Take it or Leave it : Optimal Transfer Programs, Monitoring and Takeup

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Take it or Leave it: Optimal Transfer Programs, Monitoring and Takeup*

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Abstract

This paper studies the optimal income redistribution and monitoring when disability benefits are intended for disabled people but where some able agents with high distastes for work mimic them (type II errors). Labor supply responses are at the extensive margin and endogenous takeup costs burden disabled recipients (due to a reputational externality caused by cheaters or due to a snowball effect). Under a non-welfarist criterion which does not compensate for distaste for work, (inactive) disabled recipients get a strictly lower consumption than disabled workers. The usual conditions under which the optimal transfer program is a Negative Income Tax or an Earned Income Tax Credit are challenged, due to monitoring. We also show that even if perfect monitoring is costless, it is optimal to have type II errors. These results are robust to a utilitarian criterion. Numerical simulations calibrated on US data are provided.

Key Words: optimal income taxation, tagging, takeup, extensive margin.
JEL Classification: H21

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1 Introduction

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

The standard optimal taxation model assumes that individuals are distributed over some private characteristic, such as 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 enhanced when some characteristics correlated with low productivity (or 'tag' to use the terminology introduced by Akerlof, 1978), like the disability status, are monitored for a subset of the disabled population.

This paper differs from the existing literature by endogenizing the monitoring technology[1] and all the behavioral responses (participation to the labor market and to disability programs), which allows to cast light on three important redistributive issues.

First: Who gets the largest consumption level? The tagging literature shows that tagged disabled agents receive a larger consumption level than untagged disabled people.[2] 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. This paper models behavioral responses such as labor supply responses and takeup responses as accurately as possible and shows that the optimal ranking of consumption bundles is then reversed, due to an efficiency effect.

Second: Who gets the largest transfer? By definition, an Earned Income Tax Credit (EITC) provides the largest transfer to the disabled (or low-productivity) workers. On the contrary, with a Negative Income Tax (NIT), the non-employed agents receive the largest transfer. As usual in the

[1] 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 when 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 the 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.

[2] See Akerlof (1978), Diamond and Sheshinski (1995), Parsons (1996) and Salanié (2002).

literature, let us define the ratio of the 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 to participate or not 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 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, for efficiency reasons. It allows to give incentives to work to a subset of the disabled as well as it avoids that all the able people mimic disabled workers.

In the paper, optimal tax formulas are derived providing a clear understanding of the key economic effects underlying them. This allows to better emphasize the new effects that monitoring and takeup imply on standard formulas. For easing the comparisons with the existing literature, these formulas are presented as functions of the behavioral elasticities.

Non-taking up exists due to costs of learning about and applying for the program or due to 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-takeup phenomenon. Due to the imperfect observability of disability,[3] 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. No empirical papers have studied this endogenous stigma but anecdotal evidence about people who cheat in welfare programs and then create doubts or social resentment

[3] In 2005, about 80% of disability recipients suffer from mental disorders and musculoskeletal diseases (e.g., back pain) (Social Security Administration, 2006). Most of these disabilities are generally neither easily observable nor perfectly monitorable 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. Moreover, some of those who are eligible for benefits will not take them up. In EU countries, about 30% of people who report severe disability do not get disability benefits and therefore work (Eurostat, 2001).

against their peers, seems persistent enough to open the path to more investigations. 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. Moreover, this paper also studies the robustness of the optimal tax formulas to an alternative takeup cost function.

The analysis is realized under a normative criterion corrected for features individuals are responsible for (Bossert *et al.*, 1999; Schokkaert *et al.*, 2004). According to this non-welfarist approach, income should not be transferred as compensation for distaste for work 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. 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 non-welfarist 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 the main numerical simulations of optimal tax and monitoring schemes (for which, details can be found in the Appendix).

2 The model

Productivities, disabilities and tastes for work

Individuals preferences are additively separable in consumption, labor and takeup costs and represented by:

$$u(x, \ell, \sigma, \phi, \delta) = v(x) - \delta\ell - (1-\ell)\sigma\mathbb{I}$$

where v is continuous, differentiable, strictly increasing and concave in consumption x (which is constrained to be nonnegative). ℓ is labor supply modeled on the extensive margin[4] i.e. $\ell \in \{0, 1\}$. δ is a parameter measuring disutility when working and σ denotes the (endogenous) takeup cost. $\mathbb{I}$ is an indicator function that takes the value of 1 if inactive agents take up disability benefits and 0 otherwise. This paper follows Parsons (1996) and Salanié (2002) who point out that recipients

[4]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 (Eissa and Liebman, 1996; Meyer and Rosenbaum, 2001) while most estimates of hours of work elasticities conditional on working are small (Blundell and MaCurdy, 1999; see also the discussion in Saez, 2002).

of disability benefits are generally banned from working in the real world.

An agent is described by a set of exogenous characteristics, denoted by (w, δ_d, δ_a). The first coordinate, $w \in \{w_L, w_H\}$, with $w_H > w_L > 0$, denotes his (low or high) productivity. As usual in the optimal taxation literature, people are not responsible for w which is interpreted as determined by their innate characteristics and their family background. δ_d measures disutility when working due to disability, i.e. the intensity of the physical or mental pain associated with work due to disability if relevant (Harkness, 1993; Cuff, 2000; Marchand *et al.*, 2003). The third coordinate, δ_a, is disutility when working due to distaste for work or work aversion (Laroque, 2005). Following Arneson (1990) and Roemer (1998), people are hold responsible for their taste for work δ_a while δ_d stems from luck hence people are not responsible for it. These characteristics are private information to each person; their distributions are public information. It is assumed that δ_d is distributed over the interval $[0, \infty)$, according to the cumulative distribution $F(\delta_d)$ with $F'(\delta_d) = f(\delta_d)$, $f(\delta_d) > 0$ $\forall \delta \in [0, \infty)$, $F(\infty) = 1$. The work aversion δ_a is distributed on the interval $[0, \infty)$, according to the cumulative distribution $G(\delta_a)$ with $G'(\delta_a) = g(\delta_a)$, $g(\delta_a) > 0$ $\forall \delta_a \in [0, \infty)$ and $G(\infty) = 1$.

When working, an agent produces a quantity w_L or w_H of an undifferentiated desirable commodity which can be reinterpreted as the gross labor earning in unskilled or skilled jobs respectively. 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. Their productivity is w_H. There is a perfect correlation between disability and a 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 productivity and precludes any substantial and gainful work (Hu at al., 2001). A disabled worker in a wheelchair who has the functional capability to engage in a substantial gainful job is not considered disabled neither by the U.S. Social Security Act nor in this model. This model highlights the effects of errors in attributing disability benefits. Therefore a clear boundary between eligible and non-eligible people is needed. This motivates the assumption that disabled people do not suffer from distaste for work (δ_a) such that all able (disabled) people are unambiguously non-eligible (eligible) for disability benefits.[5]

[5]The parameter for disabled people could be disentangled in two components: $\delta = \delta_a + \delta_d$ and again holding

Among its decision variables, the government has the after tax incomes which are denoted by x_j with $j = l, h, b$ denoting net incomes respectively in unskilled jobs, in skilled jobs and when receiving disability benefits hence non-participating in the labor force.

Reputational stigma

The definition of stigma adopted here follows Besley and Coate (1992) and the sociological literature on stigma since Goffman (1963). Stigma is viewed as resulting from a reputational externality.

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 (Elster, 1989; Sen, 1995; Lindbeck *et al.*, 1999). A social norm claiming that disabled low-productivity people should get transfers also prevails (Romer, 1997; Wolff, 2004). Due to the imperfect observability of disability, there are recipients whose decision to claim benefits can be directly attributed to laziness and not to disability. Stigma prevails because taxpayers know (for instance, from media) that among the inactive people who get disability benefits there are able people. These undeserving can generally not (perfectly) be distinguished from the deserving, neither by the tax authority and nor by people in general. Hence, undeserving individuals impose a "reputational externality" (Besley and Coate, 1992) on the deserving ones. When it is known that an individual is receiving disability benefits, other individuals will infer that this individual will likely be lazy. Stigma results then from statistical discrimination. To be a disabled inactive recipient and considered as an undeserving (i.e. lazy) recipient, when one truly is disabled is demeaning and stigmatizing. Disabled people who take up transfers feel—and are— stigmatized, hence are burdened by a stigma disutility of $\sigma \geq 0$.[6]

Invoking the notion of stigma used by Besley and Coate (1992), it is assumed that the stigma cost, $\sigma(.)$, is an increasing function of the proportion of undeserving recipients in the economy,[7] denoted π_a^{NW}. The undeserving beneficiaries are able and not working hence the subscript a and

people responsible for their taste parameter δ_a, but not for their disability parameter δ_d. However this complexifies the model without bringing further analytical results.

[6] 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 became suspected of being cheaters.

[7] For our qualitative results to be valid, all we really need is that there be a monotonic positive relationship between π_a^{NW} and the subjective number of undeserving recipients taxpayers inferred from media. Alternatively, we may consider that the proportion of able people N_a is common knowledge and that a statistic over people employed in skilled jobs is also available. Therefore, by subtraction, every taxpayer can deduce the statistics about undeserving recipients, π_a^{NW}.

the superscript NW are used. It is assumed that

$$\sigma'(\pi_a^{NW}) > 0$$

The higher π_a^{NW} is, the more people depreciate inactive recipients and the higher is stigma. It seems realistic to assume that reputational stigma hurts deserving people more than undeserving ones 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 intuitions behind the optimal tax schedule, zero stigma effect for the able recipients is assumed. However, the results are still valid when able people also face a positive stigma. Precisely how much a person will feel stigmatized will also depend on individual specific characteristics, e.g. his own self-esteem. To put the argument regarding the endogeneity of stigma and the impact of monitoring in sharpest relief, we follow Besley and Coate (1992) and set aside this heterogeneity of stigma costs, without discounting its importance.

Moreover, to fix $\sigma(.) = 0$ is equivalent to neglecting any takeup cost. Then, the endogenous takeup depends on the tax-transfer schedule as usually assumed in the optimal tax and tagging literature.

The definition of stigma presented above 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 cheaters and old foxes are admired, the following definition of stigmatization needs to be considered.

Takeup cost due to snowball effect

Even if the reputational stigma is largely documented in sociology, it could be interesting to consider the case where the larger the population who unduly collect benefits, the lower the takeup cost by deserving recipients, i.e.

$$\sigma'\left(\pi_a^{NW}\right) < 0$$

and then, the larger the proportion of the deserving population who takes up. The takeup by undeserving people plays like a snowball effect on the takeup by the deserving.

Rather than explaining the snowball effect with a society where cheaters and old foxes are admired, an alternative empirical explanation can prevail. in the vein of recent empirical studies that study endogenous social interactions and peer effects (a.o. Borjas and Hilton, 1996; Bertrand *et al.*, 2000; Aizer and Currie, 2004), it can become less embarrassing to live on transfers when more individuals do likewise (Lindbeck *et al.*, 1999). However, this effect is probably much more difficult to justify with disability benefits than with unemployment or welfare benefits for instance. Disability benefits do not seem to convey the same embarrassment of living on transfers as unemployment benefits or welfare benefits because a social norm is that disabled people deserve benefits. Unemployment and welfare benefits however have less legitimacy in societies where people are convinced that effort is what principally accounts for how people do in life, and that those who are poor simply have not tried hard enough (Rainwater, 1974; Alesina and Angeletos, 2005).

The phenomenon that disabled recipients are viewed with some suspicion and are vulnerable to the accusations of laziness has largely been documented by psychologists and sociologists. To the best of our knowledge, it has been largely neglected in economics and definitely deserves more investigation. This motivates the focus of the rest of the paper on the reputational stigma à la Besley and Coate (1992). However, the robustness of our results to a takeup cost due to snowball can be checked. To ease this exercise, the necessary conditions of the optimal tax and monitoring policy will be written with the general form $\sigma'\left(\pi_a^{NW}\right)$.

The monitoring technology

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 determining individual eligibility has been called ‘tagging’ by Akerlof (1978). In Akerlof (1978), tagging allows to perfectly identify a given subset of disabled people. In this paper, it is assumed that the accuracy of tagging is limited by a non-takeup phenomenon. Even if disabled people are aware of their eligibility, part of them might not claim disability benefits depending on the level of benefit and the associated stigma or takeup cost. Moreover, it is assumed that disability agencies only imperfectly 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 amount of 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 analyses the choice of monitoring expenditures (M), which 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 $M(1) = 0$.[8]

3 Full information

As a benchmark, a social planner's solution where there is full observability of each individual's productivity and kind of labor disutility is considered. Under full information, the government can use the individual information on δ and w to redistribute. The disability agencies have no role to play, there is no monitoring and no type II error. Therefore, there is no stigma effect: $\sigma(\pi_a^{NW}) = 0$. The problem for the government is to determine two consumption functions $\chi(\delta_d, w_L)$ and $\chi(\delta_a, w_H)$, i.e. a continuum of consumption bundles conditional on each productivity. The government has also to assign people of both types of skill to work or inactivity, depending on their δ_k ($k = d, a$). Let $\mathcal{D}$ denote the set of the measurable subsets of $[0, +\infty)$. $\forall\delta_d \in \mathcal{D}$ we have $\ell(\delta_d) : \mathcal{D} \to \{0, 1\}$ such that $\ell(\delta_d) = 1$ if all disabled with δ_d in $\mathcal{D}$ are employed and $\ell(\delta_d) = 0$ if all disabled with δ_d in $\mathcal{D}$ are inactive. $\forall\delta_a \in \mathcal{D}$ we have $\ell(\delta_a) : \mathcal{D} \to \{0, 1\}$ such that $\ell(\delta_a) = 1$ if all able with δ_a in $\mathcal{D}$ are employed and $\ell(\delta_a) = 0$ if all able with δ_a in $\mathcal{D}$ are inactive. Since the variable δ_k ($k = d, a$) is continuously distributed, we need to work with functions defined over measurable subsets of the domain. As a consequence $\int_0^\infty \ell(\delta_d)\, dF(\delta_d)$, for instance, is the number of disabled that are employed and do not take up disability benefits. Therefore, the problem for the government can be rewritten as the choice of consumption functions $x_j(\delta_k, w_i)$ with intensity of labor disutility δ_k ($k = d, a$), skills w_i ($i = L, H$) and where $j = l, h, b$ denotes the activity respectively in unskilled jobs, in skilled jobs and when non-participating in the labor force. More precisely, there are four consumption functions $x_\ell(\delta_d, w_L)$, $x_h(\delta_a, w_H)$, $x_b(\delta_d, w_L)$ and $x_b(\delta_a, w_H)$.[9]

[8] In summary, disability agencies do not observe neither δ_d nor δ_a. They perfectly observe w_L hence the disability status of claimants (i.e. there is no type I error). However, they imperfectly observe w_H such that type II errors prevail.

[9] In full information, since efficiency matters, it will never be optimal that able people work in unskilled jobs. By putting these people in skilled jobs instead of unskilled jobs, they produce more which can be used to increase someone's consumption and hence his utility. Consequently, the consumption function $x_\ell(\delta_a, w_H)$ can be neglected.

The government budget constraint can then be formulated as follows:

$$N_d \left[\int_0^\infty \left[\ell\left(\delta_d\right)\left(w_L - x_l(\delta_d, w_L)\right) - \left(1 - \ell\left(\delta_d\right)\right) x_b(\delta_d, w_L) \right] dF(\delta_d) \right]$$
$$+N_a \left[\int_0^\infty \left[\ell\left(\delta_a\right)\left(w_H - x_h(\delta_a, w_H)\right) - \left(1 - \ell\left(\delta_a\right)\right) x_b(\delta_a, w_H) \right] dG(\delta_a) \right] = -R$$

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

The normative criterion is a sum (weighted by the share in the population) of utility functions corrected for features individuals are responsible for. Implicit to 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. We then use a paternalistic view for the valuation of labor disutility by the normative criterion as in Bossert and Van de Gaer (1999) and Schokkaert *et al.* (2004). The reference distaste for work (i.e. the weight attached by the government to the distaste for work δ_a of any individual) is equal to zero. The approach is clearly non-Paretian and close to that used in behavioral economics when the social planner does not use, in its objective function, individual preferences but its own preferences (O' Donoghue and Rabin, 2003, Kanbur *et al.*, 2006). The normative criterion is

$$N_d \left[\int_0^\infty \left[\ell\left(\delta_d\right)\left(v\left(x_l(\delta_d, w_L)\right) - \delta_d\right) + \left(1 - \ell\left(\delta_d\right)\right) v\left(x_b(\delta_d, w_L)\right) \right] dF(\delta_d) \right]$$
$$+N_a \left[\int_0^\infty \left[\ell\left(\delta_a\right) v\left(x_h(\delta_a, w_H)\right) + \left(1 - \ell\left(\delta_a\right)\right) v\left(x_b(\delta_a, w_H)\right) \right] dG(\delta_\alpha) \right]$$

where the δ_a distastes for work do not appear into the normative criterion.

Properties of the full-information optimum *Under full information, all the agents receive the same level of consumption ($\overline{x}$), a Negative Income Tax is then optimal. All the able people work while only disabled agents with $\delta_d \leq v'(\overline{x})w_L$ do work.*

A formal proof is given in the Appendix and the intuition for this is as follows. Suppose all the able individuals are working. The social benefit of having the able individuals with the highest δ_a to 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 the disabled people. Suppose all the disabled individuals are working. The social benefit of having the disabled people with the highest δ_d to stop working is $\delta_d \in [0, \infty)$ and the social cost is $w_L(> 0)$ which is constant. Therefore, the choice of set of working disabled amounts to choosing a threshold value $\widehat{\delta_a}$ such that those with $\delta_a > \widehat{\delta_a}$ do not work and those with $\delta_a \leq \widehat{\delta_a}$ do work. $\widehat{\delta_a}$ is such that the net loss of utility when the marginal disabled individuals are shifted from the disability assistance to the unskilled 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 for all individuals with additively separable utility functions. Therefore, the transfer (or tax) towards the disabled workers, $\overline{x} - w_L$, is lower than the transfer to the inactive disabled, $\overline{x}$. A Negative Income Tax (NIT) is then optimal.

4 Asymmetric information

4.1 Results and derivation

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_b, x_l, x_h (doing so, it also assigns people to work or inactivity)[10] and the optimal level of type II errors $\mu \in (0, 1]$.

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

Since the objective function is increasing in individual's consumption, it will never be optimal that able people work in unskilled jobs. By putting these people in skilled jobs instead of unskilled jobs, they produce more which can be used to increase someone's consumption and hence his

[10] In the literature on optimal redistributive taxation initiated by Mirrlees (1971), non-employment, if any, is synonymous with non-participation. 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, disabled people face a real (physical or mental) pain at work they are not responsible for hence they are eligible for disability benefits (x_b).

utility. Consequently, to induce able people to work in skilled jobs is always optimal hence:

$$x_h \geq x_l$$

since the individual aversion to work δ_a is the same in both jobs. A formal proof is given in the Appendix. Therefore, no able individuals mimic disabled workers at the optimum. 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.[11,12] Able agents choose either $v(x_h)-\delta_a$ or, with a probability μ, $v(x_b)$ and with a probability $1-\mu$, $v(x_h)-\delta_a$. The ICC on able agents states

$$\begin{aligned} & v(x_h)-\widetilde{\delta}_a=\mu v(x_b)+(1-\mu)\left[v(x_h)-\widetilde{\delta}_a\right] \\ & \Leftrightarrow \widetilde{\delta}_a=v(x_h)-v(x_b) \end{aligned} \tag{1}$$

Equation (1) emphasizes that the decision of able people to apply or not for disability benefits does not depend on the probability μ. The functions $\ell(\delta_a)$ then has the following shape: $\ell(\delta_a)=1$ for all $\delta_a \leq \widetilde{\delta}_a$ and $\ell(\delta_a)=1$ ($\ell(\delta_a)=0$) with a probability $1-\mu$ (μ) for all $\delta_a > \widetilde{\delta}_a$.

Disabled agents choose between $v(x_l)-\delta_d$ and $v(x_b)-\sigma\left(\pi_a^{NW}\left(\widetilde{\delta}_a,\mu\right)\right)$. The function $\ell(\delta_d)$ then has the following shape: $\ell(\delta_d)=1$ for all $\delta_d \leq \widetilde{\delta}_d$ and zero otherwise. The ICC on disabled states:

$$\widetilde{\delta}_d=v(x_l)-v(x_b)-\sigma\left(\pi_a^{NW}\left(\widetilde{\delta}_a,\mu\right)\right) \tag{2}$$

[11] Having all detected able claimants who go back to work can be assumed or it can be shown that this is the result of the optimal tax program where able agents who claim disability benefits and are detected choose either to be inactive and to receive a (welfare) benefit T or to go back to work (then, they consume x_h). Then, $T=0$ is optimal and all caught able claimants go back to work.

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

$$v(x_h)-\widetilde{\delta}_a=\mu v(x_b)+(1-\mu)\left[Max\left\{v(x_h)-\widetilde{\delta}_a, v(T)\right\}\right]$$

Since $-\delta_a$ is not valued by the welfare function and because efficiency matters, $\forall\delta_a \in [0,\infty)$, it is optimal that $v(x_h)-\delta_a \geq v(T)$. 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 (1).

[12] Boadway and Cuff (1999) distinguish between voluntarily and involuntarily unemployed. 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 voluntary inactive able people (see footnote 11) implies that they go back to work.

with $\pi_a^{NW}\left(\widetilde{\delta}_a,\mu\right) = N_a\mu\left(1 - G\left(\widetilde{\delta}_a\right)\right)$, the share of population which is able and unduly collect disability benefits.

Recall that the stigma function satisfies $\sigma'(\pi_a^{NW}) > 0$. Moreover, $\sigma \to 0$ if either $\widetilde{\delta}_a \to 0$ or $\mu \to 0$. For instance, the stigma function can be a linear function of π_a^{NW} as

$$\sigma\left(\pi_a^{NW}\left(\widetilde{\delta}_a,\mu\right)\right) = s\pi_a^{NW}\left(\widetilde{\delta}_a,\mu\right) \quad \text{with } s > 0 \tag{3}$$

where s is the marginal disutility of stigma, $\sigma'(\pi_a^{NW})$.

From (1) and the definition of π_a^{NW}:

$$\frac{\partial\sigma}{\partial x_b} = -\frac{\partial\sigma}{\partial\pi_a^{NW}}\frac{\partial\pi_a^{NW}}{\partial\widetilde{\delta}_a}v'(x_b) = \sigma'(\pi_a^{NW})N_a\mu g\left(\widetilde{\delta}_a\right)v'(x_b) > 0 \tag{4}$$

Combining these results with (2), and totally differentiating gives:

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

If one wanted to guarantee that $\partial\widetilde{\delta}_d/\partial x_b < 0$[13], one would need to assume that, at the optimum:

$$\frac{\partial\sigma}{\partial\pi_a^{NW}} < \frac{1}{N_a\mu g\left(\widetilde{\delta}_a\right)} \tag{5}$$

i.e. an upper bound on the marginal disutility of stigma.

The reader more interested in the snowball takeup cost can alternatively consider $\sigma'(\pi_a^{NW}) < 0$ and assume that $\sigma(\pi_a^{NW})$ reaches its minimum value if either $\widetilde{\delta}_a \to 0$ or $\mu \to 1$.

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

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 stigma) are finite, from (1) and ((2)), $\widetilde{\delta}_a$ and $\widetilde{\delta}_d$ cannot tend to ∞.

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

(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 $R' \stackrel{\text{def}}{\equiv} Max\{0, R\}$. This allocation will not be optimal if those with the least handicap, δ_d (the least disutility of work, δ_a) were to choose to work for the additional consumption equal to their marginal product. It will be the case because: $v(R' + w_L) > v(R')$ $(v(R' + w_H) > v(R'))$. 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. ■

From (1) and $\widetilde{\delta}_a > 0$, we know:

$$x_h > x_b$$

The government budget constraint becomes

$$\pi_d^W (w_L - x_l) - \left(\pi_d^{NW} + \pi_a^{NW}\right) x_b + \pi_a^W (w_H - x_h) - \left(\pi_d^{NW} + \frac{\pi_a^{NW}}{\mu}\right) M(\mu) = -R \qquad (6)$$

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

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

Table 1: Distribution of individuals in the population

There is an interesting approach in the optimal income tax literature where the optimal tax schedule is rewritten as expressions of the labor supply elasticities (Saez (2001), Saez (2002)). This paper will also state the first-order conditions involving the elasticities of participation. This will allow a straightforward comparison, emphasizing how the standard formulas are affected when monitoring costs and stigma are considered. Let us then define the elasticity of participation of the disabled workers with respect to x_l as

$$\eta\left(x_l, \widetilde{\delta}_d\right) \overset{\text{def}}{\equiv} \frac{x_l}{\pi_d^W} \frac{\partial \pi_d^W}{\partial x_l} \tag{7}$$

where $\partial \pi_d^W / \partial x_l = N_d f\left(\widetilde{\delta}_d\right) v'(x_l)$ from (2). And the elasticity of participation of the able workers with respect to x_h as

$$\eta\left(x_h, \widetilde{\delta}_a\right) \overset{\text{def}}{\equiv} \frac{x_h}{\pi_a^W} \frac{\partial \pi_a^W}{\partial x_h} \tag{8}$$

where $\partial \pi_a^W / \partial x_h = N_a \mu g\left(\widetilde{\delta}_a\right) v'(x_h)$ from (1). These elasticities measure the percentage number of disabled (able) workers in unskilled (skilled) job 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:

$$g_l \overset{\text{def}}{\equiv} \frac{v'(x_l)}{\lambda} \tag{9}$$

$$g_h \overset{\text{def}}{\equiv} \frac{v'(x_h)}{\lambda} \tag{10}$$

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 non-welfarist objective function. The Lagrangian states as

$$\begin{aligned}
\pounds = {} & N_d \left[\int_0^{\widetilde{\delta}_d} \left(v\left(x_l\right) - \delta_d\right) dF\left(\delta_d\right) + \left(1 - F\left(\widetilde{\delta}_d\right)\right)\left(v\left(x_b\right) - \sigma\left(\widetilde{\delta}_a, \mu\right)\right) \right] + \pi_a^W v(x_h) \\
& + \pi_a^{NW} v(x_b) + \lambda \left[\pi_d^W \left(w_L - x_l\right) - \left(\pi_d^{NW} + \pi_a^{NW}\right) x_b + \pi_a^W \left(w_H - x_h\right) \right. \\
& \left. - \left(\pi_d^{NW} + \pi_a^{NW}/\mu\right) M(\mu) + R \right]
\end{aligned}$$

where $\widetilde{\delta}_a$ ($\widetilde{\delta}_d$) is given by (1) ((2)).

Proposition 1 *Under asymmetric information, the optimal levels of consumption and type II errors have to satisfy the budget constraint (6) and the following four equations:*

$$\frac{x_l - w_L - x_b - M(\mu)}{x_l} = \frac{1}{\eta\left(x_l, \widetilde{\delta}_d\right)}(g_l - 1) \tag{11}$$

$$\frac{x_h - w_H - x_b - \frac{M(\mu)}{\mu}}{x_h} = \frac{1}{\eta\left(x_h, \widetilde{\delta}_a\right)}\left[(g_h - 1) + \frac{S(x_h, x_l, x_b, \mu)}{\pi_a^W}\right] + \frac{\widetilde{\delta}_a}{\lambda x_h} \tag{12}$$

where $S(x_h, x_l, x_b, \mu) = (w_L - x_l + x_b + M(\mu))\frac{\partial \pi_d^W}{\partial x_h} - \frac{\pi_d^{NW}}{\lambda}\frac{\partial \sigma}{\partial x_h}$ *states for the indirect behavioral reponses and indirect welfare change which arise from the endogenous stigma,*

$$\frac{1}{\lambda} = \frac{\pi_d^W}{v'(x_l)} + \frac{\pi_d^{NW} + \pi_a^{NW}}{v'(x_b)} + \frac{\pi_a^W}{v'(x_h)} \tag{13}$$

and

$$(1-\mu)\frac{\partial \pounds}{\partial \mu} = 0 \text{ and } \frac{\partial \pounds}{\partial \mu} \geq 0 \tag{14}$$

where $\partial \pounds / \partial \mu$ *is given by (18) below.*

The proof is given below as well as a simple heuristic interpretation in the spirit of Saez (2002) that illuminates the economics behind these necessary conditions. Moreover, it is straightforward to see the following characteristics of the optimum.

Substituting $M(\mu) = 0$ in (11), it yields the standard optimal tax schedule with extensive responses (Diamond, 1980; Saez, 2002). The financial incentive to enter the labor force, i.e. the difference between the transfer (or tax) to disabled workers $(x_l - w_L)$ and the transfer to the non-employed people (x_b), 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 incentives to enter the labor force increases with the marginal social welfare weight of (disabled) workers (g_l). When monitoring costs are included (i.e. $M(\mu) > 0$), $\eta\left(x_l, \widetilde{\delta}_d\right)$ and g_l determine the difference between the transfer (or tax) towards disabled workers $(x_l - w_L)$ and the total cost of a transfer towards disabled recipients $(x_b + M(\mu))$.[14] Proposition 3 will discuss the differences between our formula and the one of Saez

[14] From (11), an optimal replacement rate formula can also be derived as done in Kroft (2008). It implies to follow 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 $\left[(x_l - x_b)/\pi_d^W\right]\left(\partial \pi_d^W / \partial x_l\right)$. Then it can easily be shown that (11) becomes an optimal

(2002) in deeper details.

Compared to (11), the optimal formula (12) has two key changes due to the stigma externality and the non-welfarist criterion. $S(x_h, x_l, x_b, \mu)$ includes all the effects due to the stigma externality. The term $\widetilde{\delta}_a/(\lambda x_h)$ is due to the fact that the marginal disutility $\widetilde{\delta}_a$ is not included into the non-welfarist criterion. This term appears since the effect of an infinitesimal change in the consumption bundle of able workers induces the marginal able agents to start working, which has a first order effect on the non-welfarist evaluation of their well-being equal to $v(x_h) - v(x_b)$, which by virtue of (1) reduces to $\widetilde{\delta}_a$. The denominator in (12) 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).[15] It corrects the labor supply of able people to (better) correspond to social preferences.

Equation (13) is similar to Diamond and Sheshinski (1995)'s equation (6), p.6 and, without income effects on labor supply to Saez (2002)'s equation (2), p.1047. It gives an important redistributive principle of the optimal redistributive programs, which prevails independently of stigma effects. At the optimum, the inverse of the marginal cost of public funds is equal to the average of the inverses of the marginal utilities of consumption of each individual in each group, the weights being the shares in the population.[16] Multiplying both sides of (13) by λ, this principle can be rephrased as: the average (using population proportions) value of the inverses of the marginal welfare weights is one.

Proof and heuristic interpretation of Proposition 1

First-order condition with respect to x_l, (11)

From the Lagrangian, the first-order condition with respect to x_l gives

$$\pi_d^W \left(\frac{v'(x_l)}{\lambda} - 1 \right) = - \left(w_L - x_l + x_b + M(\mu) \right) \frac{\partial \pi_d^W}{\partial x_l} \tag{15}$$

Using (7) and (9), this necessary condition can be rewritten as (11).

replacement rate formula as a function of the elasticity of participation.

[15] $\widetilde{\delta}_a > 0$ (Lemma 1) hence $\widetilde{\delta}_a$ is always larger than the reference distaste for work.

[16] It can easily been checked that at the optimum, the inverse of the marginal cost of the public funds is, more generally, equal to the average of the inverse (individual) marginal utilities of consumption, divided by the social marginal utility of (individual) utilities. The latter equals one for the non-welfarist planner and the utilitarian one (that we will study in Section 5).

A simple heuristic interpretation in the spirit of Saez (2002) follows. Consider a small increase of the consumption x_l (i.e. a small reduction of the income tax in unskilled 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 $v'(x_l)/\lambda$ $(\equiv g_l)$.[17] Thus the mechanical welfare gain (expressed in terms of the value of public funds) due to 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 (or labor supply) 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 $w_L - x_l + x_b + M(\mu)$. That is the tax paid by a disabled worker $(w_L - x_l)$ plus the benefit that was paid to her as a disabled recipient (x_b) as well as the associated cost of monitoring $(M(\mu))$. The total behavioral gain is equal to $(w_L - x_l + x_b + M(\mu))\left(\partial\pi_d^W/\partial x_l\right) dx_l$.

At the optimum, the sum of the mechanical and behavioral effects equal zero and gives (15).

First-order condition with respect to x_h, (12)

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.

[17] Intuitively, the non-welfarist government is indifferent between g_l more euro of public funds and one more euro consumed by the disabled workers.

Behavioral effect

There are two effects (a direct one and an indirect one) on government revenue due to 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 $w_H - x_h + x_b$, i.e. the tax paid by each new able worker $(w_H - x_h)$ and the benefit that stops to be paid to her. There is also a gain in monitoring expenditures $(M(\mu))$ for the $\left(\partial N_a G\left(\widetilde{\delta}_a\right) / \partial x_h\right)$ able people who stop applying for disability benefits. The gain of government expenditures is then $\left(w_H - x_h + x_b + M(\mu)/\mu\right)\left(\partial \pi_a^W / \partial x_h\right) dx_h$. 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 into the welfare function. Valued in terms of public funds, this welfare gain is $\left(\widetilde{\delta}_a / \lambda\right)\left(\partial \pi_a^W / \partial x_h\right) dx_h$.

(2) The previous direct behavioral effect implies an externality effect through the change in the stigma disutility: the change dx_h indirectly induces $\partial \pi_d^W / \partial x_h$ pivotal disabled recipients to change their occupational choice due to stigma effects. Using the envelope theorem and (1) and (2), $\partial \pi_d^W / \partial x_h > 0$ (< 0) if $\partial \sigma / \partial \widetilde{\delta}_a > 0$ (< 0). Each disabled recipient entering the labor force induces a revenue gain of $w_L - x_l + x_b + M(\mu)$ for the government. Hence the total gain is $\left(w_L - x_l + x_b + M(\mu)\right)\left(\partial \pi_d^W / \partial x_h\right) dx_h$. The change dx_h also affects welfare through a change in the stigma intensity of the π_d^{NW} disabled recipients. This change in terms of public funds is valued $-\pi_d^{NW}\left(\partial \sigma / \partial x_h / \lambda\right) dx_h$ by the government. Then, all the indirect effects implied by the stigma externality when $dx_h > 0$ are denoted by $S\left(x_h, x_l, x_b, \mu\right)$ defined in Proposition 1.

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

$$\begin{aligned} & \pi_a^W\left(\frac{v'(x_h)}{\lambda} - 1\right) - \frac{\pi_d^{NW}}{\lambda}\frac{\partial \sigma}{\partial x_h} + \frac{\widetilde{\delta}_a}{\lambda}\frac{\partial \pi_a^W}{\partial x_h} = \\ & -\left(w_H - x_h + x_b + \frac{M(\mu)}{\mu}\right)\frac{\partial \pi_a^W}{\partial x_h} - \left(w_L - x_l + x_b + M(\mu)\right)\frac{\partial \pi_d^W}{\partial x_h} \end{aligned} \tag{16}$$

Using (8) and (10) the latter equation can be rewritten as (12).

A necessary condition on the marginal cost of public funds λ, (13)

The necessary condition (13) comes from equations (11), (12) and the necessary condition with respect to x_b that can be stated as

$$\left(\pi_a^{NW}+\pi_d^{NW}\right)\left(\frac{v'(x_b)}{\lambda}-1\right)-\frac{\pi_d^{NW}}{\lambda}\frac{\partial\sigma}{\partial x_b}+\frac{\widetilde{\delta}_a}{\lambda}\frac{\partial\pi_a^W}{\partial x_b}= \tag{17}$$
$$=-\left(w_H-x_h+x_b+\frac{M(\mu)}{\mu}\right)\frac{\partial\pi_a^W}{\partial x_b}-\left(w_L-x_l+x_b+M(\mu)\right)\frac{\partial\pi_d^W}{\partial x_b}$$

Dividing (15), (16) and (17) by $v'(x_l)$, $v'(x_h)$, $v'(x_b)$ respectively, and adding these equations gives (13).

The first-order condition with respect to x_b could be substituted to equation (13) to characterize the optimum in the above Proposition. Details about this alternative equation can be found in Appendix C.

First-order condition with respect to μ, (14)

$\frac{\partial\pounds}{\partial\mu}\geq 0$ from (14) can be rewritten as

$$\frac{\pi_d^{NW}}{\lambda}\frac{\partial\sigma}{\partial\mu}+\frac{\pi_a^{NW}}{\mu}\frac{\widetilde{\delta}_a}{\lambda}\leq \tag{18}$$
$$\frac{\partial\pi_d^W}{\partial\mu}\left(w_L-x_l+x_b+M(\mu)\right)-\frac{\pi_a^{NW}}{\mu}(w_H-x_h+x_b)-\left(\pi_d^{NW}+\frac{\pi_a^{NW}}{\mu}\right)\frac{\partial M(\mu)}{\partial\mu}$$

$d\mu>0$ implies the following mechanical and behavioral effects on government revenue and welfare.

Mechanical effect

There is a mechanical gain in monitoring expenditures equal to

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

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

Behavioral effect

There are two effects on government revenue due to behavioral responses.

(1) There is a loss in tax revenue equal to $-(w_H-x_h+x_b)N_a\left(1-G\left(\widetilde{\delta}_a\right)\right)d\mu$ with $N_a\left(1-G\left(\widetilde{\delta}_a\right)\right)\equiv\pi_a^{NW}/\mu$, due to additional able people receiving disability benefits rather than working. This in-

duces a welfare loss due to the reduction of workers whose disutility $\widetilde{\delta}_a$ was not valued into the non-welfarist criterion hence who imply a welfare gain. This welfare loss expressed in public funds is $-\left(\widetilde{\delta}_a/\lambda\right)\left(\pi_a^{NW}/\mu\right)d\mu$.

(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 $w_L - x_l + x_b$ as well as a gain in monitoring cost of $M(\mu)$. In total, this indirect behavioral gain is $(w_L - x_l + x_b + M(\mu))\left(\partial\pi_d^W/\partial\mu\right)d\mu$. The change $d\mu$ also affects welfare through a change in the stigma intensity of the π_d^{NW} disabled recipients. This change in terms of public funds is valued $-\pi_d^{NW}\left(\partial\sigma/\partial\mu/\lambda\right)d\mu$ by the government.

In case of an interior solution $(\mu < 1)$, the optimal amount of monitoring is such the impact of a small increase of the probability of type II errors $d\mu > 0$ cancels out the mechanical and behavioral effects such that (18) takes the equal sign.

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 improves efficiency and also reduces stigmatization (with $\partial\sigma/\partial\mu > 0$). However, when $|\partial M/\partial\mu|$ is very high, the right-hand side of (18) can become strictly higher than the left-hand side and therefore, from (14), $\mu = 1$ prevails at the optimum. No monitoring is optimal, whoever applies for disability benefits is granted them. From simulations calibrated using US data, Appendix D gives the threshold level of per capita cost of monitoring beyond which monitoring becomes suboptimal (i.e. $\mu = 1$).

Proposition 2 *Consumption of workers in low-productivity jobs is strictly larger than the disability benefit, $x_l > x_b$. It cannot be ruled out that workers in unskilled jobs pay taxes.*

Proof. From $\widetilde{\delta}_d > 0$ and $\widetilde{\delta}_a > 0$ (see Lemma 1) and (13) two rankings can prevail at the optimum: either

$$\frac{1}{v'(x_h)} \geqslant \frac{1}{v'(x_l)} > \frac{1}{v'(x_b)} \Leftrightarrow x_h \geqslant x_l > x_b \qquad \text{or} \tag{19}$$

$$\frac{1}{v'(x_h)} > \frac{1}{v'(x_b)} \geqslant \frac{1}{v'(x_l)} \Leftrightarrow x_h > x_b \geqslant x_l \tag{20}$$

In both cases, (19) and (20), $v'(x_h) < \lambda$. Moreover, if (19) prevails, we have: $v'(x_b) > \lambda$ and if (20) is correct then: $v'(x_l) > \lambda$. However $v'(x_l) > \lambda$ implies that the left-hand side of (11) is positive. This requires that $w_L - x_l + x_b + M(\mu) < 0 \Leftrightarrow x_l - x_b > w_L + M(\mu) > 0$, which contradicts $x_b \geqslant x_l$.

The sign of $w_L - x_l$ is ambiguous since the budget constraint (6) can be rewritten as:

$$w_L - x_l = \left(\pi_d^{NW} + \pi_a^{NW}\right) w_L + \left(\pi_d^{NW} + \pi_a^{NW}\right)(x_l - x_b) + \pi_a^W (w_L - w_H)$$
$$+\pi_a^W (x_h - x_l) + \left(\pi_d^{NW} + \frac{\pi_a^{NW}}{\mu}\right) M(\mu) - R$$

where in the right-hand side, two terms are negative: $\pi_a^W (w_L - w_H)$ and $\left(\pi_d^{NW} + \pi_a^{NW}\right)(x_l - x_b)$ and the other terms are positive except $-R$ which can take both signs. Hence, the gross income of disabled workers can be increased (in case of a transfer: $w_L - x_l < 0$) or decreased (in case of a tax: $w_L - x_l > 0$) by the optimal tax-transfer system. ■

The result $x_l > x_b$ can seem counter-intuitive at first sight for two reasons. First, those who get the lowest consumption are also those who suffer from stigma. Second, it is well known from the tagging literature that tagged disabled people get a larger consumption than untagged ones, i.e. $x_l > x_b$ (e.g., Parsons, 1996; Salanié, 2002). In this literature, tagging allows to improve equity since some of the needy get higher transfers. At the same time, tagging also improves efficiency by circumventing the incentive constraints that normally limit the extent of redistribution. In our model, tagging also circumvents the incentive constraints but giving financial incentives to work up to the point that x_l becomes strictly larger than x_b improves efficiency further. In standard tagging models, since disabled are by assumption always inactive, no efficiency effect will push the consumption of untagged disabled above the one of tagged disabled.

The next question to address is: which individuals will the government want to redistribute more? Since the early work of Diamond (1980), it is known that in the extensive model, under asymmetric information, it may be worthwhile to implement a NIT or to subsidize work using the Earned Income Tax Credit (EITC). The latter consists in providing a transfer larger to unskilled workers than to inactive people.

With labor supply modeled along the extensive margin, Saez (2002) shows that comparing the value of the marginal social welfare of workers with low productivity (i.e. of disabled workers in our context) and the marginal cost of public funds allows to conclude about the optimality of an EITC versus a NIT. In particular, without income effects on labor supply, Saez (2002) shows that an EITC prevails when the marginal social welfare of workers with low productivity is larger than the marginal cost of public funds (i.e. $v'(x_l)/\lambda \equiv g_l \geq 1$). (Saez, 2002, pp.1048-50). The following proposition emphasizes that this result is robust to the introduction of income effects and to the introduction of costly monitoring. Saez (2002) also derives that a necessary and sufficient condition for having a NIT at the optimum is $g_l < 1$ (Saez (2002), Proposition 1). The following proposition points out the robustness of this result to the introduction of costless monitoring. However, it is shown that $g_l < 1$ is not sufficient for advocating a NIT as soon as costly monitoring is considered. It can then be argued that costly monitoring plays in favor of an EITC.

Proposition 3 *When costless monitoring is assumed, an EITC (a NIT) is optimal when $g_l \geq 1$ ($g_l < 1$), in the vein of 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 (11), $g_l \geq 1 \Leftrightarrow x_l - w_L \geq x_b + M(\mu)$. Disabled workers receive a transfer $(x_l - w_L)$ that is larger than the transfer towards disabled recipients (x_b), i.e. an EITC is optimal. This result prevails with $M(\mu) \geq 0$.

From (11), $g_l < 1 \Leftrightarrow x_l - w_L < x_b + M(\mu)$. When $M(\mu) = 0 : x_b > x_l - w_L$, i.e. a NIT is optimal. When $M(\mu) > 0$ (i.e. $\mu < 1$) the previous inequality does not imply $x_b > x_l - w_L$ anymore. ■

The question addressed in the next proposition is: Should perfect monitoring be used when its implementation is costless? Proposition 4 will emphasize that even if monitoring is costless and could be perfect, some type II errors do prevail at the optimum. In other words, when perfect monitoring can be realized without any governmental spending, it is however not optimal to use it.

Proposition 4 *With costless monitoring, perfect monitoring (i.e. $\mu = 0$) is not optimal (with or without stigma).*

Proof. By contradiction, assume $\mu = 0$. We then have $\sigma(.) = 0$ and $\pi_a^W = N_a$. The first-order condition with respect to x_h, (16), becomes:

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

Therefore $v'(x_h) = \lambda$ when $\mu = 0$. This implies that (13) (which is still valid with costless monitoring) becomes:[18]

$$\frac{1-N_a}{v'(x_h)} = \frac{\pi_d^W}{v'(x_l)} + \frac{\pi_d^{NW}}{v'(x_b)} \tag{21}$$

Since a weighted average with positive weights is bounded by its least and greatest elements, and since $x_l > x_b$ (from (2)): $\frac{1}{v'(x_l)} \geq \frac{1}{v'(x_h)} \geq \frac{1}{v'(x_b)}$ 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 caught able would work in unskilled jobs, which is inefficient) hence $x_l = x_h$. Substitute the latter into (21) gives $v'(x_l) = v'(x_b)$ (since $1 - N_a = \pi_d^W + \pi_d^{NW}$). This contradicts $x_l > x_b$. Therefore $\mu > 0$. ■

Intuitively, costless and perfect monitoring means that the government can identify able and disabled perfectly (it perfectly observes their productivity levels) at zero cost if they apply for disability benefits. All able people would then be indifferent between applying and not applying since they would never obtain the disability benefits. All able people would work and stigma would then be nil. However, a perfect monitoring is more costly for the government than allowing some type II errors: No type II errors would prevent to give incentives to work to a subset of the disabled as well as it would imply that all the able workers mimic disabled workers.

5 Utilitarian criterion

We now consider a utilitarian social welfare function (SWF), i.e. a sum of utilities weighted by the share in the population. The only differences with the non-welfarist criterion is (i) the terms $v\left(x_h(\delta_a, w_H)\right)$ which are substituted by $v\left(x_h(\delta_a, w_H)\right) - \delta_a$ in the Lagrangian function, under full information, (ii) the terms $v\left(x_h\right)$ which are substituted by $v(x_h) - \delta_a$ in the Lagrangian function, under asymmetric information.

[18]**Proof.** When $\mu = 0$, (15) becomes

$$\pi_d^W\left(\frac{v'(x_l)}{\lambda} - 1\right) = -\left(w_L - x_l + x_b\right)\frac{\partial \pi_d^W}{\partial x_l} = -\left(w_L - x_l + x_b\right) N_d f\left(\widetilde{\delta}_d\right) v'\left(x_l\right)$$

and (17) becomes:

$$\pi_d^{NW}\left(\frac{v'(x_b)}{\lambda} - 1\right) = -\left(w_L - x_l + x_b\right)\frac{\partial \pi_d^W}{\partial \widetilde{\delta}_d}\frac{\partial \widetilde{\delta}_d}{\partial x_b} = \left(w_L - x_l + x_b\right) N_d f\left(\widetilde{\delta}_d\right) v'\left(x_b\right)$$

Dividing these two equations by $v'(x_l)$ and $v'(x_b)$ respectively, and adding them gives

$$\frac{\pi_d^W + \pi_d^{NW}}{\lambda} = \frac{\pi_d^W}{v'(x_l)} + \frac{\pi_d^{NW}}{v'(x_b)}$$

Substituting $\lambda = v'\left(x_h\right)$ into the latter gives (21).

It can be seen as contradictory to use 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 SWF, on the other hand. However, this is the objective function generally used in the tagging literature.

Full information

Under full information, it is optimal to have able people who do not work and receive disability benefits, for a utilitarian social planner. This result contrasts with the full information optimum under a non-welfarist criterion.

Proof. It is easy to see that the same first order conditions as with the non-welfarist objective are obtained, and so the solution is given by (24). From the budget constraint, we then have (25). Substituting (25) in the value of the objective function, gives the value of utilitarian social 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 though the terms on the last line that the shape of the $\ell(\delta_d)$ and $\ell(\delta_a)$ functions matter for a utilitarian planner. 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 ∞. For a utilitarian social planner, it is always optimal to have those in work with the lowest $\delta_k (k = d, a)$. Therefore the functions $\delta_L(\alpha)$ and $\delta_H(\alpha)$ 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. The critical values are

$$\widehat{\delta_k} = v'(\overline{x}) w_j > 0 \qquad (k, j) = (d, L), (a, H)$$

Differing from the optimum under a non-welfarist 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.

Note that from $w_H > w_L$, $\widehat{\delta_a} > \widehat{\delta_d} = v'(\overline{x}) w_L$ as under the non-welfarist criterion. ■

Asymmetric information

Proposition 5 *Under asymmetric information, qualitative properties highlighted with the non-welfarist criterion (i.e. Propositions 2-4) are also valid under the utilitarian criterion.*

Proof. The Lagrangian states as

$$
\begin{aligned}
\pounds = {} & N_d \left[\int_0^{\widetilde{\delta}_d} \left(v\left(x_l\right) - \delta_d\right) dF\left(\delta_d\right) + \left(1 - F\left(\widetilde{\delta}_d\right)\right) \left(v\left(x_b\right) - \sigma\left(\widetilde{\delta}_a, \mu\right)\right) \right] \\
& + N_a \left[\left(G\left(\widetilde{\delta}_a\right) + (1-\mu)\left(1 - G\left(\widetilde{\delta}_a\right)\right)\right) v\left(x_h\right) - \int_0^{\widetilde{\delta}_a} \delta_a dG(\delta_a) \right. \\
& \left. - (1-\mu) \int_{\widetilde{\delta}_a}^{\infty} \delta_a dG(\delta_a) + \mu \left(1 - G\left(\widetilde{\delta}_a\right)\right) v(x_b) \right] \\
& + \lambda \left\{ \pi_d^W \left(w_L - x_l\right) - \left(\pi_d^{NW} + \pi_a^{NW}\right) x_b + \pi_a^W \left(w_H - x_h\right) - \left(\pi_d^{NW} + \frac{\pi_a^{NW}}{\mu}\right) M(\mu) + R \right\}
\end{aligned}
$$

The first-order conditions are the resource constraint (6), the first-order conditions with respect to x_l (11), with respect to μ (i.e. (14) and (18)), equation (13) and the necessary condition with respect to x_h which can be stated as:

$$
\begin{aligned}
& \pi_a^W \left(\frac{v'(x_h)}{\lambda} - 1 \right) - \frac{\pi_d^{NW}}{\lambda} \frac{\partial \sigma}{\partial x_h} = \\
& - \left(w_H - x_h + x_b + \frac{M(\mu)}{\mu} \right) \frac{\partial \pi_a^W}{\partial x_h} - \left(w_L - x_l + x_b + M(\mu)\right) \frac{\partial \pi_d^W}{\partial x_h}
\end{aligned} \tag{22}
$$

or which, using (8), can be rewritten as:[19]

$$
\frac{x_h - w_H - x_b - \frac{M(\mu)}{\mu}}{x_h} = \frac{1}{\eta\left(x_h, \widetilde{\delta}_a\right)} \left[(g_h - 1) + \frac{S\left(x_h, x_l, x_b, \mu\right)}{\pi_a^W} \right]
$$

Propositions 2, 3 and 4 are still valid since their proofs exclusively depend on (13) which can be shown to be still valid with a utilitarian criterion. The proof is straightforward. Equation (13) is obtained from the first-order conditions with respect to x_l and x_h and from the first-order

[19] There is no more change in welfare (directly) due to the behavioral response of the marginal able workers leaving the labor force, characterized by $\delta_a = \widetilde{\delta}_a$. On the margin these individuals are indifferent between receiving disability benefits and working (see equation (1)). Their well-being weight is now the same in the SWF, whether they are recipients or workers, which was not the case under the non-welfarist criterion.

condition with respect to x_b, i.e.:

$$\left(\pi_a^{NW} + \pi_d^{NW}\right)\left(\frac{v'(x_b)}{\lambda} - 1\right) - \frac{\pi_d^{NW}}{\lambda}\frac{\partial \sigma}{\partial x_b} = \tag{23}$$
$$= -\left(w_H - x_h + x_b + \frac{M(\mu)}{\mu}\right)\frac{\partial \pi_a^W}{\partial x_b} - \left(w_L - x_l + x_b + M(\mu)\right)\frac{\partial \pi_d^W}{\partial x_b}$$

Dividing (15), (22) and (23) by $v'(x_l)$, $v'(x_h)$, $v'(x_b)$ respectively, and adding them implies (13). ■

The qualitative nature of the social optimum under both criteria is identical since they both take a weighted additively separable form. But this does not mean that the optima are quantitatively identical as shown in Section 6.

6 An illustration

Appendix D illustrates our model by calibrating it with US data. It quantitatively characterizes the optimal tax and monitoring policy. Let us emphasize some of these results.

Compared to the utilitarian optimum, the non-inclusion of the disutility terms $-\delta_a$ into the non-welfarist criterion always implies more able workers at the optimum and this drives the following results. Compared to the utilitarian optimum, the non-welfarist optimum is always characterized by (i) a higher welfare level, (ii) a lower stigma level and (iii) a lower probability of type II error.

Simulations highlight situations where no monitoring is optimal. Under a utilitarian criterion, there always exists a level of exogenous resources R beyond which monitoring becomes suboptimal (i.e. $\mu = 1$). Since the disutility terms δ_a reduces the social welfare level, it is optimal that more and more able workers stop working when R increases. When the economy has high exogenous resources, monitoring becomes suboptimal (no more able with $\delta_a > \widetilde{\delta}_a$ work), as illustrated in Figure 1. Contrarily, monitoring is always optimal ($\mu < 1$) under the non-welfarist criterion, whatever R. Intuitively, able people who stop working reduce efficiency without improving equity under that criterion.

When the marginal disutility of stigma s (with $\sigma'\left(\pi_a^{NW}\right) < 0$) increases, the welfare levels under both criteria continuously decrease. Monitoring is used more intensively, and therefore type II errors decrease with s.

7 Conclusion

This paper has assumed an economy where lazy able people may pretend to be disabled and where some disabled people may not takeup disability benefits designed for them. It has been shown that modeling the monitoring technology and the participation decisions, i.e. participation to the labor market and to disability programs, is critical to design the optimal tax schedule. Formulas for the optimal taxation and optimal monitoring accuracy have been provided where the mechanical and behavioral effects are highlighted.

This paper has introduced an endogenous takeup cost in an optimal tax framework. It has emphasized that the qualitative nature of the optimal policy is not affected by this takeup cost. Relaxing the usual (and unrealistic) assumption that disabled people do not work, it has been shown that disabled recipients get a strictly lower consumption than disabled workers.

Conditions under which the optimal transfer program is a Negative Income Tax or an Earned Income Tax Credit have been stated. Since it is novel to consider and to endogenize monitoring, these conditions differ from the usual ones in the optimal income tax literature. In particular, with costly monitoring, a marginal social welfare weight on disabled workers lower than one is not sufficient for advocating a Negative Income Tax. Moreover, this paper has shown that when monitoring is costless, perfect monitoring is not optimal. In other words, some cheating is always optimal. The quantitative sensitivity of the optimal program to a non-welfarist criterion (which does not compensate for distaste for work) versus a utilitarian criterion has been emphasized through simulations.

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Appendix

A Proof of the optimum's properties under full-information

The Lagrangian can be stated as

$$\begin{aligned}
\pounds &= N_d \left[\int_0^\infty \left[\ell\left(\delta_d\right)\left(v\left(x_l(\delta_d, w_L)\right) - \delta_d\right) + \left(1 - \ell\left(\delta_d\right)\right) v\left(x_b(\delta_d, w_L)\right)\right] dF(\delta_d) \right] \\
&+ N_a \left[\int_0^\infty \left[\ell\left(\delta_a\right) v\left(x_h(\delta_a, w_H)\right) + \left(1 - \ell\left(\delta_a\right)\right) v\left(x_b(\delta_a, w_H)\right)\right] dG(\delta_\alpha) \right] \\
&+ \lambda \left\{ N_d \left[\int_0^\infty \left[\ell\left(\delta_d\right)\left(w_L - x_l(\delta_d, w_L)\right) - \left(1 - \ell\left(\delta_d\right)\right) x_b(\delta_d, w_L)\right] dF(\delta_d) \right] \right. \\
&\left. + \, N_a \left[\int_0^\infty \left[\ell\left(\delta_a\right)\left(w_H - x_h(\delta_a, w_H)\right) - \left(1 - \ell\left(\delta_a\right)\right) x_b(\delta_a, w_H)\right] dG(\delta_a) \right] - R \right\}
\end{aligned}$$

where λ is the (non-negative) Lagrangian multiplier associated to the budget constraint. For any pair (δ_d, δ_a), the first-order conditions with respect to the four consumption functions are:

$$\begin{aligned}
&\int_0^\infty \ell\left(\delta_d\right)\left[v'(x_l(\delta_d, w_L)) - \lambda\right] dF(\delta_d) = 0 \\
&\int_0^\infty \left(1 - \ell\left(\delta_d\right)\right)\left[v'(x_b(\delta_d, w_L)) - \lambda\right] dF(\delta_d) = 0 \\
&\int_0^\infty \ell\left(\delta_a\right)\left[v'\left(x_h(\delta_a, w_H)\right) - \lambda\right] dG(\delta_a) = 0 \\
&\int_0^\infty \left(1 - \ell\left(\delta_a\right)\right)\left[v'(x_b(\delta_a, w_H)) - \lambda\right] dG(\delta_a) = 0
\end{aligned}$$

Hence we get the following four conditions, for any pair (δ_d, δ_a):

$$\begin{aligned}
&\ell\left(\delta_d\right)\left[v'(x_\ell(\delta_d, w_L)) - \lambda\right] = 0 \\
&\left(1 - \ell\left(\delta_d\right)\right)\left[v'(x_b(\delta_d, w_L)) - \lambda\right] = 0 \\
&\ell\left(\delta_a\right)\left[v'(x_h(\delta_a, w_H)) - \lambda\right] = 0 \\
&\left(1 - \ell\left(\delta_a\right)\right)\left[v'(x_b(\delta_a, w_H)) - \lambda\right] = 0
\end{aligned}$$

But since $\ell\left(\delta_k\right)$ $(k = d, a)$ are equal to 1 or 0, only two of them matter. For those that matter the corresponding marginal utilities of consumption have to be equal. For the other two, the consumption functions do not matter (as nobody with this value for δ_k is receiving it). Therefore, since λ is a constant, we have that the first-order conditions with respect to consumption reduce to $\forall\left(\delta_d, \delta_a\right)$:

$$\begin{aligned}
&v'(x_l(\delta_d, w_L)) = v'(x_b(\delta_d, w_L)) = v'(x_h(\delta_a, w_H)) = v'(x_b(\delta_a, w_H)) = \lambda \\
&\Longleftrightarrow \overline{x} = x_l(\delta_d, w_L) = x_b(\delta_d, w_L) = x_h(\delta_a, w_H) = x_b(\delta_a, w_H)
\end{aligned} \tag{24}$$

From (24), the tax transfer towards 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

$$\overline{x} = N_d w_L \int_0^\infty \ell(d_\delta)\, dF(d_\delta) + N_a w_H \int_0^\infty \ell(\delta_a)\, dG(\delta_a) + R \tag{25}$$

$\overline{x}$ 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 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

$$v'(\overline{x}) N_d w_L f\left(\widehat{\delta_d}\right) - N_d \widehat{\delta_d} f\left(\widehat{\delta_d}\right) = 0$$
$$\Leftrightarrow \widehat{\delta_d} = v'(\overline{x}) w_L > 0$$

$\widehat{\delta_d}$ is such that the net loss of utility when the marginal disabled individuals are shifted from the disability assistance to the unskilled job is equal to the gain of resources (w_L) valued according to their common marginal utility. 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.

B Proof that $x_h \geq x_l$ under asymmetric information

By contradiction, suppose $x_h < x_l$. All able individuals who work choose to produce w_L units and receive net income x_l. From (1) and (2), nobody get x_h as 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 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 (2), $\widetilde{\delta_d}$ and the number of disabled taking up assistance do not change as well. Yet, all able workers now choose 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: $x_h \geq x_l$.

This implies that only disabled people work in unskilled jobs at the optimum. Therefore they are perfectly tagged as disabled. However being recognized as disabled is not a characteristic that implies stigma, contrarily.

C Economics behind the first-order condition with respect to x_b

A small change $dx_b > 0$ implies mechanical and behavioral effects on government revenue and welfare.

Mechanical effect

There is a mechanical decrease in tax revenue equal to $-\left(\pi_a^{NW} + \pi_d^{NW}\right) dx_b$ because recipients receive extra benefit dx_b. This mechanical decrease in tax revenue, however, is valued $\left(\pi_a^{NW} + \pi_d^{NW}\right) \left(v'(x_b)/\lambda - 1\right) dx_b$ by the government since the consumption gain dx_b is socially valued $v'(x_b)/\lambda$ in terms of public funds.

Behavioral effect

There are two effects on government revenue due to behavioral responses.

(1) The change dx_b induces $\partial\pi_a^W/\partial x_b$ able recipients to leave the labor force. Each able agent leaving the labor force induces a loss in tax revenue of $w_H - x_h + x_b$, i.e. the tax she paid $(w_H - x_h)$ and the benefit that she now receives. There is also a loss in monitoring expenditures $(M(\mu))$ for the additional $\partial\left(N_a G\left(\widetilde{\delta}_a\right)\right)/\partial x_b$ able people who apply for disability benefits. The loss of government expenditures is then $(w_H - x_h + x_b + M(\mu)/\mu)\ \left(\partial\pi_a^W/\partial x_b\right) dx_b$. $dx_b > 0$ also induces a welfare loss due to the reduction of workers $(\partial\pi_a^W/\partial x_b < 0)$ whose disutility $\widetilde{\delta}_a$ was not valued into the non-welfarist criterion. This welfare loss expressed in public funds is $\left(\widetilde{\delta}_a/\lambda\right) \left(\partial\pi_a^W/\partial x_b\right) dx_b$.

(2) The change dx_b induces $\partial\pi_d^W/\partial x_b$ disabled workers to leave the labor force (through direct effect and indirect stigma effect). Each disabled agent leaving the labor force induces a government revenue loss of $w_L - x_l + x_b + M(\mu)$. Hence the loss is $(w_L - x_l + x_b + M(\mu))\ \left(\partial\pi_d^W/\partial x_b\right) dx_b$. The change dx_b also affects welfare through a change in the stigma intensity of the π_d^{NW} disabled recipients. This change in terms of public funds is valued $-\pi_d^{NW} \left(\partial\sigma/\partial x_b/\lambda\right) dx_b$ by the government.

The sum of all these effects equal zero at the optimum. This gives (17), the first-order condition with respect to x_b.

D Simulations

Combining constraints (1), (2), (6) and the non-welfarist criterion, it is convenient to rewrite the problem as:

$$W_1\left(\widetilde{\delta_d},\widetilde{\delta_a},\mu,x_b\right)\equiv N_d\left[\widetilde{\delta_d}F(\widetilde{\delta_d})-\sigma\left(\widetilde{\delta_a},\mu\right)-\int_0^{\widetilde{\delta_d}}\delta_d dF(\delta_d)\right]+$$
$$+\left[N_a\left((1-\mu)+G\left(\widetilde{\delta_a}\right)\right)\right]\widetilde{\delta_a}+v(x_b) \tag{26}$$

with

$$x_b\left(\widetilde{\delta_d},\widetilde{\delta_a},\mu\right)=\frac{\pi_d^W w_L+\pi_a^W w_H-\left(\pi_d^{NW}+\frac{\pi_a^{NW}}{\mu}\right)M(\mu)+R}{\pi_d^W e^{\widetilde{\delta_d}-\sigma\left(\widetilde{\delta_a},\mu\right)}+\left(\pi_d^{NW}+\pi_a^{NW}\right)+\pi_a^W e^{\widetilde{\delta_a}}}$$

where a logarithmic utility function $u(.)\equiv\ln(.)$ and equations (1), (2) have been used. Therefore, the problem becomes a three dimensional problem $\left(\widetilde{\delta_d},\widetilde{\delta_a},\mu\right)$. In the same vein, the constrained maximization of the utilitarian criterion can easily be rewritten as a three dimensional problem.

The subjacent 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 $F(\delta_d)$, $G(\delta_a)$ and monitoring function $M(\mu)$, the objective function (26) is evaluated for a wide range of values of the endogenous variables $\left(\widetilde{\delta_d},\widetilde{\delta_a},\mu\right)$. Through this numerical method, we check whether the solution found is the global optimum.

Calibration

There is no empirical evidence concerning the disutility of work due to disability or aversion to work. Therefore, δ_d and δ_a are distributed according to Gamma distributions since the latter take a very large variety of shapes by perturbing only its r parameter.[20] 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 US report some level of disability (Stoddard *et al.*, 1998). In 2001, almost 15% of the population of working age from EU countries report 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, $N_d=0.15$. Here, with two levels of skills, assumptions about w_H and w_L can hardly be based on actual wage distributions. As a benchmark, the base setting for parameters is

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

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

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

where $\Gamma(r)$ is a Gamma law of parameter and the later 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 $[0,+\infty)$.

A sensitivity analysis on s will be conducted later. We consider R strictly larger than $-[N_d w_H + N_a w_L] = -92.5$ otherwise the budget constraint (6) is violated. The specification of the monitoring function is

$$M(\mu) = m(1/\mu - 1) \quad \text{with } m > 0 \tag{27}$$

The value of m is given by (27) 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 and is about the (average) labor earnings of disabled people w_L (however the variance is large) (Benitez-Silva *et al.*, 2004b). The average cost of running 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 $w_L = 50$, $M = 10.6$. $M \in [7.5; 15]$ is considered to get a range of empirically relevant parameters. Substituting $\mu = 0.2$ and $M \in [7.5; 15]$ into (27) gives a large interval of plausible values for m: $m \in [1.8; 3.8]$. Finally, when m needs to be fixed, $m = 2$ is taken.

When monitoring is suboptimal

Our simulations give the threshold values of m, the parameter of the per capita monitoring cost in (27) beyond which monitoring is suboptimal (i.e. $\mu = 1$) as expected in Section 4. With the non-welfarist criterion, monitoring is suboptimal when $m \geq 73$. With the utilitarian criterion, monitoring is suboptimal when $m \geq 50.3$. Under both criteria, the threshold value beyond which monitoring is suboptimal is large relative to labor earnings in low-productivity jobs ($w_\ell = 50$) or relative to (per capita) governmental exogenous resources ($R = 0$). These thresholds also seem unrealistically high compared to the interval of empirically plausible values, $1.8 \leq m \leq 3.8$.

Another situation where monitoring is suboptimal which cannot be grasped by the first-order conditions analysis, but through simulations is the following. Under the utilitarian criterion, when the exogenous resources R become very high (and larger than m and w_h according to all our simulations), monitoring becomes suboptimal ($\mu = 1$). With our previous calibrations, monitoring becomes suboptimal when $R \geq 130.96$ under the utilitarian criterion, as shown in Figure 1. For $R \geq 130.96$, monitoring stops being used and no more able people with $\delta_a > \widetilde{\delta}_a$ work. The proportion of able workers, π_a^W, then sharply shrinks. 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 then has also a discontinuity at $R = 130.96$ (see Figure 1).

Under the criterion which does not compensate for distaste for work, our simulations do not report a threshold R beyond which monitoring is suboptimal, given the previously chosen parameters. Intuitively, able people who stop working reduce efficiency without improving equity under the non-welfarist criterion. Therefore, under this criterion, the proportion of able people who work, π_a^W, is stable (see Figure 1) with R. Financial incentives and monitoring (hence tagging) both are used to maintained π_a^W high and stable.

Comparison of the optima under the non-welfarist and the utilitarian criteria

The non-welfarist criterion always allows to reach a higher welfare level than the utilitarian criterion and a lower stigma level. According to simulations, any non-welfarist optimum always gives incentives to or enforce more able people to work (the probability of type II errors is lower) than the utilitarian optimum.

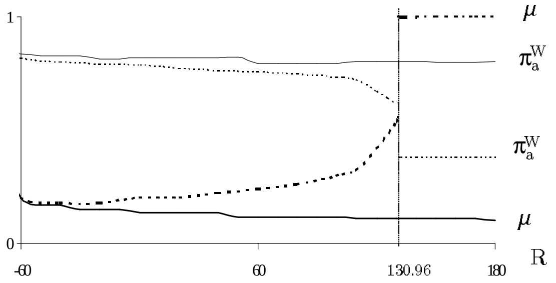
The results of simulations do not allow to give general rankings of the optimal x_j ($j = l, h, b$) under the utilitarian SWF compared to the same consumption bundle under the non-welfarist criterion. For example, in Figure 2, when $m < 37$, the optimal level of x_l under the utilitarian criterion is below the optimal level of x_l under the non-welfarist criterion. When $m \geq 37$, this ranking is reversed.

Sensitivity analysis

The non-welfarist and utilitarian social welfare levels are continuous and decreasing in the parameter of the per capita cost of monitoring (m) and increasing in the exogenous resources (R). Increasing the cost parameter a in the range where monitoring is suboptimal (i.e., $m \geq 50.3$ under the utilitarian criterion and $m \geq 73$ under the non-welfarist criterion) has no more impact on the optimal variables, see Figure 2. Stigma is not monotonous neither with m nor with R. The probability of type II error (μ) continuously increases with the cost parameter m (up to $\mu = 1$). Under the non-welfarist criterion, consumption bundles have discontinuities at $m = 73$, i.e. when monitoring becomes suboptimal (see Figure 2). Under the utilitarian criterion, consumption bundles are continuous with m.

When the exogenous resources increase, we already know that the proportion of able workers never increases. And the proportion of disabled workers, π_d^W, decreases under both criteria. When $R > 120$, π_d^W decreases below 0.001 under both criteria.

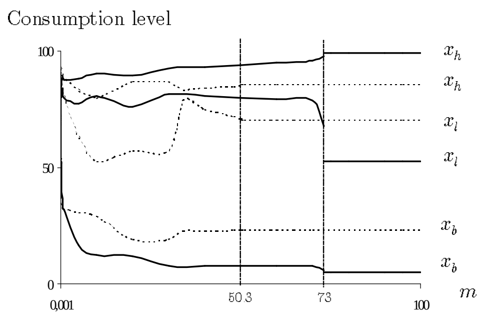
When the marginal disutility of stigma s increases, the welfare levels under both criteria continuously decrease. The effect of s on the optimum stigma level $\sigma(.)$ level is always positive for small s and may become negative for larger values. Monitoring is used more intensively, and therefore type II errors decrease with s. With our calibrations, under the utilitarian criterion, as long as $s < 14.7$, inequality (5) is satisfied hence $\partial\widetilde{\delta}_d/\partial x_b < 0$ is guaranteed. Under the non-welfarist criterion, $s < 15.2$ guarantees $\partial\widetilde{\delta}_d/\partial x_b < 0$.



Under Non-Welfarist SWF

Under Utilitarian SWF

Figure 1: Under the utilitarian SWF, the probability of type II error, μ, increases and the proportion of able workers, π_a^W, decreases, with exogenous resources, R. Under the non-welfarist criterion, μ decreases with R and π_a^W is maintained stable. Under the utilitarian SWF, tagging is suboptimal ($\mu = 1$) when $R \geq 130.96$.



Under Non-Welfarist SWF

Under Utilitarian SWF

Figure 2: Consumption levels under the utilitarian and the non-welfarist criteria as functions of m, the magnitude of the per capita cost of monitoring. Monitoring is suboptimal and consumption bundles constant when $m \geq 73$ under the non-welfarist criterion, and when $m \geq 50.3$ under the utilitarian criterion.

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