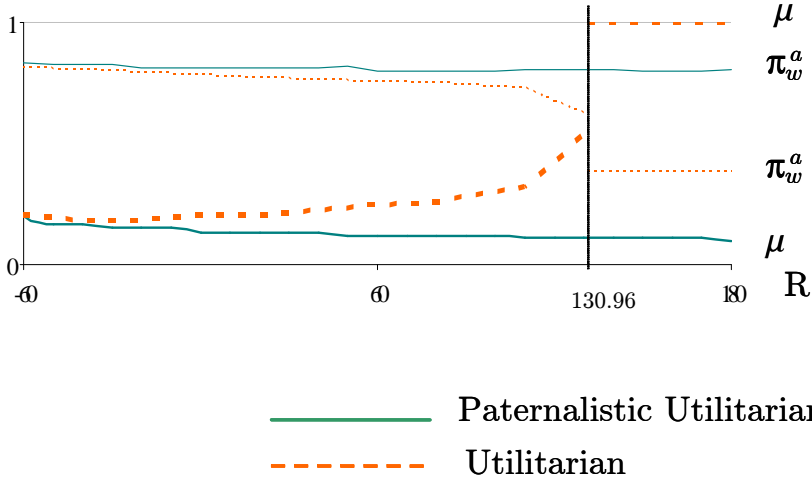
Figure 1: Optimal probability of type II error and proportion of able workers as functions of R.

work, π_a^w, is stable (see Figure 1 where $m = 2$) with R. Financial incentives and monitoring are both used to keep π_a^w high and stable. When governmental resources R increase, Type II errors are reduced. They decrease from 20% to 10% when R increases from -60 to 180.

7   Conclusion

This paper assumed an economy where lazy able people may pretend to be disabled and where some disabled people may not take up disability benefits designed for them. It has been shown that modeling the monitoring technology and the participation decisions (participation in the labor market and in disability programs) is critical to designing the optimal tax schedule. Formulas for optimal taxation and optimal monitoring accuracy have been provided under paternalistic utilitarian and utilitarian preferences. It has been shown that expensive monitoring supports the use of an Earned Income Tax Credit. We have also discussed how introducing some endogenous take-up cost (as in Besley and Coate, 1992) modifies the optimal tax formula.

This paper has also shown that when monitoring is costless, perfect monitoring is not optimal. In other words, some cheating is always optimal. Our simulations have shown the quantitative sensitivity of the optimal level of type II errors.

A   Proofs of Propositions 1 and 5

The Lagrangian states as

$$
\mathcal{L} = S^X + \lambda \left\{ N_d \left[\int_0^\infty \left[\ell\left(\delta_d\right)\left(w_L - x_L^w(\delta_d)\right) - \left(1 - \ell\left(\delta_d\right)\right) x_L^u(\delta_a) \right] dF(\delta_d) \right] \right.
$$
$$
\left. + N_a \left[\int_0^\infty \left[\ell\left(\delta_a\right)\left(w_H - x_H^w(\delta_a)\right) - \left(1 - \ell\left(\delta_a\right)\right) x_H^u(\delta_a) \right] dG(\delta_a) \right] - R \right\},
$$

where λ is the (nonnegative) Lagrangian multiplier associated with the budget constraint. We discuss the paternalistic utilitarian case first (i.e., $X = P$), and show how the properties of the

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utilitarian case $(X = U)$ follow.

For any pair (δ_d, δ_a), the first-order conditions with respect to the four consumption functions can be written as:

$$\ell(\delta_d)[v'(x_L^w(\delta_d)) - \lambda] = 0$$
$$(1 - \ell(\delta_d))[v'(x_L^u(\delta_d)) - \lambda] = 0$$
$$\ell(\delta_a)[v'(x_H^w(\delta_a)) - \lambda] = 0$$
$$(1 - \ell(\delta_a))[v'(x_H^u(\delta_a)) - \lambda] = 0$$

Since $\ell(\delta_y)$ $(y = d, a)$ is equal to 1 or 0, only two of these first-order conditions matter. For those that matter, the corresponding social marginal utilities of consumption have to be equal. For the other two, the consumption function does not matter (as nobody with this value for δ_y is receiving it). Therefore, since λ is a constant, we have that the first-order conditions with respect to consumption reduce to $\forall (\delta_d, \delta_a)$:

$$v'(x_L^w(\delta_d)) = v'(x_L^u(\delta_d)) = v'(x_H^w(\delta_a)) = v'(x_H^u(\delta_a)) = \lambda$$
$$\iff \overline{x} = x_L^w(\delta_d) = x_L^u(\delta_d) = x_H^w(\delta_a) = x_L^u(\delta_a), \tag{17}$$

From (17), the tax/transfer toward the disabled workers, $\overline{x} - w_L$, is lower than the transfer to the inactive disabled, $\overline{x}$. A NIT is optimal. From the budget constraint, we have

$$\overline{x} = N_d w_L \int_0^\infty \ell(d_\delta) dF(d_\delta) + N_a w_H \int_0^\infty \ell(\delta_a) dG(\delta_a) + R \tag{18}$$

$\overline{x}$ only depends on the number of disabled and the number of able agents who are employed. Consequently, the value of our objective function becomes

$$v\left(N_d w_L \int_0^\infty \ell(\delta_d) dF(\delta_d) + N_a w_H \int_0^\infty \ell(\delta_a) dG(\delta_\alpha) + R\right)$$
$$- N_d \int_0^\infty \ell(\delta_d) \delta_d dF(\delta_d)$$

The value of our objective function is maximal when all able agents work: $\ell(\delta_a) = 1 \; \forall \delta_a$. Therefore, from the budget constraint, we have $\overline{x} = N_d w_L \int_0^\infty \ell(d_\delta) dF(d_\delta) + N_a w_H + R$. Further, as δ_d rises from 0 to ∞, the function $\ell(\delta_d) \delta_d$, where $\ell(\delta_d) = 1 \; \forall \delta_d$, goes from 0 to ∞. Hence, among the disabled, it will always be optimal to have those in work with the lowest δ_d. Consequently, the function $\ell(\delta_d)$ will have the following shape: $\ell(\delta_d) = 1$ for all $\delta_d \leq \widehat{\delta}_d$ and $\ell(\delta_d) = 0$ otherwise. The critical value is determined by

$$v'(\overline{x}) N_y w_Y f\left(\widehat{\delta}_y\right) - N_y \widehat{\delta}_y f\left(\widehat{\delta}_y\right) = 0$$
$$\Leftrightarrow \widehat{\delta}_y = v'(\overline{x}) w_Y > 0, \tag{19}$$

with $(y, Y) = (d, L)$. Since $v'(\overline{x})$ and w_L are finite, $\widehat{\delta}_d < \infty$. It implies that it is optimal for some disabled individuals not to work.

Under utilitarian preferences S^U, it is easy to see that the same first-order conditions as under S^P are obtained, and so the solution is given by (17). Again, we drop the superscript $X = U$ to

ease the notations. From the budget constraint, we then have (18). Substituting (18) in S^U gives the value of utilitarian welfare as a function of the $\ell(\delta_d)$ and $\ell(\delta_a)$ functions:

$$v \left(N_d w_L \int_0^\infty \ell(\delta_d) \, dF(\delta_d) + N_a w_H \int_0^\infty \ell(\delta_a) \, dG(\delta_\alpha) + R \right)$$
$$- N_d \int_0^\infty \ell(\delta_d) \, \delta_d dF(\delta_d) - N_a \int_0^\infty \ell(\delta_a) \, \delta_a dF(\delta_a).$$

Keeping the number of employed of both types fixed, it is only through the terms on the last line that the shape of the $\ell(\delta_d)$ and $\ell(\delta_a)$ functions matter under utilitarianism. Hence, as δ_k ($k = d, a$) rises from 0 to ∞, the function $\ell(\delta_k) \, \delta_k$, where $\ell(\delta_k) = 1 \, \forall \delta_k$, goes from 0 to ∞. Then it is always optimal to have those in work with the lowest $\delta_k (k = d, a)$. Therefore, the functions $\ell(\delta_d)$ and $\ell(\delta_a)$ have the following shape: $\ell(\delta_d) = 1$ for all $\delta_d \leq \widehat{\delta}_d$, otherwise zero and $\ell(\delta_a) = 1$ for all $\delta_a \leq \widehat{\delta}_a$, otherwise zero. Both critical values satisfy (19) with $(y, Y) = (d, L)$ and (a, H), respectively. Differing from the optimum under the paternalistic criterion, since $v'(\overline{x})$ and w_H are finite, we now have $\widehat{\delta}_a < \infty$, i.e., there are able agents who do not work and receive benefits. From $w_H > w_L$ and (19), $\widehat{\delta}_a > \widehat{\delta}_d$ as under paternalism.

B   Proof of Equation (1)

By contrast, suppose $x_H < x_L$. All able individuals who work choose to produce w_L units and receive net income x_L. From (2) and (3), nobody gets x_H as a consumption bundle. Then, keeping x_L fixed, we can assume $dx_H > 0$ such that $x_H + dx_H = x_L$. Now, able people who work produce w_H units and get x_H as a consumption bundle. Increasing the level of x_H up to x_L does not require any additional consumption since $x_H + dx_H - x_L = 0$ and since $\widetilde{\delta}_a$ and the number of able people who work is unchanged. The number of able people who apply for and take up benefits is then also unchanged. Hence, from (3), $\widetilde{\delta}_d$ and the number of disabled taking up assistance does not change as well. Yet, all able workers now choose high-skilled jobs and earn $w_H(> w_L)$. Since the cost in terms of supplementary consumption is zero and the difference $w_H - w_L$ is strictly positive, a net receipt appears: $w_H - w_L > 0$. The fiscal pie increases and more redistribution can occur. This will indubitably increase welfare. Therefore, it cannot be optimal for the government to let $x_L > x_H$ and, thus, consumption when producing more units must be larger: $x_H \geq x_L$.

C   At the optimum, all detected able claimants go back to work: Proof

Proof. Assume $\lim_{x \to 0} v(x) = -\infty$. Able agents choose either $v(x_H) - \delta_a$ or, with a probability μ, $v(x^u) - \delta_a$ and with a probability $1 - \mu$, $Max\{v(x_H) - \delta_a, v(T)\}$, where T is a welfare benefit. The ICC on able agents states

$$v(x_H) - \widetilde{\delta}_a = \mu v(x^u) + (1 - \mu) \left[Max\left\{ v(x_H) - \widetilde{\delta}_a, v(T) \right\} \right]$$

Since $-\delta_a$ is not valued by the Paternalistic Utilitarian criterion and because efficiency matters, $\forall \delta_a \in [0, \infty)$, it is optimal that $v(x_H) - \delta_a \geq v(T)$. This is the famous "principle of maximum

deterrence". Therefore, since $x_H > 0$, the maximum penalty $T = 0$ is optimal and all caught able people go back to work. Therefore, the ICC on able people can be written as (2). ∎

Boadway and Cuff (1999) distinguish between the voluntarily and involuntarily non-employed. In their model, when the government perfectly identifies the voluntary unemployed, the maximum penalty of zero consumption is assumed. In this model, the maximum penalty to the voluntarily inactive able people implies that they do go back to work.

D   Proof of Lemma 1

Proof. (1) Both $\widetilde{\delta}_a$ and $\widetilde{\delta}_d$ are smaller than ∞. As $\forall \delta_a : g(\delta_a) > 0$ ($\forall \delta_d : f(\delta_d) > 0$), all able (disabled) people work means $\widetilde{\delta}_a \to \infty$ ($\widetilde{\delta}_d \to \infty$) at the optimum. Since consumption levels (and $\sigma(\pi_a^u)$) are finite, from (2) and ((3)), $\widetilde{\delta}_a$ and $\widetilde{\delta}_d$ cannot tend to ∞.
(2) If no one works, i.e., $\widetilde{\delta}_a = \widetilde{\delta}_d = 0$, it is optimal for everyone to have the same consumption: $x_l = x_h = x_b = R'$ with $R' \overset{\text{def}}{\equiv} Max\{0, R\}$. This allocation will not be optimal if those with the least δ were to choose to work for the additional consumption equal to their marginal product. It will be the case since $v(R' + w_Y) > v(R')$ $Y = L, H$. This implies that $\widetilde{\delta}_d > 0$ ($\widetilde{\delta}_a > 0$) at the optimum. More generally, for all planners with an objective function that is increasing in individual utilities, making some disabled work is optimal. ∎

E   Proof and heuristic interpretation of Proposition 2

This appendix derives the necessary conditions of Theorem (2) and gives heuristic interpretations.
First-order condition with respect to x_L, (12)
From the Lagrangian, the first-order condition with respect to x_L gives

$$\pi_d^w \left(\frac{v'(x_L)}{\lambda} - 1 \right) = - (w_L - x_L + x_b + M(\mu)) \frac{\partial \pi_d^w}{\partial x_L}. \tag{20}$$

Using (6) and (8), this necessary condition can be rewritten as (12).

A simple heuristic interpretation follows. Consider a small increase in consumption x_L (e.g., a small reduction of the income tax in low-skilled jobs), around the optimal tax schedule. There are a mechanical effect and a behavioral (or labor supply response) effect.
Mechanical effect

There is a mechanical decrease in tax revenue equal to $-\pi_d^w dx_L$ because disabled workers have dx_L additional consumption. This mechanically increases social welfare of disabled workers by their marginal social welfare weight $v'(x_L)/\lambda$ ($\equiv g_L$). Thus, the mechanical welfare gain (expressed in terms of the value of public funds) as a result of dx_L is equal to $(v'(x_L)/\lambda) \pi_d^w dx_L$. Therefore, the total mechanical effect is $\pi_d^w (v'(x_L)/\lambda - 1) dx_L$.
Behavioral effect Behavioral responses imply a gain in tax revenue. The change $dx_L > 0$ induces $\partial \pi_d^w / \partial x_L$ (pivotal) disabled workers to enter the labor force. Each worker leaving disability assistance induces a gain in government revenue equal to $w_L - x_L + x^u + M(\mu)$. That is the tax paid by each disabled worker ($w_L - x_L$) and the savings from the benefits no longer paid to him/her as

disabled recipient (x^u), as well as the associated cost of monitoring $(M(\mu))$. The total behavioral gain is equal to $(w_L - x_L + x^u + M(\mu))(\partial \pi_d^w / \partial x_L) dx_L$.

At the optimum, the sum of the mechanical and behavioral effects equals zero and gives (20).

First-order condition with respect to x_H, (13)

Consider a small change $dx_H > 0$. This change implies mechanical and behavioral effects on government revenue and welfare.

Mechanical effect

There is a mechanical decrease in tax revenue equal to $-\pi_a^w dx_H$ because able workers consume an additional dx_H. This mechanical decrease in tax revenue, however, is valued $(v'(x_H)/\lambda - 1) \pi_a^w dx_H$ by the government since each Euro not raised increases the consumption of able workers and this consumption gain is socially valued $v'(x_H)/\lambda$ $(\equiv g_H)$ in terms of public funds.

Behavioral effect

There are two effects (direct and indirect) on government revenue as a result of behavioral responses following $dx_H > 0$.

(1) A direct behavioral response comes from $\partial \pi_a^w / \partial x_H$ (pivotal) previously inactive able agents who enter the labor force. Each recipient entering the labor force induces a gain in tax revenue of $w_H - x_H + x^u$, i.e., the tax paid by each new able worker $(w_H - x_H)$ and the benefit that stops being paid to him/her. There is also a gain in monitoring expenditures $M(\mu)$ for the $(\partial N_a G(\widetilde{\delta}_a)/\partial x_H)$ able people who stop applying for disability benefits. The gain in government expenditures is then $(w_H - x_H + x^u + M(\mu)/\mu)(\partial \pi_a^w / \partial x_H) dx_H$. The change dx_H also induces a welfare gain since there are $\partial \pi_a^w / \partial x_H$ new pivotal workers whose aversion to work $\widetilde{\delta}_a$ is not valued in the welfare function. Valued in terms of public funds, this welfare gain is $\left(\widetilde{\delta}_a / \lambda\right)(\partial \pi_a^w / \partial x_H) dx_H$. (2) The previous direct behavioral effect implies an externality effect through the change in the take-up disutility: the change dx_H indirectly induces $\partial \pi_d^w / \partial x_H$ pivotal disabled recipients to change their occupational choice as a result of stigma effects. Using the envelope theorem, (2) and (3), we have $\partial \pi_d^w / \partial x_H > 0$ (< 0) if $\partial \sigma / \partial \widetilde{\delta}_a > 0$ (< 0). Each disabled recipient entering the labor force induces a revenue gain of $w_L - x_L + x^u + M(\mu)$ for the government. Hence, the total gain is $(w_L - x_L + x^u + M(\mu))(\partial \pi_d^w / \partial x_H) dx_H$. The change dx_H also affects welfare through a change in the take-up cost's intensity of the π_d^u disabled recipients. This change in terms of public funds is valued $-\pi_d^u (\partial \sigma / \partial x_H / \lambda) dx_H$ by the government. Then, all indirect effects implied by the stigma (or snowball take-up cost) externality when $dx_H > 0$ are denoted by $\Omega(x_H, x_L, x^u, \mu)$, defined in Proposition 2.

At the optimum, the sum of the mechanical and all of the behavioral effects has to be nil, which gives:

$$\pi_a^w \left(\frac{v'(x_H)}{\lambda} - 1\right) - \frac{\pi_d^u}{\lambda} \frac{\partial \sigma}{\partial x_H} + \frac{\widetilde{\delta}_a}{\lambda} \frac{\partial \pi_a^w}{\partial x_H} = \tag{21}$$
$$- \left(w_H - x_H + x^u + \frac{M(\mu)}{\mu}\right) \frac{\partial \pi_a^w}{\partial x_H} - (w_L - x_L + x^u + M(\mu)) \frac{\partial \pi_d^w}{\partial x_H}.$$

Using (7) and (9), the latter equation can be rewritten as (13).

A necessary condition on the marginal cost of public funds λ, (14)

The necessary condition (14) comes from equations (12), (13), and the necessary condition with respect to x^u that can be stated as

$$(\pi_a^u + \pi_d^u)\left(\frac{v'(x^u)}{\lambda} - 1\right) - \frac{\pi_d^u}{\lambda}\frac{\partial\sigma}{\partial x^u} + \frac{\widetilde{\delta}_a}{\lambda}\frac{\partial\pi_a^w}{\partial x^u} = \tag{22}$$
$$= -\left(w_H - x_H + x^u + \frac{M(\mu)}{\mu}\right)\frac{\partial\pi_a^w}{\partial x^u} - (w_L - x_L + x^u + M(\mu))\frac{\partial\pi_d^w}{\partial x^u}.$$

Dividing (20), (21), and (22) by $v'(x_L)$, $v'(x_H)$, and $v'(x^u)$, respectively, and adding these equations gives (14).

First-order condition with respect to μ, (15)

$\frac{\partial\pounds}{\partial\mu} \geq 0$ from (15) can be rewritten as:

$$\frac{\pi_d^u}{\lambda}\frac{\partial\sigma}{\partial\mu} + \frac{\pi_a^w}{\mu}\frac{\widetilde{\delta}_a}{\lambda} \leq \tag{23}$$
$$\frac{\partial\pi_d^w}{\partial\mu}(w_L - x_L + x^u + M(\mu)) - \frac{\pi_a^u}{\mu}(w_H - x_H + x^u) - \left(\pi_d^u + \frac{\pi_a^u}{\mu}\right)\frac{\partial M(\mu)}{\partial\mu}.$$

We interpret this equation heuristically as follows. Consider $d\mu > 0$, which implies the following mechanical and behavioral effects on government revenue and welfare:

Mechanical effect

There is a mechanical gain in monitoring expenditures equal to

$$-\left(\pi_d^u + \pi_a^u/\mu\right)\left(\partial M(\mu)/\partial\mu\right)d\mu$$

because the per capita cost on the $(\pi_d^u + \pi_a^u/\mu)$ people who are monitored is reduced $(\partial M(\mu)/\partial\mu < 0)$.

Behavioral effect

There are two effects on government revenue as a result of behavioral responses.

(1) There is a loss in tax revenue equal to $-(w_H - x_H + x^u)N_a\left(1 - G\left(\widetilde{\delta}_a\right)\right)d\mu$ with $N_a\left(1 - G\left(\widetilde{\delta}_a\right)\right) \equiv \pi_a^u/\mu$, as a result of additional able people receiving disability benefits rather than working. This induces a welfare loss at the expense of workers whose disutility $\widetilde{\delta}_a$ was not valued in the paternalistic utilitarian criterion. That welfare loss expressed in public funds is $-\left(\widetilde{\delta}_a/\lambda\right)(\pi_a^u/\mu)d\mu$.

(2) Through stigma effects, $d\mu > 0$ induces $\partial\pi_d^w/\partial\mu > 0 \ (< 0)$ disabled agents to enter (leave) the labor force when $\partial\sigma/\partial\mu > 0 \ (\partial\sigma/\partial\mu < 0)$. Each disabled recipient entering the labor force induces a gain in tax revenue of $w_L - x_L + x^u$, as well as a gain in monitoring cost of $M(\mu)$. In total, this indirect behavioral gain is $(w_L - x_L + x^u + M(\mu))\left(\partial\pi_d^w/\partial\mu\right)d\mu$. The change $d\mu$ also affects welfare through a change in the stigma intensity of the π_d^u disabled recipients. This change in terms of public funds is valued at $-\pi_d^u\left(\partial\sigma/\partial\mu/\lambda\right)d\mu$ by the government.

In case of an interior solution for μ, all of these mechanical and behavioral effects sum to zero. The inequality (23) is then binding.

F   Proof of Proposition 3

Proof. From $\widetilde{\delta}_d > 0$ and $\widetilde{\delta}_a > 0$ (see Lemma 1) and (14), two rankings can prevail at the optimum, either:

$$\frac{1}{v'(x_H)} \geqslant \frac{1}{v'(x_L)} > \frac{1}{v'(x^u)} \Leftrightarrow x_H \geqslant x_L > x^u \quad \text{or} \tag{24}$$

$$\frac{1}{v'(x_H)} > \frac{1}{v'(x^u)} \geqslant \frac{1}{v'(x_L)} \Leftrightarrow x_H > x^u \geqslant x_L \tag{25}$$

In both cases, (24) and (25), $v'(x_H) < \lambda$. Moreover, if (24) prevails, we have: $v'(x^u) > \lambda$ and if (25) is correct then: $v'(x_L) > \lambda$. However, $v'(x_L) > \lambda$ implies that the left-hand side of (12) is positive. This requires that $w_L - x_L + x^u + M(\mu) < 0 \Leftrightarrow x_L - x^u > w_L + M(\mu) > 0$, which contradicts $x^u \geqslant x_L$. ∎

G   Proof of Proposition 4

Proof. For contrast, we assume $\mu = 0$. We then have $\sigma(.) = 0,$[20] $\pi_a^w = N_a$ (and the ICC on the able agents (2) is neglected). The first-order condition with respect to x_H becomes:

$$N_a \left(\frac{v'(x_H)}{\lambda} - 1 \right) = 0$$

Therefore, $v'(x_H) = \lambda$ when $\mu = 0$. This implies that (14) (which is still valid with costless monitoring) becomes:[21]

$$\frac{1 - N_a}{v'(x_H)} = \frac{\pi_d^w}{v'(x_L)} + \frac{\pi_d^u}{v'(x^u)} \tag{26}$$

Since a weighted average with positive weights is bounded by its least and greatest elements, and since $x_L > x^u$ (from (3)): $\frac{1}{v'(x_L)} \geq \frac{1}{v'(x_H)} \geq \frac{1}{v'(x^u)}$ with at least a strict inequality. From the first inequality: $x_L \geq x_H$. However $x_L > x_H$ does not prevail at the optimum (otherwise all able recognized as cheaters would work in low-skilled jobs, which is inefficient) hence $x_L = x_H$. Substitute the latter into (26) gives $v'(x_L) = v'(x^u)$ (since $1 - N_a = \pi_d^w + \pi_d^u$). This contradicts $x_L > x^u$. Therefore $\mu > 0$. ∎

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[20] With snowball take-up cost, $\mu = 0$ implies that $\sigma(\pi_a^u)$ is maximal and is not affected by a marginal change in any consumption level. Therefore, this proof is still valid.

[21] **Proof.** When $\mu = 0$, (20) becomes

$$\pi_d^w \left(\frac{v'(x_L)}{\lambda} - 1 \right) = -(w_L - x_L + x^u) \frac{\partial \pi_d^w}{\partial x_L} = -(w_L - x_L + x^u) N_d f\left(\widetilde{\delta}_d \right) v'(x_L)$$

and (22) becomes:

$$\pi_d^u \left(\frac{v'(x^u)}{\lambda} - 1 \right) = -(w_L - x_L + x^u) \frac{\partial \pi_d^w}{\partial \widetilde{\delta}_d} \frac{\partial \widetilde{\delta}_d}{\partial x^u} = (w_L - x_L + x^u) N_d f\left(\widetilde{\delta}_d \right) v'(x^u).$$

Dividing these two equations by $v'(x_L)$ and $v'(x^u)$, respectively, and adding them gives

$$\frac{\pi_d^w + \pi_d^u}{\lambda} = \frac{\pi_d^w}{v'(x_L)} + \frac{\pi_d^u}{v'(x^u)}.$$

Substituting $\lambda = v'(x_H)$ into the latter gives (26).

H   Numerical method

Combining constraints (2), (3), (5), and the paternalistic utilitarian criterion, it is convenient to rewrite the problem as:

$$\widetilde{S}^P\left(\widetilde{\delta}_d,\widetilde{\delta}_a,\mu,x^u\right) \equiv N_d\left[\widetilde{\delta}_d F(\widetilde{\delta}_d) - \sigma\left(\widetilde{\delta}_a,\mu\right) - \int_0^{\widetilde{\delta}_d}\delta_d dF(\delta_d)\right] +$$

$$+ \left[N_a\left((1-\mu) + G\left(\widetilde{\delta}_a\right)\right)\right]\widetilde{\delta}_a + v(x^u) \tag{27}$$

with

$$x^u\left(\widetilde{\delta}_d,\widetilde{\delta}_a,\mu\right) = \frac{\pi_d^w w_L + \pi_a^w w_H - \left(\pi_d^u + \frac{\pi_a^u}{\mu}\right)M(\mu) + R}{\pi_d^w e^{\widetilde{\delta}_d - \sigma\left(\widetilde{\delta}_a,\mu\right)} + (\pi_d^u + \pi_a^u) + \pi_a^w e^{\widetilde{\delta}_a}},$$

where $u(.) \equiv \ln(.)$ and equations (2) and (3) have been used. Therefore, the problem becomes a three-dimensional problem $\left(\widetilde{\delta}_d,\widetilde{\delta}_a,\mu\right)$. Similarly, the constrained maximization of the utilitarian criterion can easily be rewritten as a three-dimensional problem.

The associated system of first-order conditions is highly nonlinear and too complex to be studied analytically. Therefore, since multiple local optima may exist, for each vector of parameters (s, R, w_L, w_H, N_d) and for some specific distribution functions $F(\delta_d)$ and $G(\delta_a)$, and monitoring function $M(\mu)$, the objective function (27) is evaluated for an extremely wide range of values of the endogenous variables $\left(\widetilde{\delta}_d,\widetilde{\delta}_a,\mu\right)$. Through this numerical method, we are able to check whether the solution found is the global optimum.

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